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Integrated Approach to Taxation Optimisation in Latvia

Doctoral Thesis for obtaining a doctoral degree
“Doctor of Science (*PhD*)”

Sector – Economics and Business
Sub-Sector – Regional Economics

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Anotācija

Integrēta pieeja nodokļu optimizācijai Latvijā

Nodokļu sistēma ir viens no būtiskākajiem valsts fiskālās sistēmas un nodokļu politikas elementiem; tā ir galvenais valsts dzīvotspējas un ilgtspējīgas attīstības kritērijs. Stabils un efektīvi funkcionējošas fiskālās sistēmas izveide un uzturēšana ilgtermiņā ir jebkuras valsts galvenais mērķis. Doktora disertācijas darba mērķis ir izstrādāt instrumentus Latvijas nodokļu sistēmas pilnveidošanai un noturīguma palielināšanai, ņemot vērā valsts un uzņēmējdarbības atšķirīgās intereses turpmākai kompleksai nodokļu optimizācijai.

Pirmajā nodaļā ir analizēti nodokļu politikas teorijas jautājumi, apkopojot nodokļu attīstības un nodokļu uzlikšanas teorētiskus aspektus un sistematizējot nodokļu politikas kritērijus un veiktos pētījumus, kas saistīti ar piedāvājuma ekonomikas teorijas un A. B. Lafēra līknes kā uz valsti orientētu kritēriju piemērošanu valsts nodokļu politikas optimizācijai. **Otrajā nodaļā** tika veikts pētījums par Eiropas Savienības nodokļu sistēmas prasību, kuras ierobežo uz valsti orientētas nodokļu politikas optimizācijas kritērijus, ietekmi uz nodokļu politikas attīstību Latvijā no 1990. līdz 2021. gadam. Latvijas reģionālais iedalījums tika aplūkots saistībā ar nodokļu sistēmu. **Trešajā nodaļā** analizēts nodokļu optimizācijas process divos aspektos: uz valsti orientētajā un uz uzņēmējdarbību orientētajā aspektā, ieviests nodokļu sistēmas noturīguma jēdziens. Izstrādāta nodokļu prizmas metode un piedāvāta variantu optimizācijas metode, lai atrisinātu racionālas kombinācijas noteikšanas problēmu sistēmā “taisnīgums – efektivitāte”. Nodokļu sistēma ir pārveidota par saliktu sistēmu. **Ceturtajā nodaļā**, izmantojot 3. nodaļā izstrādātos instrumentus, ir sniegti Latvijas nodokļu sistēmas noturīguma pēc 2018. un 2020. gada reformām, izvērtējuma rezultāti un demonstrēts nodokļu prizmu lietojums. Latvijas budžetā ikmēneša nodokļu ieņēmumu laikrindas, sākot ar 2016. gadu, tiek veidotas un analizētas, izmantojot laikrindu modeļus. Variantu optimizācijai tiek veidotas kombinētās diagrammas, sniegti ekspertu aptaujas apstrādes rezultāti. Pamatojoties uz Latvijā spēkā esošā transportlīdzekļu ekspluatācijas nodokļa (tostarp citu nodokļu faktoru, kas ietekmē transportlīdzekļu lietošanas izmaksas) analīzi, tiek veikta scenāriju analīze. Pamatojoties uz veikto pētījumu, ir izdarīti **secinājumi un ieteikumi**.

Darba saturs (ievads, četras nodaļas, secinājumi un ieteikumi) ir izklāstīts 185 lappusēs (neskaitot bibliogrāfiju, informāciju par autora publikācijām un konferencēm un pielikumiem), ilustrēts ar 44 attēliem un 9 tabulām, un tajā ir 26 formulas. Literatūras sarakstā iekļautas 294 atsauces. Darbam pievienoti 11 pielikumi.

Atslēgvārdi: Latvijas nodokļu sistēma, taisnīgums, efektivitāte, noturīgums, nodokļu prizmas metode, relatīvo vienoto rādītāju metode, saliktā sistēma, Latvijas reģioni.

Abstract

The tax system is one of the crucial elements of a state's fiscal system, and the tax policy; is the main criterion of a state's viability and sustainable development. Creating and maintaining a stable and effectively operating fiscal system in the long term is a major goal of any state. The aim of the Doctoral Thesis is to develop tools for improving the tax system in Latvia and increasing its reliability, considering the multidirectional interests of the state and business, for the following integrated optimisation.

In the first chapter, the issues of tax policy theory, summarising the theoretical aspects of tax evolution and tax application, systematising tax policy criteria and conducted research related to the application of the supply economics theory and the A. B. Laffer curve as state-oriented criteria for the optimisation of national tax policy are investigated. **In the second chapter** a study was conducted on the impact of the European Union's taxation requirements, which are limiting the optimisation criteria of state-oriented tax policy, on the tax policy development in Latvia from 1990 to 2021. The regional division of Latvia was considered in the relation to the tax system. **In the third chapter**, the process of optimisation of taxation is analysed in two aspects: state-oriented and business-oriented, the concept of reliability of the tax system is introduced. A tax prism method is developed, and a variant optimisation method is proposed to solve the problem of determining a rational combination in the "equity – efficiency" system. The tax system is transformed into a composite system. **In the fourth chapter**, using the tools developed in Chapter 3, the results of assessing the reliability of the Latvian tax system after the reforms of 2018 and 2020 are presented. The application of the tax prisms is demonstrated. Time series of monthly tax revenues to the Latvian budget, starting from 2016, are constructed and analysed using time series models. For the implementation of variant optimisation, combined diagrams are built, the results of processing a survey of experts are given. Based on the analysis of the Vehicle Operation Tax in force (including other tax factors, impacting the cost of vehicle usage) in Latvia, scenario analysis is carried out. Based on the conducted research, the **conclusions and recommendations** are made.

The content of the work (introduction, four chapters, conclusions and recommendations) is presented on 185 pages (excluding bibliography, information about author's publications and conferences and annexes), illustrated with 44 figures and 9 tables, and has 26 formulas. The bibliography includes 294 references. 11 annexes are attached to the Thesis.

Keywords: tax system of Latvia, equity, efficiency, reliability, tax prism method, relative single indexes, composite system, regions of Latvia.

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List of Abbreviations

ADF	Augmented Dickey–Fuller test
AIC	Akaike Information Criterion
AIN	Lottery and Gambling Tax (Latvian: <i>Azartspēļu un izložu nodoklis (AIN)</i>)
AN	Excise Duties (Latvian: <i>Akcīzes nodoklis (AN)</i>)
AR	Autoregressive
ARIMA	Autoregressive integrated moving average
ARIMAX	Autoregressive integrated moving average extended
ATR	Administrative-territorial reform
CBAM	Carbon Border Adjustment Mechanism
CJSC	Closed joint stock company
CSDD	Road Traffic Safety Directorate (Latvian: <i>Ceļu Satiksmes Drošības Direkcija (CSDD)</i>)
DRN	Natural Resources Tax (Latvian: <i>Dabas resursu nodoklis (DRN)</i>)
EC	European Commission
EDS	Electronic declaration system
EEC	Equity – Efficiency combination
EN	Electricity Tax (Latvian: <i>Elektroenerģijas nodoklis (EN)</i>)
EU	European Union
EU-27	European Union 27 member states
EUR	Euro – the currency in Latvia and in the Eurozone of the European Union
FDP	Fiscal Discipline Council (Latvian: <i>Fiskālās disciplīnas padome (FDP)</i>)
GDP	Gross Domestic Product
GPS	Global Positioning System
I	Integrated
IBFD	International Bureau of Fiscal Documentation
IIN	Personal Income Tax (Latvian: <i>Iedzīvotāju ienākuma nodoklis (IIN)</i>)
IMF	International Monetary Fund
ITCI	International Tax Competitiveness Index
KPSS	Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test
LDTA	Latvian Fuel Traders Association (Latvian: <i>Latvijas Degvielas tirgotāju asociācija (LDTA)</i>)
LLPA	Big cities association of Latvia (Latvian: <i>Latvijas Lielo pilsētu asociācija (LLPA)</i>)
LLU	Latvia University of Life Sciences and Technologies (Latvian: <i>Latvijas Lauksaimniecības universitāte (LLU)</i>)
LPS	Latvian Association of Local Governments (Latvian: <i>Latvijas Pašvaldību savienība (LPS)</i>)

LU BVEF	University of Latvia, Faculty of Business, Management and Economics (Latvian: <i>Latvijas Universitātes Biznesa, vadības un ekonomikas fakultāte (LU BVEF)</i>)
LU ĢZZF	University of Latvia, Faculty of Geography and Earth Sciences (Latvian: <i>Latvijas Universitātes Ģeogrāfijas un Zemes zinātņu fakultāte (LU ĢZZF)</i>)
LV	Latvia, Republic of Latvia
LZA	Latvian Academy of Sciences (Latvian: <i>Latvijas Zinātņu akadēmija (LZA)</i>)
MA	Moving average
MAPE	Mean absolute percentage error
MN	Customs Duty (Latvian: <i>Muitas nodoklis (MN)</i>)
MUN	Micro-enterprise Tax (Latvian: <i>Mikrouzņēmumu nodoklis (MUN)</i>)
NUTS	Nomenclature of territorial units for statistics
OECD	Organisation for Economic Co-operation and Development
PWC	PricewaterhouseCoopers
SARIMA	Seasonal autoregressive integrated moving average
SARIMAX	Seasonal autoregressive integrated moving average extended
SIA	Limited liability company (Latvian: <i>Sabiedrība ar ierobežotu atbildību (SIA)</i>)
SRS	State Revenue Service (Latvian: <i>Valsts ieņēmumu dienests (VID)</i>)
SSIA	State Social Insurance Agency (Latvian: <i>Valsts sociālās apdrošināšanas aģentūra (VSAA)</i>)
TEN	Vehicle Operation Tax (Latvian: <i>Transportlīdzekļa ekspluatācijas nodoklis (TEN)</i>)
UIN	Corporate Income Tax (Latvian: <i>Uzņēmumu ienākuma nodoklis (UIN)</i>)
UK	The United Kingdom of Great Britain and Northern Ireland
US	The United States of America
UVTN	Company Car Tax (Latvian: <i>Uzņēmumu vieglo transportlīdzekļu nodoklis (UVTN)</i>)
VARAM	Ministry of Environmental Protection and Regional Development (Latvian: <i>Vides aizsardzības un reģionālās attīstības ministrija (VARAM)</i>)
VAT	Value added tax
VSAOI	Mandatory State Social Insurance Contributions (Latvian: <i>Valsts sociālās apdrošināšanas obligātās iemaksas (VSAOI)</i>)
ZZS	Union of Greens and Farmers (Latvian: <i>Zaļo un Zemnieku savienība (ZZS)</i>)

Introduction

Relevance of the research topic

The process of collecting taxes from the moment of its initial inception to the present day is constantly at the forefront of the contradictions between public and private interests.

The economic development of the state is directly related to tax revenues to the budget and, accordingly, to the optimal structure of the tax system. Moreover, these issues became relevant simultaneously with the emergence of the state and much earlier than the emergence of economic science in the modern sense of this definition.

The fourth decade has begun since the restoration of independence of the Republic of Latvia, and all this time its tax policy has been developing and improving, being one of the main prerogatives that determine the country's economic development.

A new round of increased attention to the problems of taxation (to the tax system) took place at the beginning of 2018, when a tax reform was introduced, prepared by the Ministry of Finance, at that time headed by Dana Reizniece-Ozola.

The development of the national economy of independent Latvia is influenced by both the constantly changing world economic situation and the economic situation within the country. The financial system and economy of Latvia to a certain extent depend on global processes.

The main challenge for the tax system is the need to be consistent with these processes. At the same time, its efficiency and fairness must be preserved and maintained at the required level. Traditionally, the state is interested in increasing the revenue part of the budget formed from taxes (hereinafter referred to as the tax part of the budget) and is forced to seek additional reserves if tax collections are not received in full. In the latter case, it is difficult for the state to fulfil the functions assigned to it. Individuals and legal entities, on the other hand, often criticise tax policy, pointing out an excessive and sometimes unbearable tax burden.

Meanwhile, any form of tax harmonisation can reduce a firm's compliance costs and help raise government revenues.¹

In 2019, Prime Minister Krišjānis Kariņš called on Latvians to be more conscientious about paying taxes, stressing that he would like to reduce tax rates, but this requires more people to fulfil their obligations to the state.²

¹ Thomsen, M. and Watrin, C. 2018. Tax avoidance over time: A comparison of European and U.S. firms. *Journal of International Accounting, Auditing and Taxation*. 33, 40–63.

² Kupčs, E. un Zvirbulis, Ģ. 2019. Kariņš gribētu mazināt nodokļus, ja vairums sabiedrības tos godprātīgi maksātu. *LSM.lv, Latvijas Sabiedriskie Mediji*. <https://www.lsm.lv/raksts/zinas/ekonomika/karins-gribetu-mazinat-nodoklus-ja-vairums-sabiedribas-tos-godpratigi-maksatu.a323676/>.

The close attention that Latvian society pays to the tax system of its country is due to the tax reform that began in 2018, which arose in connection with its introduction of criticism, and subsequent statements by the country's leadership about the need for a new reform already at a time when all points of the plan, provided for by this reform have not yet been fully implemented.

Experts in taxation policy in Latvia and the European Commission (EC), as well as researchers in this field, took part in the discussions on the effectiveness of the tax reform in 2018, which underlines the absolute importance of this problem specifically for Latvia as a separate country and for Latvia as a member state of the European Union (EU).

In the period from 1990 to the moment of Latvia's accession to the EU (since 2004), the tax system was built with a focus on economic activity, mainly taking place within the country.

After Latvia's accession to the EU and the Eurozone, the country's tax system moved away from the position when the national economy was a relatively self-sufficient entity, isolated by barriers preventing the free movement of goods, persons, services and capital.

Moreover, every year, national economies are increasingly merging into an interconnected, integrated global economic system. For business, the ongoing process of globalisation creates many opportunities for choosing countries with different tax systems. In this sense, the Latvian tax system has to meet the competitive requirements of modern economic trends. Low tax and excise rates in other countries create a dangerous spillover tendency for taxpayers. According to the Latvian Fuel Traders Association (LDTA),³ the excise tax policy on petroleum products has an extremely negative effect on the volume of fuel sales, as competitiveness with Estonia and especially with Lithuania decreases.

From 1990 to the present, Latvia's tax policy has been continuously transforming. This is reflected in the correction of tax rates, changes in the tax base, the conditions for collecting taxes, the system of benefits, etc. Moreover, the modernisation of the tax system is carried out both selectively and globally (for example, during the transition to a progressive taxation scale in 2018). It should be noted that, at the same time, these changes do not always achieve the set goals, and in some cases their consequences turn out to be negative, which has an adverse effect on taxpayers, reducing their income and ability to pay, as well as increasing the gap between segments of the population. This was pointed out in 2019 by the EC in its recommendations for Latvia.

³ Latvijas Degvielas tirgotāju asociācija. 2019. Nodokļu slogs benzīnam un dīzeļdegvielai no 2020. gada 1. janvāra būs līdz 10 centiem litrā lielāks nekā Lietuvā. <https://ldta.lv/news/nodoklu-slogs-benzinam-un-dizeldegvielai-no-2020-gada-1-janvara-bus-lidz-10-centiem-litra-lielaks-neka-lietuva/>.

Similar results were obtained by the author, who has conducted a survey with the assistance of specialists from the University of Latvia. The analysis of the survey results showed that the majority of respondents believe that the 2018 tax reform did not achieve its goals (Annex 9).

Also, the EC⁴ noted high income inequality in Latvia, as well as low redistribution through the tax-benefit system. In addition, Latvia was encouraged to ensure effective supervision and compliance with the anti-money laundering system.

In the report *The Sustainable Development Goals Report 2021*, as well as in the report *Progress towards the Sustainable Development Goals (Advance unedited version, 2022)*⁵ it was stated that before the COVID-19 pandemic, there was achieved certain progress in fighting against the inequality due to the various measures. As a result, in some countries, income inequality had fallen down.

Nevertheless, inequality is still there: in income, wealth, opportunities and other aspects. Those, who are among the vulnerable groups are facing various forms of discrimination. The ongoing pandemic is making the situation worse by amplifying existing inequalities within countries – it is hitting the most vulnerable group of people and the poorest countries. Handling inequality is one of the most crucial aspects of Sustainable Development Goals and can be considered as one of the major policy directions for 2030, aiming at the support of the world's most vulnerable.

The global COVID-19 pandemic, which began in December 2019 in China and by March 2020, also affecting all EU countries, including Latvia, immediately influenced the economy, and through it, the tax system and budget. From March 12, 2020, an emergency situation was declared in Latvia, initially until April 14, 2020. Later it was extended, and then, due to a sharp deterioration in the epidemiological situation, it was reintroduced in October – November 2021.

As a result of the forced downtime, enterprises stopped receiving the planned income, some of them were forced to close, and people began to lose their jobs. As a matter of urgency, Cabinet of Ministers Regulations No. 179 on benefits for self-employed persons affected by the pandemic⁶ were adopted. In accordance with them, the necessary funds were allocated from the budget.

⁴ European Commission, Secretariat-General. 2019. Recommendation for a COUNCIL RECOMMENDATION on the 2019 National Reform Programme of Latvia and delivering a Council opinion on the 2019 Stability Programme of Latvia. COM (2019) 514 final. 05.06.2019. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52019DC0514>.

⁵ Sustainable Development. United Nations. <https://sdgs.un.org/goals>.

⁶ Ministru kabineta 31.03.2020 noteikumi Nr. 179 "Noteikumi par dīkstāves pabalstu pašnodarbinātām personām, kuras skārusi Covid-19 izplatība". *Latvijas Vēstnesis*, 66B, 02.04.2020. Pieņemts: 31.03.2020.

Already by the beginning of April 2020, a grace period was granted to 949 companies with forced downtime in the total amount of 14 336 650 euros. These support measures were provided to taxpayers who previously fulfilled their obligations to the state in a diligent and conscientious manner, as well as in accordance with the criteria established for the SRS by Cabinet of Ministers Regulations No. 165,⁷ which regulate cases when the SRS is not entitled to provide these benefits.

At the same time, the Prime Minister of Latvia Krišjānis Kariņš announced that plans to improve the tax system would not be suspended due to the COVID-19 epidemic, but on the contrary would be implemented much more aggressively. The opposite point of view was held by the Fiscal Discipline Council (FDP), headed by Inna Šteinbuka, which called for postponing tax reform and other fiscal-sensitive measures until the situation normalises. The Council pointed out that in the extreme conditions caused by the pandemic, the economic situation was highly volatile and unpredictable. The Council made a forecast⁸ that in the coming months it would be especially problematic to achieve the growth indicators expected by the Ministry of Finance, budget revenues would be less than planned, and the budget deficit would increase.

All this suggests that the tax policy of the state at any time is the main criterion for its viability and makes the study of issues and problems of tax policy extremely **relevant**.

The level of scientific development of the problem

The evolution of taxation is closely related to the social and economic development of society and the state. The history of the development and improvement of tax systems from ancient times to the present is well-studied.

The research of J. Mirrlees⁹ published 1971 can be considered as the beginning of the modern theory of optimal taxation. However, a number of aspects of optimal taxation were studied earlier by other authors, for example, by F. Ramsey.¹⁰

The scientists saw the task of optimal taxation in the search for a tax system that maximises social welfare under any restrictions. However, they did not use an integrated approach to solve the problem. Yet, decisions to improve the tax system, including by correcting its fiscal function, which are taken on the basis of the analysis and change of any

⁷ Latvijas Republikas Finanšu ministrija. 2020. VID izmaksājis dīkstāves pabalstus 5516 darbiniekiem; nodokļu samaksas termiņa pagarinājumu saņēmuši 949 uzņēmumi. *Aktualitātes*. <https://www.fm.gov.lv/lv/aktualitates/jaunumi/62071-vid-izmaksajis-dikstaves-pabalstus-5516-darbiniekiem-nodoklu-samaksas-termina-pagarinajumu-sanemusi-949-uznemumi>.

⁸ Telegraf.lv. 2020. Premijer: ChS ne ostanovit nalogovuju reform, naoborot ona stanet agressivnee. *Telegraf.bb.lv, Society*. <https://telegraf.bb.lv/vse-novosti/item/9170934-premer-chs-ne-ostanovit-nalogovuyu-reformu-naoborot-ona-stanet-agressivnee>.

⁹ Mirrlees, J. 1971. An Exploration in the Theory of Optimum Income Taxation. *The Review of Economic Studies*. 38(2), 175–208.

¹⁰ Ramsey F. 1927. Contribution to the Theory of Taxation. *Economic Journal*. 145(37), 47–61.

discrete parameter (a group of parameters of the same type) that do not involve the use of an integrated approach, often do not give the desired result.

The necessity of application of the integrated approach was mentioned by Ē. Žubule, I. Sproģe and others in the doctoral theses related to the tax system of Latvia.^{11, 12} However, these researchers are only limited to corresponding recommendations. One of the major reasons for the necessity of the integrated approach for improving and enhancing the tax system is its objective process of constant adaptation to the ever-changing internal and external environments in which the tax system functions.

The stimulus for the integrated approach is the growing uncertainty, in which professionals involved in the development of reforms or corrective measures have to make decisions. The higher the level of uncertainty is, the more factors must be taken into account simultaneously.

At the same time, an analysis of both Latvian and foreign works and methods shows that so far the researchers have demonstrated a rather narrow approach, and only recommended replacing it with an integrated one. In the studied doctoral theses, researchers usually confine themselves to small, narrow questions, in some cases only indicating that the result can be achieved by applying an integrated approach.

Based on the aforementioned, it was decided to use an integrated approach, which implies that decisions on assessing the current tax system and recommendations for changing (modernising) it are made based not on the analysis of any one indicator or criterion, but on the basis of a number of conditions (criteria).

To select the most appropriate solution, it is proposed to use the optimisation process, which herein refers to the application of scientific methods, united under the name “operations research”, i.e., application of mathematical, quantitative methods to justify and develop decisions related to changes in the tax system.

As an optimal solution will be considered a solution, not being absolutely the best in the literal sense of the Latin term “optimum” (from Latin – the best), yet being for one reason or another, is more preferable in relation to others. In the case of the absence of suitable solutions, (that is, relatively speaking, in the presence of only “bad” solutions), the approach proposed by operations research allows choosing the most preferable of them.

The important role in the problem of tax system optimisation using an integrated approach is related to the dependence of tax revenues on tax rate described by the Laffer curve.

¹¹ Žubule, E. 2012. *Valsts budžeta procesa analīze un pilnveidošana: promocijas darbs: specialitāte – ekonomika*. Rīga: Latvijas Universitāte, 219.

¹² Sproģe, I. 2010. *Nodokļu politika ekonomikas attīstības mainīgajos apstākļos: promocijas darbs: specialitāte – ekonomika*. Rīga: Latvijas Universitāte, 213.

The Laffer curve has been thoroughly studied by various researchers, it has been severely criticised from a practical point of view, and there have been made numerous attempts to improve it. However, the analysis of studies has shown that modernisation attempts did not allow to create a universal tool for tax system analysis and the results are operating either on a theoretical dimension, or a very narrow practical one, not providing sufficient results.

The integrated approach to the tax optimisation is also very important factor of a regional development, as the tax system operates on a specific territory, establishing corresponding tax regime, that directly affects the wellbeing and standards of living of the population. Inter-country regional division and its specificities could be used as a one of the criteria for tax system optimisation using the integrated approach.

Among the experts who have researched the tax system and its impact on the economy, the following ones should be noted: Pigou A., Musgrave R., Musgrave P., Keynes J., Stiglitz J., Mirrlees J., Diamond P., Banks J., Krugman P., Laffer A., Wanniski J., Mankiw G., Romer C., Romer D., Gardner M., Gahvari F., Dalamagas B., Papava V., Henderson D., etc.

Among the works of related to the problems of taxation, carried out in Latvia, the following researches and doctoral dissertations can be noted: Brēķis E., Brūna I., Būmane I., Eglīte S., Fainglozs L., Jonina V., Joppe A., Jurušs M., Kavale L., Kaže V., Ketners K., Kodoliņa-Miglāne I., Kokins G., Kovaļa L., Medne A., Pluta A., Prohorovs A., Pūle B., Rupeika-Apoga R., Saksonova S., Seļivanova-Fjodorova N., Sloka B., Sprōģe I., Strateičuks A., Zasova A., Zelgalvis E., Zvejnieks A., Žubule E., etc.

Moreover, thematic scientific articles and publications related to the improvement of tax systems placed on the Tax Research Platform were analysed, as well as in the journals *IBFD World Tax Journal*; *International Tax Studies*; *Bulletin for International Taxation*; *National Tax Journal*; *Journal of International Accounting, Auditing and Taxation*; *International Journal of Economics and Financial Issues*; *Notes du conseil d'analyse économique*; *EC Tax Review*; *ASEAN Economic Bulletin*; *Journal of International Taxation*; *Journal of Economics, Finance and Administrative Science*; *Journal of International Economic Law*; *Journal of International Development*; *Journal of Tax Administration* and others.

Hypothesis

The use of the integrated approach for substantiation of tax policy measures permits rational decision making.

Aim of the Doctoral Thesis

The aim of the doctoral research is to develop tools for improving the tax system of Latvia and increasing its reliability, taking into account the multidirectional interests of the state and business.

Tasks of the Doctoral Thesis

To achieve the aim, the following tasks were formulated:

1. To analyse the evolution of approaches to taxes and taxation and definitions, as well as the criteria for tax systems and the stages of implementing tax reforms.
2. To study specific aspects of the tax policy of the EU, and the EU requirements for taxation, changes in the tax system to reduce social stratification.
3. To analyse the evolution of Latvian tax policy within the framework of the tax system.
4. To develop a set of tools that will allow a comprehensive assessment of the tax situation in Latvia, regarding the interests of the state and business.
5. To develop proposals for the modernisation of the Latvian tax system in order to build a more reliable and optimal tax system.
6. To assess the impact of the proposed changes on the tax system of Latvia on the example of Vehicle Operation Tax (including other tax factors, affecting the cost of vehicle usage), by applying the integrated approach instruments.

Object of the Doctoral Thesis

The object of the research is the process of reform and improvement of the tax system.

Subject of the Doctoral Thesis

The subject of the research is the tax system of Latvia.

Theses for the defence

1. The tax system of Latvia after the reforms introduced since January 1, 2018 does not fully meet the criteria of equity and efficiency and is not reliable.
2. Assessment of the reliability of tax reforms at the stage of their development contributes to the creation of a tax system that meets all the necessary criteria to the maximum extent.
3. One of the most important criteria of the tax system are the principles of efficiency and equity. The joint use of state-oriented and business-oriented aspects in the

analysis, construction and change (reform) of the tax system allows to take into account these criteria of taxation for tax system improvement.

4. Tax policy instruments can give the maximum effect if the principle of an integrated approach is applied when all types of activities are mutually coordinated and subordinated to the implementation of national development priorities.
5. The application of the tax prism method, relative single indexes, reliability assessment, statistical analysis, as well as analysis of the composite system is defining possibilities to have of comprehensive assessment of the tax system for its rational reform.

Research methods, data collection tools and techniques

In the Doctoral Thesis, the following research methods are used: analysis of primary and secondary data; method of graphical differentiation and integration; time series analysis methods (ARIMA, SARIMA); method of expert assessments; method for analysing the consistency of opinions in subgroups of experts using the Kendall's coefficient of concordance; method of mathematical modelling; methods of geometric similarity, mathematical analysis (including functional analysis); scenario analysis method; deterministic, probabilistic and quantum modelling of composite systems; variational calculus method; methods of determining reliability and methods of operations research (including decision theory).

Calculations were carried out using software (SPSS Statistics, Gretl, Python programming language).

The theoretical and methodological basis of the study is the achievements of Latvian and foreign scientists studying the issues of improving the mechanisms of tax regulation, determining the optimality of specific taxes, the main provisions of the theory of taxation and the concept of regional development, as well as mathematical methods of economic and statistical analysis, and determining the reliability of systems.

Research limitations

Within the framework of the study, the economy and tax system of Latvia, including in particular as a member state of the European Union, was considered. In addition, six main regions of Latvia were studied, and the country's administrative-territorial division was taken into account, which was in effect until July 1, 2021, as well as after that date.

To study the tax system, the period was chosen from the beginning of 1991 (when, in accordance with the decision of the Supreme Council of the Republic of Latvia, it was established that a new tax system came into force in Latvia, and the legislation on taxes and

duties of the USSR was no longer applied) and until the beginning of 2022. The specified research period was divided into several time segments. The benchmarks were: 2004, when Latvia joined the European Union, and its tax system came to be regarded as the tax system of the European Union region, complying with the norms of its tax law; the crisis years (2008 – 2010, then Latvia's GDP fell by 17.8 %, which was a world anti-record), when the largest tax changes took place in Latvia, and in 2011, a number of taxes were significantly changed with the aim of budgetary consolidation. The greatest attention was paid to the period that began on January 1, 2018, when the tax reform came into effect in Latvia, which had been prepared over the past several years and was constantly continued (corrected, changed) over the next years until the end of the study period. It should be noted that a large number of changes since 2019 are associated not only with the need to eliminate shortcomings of the 2018 reform, but also with the next global economic crisis, aggravated by the coronavirus pandemic, which began at the end of 2019 and has not stopped until now.

For the analysis of time series according to the available statistics of the State Revenue Service of Latvia was determined and studied the frame from 2016 to 2020 inclusive, when major tax changes were entered into force, and the COVID-19 pandemic started to affect taxation.

Scientific novelty

1. The systematisation of approaches to the analysis of the Laffer curve and preparation of grounding for creating a new tool that would allow to describe the relationship between the parameters proposed by Laffer more effectively and clearly, as well as additionally qualitatively and quantitatively consider their relationship with the tax base.
2. The analysis of the changes in the definition of "tax" in the legislation of Latvia, from 1995 to the present.
3. Newly introduced advanced definitions:
 - state-oriented aspect of tax optimisation (approach to taxation);
 - business-oriented aspect of tax optimisation (approach to taxation).
4. The concept of reliability of the tax system has been introduced and the reliability criterion has been developed for assessing the tax reforms and the tax system as a whole.
5. For economic interpretation of the formation of the tax (revenue) part of the budget, for its assessment and research, the concept of a tax prism has been introduced.

6. The concept of static and dynamic tax prism has been introduced and a methodology for their calculation has been developed, allowing to consider the decrease in the volume of collected taxes due to the use of legal tax optimisation schemes by taxpayers.
7. Relative single indexes are formed to determine the rational combination in the system “equity – efficiency”. Possible equity – efficiency combination (EEC) scenarios are identified and their interpretation is described. For cases of fatal incompatibility of requirements, it is proposed to use the method of successive concessions (with the use of expert judgment).
8. The tax system modelling in form of a composite system, where each of the taxes represents its element, is proposed to assess the specified criteria in the “equity – efficiency” system and the relationship between taxes.

Practical significance

The implementation of the author’s proposals and recommendations will improve the reliability of the tax reforms under development and other adjustments made to the tax system of the state. This will increase the efficiency of the functioning of the tax system and its balance, and at the same time will allow taking into account the interests of the state and the taxpayer in conditions of economic instability and the ongoing pandemic.

The implementation of the proposed measures will ensure activation of business and the stable development of the country by reducing and subsequently eliminating the budget deficit and will make it possible to create a more stable tax system that meets all the requirements (criteria) imposed on it and fully implement the recommendations of the European Commission, developed by it as a result of the tax reform 2018 and subsequent adjustments.

The results obtained can be used by state and regional (municipal) authorities to develop concepts, strategies and programs for sustainable development of regions by improving the tax system in Latvia as part of the implementation of the recommendations of the European Commission.

The results of the conducted economic analysis to assess the impact of external socio-economic indicators on total tax collections (including social payments) have practical importance.

The main provisions of the Doctoral Thesis expand and supplement the existing research on theoretical and practical problems of improving the tax system, assessing its reliability, and also contain a new approach to the relationship between the volume of tax revenues and tax rates (the author’s method of tax prism). The tools proposed by the author can also be used in

the field of higher and specialised professional education, in particular, in the process of teaching the disciplines “Macroeconomics”, “Regional Economics”, “Regional Finance”, “Taxes and Taxation” and a number of other specialised disciplines.

Practical approbation of developed tools is done on various fields of economy and economic activity in Latvia, including variant optimisation of Vehicle Operation Tax and tax costs related to the vehicle operation, as well as their scenario analysis.

Evaluation of the research results

The main provisions of the study were presented by the author to a wide range of interested parties and set out:

- in 22 scientific articles published in Latvian and foreign scientific journals and collections, including 5 publications indexed in databases (4 publications indexed in SCOPUS, 2 publications indexed in Web of Science; see the Section *Information about publications and conferences*);
- in presentations and reports at 15 international scientific and research-to-practice conferences and forums (in the Section *Information about publications and conferences*);
- in the educational process when giving lectures and conducting seminars for master’s degree students of economic specialties.

The research within the framework of this Doctoral Thesis was carried out:

- during development of computer programs for the improvement and business-oriented tax optimisation and analysis of financial activities of the annual International Congress “Person and Medicine” in which takes part leading pharmaceutical companies “AstraZeneca plc”, “Pfizer Inc”, “Krka, d. d.”, “Boehringer Ingelheim”, “Veropharm”, “Novartis International AG”, “Les Laboratoires Servier”, etc.;
- during development of computer programs for the improvement and business-oriented tax optimisation and analysis of financial activities of the company “Leon News Agency spol. s.r.o.” (the review is attached);
- during development of computer programs for the improvement and business-oriented optimisation of the financial activities of the company “Magistral”;
- during creation of a strategy for improving the financial performance of the SIA “Trade Hub Productions” company (the review is attached).

The structure of the Doctoral Thesis

The Doctoral Thesis consists of an introduction, 4 chapters, conclusions and recommendations, a bibliography, a list of abbreviations, and 11 annexes. The volume and structure of the Doctoral Thesis are determined by the aim, tasks and logic of the research.

In the introduction, the relevance of the topic of the Doctoral Thesis is substantiated, hypothesis is formulated, the aim of the Thesis and objectives are formulated, the subject and object of research are determined, the novelty and practical significance of the research are defined and illustrated. A literature review is given, demonstrating the level of scientific development of the problem, the sources under study and the research methods used.

In the first chapter the issues of tax policy theory, summarising the theoretical aspects of tax evolution and tax application, systematising tax policy criteria and conducted research related to the application of the supply economics theory and the Laffer curve as state-oriented criteria for the optimisation of national tax policy are investigated.

In the second chapter a study was conducted on the impact of the European Union's taxation requirements, which are limiting the optimisation criteria of state-oriented tax policy, on the tax policy development in Latvia from 1990 to 2021. The regional division of Latvia was considered in the relation to the tax system.

In the third chapter the author, based on the systematisation of scientific theories and concepts of the categorical apparatus that make up the subject area of budgetary and tax policy, proposes to consider the process of tax optimisation in two aspects: from the position of state bodies (state-oriented aspect), and from the position of a taxpayer (legal or individual – business-oriented aspect).

The concept of reliability of the tax system is introduced, and a theory for assessing the reliability of tax reforms and the tax system as a whole is developed by the author.

For economic interpretation of the formation of the tax (revenue) part of the budget, for its assessment and research, the concept of “tax prism” is introduced, and its definition is given. The tax prism, in contrast to the Laffer curve linking two parameters, allows three parameters to be taken into account simultaneously in an explicit form: the volume of taxes in the study period, the amount of taxes (tax rate) and the tax base. It is shown that the tax prism can be used both in the state-oriented and business-oriented aspects and introduces the concepts of static and dynamic tax prism.

To solve the problem of determining a rational combination in the “equity – efficiency” system, it is proposed to use the method of variant optimisation.

To assess the given EEC criteria, the author transformed the tax system into a composite system, where each of the taxes represents its element. The classical and quantum approaches are considered separately.

In the fourth chapter the author analysed the reliability of the tax reform in Latvia, introduced on January 1, 2018, and its results, which reflect the efficiency of the tax system by the beginning of 2019 and beyond; analysed actions to minimise failures and increase the life cycle of the stable operation of the tax system; possible options for making a decision are considered in the case when the tax system ceases to correspond to the current situation; using the Weibull curve, an empirical analysis is carried out and the reliability of the Latvian tax system after the reforms of 2018 and 2020 is assessed.

Using econometric methods and computer data processing (including the usage of the Python programming language), time series of monthly tax revenues to the Latvian budget, starting from 2016, were constructed and analysed using the ARIMA and SARIMA models.

To implement the variant optimisation method proposed by the author in Chapter 3, a system of relative single indexes for constructing a combined diagram has been developed. Using the developed methodology, an analysis of the Vehicle Operation Tax and tax costs related to the vehicle operation in force in Latvia was carried out and a scenario analysis was conducted.

The cases of incompatibility in case of the incomparability of requirements in the system “equity – efficiency” have been studied. The use of the method of successive concessions in identifying significant incompatibility of the requirements of the EEC has been demonstrated. For this, the ranking of taxes and tax criteria was carried out by means of an expert survey, which made it possible to determine the criteria by which more significant concessions are possible.

In the final part of the Thesis, conclusions and recommendations are formulated based on the results of the study.

1 Theoretical aspects of tax policy

1.1 Evolution of tax concepts

The viability of every state is ensured by the necessary amount of financial resources, most of which are formed by its tax system.

Tax issues affect all members of modern society. The economic content of taxes is expressed by the relationship between the state and economic entities (legal entities) and individuals, as a result of which public finances are formed (tax part of the budget or budget revenues).

Taxes, being the main tool for mobilising state budget revenues, simultaneously play the role of a regulator of economic activity and the activities of tax subjects.

Exactly taxes make a significant contribution to the structure of the consolidated budget revenues of most states, and also participate in the redistribution of gross domestic product and national income, being part of social reproduction and a specific form of production relations.

Taxes, becoming the property of the state, are used by it to fulfil its functions, providing for the needs of social development.

According to the estimation of the International Centre for Taxation and Development,¹³ total tax revenues account for more than 80 % of total government revenues in about half of the countries in the world, and more than 50 % in almost every country.

The main purpose of taxation is to finance government spending by transferring funds from taxpayers (individuals or legal entities) in favour of the state. The overall goal of collecting and spending government revenues should be maximising social welfare. This includes securing funding to improve the welfare of public goods, particularly in the areas where severe market failures are usually observed (e.g., education, health, social protection, infrastructure, pollution and climate change).

However, since taxation itself is expensive and in most cases influences people's decision-making,¹⁴ it is necessary to solve the problem of obtaining a certain level of tax revenue while ensuring maximum social welfare.

As shown by studies of the genesis of taxation – the oldest institution that has been accompanying the development of human society from the moment taxes appeared to the present time – the antagonistic opposite, known as tax evasion, arose and developed

¹³ Ortiz-Ospina, E. and Roser, M. 2016. Taxation. *Published online at OurWorldInData.org.* <https://ourworldindata.org/taxation>.

¹⁴ European Commission, Secretariat-General. 2020. Tax policies in the European Union. 2020 survey. SWD (2020) 14 final. 30.01.2020. <https://data.consilium.europa.eu/doc/document/ST-5695-2020-INIT/en/>.

simultaneously with it. Many taxpayers for various reasons negatively perceive the need for tax confiscation of part of the income received.

A. Smith, who is considered the founder of modern economic science, back in the 18th century, defending the idea of non-intervention of the government in the economy, defined taxes as the main means of replenishing the treasury. At the same time, he did not exclude that in a number of cases taxes could also be used to support national production,¹⁵ for example, being one of the instruments of trade protectionist policy.

D. Ricardo, characterising taxes, noted their exclusively fiscal function, and examining the stimulating function of the tax system, he wrote that any tax slow down accumulation of savings and that there was not a single tax that would not interfere with production. In his opinion, any tax is ultimately shifted on the entrepreneur, entails a decrease in his profits and limits the development of production. As a result, Ricardo concluded¹⁶ that there were no taxes that did not tend to diminish the power of savings.

French economist Jean Baptiste Say, who lived at the turn of the 18th – 19th centuries, noted that “it is a glaring absurdity to pretend, that taxation contributes to national wealth, by engrossing part of the national produce, and enriches the nation by consuming part of its wealth”.¹⁷

Pointing that “taxation is the transfer of a portion of the national products from the hands of individuals to those of the government, for the purpose of meeting public consumption or expenditure”, Jean Baptiste Say considered that “whatever be the denomination it bears, whether tax, contribution, duty, excise, custom, aid, subsidy, grant, or free gift, it is virtually a burden imposed upon individuals, either in a separate or corporate character, by the ruling power for the time being, for the purpose of supplying the consumption it may think proper to make at their expense; in short, an impost, in the literal sense”.¹⁸

Among the economists of the 19th century, J. S. Mill shared opinion that the introduction of a progressive income tax cannot lead to economic growth, as it is a de-stimulating function. He was a supporter of imposing a land tax levied on the increment to land values, considering that it should become a government revenues basis.¹⁹ Also, J. S. Mill had proposals regarding tax wealth transfers and bequeathments – he suggested to set an upper bound on how much can a person receive from such a wealth transfer. This approach is usually, and fairly criticised,

¹⁵ Smith, A. 1776 (2007). *An inquiry into the nature and causes of the wealth of nations*. (Soares, S. M., eds.), International Edition: MetaLibri, 745.

¹⁶ Ricardo, D. 1817. *On the Principles of Political Economy and Taxation*. London: John Murray, Albemarle-Street, 603.

¹⁷ Say, J.-B. 1964. *A Treatise on Political Economy*. New York: Augustus M. Kelley, 490.

¹⁸ Rothbard, M. N. 1981. The Myth of Neutral Taxation. *Cato Journal*. 1(2), 551–554.

¹⁹ Coleman, A. and Grimes, A. 2010. Betterment taxes, capital gains and benefit cost ratios. *Economics Letters*, 109(1), 54–56.

as it distorts several important baselines, such as private property and negatively impacts on an incentive to work and save, yet in some cases, it is considered more just and fairer, in comparison to other approaches that are less relied on wealth transfer taxation.²⁰

Joseph Schumpeter stated that taxation should encroach on the net income of a business as little as possible.²¹ He directly pointed out that there should be no tax progression in the area of direct taxation.

According to Y. Bernard and J. Collie,²² tax is a mandatory and gratuitous withdrawal of funds by the state or local government to fund public spending. They pointed out that taxes are both an instrument of tax policy and are used to improvement of the market relations. This reflects the social nature of taxation aimed at protecting society.

In a number of works, the institution of taxation is seriously criticised.

Thus, Hans-Hermann Hoppe expressed opinion that taxes invariably reduce production, and with it the standard of living of consumers.²³ He concluded that taxation is a mean of discouraging wealth formation and thus creating relative impoverishment.

Francis Ysidro Edgeworth, developing issues of social justice in taxation, pointed out that in order to achieve social justice, the principle of least aggregate sacrifice should be the main principle of taxation.²⁴ Edgeworth's taxation paradox is being considered in the scope of excise taxation, where unit excise tax can affect the price – to reduce it, as well as to increase output.²⁵

The same principle was developed by the English economist Arthur Cecil Pigou, who was one of the founders of the economic theory of welfare. He pointed out that the market system, despite all its effectiveness, can contribute to the uneven distribution of income. This, in turn, leads to the emergence of social stratification in society. In the 1930s, Arthur Pigou substantiated the use of corrective taxes, although they were known for a long.

Pigou expressed opinion that the introduction of corrective taxes is necessary if, for example, the activities of a particular company not only bring profit to it, but also pollute the environment. Moreover, the higher the profit, the stronger the pollution. If there are no

²⁰ Cappelen, C. and Pedersen, J. 2018. Just wealth transfer taxation: Defending John Stuart Mill's scheme. *Politics, Philosophy and Economics*, 17(3), 317–335.

²¹ Schumpeter, J.–A. 2006 (1954). *History of economic analysis*. New York: Oxford University, Press Taylor & Francis, 1283.

²² Bernard, Y. and Colli, J. 1996. *Dictionnaire économique et financier*. Sixième édition. Paris: rue Jacob, VIe, 572.

²³ Hoppe, H.–H. 2006. *The Economics and Ethics of Private Property*. Auburn, Alabama: Studies in Political Economy and Philosophy/ Second Edition/ Ludwig von Mises Institute, 433.

²⁴ Vitaliano, D. 2018. The Hedonic Theory of Taxation: An Application to the U.S. Income Tax. *Public Finance and Management*. 18(3), 251–264.

²⁵ Ritz, R. 2014. A new version of Edgeworth's taxation paradox. *Oxford Economic Papers*, Oxford University Press. 66(1), 209–226.

restrictions on pollution, then the company does not take it into account in its plans. However, the introduction of a tax on emissions would allow to change the situation. The tax rate is determined on the basis that society is interested in both the company making a profit and keeping pollution as low as possible. It should be noted that with such an approach it is rather difficult to determine the size of the “negative externality,” that is, the harm inflicted on society by a person’s personal choice or the activities of an enterprise, and this makes it difficult to determine the rate of the Pigouvian tax. Despite this, corrective taxes are now being applied with increasing frequency, and they are mainly related to the protection of the environment from pollution.

In addition to corrective taxes, Pigou studied progressive taxation issues, pointing out its negative consequences. In his opinion, such a tax system limits savings and capital accumulation. Pigou pointed out the need to leverage various tax breaks when levying income tax to achieve the lowest “aggregate sacrifice”.²⁶ In addition, he attempted to improve the redistribution of income policy from the rich to the poor. Subsequently, Pigou’s approaches to resolving the problem of externalities with the help of the state and the tax system were critically considered, and attempts were made to modernise them.

In modern society the green economy and the reduction of the greenhouse gases is one of the major areas where Pigouvian taxation may be naturally appealing. It is considered, that Pigouvian taxes, that are aiming at climate externalities can generate up to 6 % of GDP.^{27, 28} However, difficulties in prognosing of impact of imposing such taxes on a total greenhouse gases emission led to a significant problem of robust tax base,²⁹ which is crucial for policy-making and long-term planning.

From the point of view of R. Coase, A. Pigou’s recommendations followed from his assumption that the party causing the damage and the party suffering from it cannot achieve mutual benefit as a result of negotiations. But with zero transaction costs of production and well-defined property rights, such negotiations are possible. Therefore, according to the Coase theorem, external effects can be eliminated without the help of the state.³⁰

²⁶ Aslanbeigui, N. and Oakes, G. 2016. The Great War and the Genesis of Pigou’s A Study in Public Finance. *Oeconomia*. 6(4), 487–513.

²⁷ Jakob, M., Chen, C., Fuss, S., Marxen, A., Rao, N. D. and Edenhofer, O. 2016. Carbon pricing revenues could close infrastructure access gaps. *World Development*. 84, 254–265.

²⁸ Franks, M., Lessmann, K., Jakob, M., Steckel, J. C. and Edenhofer, O. 2018. Mobilizing domestic resources for the agenda 2030 via carbon pricing. *Nature Sustainability*. 1, 350–357.

²⁹ Edenhofer, O., Franks, M. and Kalkuhl, M. 2021. Pigou in the 21st Century: a tribute on the occasion of the 100th anniversary of the publication of *The Economics of Welfare*. *International Tax and Public Finance*. 28, 1090–1121.

³⁰ Slaev, A. 2017. Coasean versus Pigovian solutions to the problem of social cost: the role of common entitlements. *International Journal of the Commons*. 11(2), 950–968.

In the theory of public finances, which formed within the framework of the economic theory of welfare, both theoretical and practical aspects of taxation were addressed. Meanwhile, attention was drawn to two most important areas of analysis – the impact of taxes on the optimal allocation of resources and the impact on the distribution of taxes (who bears the main burden of taxation and to what extent).^{31, 32}

Another aspect of the problem of the tax system and its impact on economic activity can be traced in the discussion between neoclassicists and Keynesians.

Followers of J. M. Keynes considered taxes as a built-in stabiliser, making it possible to respond quickly to changes in market conditions and to cope with the negative effects of economic fluctuations.

J. M. Keynes and his followers pointed out the following main goals of state functioning: stabilisation, sustainable rates of economic growth, high employment and income equalisation, which are determined by the corresponding model of fiscal policy. This model was defined as “fiscalism”, or the “income-expenditure” model. From the Keynesian point of view, the tax system will stabilise the economy, as well as promote fair distribution of income and “equality” in taxation. “Equality” in taxation means levying tax on the same income at the same rate (horizontal equality) and on different incomes at different rates (vertical equality). The progressive structure of income taxation was considered a suitable tool for reducing wealth inequality, yet high income tax rates were not thought out as a viable approach.³³

From the position of neo-Keynesians, taxes are the most important means of replenishing budget revenues, since the main instrument of budgetary regulation is government spending. That is why tax (fiscal) policy should be guided by changes in the amount of taxes levied in relation to the amount of government spending. It is important that the savings accumulated through the tax system are used by the government for constructive purposes. Among these are investments in the development of “human resources”, in those areas of the economy where private capital is reluctant to go due to their low profitability or a long payback period. Usually, they are related to healthcare, education, science, the creation of a transport system, housing construction, vocational training of workers and raising their qualifications.

³¹ Desmarais-Tremblay, M. 2014. On the Definition of Public Goods. Assessing Richard A. Musgrave’s contribution. *HAL sciences humaines et sociales*. 00951577, 1–40.

³² Desmarais-Tremblay, M. 2022. Richard Musgrave in Colombia: The art of tax reform in a developing country. *Center for the History of Political Economy (CHOPE)*. Duke University, Durham. 2022-06, 1–52.

³³ Sangkuhl, E. 2015. How the Macroeconomic Theories of Keynes influenced the Development of Government Economic Finance Policy after the Great Depression of the 1930’s: Using Australia as the Example. *Athens Journal of Law*. 1(1), 32–52.

Currently, the world agenda is quite vigorously focused on the problem of poverty. Government spending is considered to be one of the most influential factors, however, some researchers are arguing that in general there is no confirmation that government spending had a significant impact on poverty reduction dynamics.

In the 70s of the XX century, the Keynesian concept of redistribution of income through taxes was widely discussed. It was noted that the progressive tax plays an important role in the redistribution of income, but at the same time it can be destabilising in nature, since in a number of cases it turned out to be unprofitable to work a lot and receive large incomes. It was concluded that the stronger the progression of taxation, the weaker the differentiation of incomes, but the lower the efficiency of the economy.

During this period, the “economic theory of supply” arose, the representatives of which were J. Wanniski, A. Laffer, R. Mundell, M. Feldstein, J. Gilder, who considered the problems of the impact of taxation on the economy. The supporters of this theory believed that high taxes lead to a decrease in business activity, since they reduce the share of savings, weaken the main incentives for economic activity (private initiative), without which economic success is impossible.

Modern assessments of the current policy in the field of taxation are different. Thus, the representative of modern Keynesianism, P. Krugman, Nobel Prize laureate for 2008 in a number of his works paid special attention to tax policy, since it affects both market processes and entrepreneurial activity, and the problems of income distribution. At the same time, he noted that in the United States, the reduction in the tax rate on personal income and corporate profits definitely increased the incentives for labour and business activity and made American capitalism more dynamic and competitive than Western European one.

At the same time, the reduction in taxes limiting the growth of personal consumption (income from the sale of property in the form of securities, real estate, precious metals, the abolition of the tax on the inheritance of real estate) led to an increase in personal consumption, and not to an increase in investments. As a matter of fact, major tax cuts for the rich are said to increase income inequality and social stratification but do not stimulate economic performance.³⁴

³⁴ Hope, D. and Limberg, J. 2022. The economic consequences of major tax cuts for the rich. *Socio-Economic Review*, 20(2), 539–559.

Many economists have been drawing attention to the sharp decline in tax revenues from the level that would have been expected without tax cuts.³⁵

Supply-side economics in its essence indicating that with lower tax rates economic activity is stimulated.³⁶ It should lead that a person would like to work more, a lot of new people would join the workforce, savings would spike, revenues would increase so much that even at lower tax rates, budget revenues will increase.

The 1976 Nobel Prize laureate in Economics M. Friedman popularised the so-called “negative income tax” program.³⁷ He considered that it would be more expedient to use a system in which workers, whose income is less than a certain level, are simply returned funds that they could spend at their discretion, rather than redistributing funds through many ineffective bureaucratic structures. This idea was once supported by J. Tobin, J. Pechman and the 37th US President R. Nixon.

An analysis of a number of the positions mentioned above, devoted to the problems of the influence of taxes and taxation on the efficient allocation of resources at the corresponding historical and economic stages of development, shows that all the points of view considered above are sufficiently reasoned. Most liberal economists viewed efficient use and allocation of resources separately from each other, and in some cases as antagonistic categories. They believed that economic efficiency is determined by the Pareto principle, according to which the optimal use of resources is possible only if an increase in the income of a person does not lead to a decrease in the income of the rest of society. However, equity in distribution can be realised when an increase in the income of some individuals is possible at the expense of a decrease in the income of others.

In this regard, many economists defined the flat rate of taxation as a priority, because, in their opinion, only it contributes to economic growth.

It stands to mention that proponents of progressive taxation are often forced to admit that they reduce incentives to work and innovate. At the same time, some scientists note the stimulating function of taxes as a tool that has a positive impact on work and commercial activity. In this regard, they point to the need to reduce the tax burden, and also advocate lowering the degree of progressiveness of taxation.

³⁵ Auerbach, A. and Feenberg, D. 2000. The Significance of Federal Taxes as Automatic Stabilizers. *Journal of Economic Perspectives*. 14(3), 37–56.

³⁶ Piketty, T., Saez, E. and Stantcheva, S. 2014. Optimal Taxation of Top Labor Incomes: A Tale of Three Elasticities. *American Economic Journal: Economic Policy*. 6(1), 230–271.

³⁷ Preiss, J. 2015. Milton Friedman on Freedom and the Negative Income Tax. *Basic Income Studies*. 10(2), 169–191.

In contrast, representatives of welfare economic theory believe that taxes have little impact on incentives to work. To ensure social equality, they propose to use the distribution function of taxes. In all cases, it is noted that the optimal tax system must be efficient and comply with the laws of equity.³⁸

Obviously, the bulk of the public goods produced by the state is financed from the taxes collected. To assess the impact of taxes on efficiency and equity, it must be borne in mind that in modern conditions this part is constantly increasing. For example, education and healthcare require increased funding. With a decrease in the tax burden, an objective decrease in government spendings on science and education, the training of skilled labour can occur, which will lead to a decrease in the standard of living of the population and become an obstacle to economic growth.

Therefore, it is necessary that the tax system, in the case of an increase in tax rates, makes it possible to juxtapose the positive effect of this and the corresponding costs. In the case of a decrease in the tax burden, one should compare the advantages of such a reduction (increased investment, attraction of foreign capital, a decrease in the scale of the shadow economy) with a possible decrease in the level of welfare due to a decrease in the share of government spending on solving social problems.

At the same time, it is necessary to determine what expenditures are priority, what is the share of expenditures on the most important public goods, in which all members of society are interested, including those who receive large incomes. It is also necessary to assess the share of social expenses, as well as their impact on the activities of certain groups (for example, disabled people), in order to understand how burdensome increase in tax rates will be for them.

The gap between tax payments and the provision of public services is a serious shortcoming of the tax system. No matter how the problems of efficiency and equity are interpreted (a serious contradiction between them is noted by many economists), the main goal of economic policy is to find the optimal combination. There is a problem of public choice of various priorities of the state's economic policy, the problem of combining economic efficiency and public interests.

The state uses tax policy as a tool for the redistribution of national income in order to improve the economic development of the regions and increase the well-being of the population. Analysing the aforesaid, the author comes to the conclusion about the need for an integrated approach to theoretical and practical issues of tax policy, including during the preparation and implementation of tax reforms.

³⁸ Bejakovic, P. 2020. How to Achieve Efficiency and Equity in the Tax System? *Revija za socijalnu politiku*. 27(2), 137–150.

1.2 Tax system requirements

The basis for the existence of the state is its competent tax policy, which determines the economic development of the country and the level of well-being of its citizens. Tax policy must comply with certain requirements.

Adam Smith paid great attention to the requirements of a good tax system.³⁹ He considered that tax policy should comply with four pillars: fairness, certainty, convenience and efficiency.

The International Monetary Fund formulated the following basic criteria of taxation:⁴⁰

- Legal Foundation – any tax must have a firm basis in law.
- Criterion of Equality.
- Fair Play (or Public Trust) in Tax Administration – the taxation authority must not be allowed an unfair advantage in its dealings with taxpayers.
- Proportionality and Ability to Pay – tax liability should be based on the taxpayer's ability to pay is accepted in most countries as one of the bases of a socially just tax system. The principle of ability to pay is, for example, opposed to head or poll taxes, against which the British revolted in 1990.
- Nonretroactivity – tax statutes may not be applied retroactively can be justified on the basis that taxpayers should be able to make economic decisions with knowledge of their tax consequences and that it is unfair to provide tax consequences for an investment or other economic decision that differs from the tax treatment at the time the decision was made.
- Other Constitutional Limitations Depending on the provisions of a country's constitution, various other limitations on the power to make tax laws may apply. For example, in Germany, the income tax provision subjecting the aggregate income of husband and wife to a progressive rate schedule in such a manner that a married couple could pay a higher tax than if they were taxed separately was held to violate article 6/1 of the constitution, relating to protection of marriage and family.

³⁹ Terrefe, M. 2016. A Close Scrutiny of Self-Assessment System and its Impact on the Tax Compliance Level of Taxpayers: The Case of Wolaita Zone. *American Academic Scientific Research Journal for Engineering, Technology, and Sciences*. 20(1), 78–103.

⁴⁰ Thuronyi, V. 1996. *Tax law design and drafting*. International Monetary Fund. 1, 531.

The processes of global economic regulation in the field of taxation have a historical and institutional continuity. The OECD continued the economic research of the League of Nations (1919–1946), which recognised that the interaction of domestic tax systems can lead to double taxation and negatively affect the dynamics of international trade.

The Organisation for Economic Cooperation and Development (OECD) pointed out the need to comply with the criteria of taxation. This organisation identified the following requirements:⁴¹

- Neutrality – taxation should seek to be neutral and equitable between forms of business activities.
- Efficiency – compliance costs to business and administration costs for governments should be minimised as far as possible.
- Certainty and simplicity – tax rules should be clear and simple to understand, so that taxpayers know where they stand.
- Effectiveness and fairness – taxation should produce the right amount of tax at the right time, while avoiding both double taxation and unintentional non-taxation.
- Flexibility – taxation systems should be flexible and dynamic enough to ensure they keep pace with technological and commercial developments.
- Equity – important consideration within a tax policy framework, including two main elements: horizontal equity and vertical equity.

The same OECD document contains certain criteria and important aspects of specific tax categories. For example, VAT on cross-border transaction – the destination principle.

Researchers also state that one of the important tax policy design requirements is the fairness of the taxation,⁴² which is crucial for both for tax system design and allocation of tax rights.

In “Tax policies in the European Union. 2020 survey” four channels are highlighted through which taxation can influence social welfare:⁴³

- Distortion of economic decisions – in the absence of market failure, most forms of taxation distort otherwise efficient economic decisions, leading to sub-optimal outcomes.

⁴¹ OECD. 2015. *Addressing the Tax Challenges of the Digital Economy*. Paris: OECD Publishing. 1(2), 29–50.

⁴² Lubis, A. and Rahay, N. 2021. Emphasizing Inter-Nation Equity in the New Digital Economy’s Taxing Rights Allocation Scheme. *International Journal of Scientific and Research Publications*. 11, 402–408.

⁴³ European Commission, Secretariat-General. 2020. Tax policies in the European Union. 2020 survey. SWD (2020) 14 final. 30.01.2020. <https://data.consilium.europa.eu/doc/document/ST-5695-2020-INIT/en/>, 124.

- Social preferences – it is not only the level of overall income that matters, but also the extent to which it is shared among members of a society. Taxation can be a powerful instrument for redistribution. Depending on social preferences and policy goals, redistributive taxes can be welfare enhancing.
- Market failures – sometimes, economic decision-making in the absence of taxation is neither efficient nor fair. In such cases, taxation can play a role in correcting for economic inefficiencies to the benefit of the society as a whole.
- Administrative costs – levying taxes is costly for administrations and taxpayers. Efficient tax administration minimises these costs.

The researchers in “Tax policies in the European Union. 2020 survey” are pinpointing key features to be taken into account (and how well the government handles them) when assessing the fairness and efficiency of a tax system:⁴⁴

- Stimulation of investment and addressing positive and negative externalities.
- Improvement of tax administration and tax certainty.
- Development of a more employment-friendly environment.
- Correcting inequalities and promoting social mobility.
- Fight against tax fraud, evasion and avoidance.

One of the approaches to assessing the fairness of tax policy was graphically illustrated by M. Lorenz in the form of an uneven distribution of income⁴⁵ and is applied for European household wealth assessment (Figure A1.1, Annex 1B). Lorenz curve is also used for linking various indicators, including Gini index and the Pietra index (a counterpart of the Kolmogorov–Smirnov statistic), which is considered as an analogous to Gini index.⁴⁶

The requirements of taxation and good tax policy are also reflected in research devoted to finding optimal taxes. So, for example Mike Brewer, Emmanuel Saez, and Andrew Shephard⁴⁷ defined the main trade-off of the problem – which is applicable to every part of the tax system, not only the Tax on Earnings – a trade-off between equity and efficiency. Also mentioned that another important factor is that the redistribution process itself is very costly for economic efficiency as taxation has a disincentive impact on people’s will to work. However, not only taxes have such an effect, but the help provided by the government

⁴⁴ European Commission, Secretariat-General. 2020. Tax policies in the European Union. 2020 survey. SWD (2020) 14 final. 30.01.2020. <https://data.consilium.europa.eu/doc/document/ST-5695-2020-INIT/en/>, 124.

⁴⁵ Costa, R. and Pérez-Duarte, S. 2019. *Not all inequality measures were created equal. The measurement of wealth inequality, its decompositions, and an application to European household wealth*. European Central Bank: Statistics Paper Series. 31(12), 57.

⁴⁶ Eliazar, I. and Sokolov, I. 2010. Measuring statistical heterogeneity: The Pietra index. *Physica A: Statistical Mechanics and its Applications*. 389(1), 117–125.

⁴⁷ Mirrlees, J. 2017. *Dimensions of Tax Design*. Adam, S., Besley, T., Blundell, R., Bond, S. et al. (eds.). Oxford: Oxford University Press for Institute for Fiscal Studies, 1360.

(generally in the form of transfers, but possibly in any possible form of benefits) has a disincentive effect too. And this is also coherent with the tax requirements mentioned above.

It is important to keep in mind that taxes are classified as direct or indirect ones. By direct tax is meant a tax that is paid directly to the government by an individual or organisation. The common example of direct taxes includes Income tax, Property taxes, Capital gains taxes, etc. By indirect tax is meant a tax that is collected by someone (some legal entity) in the supply chain. Such taxes as VAT (Value Added Tax), Customs taxes and Excise taxes are indirect. The main advantages and disadvantages of direct and indirect taxes are shown in Figure 1.1.

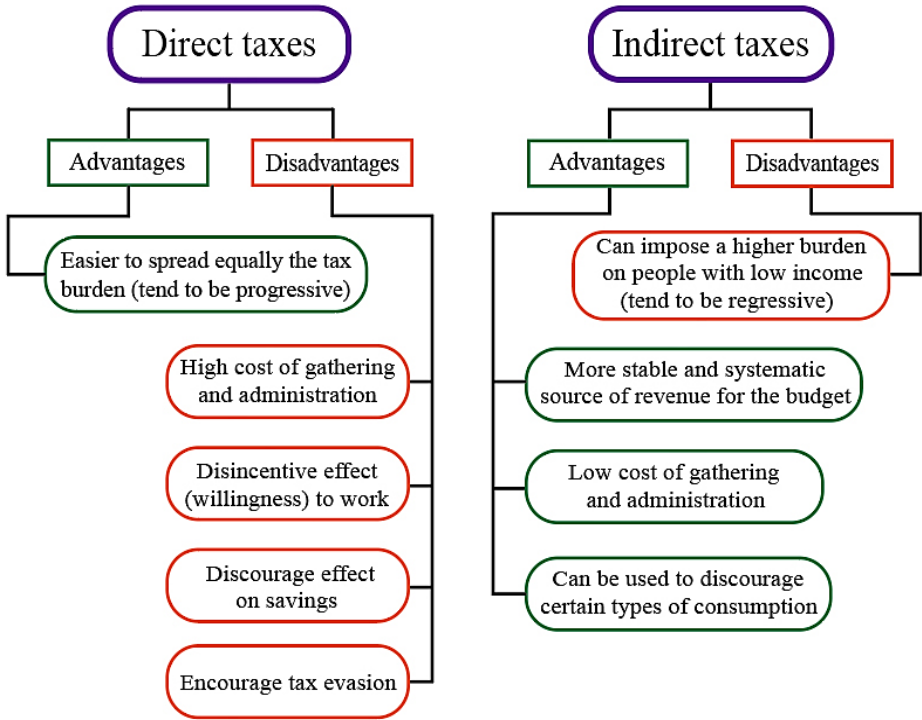


Figure 1.1 The main advantages and disadvantages of direct and indirect taxes

Source: created by the author based on general properties of direct and indirect taxation.

For example, indirect taxes often play the role of Pigouvian taxes.

James Banks and Peter Diamond, examining approaches to the optimal tax rate for direct taxes, considered three main questions:⁴⁸

- Which rate is appropriate to the capital income taxation? They were looking at several possibilities to choose from: flat rate, the rate related to the marginal tax rate on earnings or the common income tax rate for all types of income.
- How the payments into savings vehicles (special bank accounts) be treated (should they be taxable or deductible from earnings before taxation)?
- Is it good to use an age-dependent taxation?

⁴⁸ Mirrlees, J. 2017. *Dimensions of Tax Design*. Adam, S., Besley, T., Blundell, R., Bond, S. et al. (eds.). Oxford: Oxford University Press for Institute for Fiscal Studies, 1360.

The author believes that the above approaches to direct and indirect taxes interpret the general criteria of taxation and tax policy in different ways: the approach to equality and equity differs, which may partly conflict with the requirements of good tax policy.

Tax systems also differ in relation to the marginal tax rate and the tax base. There are four main types of taxation system – progressive, proportional, regressive, digressive (Figure 1.2).

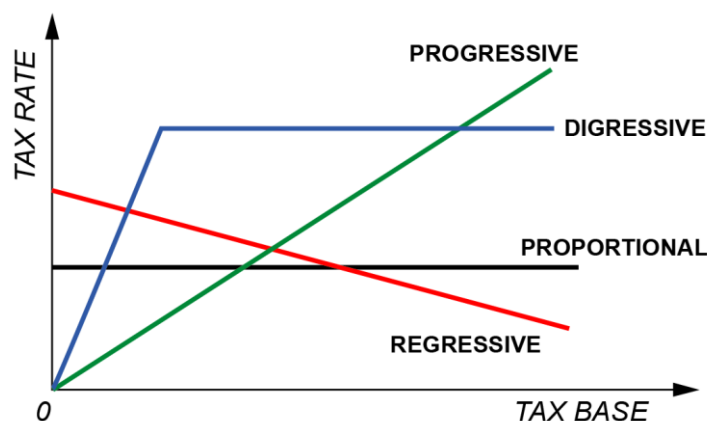


Figure 1.2 Taxation types

Source: interpreted by the author based on the general taxation approaches, including⁴⁹.

- Proportional taxation (flat tax system) – the very same tax rate is imposed on every taxpayer regardless of income or wealth.
- Progressive taxation – generally depends on the amount of a taxpayer’s income, so those who earn more pay more compared to those who earn less. Progressive taxation is widely spread concept nowadays, yet J. Mirrlees considered that optimal taxation is greatly overestimated in terms of fairness for income taxation as a tool for reducing inequalities.⁵⁰ Modern practical analysis studies indicate that progressive taxation has quite a modest effect on income inequality decrement and poverty reduction.⁵¹
- Regressive taxation – those who earn less contribute a higher amount of taxes to the state budget compared to those who earn more.
- Digressive taxation – a combination of progressive and proportional approaches: a tax may be progressive up to a certain threshold, but after that it may be charged at a flat rate.

⁴⁹ Varela, P. 2016. What are progressive and regressive taxes? *Tax and Transfer Policy Institute (TTPI) – Policy Brief*. Canberra: The Australian National University. 2016(3), 1–10.

⁵⁰ Mirrlees, J. 1971. An Exploration in the Theory of Optimum Income Taxation. *The Review of Economic Studies*. 38(2), 175–208.

⁵¹ Popescu, M., Militaru, M., Stanila, L., Vasilescu, M. and Cristescu, A. 2019. Flat-Rate versus Progressive Taxation? An Impact Evaluation Study for the Case of Romania. *Sustainability*. 11(22), 1–16.

Each of the considered types can be used in the framework of a separate tax, and is a tool with which the state can strive to create the most efficient and fair tax system, or achieve other goals. The application of this or that type of taxation system is individual for each state and depends on many socio-economic factors. Also, the choice of the type of taxation system is often a political tool. Thus, I. Sproģe has pointed out that despite the fact that the choice of the taxation system is a subject of wide discussion between economists and politicians, the practical choice of the system remains with the ruling party (coalition).⁵² The author believes that with such an approach, there is a danger of making ineffective decisions, in some cases populist ones, especially during pre-election periods. One such example is the speculative use of the Laffer curve. Because of its simplicity and clarity, a number of American politicians demonstrated the need to reduce taxes with its help, in some cases unreasonably appealing to the fact that tax rates are located to the right of the optimal point (i.e., they are too high, and tax revenues to the budget that in the same amount can be provided at lower tax rates). At the same time, other arguments were not taken into account. Throughout the years, the reasoning behind it remains the same – tax cuts should lead to a larger-scaled economy.⁵³

One of the important directions in the analysis of taxes is the determination of the parties who will be charged with the tax burden. Commonly, it is considered, that the statutory tax burden does not clarify the situation with the bearer of the tax – it remains unclear. However, the elasticity takes a major role in tax burden distribution: elastic supply or demand means avoiding the tax burden, while inelastic, on the contrary, indicates that party bears the taxes. The author considers the importance of taking elasticity into account when developing tax reforms and making adjustments to tax legislation.

In “Tax policies in the European Union. 2020 survey” the main types of taxes are considered in terms of their efficiency, distributional implications and administration / compliance (Table A1.1, Annex 1A).

Indicated in Table A1.1 (Annex 1A) efficiency, distributional implications and administration / compliance should be taken into account by the state both when preparing tax reforms and when making adjustments to the current tax system.

Certain changes in the tax system aimed at improving certain functions, meeting the criteria of a good tax system, reducing social inequality, etc., in one way or another are connected with tax reforms.

⁵² Sproģe, I. 2010. *Nodokļu politika ekonomikas attīstības mainīgajos apstākļos: promocijas darbs: specialitāte – ekonomika*. Rīga: Latvijas Universitāte, 213.

⁵³ Gale, W. and Samwick, A. 2014. Effects of Income Tax Changes on Economic Growth. *Economic studies at Brookings. The Brookings Institution*. (9), 1–15.

Researchers from Institute Rousseau proposed a tool and approach for providing a political interpretation for tax reforms aimed at improving an unjust tax system and is applicable to an arbitrary tax by defining its desired parameters.⁵⁴ This approach is allowing for any political party or individual to see how proposed changes would affect the economy, as well as check their own proposals, which has a significant importance for preparation of the tax reform.

An objective prerequisite for tax reforms is a significant change in the socio-economic policy of the state, leading to a revision of the concept and strategy of tax policy. After the objective need for reform has taken shape, there is a choice of goals, means and methods of tax reforms. Depending on the complexity and the number of goals set, the reform can be planned in one or several successive stages with a corresponding breakdown by goals, means and methods. The algorithm for implementing the tax reform is shown in Figure 1.3.

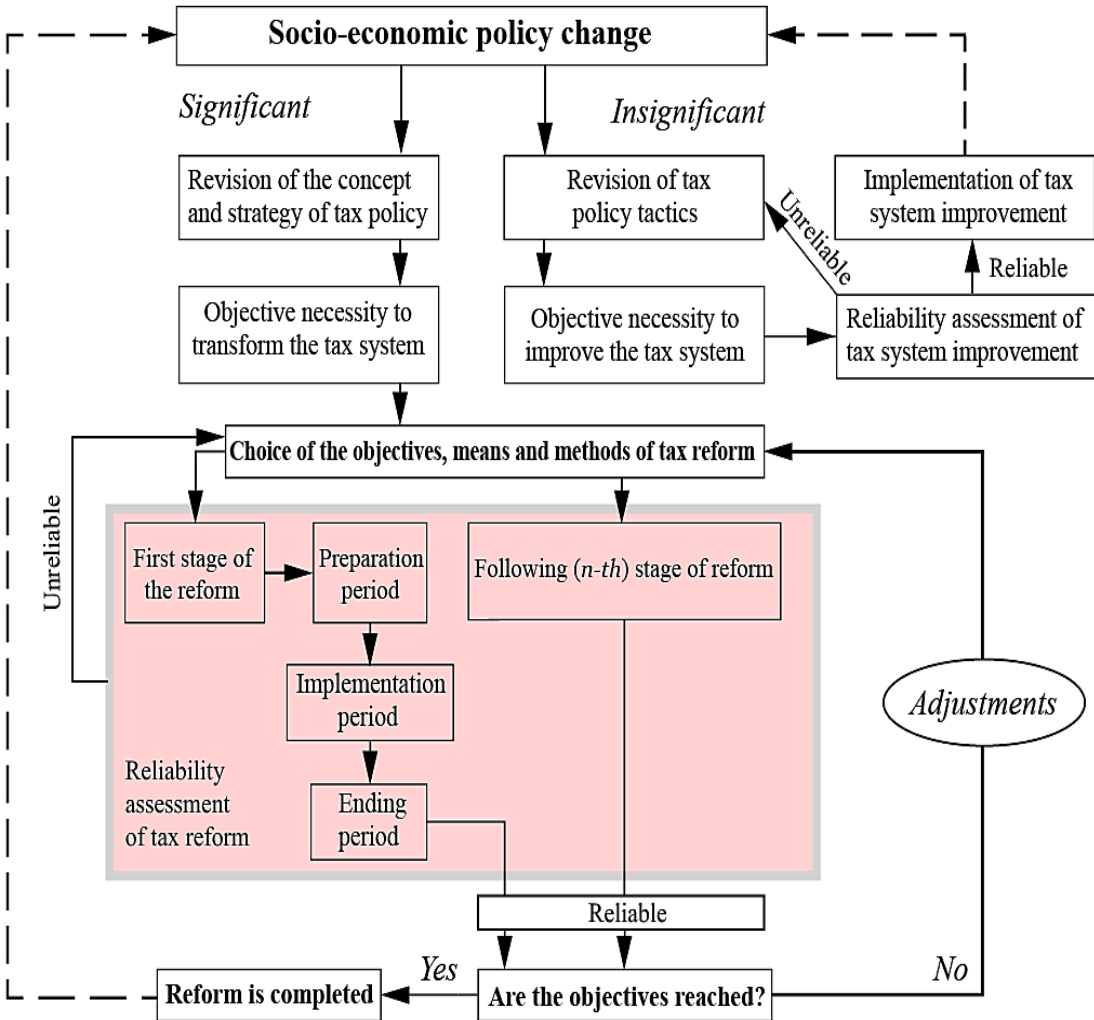


Figure 1.3 Algorithm for the implementation of tax reform

Source: created by the author.

⁵⁴ Enguehard, J., Giraud, G., Levieil, E. and Salin, M. 2021. Un outil pour la délibération fiscale: l’impôt abc. *Institut Rousseau*. (2), 1–12.

The preparation period is the period of planning, substantiating and preparing public opinion.

The period of implementation is the period of direct implementation of the tax reform, when new tax legislation is introduced, the tax mechanism is modified, and innovations are tested.

The ending period is a period for analysing the results of the reform, assessing their fiscal and socio-economic significance, developing proposals for further improving tax legislation, declaring a conclusion on the progress in achieving the stated goals and preparing a justification for completing or continuing reforms.

It is noticed that when a decision is made, the policymaking process is tightly bound by widespread uncertainty.⁵⁵ One of the crucial problems in this field – robustness-checking of policy models, as an academic approach to it, which is widely used in various research is poorly fitted for actual usage by policymakers.

Usually, the results of the reform are assessed only *fait accompli* – after its completion. Only after the final period, the reform is assessed, after which a decision can be made on its completion, or revision and adjustment, i.e. in general the determination of the conformity of the tax reform to the tasks set is done by the method of trial and error. This approach is not rational, the “cost” of a possible error can be quite large. In order to avoid mistakes and losses associated with them, it is necessary at the preliminary stage not only to assess the compliance of the developed reform with the set socio-economic objectives, but also to predict the period of stable functioning of the tax system (its reliability) in the post-reform period. Moreover, the reliability assessment should be carried out at all stages of the preparation and implementation of the tax reform. Thus, at all stages of any changes in the tax system, tax policy or its parts, it is necessary not only to assess the efficiency of the changes and fulfilment of objectives but also to assess the reliability (Figure 1.3). If the assessment would show not a sufficient degree of reliability, it is necessary to return to the previous stages and look for a different solution to the problem.

Reliability assessment is also very important in the step-by-step introduction of changes to the tax system, provided for by the developed tax reform. With a tax reform extended over time, a change in the economic and political situation in the country and in the world inevitably occurs, which can lead to a change in the reliability of the tax system.

⁵⁵ Lockwood, B., Sial, A. and Weinzier, M. 2021. Designing, Not Checking, for Policy Robustness: An Example with Optimal Taxation. *Tax Policy and the Economy*. (35), 1–54.

The author proposes his own approach to the algorithm for the preparation and implementation of the tax reform, taking into account the assessment of its reliability at various stages (Sections 3.2 and 4.1).

The requirements characterising the tax system were systematised and subdivided by the author into five main categories:

- the criterion of efficiency;
- the criterion of equity;
- the criterion of certainty and accuracy of taxes;
- the criterion of ease of collection of taxes for taxpayers;
- the criterion of obligation.

As mentioned earlier, the main tax contradiction is the antagonism of efficiency and equity (fairness), which is the main problem of creating the architecture of a rational tax system, taking into account the interests of both the state and the taxpayer.

1.3 Critical analysis of the Laffer's concept

To describe the correlation between the tax burden and tax revenues to the budget the “Laffer curve” is quite often used, named after the economist who visualised the idea that the volume of tax revenues is not always an increasing function of the tax rate. The dependence illustrated by this curve, prior to Arthur Laffer, was previously noted at various times by a number of other economists.⁵⁶ J. M. Keynes also mentioned it in his economic writings.⁵⁷

It is known that to justify his idea, Laffer referred both to the statements of past authorities and to the experience of past tax reforms. In one of his works, he quoted from “The Muqaddimah” of the famous Muslim philosopher of the 14th century, Ibn Khaldun: “It should be known that at the beginning of the dynasty, taxation yields a large revenue from small assessments. At the end of the dynasty, taxation yields a small revenue from large assessments.”⁵⁸

The graphical interpretation was proposed by Arthur Laffer in 1974, and in the official source it was first depicted and called the Laffer curve by Jude Wanniski in 1978. (Figure 1.4). Wanniski divided the curve into zones in more detail, and the version he demonstrated is considered the classical “Laffer curve”.

⁵⁶ Mach, P. 2019. On the Origin of the Laffer Curve. *ACTA VŠFS*. 13(2), 186–191.

⁵⁷ Georgetown University. Ibrahim M. Oweiss. <https://faculty.georgetown.edu/imo3/ibn.htm>.

⁵⁸ Laffer, A. 2004. The Laffer Curve: Past, Present and Future. *Executive Summary Backgrounder, The Heritage Foundation*. June 1(1765), 1–16.

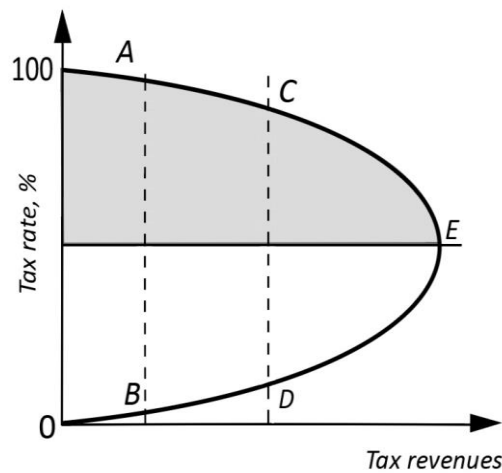


Figure 1.4 Classic visualisation of Laffer curve⁵⁹

Wanniski, following Laffer, plotted the values of the independent variable (tax rate) on the ordinate axis and the dependent variable (tax revenues) on the abscissa axis, although in most cases it is customary to do the opposite. Many researchers subsequently began to depict this relationship by reversing the axes, which resulted in the curve being rotated 90° counterclockwise.

Laffer and Wanniski depicted the curve as a parabola, symmetric about its apex, taking zero values of budget revenues at the average tax rate of 0 and 100 %, and reaching a maximum at some point called the Laffer point. They characterised the zone, highlighted in Figure 1.4 in grey, as a prohibitive range typical of top brackets for most progressive tax systems.

The unpainted area under the curve was called the low “flat tax” systems range, allowing to avoid the prohibitive range.

The term “Laffer curve” originally referred to this simple curve, although the term is also used to refer to the relationship between the tax rate and tax revenues (fiscal curve), not necessarily a simple one.

With this curve, Laffer justified the assumption that as tax rates change from 0 to 100 percent, tax yields will rise, reach a maximum, and then fall. It follows that there may be circumstances in which the government could lower tax rates and still maintain yields.

⁵⁹ Wanniski, J. 1978. Taxes, Revenues, and the “Laffer Curve”. *The Public Interest*. 3–16.

Classification of works devoted to the application of the Laffer curve

To date, many papers have been published on the analysis and study of the Laffer curve.

The issues related to the possibility of applying the Laffer dependence in practice are considered in the works of Balatsky E., Becsi Z., Buchanan J., Wanniski J., Gardner M., Gahvari F., Dalamagas B., Krugman P., Lee D., Malcomson J., Papava V., Henderson D., and many others.

The analysis has shown that recently there has been an intense flow of publications concerning the negation or confirmation of the Laffer curve concept, as well as studying the problems of its practical application.

The Economist noted in June 2019 that some 45 years after Arthur Laffer linked the two studied parameters, only about 15,000 journal articles mention “the Laffer curve” in their title. And U.S. President Donald Trump, who was incumbent at that time, presented the Presidential Medal of Freedom, America’s highest civilian award, to Mr. Laffer, an adviser to Mr. Trump’s 2016 presidential campaign and co-writer of “Trumponomics”. In its announcement of the event, the White House described Mr. Laffer as “one of the most influential economists in American history”.⁶⁰

Research sources that mention the Laffer curve in one way or another can be divided into three main groups.

The **first** group includes studies by scientists who agree with Laffer’s interpretation.

The **second** one includes those in which Laffer’s approach is considered erroneous and the existence of his curve and the validity of the economic research carried out on its basis are called into question.

The **third** group includes studies in which scientists agree with Laffer’s concept, but show its limited suitability and make attempts to improve and modernise the curve.

Separately, is distinguished the **fourth group**, which includes educational literature.

First group

The researchers in **the first group** agree with Laffer’s interpretation and usually point out that those researchers who disagree with them are often not thoroughly familiar with the explanations of Laffer himself,⁶¹ as well as Wanniski,⁶² and try to use this curve for purposes for which Laffer did not originally intend it.

⁶⁰ Can countries lower taxes and raise revenues? 2019. *The Economist* <https://www.economist.com/graphic-detail/2019/06/19/can-countries-lower-taxes-and-raise-revenues>.

⁶¹ Laffer, A. 2004. The Laffer Curve: Past, Present and Future. *Executive Summary Backgrounder, The Heritage Foundation*. June 1(1765), 1–16.

⁶² Wanniski, J. 1978. Taxes, Revenues, and the “Laffer Curve”. *The Public Interest*. 3–16.

This category includes a number of works by Laffer himself,^{63, 64} as well as other scientists engaged in research on this concept.

S. Kazman has studied and systematised works that show that the graphical relationship proposed by Laffer quite correctly shows the behaviour of economic subjects in taxation of personal income. In his research S. Kazman also refers to the work of Laffer, Canto Joines, Lindsey and Feldstein,⁶⁵ who investigated the elasticity of taxable income to the tax rate on labour and determined the section of the Laffer curve where the US economy was in different time periods.

Miravete, Seim, and Thurk suggested looking at the Laffer curve not only under the assumption that firms do not respond to changes in the tax rate (they call this approach naive), but also under the assumption that firms adjust their prices (taking elasticity into account).⁶⁶

The first group also includes the works of scientists who use the Laffer curve as an argument in their research. By now such works have accumulated quite a lot, including the works of Latvian economists. These are, for example, Gatis Kokins,⁶⁷ Anatolijs Prohorovs,⁶⁸ Sandra Eglīte,⁶⁹ Andrejs Strateičuks,⁷⁰ Valters Kaže,⁷¹ Nataļja Seļivanova-Fjodorova,⁷²

⁶³ Laffer, A. and Moore, S. 2010. *Return to Prosperity. How America Can Regain Its Economic Superpower Status*. New York: Threshold Editions, 326.

⁶⁴ Laffer, A. 2004. The Laffer Curve: Past, Present and Future. *Executive Summary Backgrounder, The Heritage Foundation*. June 1(1765), 1–16.

⁶⁵ Kazman, S. 2014. *Exploring the Laffer Curve: Behavioral Responses to Taxation*. Burlington: UVM Honors College Senior Theses, 77.

⁶⁶ Miravete, J., Seim, K. and Thurk, J. 2018. Market Power and the Laffer Curve. *Econometrica*, 86(5), 1651–1687.

⁶⁷ Kokins, G. 2010. Lafērs iztraucēts. *Latvijas Industrializācijas Programma*. <https://gatis.kokins.com/weblog/2010/04/laffer-iztrauceets.html>.

⁶⁸ Prohorovs, A. 2017. *Uzņēmumu ienākuma nodoklis Latvijā un Igaunijā: tā ietekme uz uzņēmējdarbību, investīcijām, bezdarba līmeni, nodokļu ieņēmumiem un valsts ekonomisko izaugsmi*. Rīga: “Zinātne”, 256.

⁶⁹ Eglīte, S. 2006. *Fiskālās un monetārās politikas piemērošana Latvijas ekonomikas attīstībā: promocijas darbs: specialitāte – ekonomika*. Rīga: Latvijas Universitāte, 209.

⁷⁰ Strateičuks, A. 2014. *Latvijas alkohola tirgus un tā regulēšana: promocijas darbs: specialitāte – ekonomika*. Rīga: Latvijas Universitāte, 206.

⁷¹ Strateičuks, A., Fadejeva, D. and Kaže, V. 2011. Excise Tax Policy for Alcohol and Cigarettes in Latvia, Its Impact on State Revenues and the Laffer Curve. *Conference Proceedings: Current Issues in Economics and Management Sciences*. Rīga: Latvijas Universitāte, 603–613.

⁷² Seļivanova-Fjodorova, N. 2020. *Latvijas reģionu ekonomiskā diferenciācija 21. Gadsimta sākumā: promocijas darbs: specialitāte – ekonomika*. Daugavpils: Daugavpils Universitāte.

Ļevs Fainglozs and Velta Jonina,⁷³ Ilze Sproģe,⁷⁴ Elmārs Zelgalvis and Aina Joppe,⁷⁵ Māris Jurušs,⁷⁶ and many others. In the reports of Latvian state institutions, a number of arguments are based on the dependence proposed by Laffer.⁷⁷

Second group

The **second** group includes those studies that prove the failure of Laffer's concept, including those based on the failed tax reforms undertaken in the United States during the presidency of Ronald Reagan. Such researchers are usually referred to as sceptics.

Joseph Eugene Stiglitz, criticising the huge budget deficit left by Reagan's tax cuts, which he called insane, believed that the deficit arose from a "pulled out of a hat" theory called the "Laffer curve", according to which tax cuts should have paid for themselves.⁷⁸

Josh Elliott noted that "this model rests on the rational actor model, that people exclusively act in their economic interests at all times and everyone has equal access to the same information. Not only have numerous studies and authors debunked these economic underpinnings, but the model itself is an unreliable predictor of economic outcomes"⁷⁹ and cited situations where the Laffer approach cannot produce any reliable results.

Kimberly Amadeo, a US and world economics and investment expert with more than 20 years of experience in economic analysis and business strategy, who is president of the World Money Watch economics website, said that the Laffer curve is debunked because it lacks real numbers: "In other words, the actual tax rates and the percentage increase in revenue generated are the missing factors. If Laffer had put numbers on the diagram, the government could say, "... let's increase the tax rate from 24 % to 25 % to get a 2 % increase in the tax base". If you look at the chart, it appears that the "Prohibitive Range" starts at about a 50 % tax rate. If that were the case, then the chart would no longer be relevant today. Why? The federal government hasn't taxed anyone at 50 % or higher since 1986."⁸⁰

⁷³ Prohorovs, A., Fainglozs, Ļ. and Jonina, V. 2016. *Uzņēmumu ienākuma nodokļa atliktā maksājuma ieviešana kā būtisks faktors Latvijas ekonomikas attīstībā*. Kopsavilkums. Rīga: RISEBA, 26.

⁷⁴ Sproģe, I. 2010. *Nodokļu politika ekonomikas attīstības mainīgajos apstākļos: promocijas darbs: specialitāte – ekonomika*. Rīga: Latvijas Universitāte, 213.

⁷⁵ Zelgalvis, E., Sproģe, I. and Joppe, A. 2010. Theoretical Aspects of Taxation Policy. *Economic Science for Rural Development, Jelgava*. (21), 158–165.

⁷⁶ Jurušs, M. 2016. Tax policy impact on income inequality in Latvia. *Proceedings of the 58th International Scientific Conference of Daugavpils University*, 14–15 of April 2016. 100–113.

⁷⁷ Latvijas Republikas Fiskālās disciplīnas padome. 2018. 2018. gada nodokļu reformas rezultāti un kritēriji tālākai nodokļu sistēmas pilnveidošanai. *Fiskālās disciplīnas padomes viedoklis*. <https://www.fdp.gov.lv/en/media/2988/>.

⁷⁸ Stiglitz, J. 2004. *The Roaring Nineties: A New History of the World's Most Prosperous Decade*. New York: W. W. Norton & Company, 448.

⁷⁹ Elliott, J. 2018. Why the Laffer Curve is garbage. *The Connecticut Mirror*. <https://ctmirror.org/category/ct-viewpoints/why-the-laffer-curve-is-garbage/>.

⁸⁰ Amadeo, K. 2022. What Is the Laffer Curve. Why Tax Cuts No Longer Work. *Economic Theory*. <https://www.thebalance.com/what-is-the-laffer-curve-explanation-3305566>.

Robert Nielsen also does not acknowledge the dependence shown by Laffer and stated that most economists know that the Laffer curve is not true.⁸¹

A. Goolsbee expressed opinion that the Laffer curve as a testable hypothesis has failed and, in his view, the central principle of the Laffer curve is clearly wrong – marginal rates seem to have little effect on the amount that people work.⁸²

An empirical analysis conducted in member countries of the Organisation for Economic Cooperation and Development (OECD)⁸³ at the end of the last century spread scepticism about the Laffer curve among them as well.

Laffer curve and Laffer theorem are also get criticised because it does not take into account tax avoidance, which eventually distorts tax equity.⁸⁴ The problem of the high tax rates claimed to be mistakenly interpreted – instead of lowering budget revenues, the downside is in shortening of capital accumulation and increased capital consumption.⁸⁵

Third group

In studies belonging to the **third group**, the Laffer approach is adopted, but it is often modernised.

In this case, it is possible to distinguish several areas of research.

The first of them is associated with mathematical modelling of production and fiscal processes in order to theoretically construct the dependence of tax revenues of the state on the tax rate and to identify the conditions for the emergence of Laffer points (points of extremum on the fiscal curve).^{86, 87, 88, 89}

This direction assumes modelling of production and fiscal processes and theoretical derivation of parabolic Laffer dependence from the built models. In works of this kind the emphasis is put on a rigorous proof of the existence of the “inflection effect” on the fiscal curve

⁸¹ Nielsen, R. 2012. The Mythical Laffer Curve. *Economics*. <https://whistlinginthewind.org/2012/09/07/the-mythical-laffer-curve/>.

⁸² Goolsbee, A., Hall, R. and Katz, F. 1999. Evidence on the High-Income Laffer Curve from Six Decades of Tax Reform. *Brookings Papers on Economic Activity*. (2), 1–64.

⁸³ Leibfritz, W., Thornton, J. and Bibbee, A. 1997. Taxation and Economic Performance. *OECD Economic Department Working Papers*. Paris, 176, 1–142.

⁸⁴ Morgan, J. 2021. A critique of the Laffer theorem’s macro-narrative consequences for corporate tax avoidance from a Global Wealth Chain perspective. *Globalizations*. 18(2), 174–194.

⁸⁵ Fuller, E. 2020. A Critique of the Laffer Curve. *Procesos de Mercado: Revista Europea de Economía Política*. (17), 311–316.

⁸⁶ Eklund, C.-J. and Malmsten, M. 2019. On optimal tax rates and shifts in the peak of the Laffer curve. *University of Gothenburg, Department of Economics*. Spring 2019, 1–39.

⁸⁷ Fève, P., Matheron, J. and Sahuc, J.-G. 2018. The Horizontally S-Shaped Laffer Curve. *Journal of the European Economic Association*, 16(3), 857–893.

⁸⁸ Tavor, T., Gonen, L. and Spiegel, U. 2022. The Double-Peaked Shape of the Laffer Curve in the Case of the Inverted S-Shaped Labor Supply Curve. *Mathematics*, 10(858), 1–19.

⁸⁹ Borsi, I. and Primicerio, M. 2014. Mathematical models for social and economic dynamics and for tax evasion: a summary of recent results. *Vietnam Journal of Mathematical Applications*. 12(2), 25–48.

and the identification of the conditions for its emergence. The second direction is associated with practical calculations of Laffer points for different countries. This direction can be considered as a section of the theory of macroeconomic estimation on the basis of econometric analysis of specific statistical data.⁹⁰ L. Boqiang and J. Zhijie have shown that the Laffer curve can be applied to the Chinese economy,⁹¹ and its inflection point is about 40 %. Similarly, evidence of existing non-linear dependency between the budget revenues and tax rates was found out in Turkey.⁹² Cross-country studies also involve the usage of the Laffer curve.^{93, 94, 95, 96} Some studies focus on the analysis of possible factors and effects, that can be observed within the framework of the Laffer curve.⁹⁷ Thus, limitations and constraints of this approach are pinpointed – shadow economy, public spending, etc. are not taken into account.

In this case, the functional features of the economic system give way to computational algorithms and work with specific statistical data. In a number of cases theoretical model constructions are accompanied by empirical calculations, thus providing a merger of the first and the second directions.

Within each of the two directions there are also certain differences in the approaches to the analysis of the problem.

Works related to the analysis of the initial assumptions and restrictions used in the construction of the Laffer curve are much rarer. The issue of initial assumptions is addressed in the works of D. Kiefer and P. Mirowski,^{98, 99} in which a critical analysis of the theoretical assumptions of the Laffer curve is conducted. The study of the constraints focuses on the shape of the Laffer curve. Thus, the works of R. Guesnerie and M. Jerison¹⁰⁰ have shown the

⁹⁰ Trabandt, M. and Uhlig, H. 2010. How Far Are We From The Slippery Slope? The Laffer Curve Revisited. *European Central Bank, Working paper series*, April, 1174, 1–59.

⁹¹ Boqiang, L. and Zhijie, J. 2019. Tax rate, government revenue and economic performance: A perspective of Laffer curve. *China Economic Review*. 56(1), 1–20.

⁹² Sen, H., Bulut-Çevik, Z.B. and Kaya, A. 2019. The Khaldûn–Laffer Curve Revisited: A Personal Income Tax–Based Analysis for Turkey. *Transylvanian Review of Administrative Sciences*. (15), 103–118.

⁹³ Wang, L., Rousek, P. and Hašková, S. 2021. Laffer curve – a comparative study across the V4 (Visegrad) countries. *Entrepreneurship and Sustainability Issues*. 9(2), 433–445.

⁹⁴ Ferreira-Lopes, A., Martins, L. and Espanhol R. 2020. The relationship between tax rates and tax revenues in eurozone member countries - exploring the Laffer curve. *Bulletin of Economic Research*. 72(2), 121–145.

⁹⁵ Bhimjee, D. and Leao, E. 2020. Public debt, GDP and the Sovereign Debt Laffer curve: A country-specific analysis for the Euro Area. *Journal of International Studies*. 13(3), 280–295.

⁹⁶ Liapis, K., Politis, E., Ntertsou, D. and Thalassinos, E. 2020. Investigating the Relationship between Tax Revenues and Tax Ratios: An Empirical Research for Selected OECD Countries. *International Journal of Economics and Business Administration*. 8(1), 215–229.

⁹⁷ Hájek, J., Šafář, K., Rotschedl, J. and Cadil, J. 2021. The Laffer Curve Decomposed. *Ekonomický časopis*. (69), 306–326.

⁹⁸ Kiefer, D. 1979. An Economic Analysis of the Kemp/Roth Tax Cut Bill H.R. 8333: A Description, An Examination of its Rationale, and Estimates of its Economic Effects. *The Economics of the Tax Revolt: A Reader*. New York: Harcourt, Brace, Jovanovich. 13–27.

⁹⁹ Mirowski, P. 1982. What's Wrong with the Laffer Curve. *Journal of Economic Issues*. XVI (3), 815–828.

¹⁰⁰ Guesnerie, R. and Jerison, M. 1990. Taxation as a Social Choice Problem, the Scope of the Laffer Argument. *Journal of Public Economics*. 44(90–06), 37–63.

possibility of several points of local maximum on the Laffer curve. T. Tavor, L. D. Gonen, and U. Spiegel proposed a curve with three peaks¹⁰¹ and defined them as for youth, adult men and adult women, justifying that these groups most likely would have a different reaction to possible changes.

A similar result, only for other initial assumptions and mathematical models, is obtained in the study of U. Spiegel and J. Templeman.¹⁰² Whereas in the works of F. Gahvari and J. Malcomson^{103, 104} the cases when this dependence has no optimal value at all, but will increase monotonically all the time and have a point of rupture at certain boundary conditions, are given.

A number of papers attempt to modernise the Laffer curve by constructing it on the basis of the analysis of theoretical aspects (initial assumptions). These include a number of works by A. Laffer himself and J. Wanniski, as well as by E. Balatsky, V. Papava. All these scientists give a theoretical justification for the graphical interpretation of the curve.

There are many theoretical and econometric studies of the relationship between tax revenues and the tax rate, and they do not always refer to the simple form of this relationship that Laffer envisioned.

Depending on the consideration of additional factors affecting the value of tax revenues, the shape of the Laffer curve can become asymmetric in either direction. For example, Z. Becsi. has demonstrated various types of asymmetries of the Laffer curve, based on alternative options for spending resources to balance the budget.

Becsi has shown that public investment used to balance the budget increases the area under the Laffer curve, due to its higher location relative to the Laffer curve plotted with only private investment.¹⁰⁵ Becsi also noted that if public consumption is used to balance the budget, the inflection point of the Laffer parabola will be located higher than similar points of the first two curves (Figure A1.2, Annex 1B). Thus, Becsi demonstrated the fact that, depending on initial conditions, there can be three different maximum levels of tax burden on the economy.

A number of researchers paid attention to the fact that under certain conditions the Laffer curve can have several inflection points. Thus, D. Henderson stated that the Laffer curve in its original form may be considered as approximation, yet it should have more than just one inflexion point, as it is not firmly guaranteed that tax cuts would lead to situation, where people

¹⁰¹ Tavor, T., Gonen, L.D. and Spiegel, U. 2021. Reservations on the classical Laffer curve. *The Review of Austrian Economics*. (34), 479–493.

¹⁰² Spiegel, U. and Templeman, J. 2004. A Non-Singular Peaked Laffer Curve: Debunking the Traditional Laffer Curve. *The American Economist*. 48(2), 61–66.

¹⁰³ Gahvari, F. 1989. The nature of government expenditures and the shape of the Laffer curve. *Journal of Public Economics*. 40(2), 251–260.

¹⁰⁴ Malcomson, J. 1986. Some analytics of the Laffer curve. *Journal of Public Economics*. 29(3), 263–279.

¹⁰⁵ Becsi, Z. 2000. The Shifty Laffer Curve. *Federal Reserve Bank of Atlanta. Economic review*. 85(3), 53–64.

start to work more. He shared an opinion of M. Moszer, that labour supply elasticity has the biggest impact in determining the increase in the tax revenues after subsequent tax cuts. As difference between preferences of social groups of people are varying at a big degree so does their labour supply elasticities (a number of modern studies are confirming this fact,^{106, 107} as well as that women are usually having bigger elasticities than men,¹⁰⁸ yet inter-country differences are also may take place, thus not providing a unified solution for tax system).¹⁰⁹ (Figure A 1.3, Annex 1B).

The fact that the cumulative Laffer curve can actually have several peaks is also pointed out by U. Spiegel and J. Templeman, and they explain this by the high degree of inequality in the distribution of wages in most Western countries.¹¹⁰

M. Gardner, taking into account the large number of elasticity estimation results obtained, suggested his visualisation of “perplexed Neo-Laffer curve”¹¹¹ (Figure A 1.4, Annex 1B).

It should be noted that the abovementioned researchers used the location of the axes on the graphs (Figures 1.2 – 1.4, Annex 1B) similar to the one, proposed by Laffer and Wanniski, which was shown in Figure 1.4. The author adheres to the currently most used arrangement of axes for the Laffer curve and gives their images in the version of M. Kakaulina,¹¹² with the conclusions of whom in relation to D. Henderson and Z. Becsi the author is in solidarity. However, it should be noted that, giving an illustration of the Laffer curve in the interpretation of M. Gardner, M. Kakaulina has not indicated that this figure, although it characterises the possibility of the Laffer curve to take various forms, is actually a parody or a satirical construction.¹¹³

A. Blinder notes that the analytical foundations of the Laffer curve were actually established centuries ago and do not require economic analysis at all. He also points out the discrepancy between the right-hand limits of the Laffer curve for indirect taxes and the

¹⁰⁶ Caldwell, S. and Oehlsen, E. 2022. Gender Differences in Labor Supply: Experimental Evidence from the Gig Economy. *The American Economic Association's registry for randomized controlled trials*. No. AEARCTR-0001656. 1–87.

¹⁰⁷ Bargain, O., Orsini, K. and Peichl, A. 2014. Comparing Labor Supply Elasticities in Europe and the US: New Results. *The Journal of Human Resources*. 49(3), 723–838.

¹⁰⁸ Alesina A., Ichino A., and Karabarbounis L. 2011. Gender-Based Taxation and the Division of Family Chores. *American Economic Journal: Economic Policy*. 3(2), 1–40.

¹⁰⁹ Henderson, D. 1981. Limitation of the Laffer curve as a justification for tax cuts. *Cato Journal*. 1(1), 45–52.

¹¹⁰ Spiegel, U. and Templeman, J. 2004. A Non-Singular Peaked Laffer Curve: Debunking the Traditional Laffer Curve. *The American Economist*. 48(2), 61–66.

¹¹¹ Gardner, M. 1981. Mathematical games. The Laffer curve and the other laughs in current economics. *Scientific American*. (245), 18–31.

¹¹² Kakaulina, M. 2017. Visual Representation of Laffer Curve Factoring in Implications of Capital Outflow. *Journal of Tax Reform*. 3(2), 103–114.

¹¹³ Shafrin, J. 2007. Neo-Laffer Curve. *Healthcare Economist*. Unbiased Analysis of Today's Healthcare Issues. <https://www.healthcare-economist.com/2007/09/25/neo-laffer-curve/>.

assumption that such a relationship is possible only for taxes with a narrow temporal, spatial, or commodity base.¹¹⁴

Georgian economists V. Papava and I. Ananiashvili proposed their theory of Laffer-Keynesian synthesis and developed a corresponding model of macroeconomic equilibrium in which the aggregate demand function is based on Keynesian principles and the aggregate supply function on the Laffer postulates.¹¹⁵ They use in some cases the original version of the Laffer curve, while sharing the opinion that the traditional Laffer curve, which economic supply theory talks about, simply does not exist. If apply to the inflection effect in relation to the fiscal curve, then only in relation to tax revenues over several years. In this case the Laffer curve is given a temporal dimension. The scientists refer to a number of studies confirming that after reaching some point (the optimal point), further changes in the tax rate led to changes in tax revenues only after some time. Geometrically, this means that the fiscal curve has a discontinuity. This curve differs significantly from the usual Laffer curve, and the problem of finding the optimal taxation regime is more complicated than one might assume based on the Laffer curve.

It should be noted that, in parallel with purely economic studies of the fiscal curve, there have been works that go beyond a purely economic approach. When analysing the shape of this curve, researchers try to take into account not only economic but also institutional (type of tax system, market structure, quality of the tax system, etc.) and behavioural (degree of trust in the state, tax morality, etc.) factors.^{116, 117}

The dependence of tax revenues on the tax rate is usually viewed as a composite of two effects, which Laffer called, respectively, economic and arithmetic, and some researchers – production and fiscal. It is the effect of the rate on the level of production (and the tax base) and on the volume of tax revenues at a given level of production. Initially, Laffer and his supporters thought that a change in the (average) tax rate would affect output and tax revenues in the same direction, but over time they concluded that these effects could act in different directions. The asynchrony of these effects raises the question of their relative importance for economists and policymakers. In this sense, there is a very indicative statement by D. Mitchell, a proponent of Laffer's ideas and a critic of the "big" stated, that, according to the Laffer curve, increasing

¹¹⁴ Blinder, A. 1981. Thoughts on the Laffer Curve. *The Supply Side Effects of Economic Policy*. Boston: Kluwer Nijhoff Publishing. 81–92.

¹¹⁵ Ananiashvili, I. and Papava, V. 2010. Macroeconomic equilibrium under the Laffer-Keynesian synthesis (in Georgian). *Journal Economist*. 5(10), 5–23.

¹¹⁶ Besley, T. and Persson, T. 2009. The origins of state capacity: property rights, taxation, and policy. *American Economic Review*. 99(4), 1218–1244.

¹¹⁷ Ferreira-Lopes, A., Martins, L. and Espanhol, R. 2020. The relationship between tax rates and tax revenues in eurozone member countries-exploring the Laffer curve. *Bulletin of Economic Research*, 72(2), 121–145.

taxes is a very bad idea, even if it leads to an increase in tax revenues.¹¹⁸ In other words, the paramount importance of the production effect is recognised. The asynchrony of these effects means that it is possible that the tax rate, at which the maximum volume of production is achieved (it is called the Laffer point of the first type), and the rate, at which the maximum volume of tax revenues is achieved (the Laffer point of the second type), do not coincide. In this case, the actual tax rate may be between these rates. This is not only the most interesting, but perhaps the most realistic case. In this case, the question of choosing the direction of the tax rate change becomes more complicated, and the answer to it is not always unambiguous.

It is well known that Keynesian theory was originally focused on analysing the causes of short-term equilibrium in the presence of large amounts of unoccupied resources. It is no coincidence that one of Keynes main innovations was the concept of involuntary unemployment. And in this logic, demand turned out to be a force that could leverage available but unused resources. Responding to the neo-classicists, Keynes wrote that the problem was not to determine in which industries and how to use resources (on this issue he relied on the classics), but to understand on what the degree of usage of available resources depends.¹¹⁹ According to Keynes, the danger to the economy stems from “passive” savings, which are too large to match the level of production at full employment. Accordingly, taxes were seen as a deduction from the disposable income of economic agents, and their increase – as a factor acting against an increase in production and employment. But in this logic, taxes could also act to reduce “passive” savings, depending on government policies and the redistributive effects associated with them, as well as on the propensity to spend of various groups of agents, including the state. As for the budget deficit, from Keynesian positions (at least in the short run) this problem was considered less important than the problem of unemployment. Another Keynesian feature worth noting is the assumption of relative stability of the general price level in the face of considerable idle resources. Keynesian models are constructed in coordinates “income (output) – interest”, and the Laffer model, in coordinates “income – tax rate”. In contrast to Keynesianism, supply-side economics focused on the problem of the supply of factors (labour and capital) and the role that taxes play in this. It was assumed – and here it is easy to see the influence of the classical tradition – that the question of the use of offered resources was successfully resolved by the market. And within the framework of supply-side economics, savings were viewed not as a deduction from disposable income that undermined demand, but as a resource that increased production. The production function operates with the

¹¹⁸ Mitchell, D. 2012. The Laffer Curve Shows that Tax Increases Are a Very Bad Idea - even if They Generate More Tax Revenue. *Forbes*. <https://www.forbes.com/sites/danielmitchell/>.

¹¹⁹ Keynes, J. 2007. *The General Theory of Employment, Interest and Money*. London: Palgrave. 463.

volume of used factors, while the Laffer concept focuses on their supply. At the same time, the production function reflects the production technology and, accordingly, the relative efficiency of the use of factors, while the Laffer concept does not raise the question of efficiency.¹²⁰

In some of the works referred to the **third** group, attempts are made to determine the shape of the curve by means of empirical calculations carried out on the basis of the construction of economic and mathematical models, setting the type of dependence between tax revenues and the tax burden. In this case (and it is the most common), as a rule, certain parameters of the Laffer curve for individual countries, taxes, time intervals, specific taxpayers, etc. are estimated on the basis of economic and mathematical modelling.

In a separate subgroup of works belonging to the third group, it is worth to distinguish studies, where the curve is built in an unusual coordinate plane: “tax burden – time” or “tax burden – tax base”.

However, in other cases, when the taxation of personal income is not studied, but, for example, the income tax or value added tax (VAT), it is quite difficult to determine the location of the right point of intersection of the curve with the axis along which the tax rate (point *K*) is plotted. This problem has drawn attention of Charles Read.¹²¹ It was shown that the Laffer curve can take a form similar to the one shown in Figure A1.2 (Annex 1B).

In the simplest case, the analysis of this curve shows that if the tax rates levied on a particular tax base are zero, then the budget revenue (tax) is zero, and if they are equal to 100 %, the budget revenue will also be zero, with the assumption that the tax base will disappear.¹²² Some scientists disagree with this, including E. Balatsky who argued that the boundary conditions of this curve, i.e. equality of zero tax revenues at tax rates of 0 and 100 %, are a hypothetical abstraction and zero value of all tax rates means the absence of the tax system itself and, consequently, the state. It was noted that in the other extreme case (assuming it is possible), it is absolutely not necessary that production will be completely curtailed and the state will receive nothing in the form of taxes. Thus, the boundary condition of zero tax revenues at a rate of 100 % may not be fulfilled.¹²³ He suggested that the Laffer curve, which describes the dependence of tax revenues on the tax burden, is not enough to understand the effectiveness of tax policy. For more in-depth analysis he suggested considering another curve, which he called the production Laffer curve, describing the dependence of the volume of production

¹²⁰ Ananiashvili, I. and Papava, V. 2014. *Laffer-Keynesian synthesis and macroeconomic equilibrium*. New York: Nova Science Publishers, 116.

¹²¹ Read, C. 2019. Taxation and the Economics of Nationalism in 1840s Ireland. *Taxation, Politics, and Protest in Ireland, 1662–2016*. Cham: Palgrave Macmillan. 199–225.

¹²² Peacock, A. 1989. The Rise and Fall of the Laffer Curve. *The Political Economy of Progressive Taxation*. 25–40.

¹²³ Balatsky, E. 1997. Fiscal regulation in inflationary environment. *World Economic and International Relations*. (1), 32–44.

(GDP) on the tax burden. Analysing these curves in aggregate, E. Balatsky has drawn attention to the fiscal antagonism, which consists in the fact that the growth of the tax burden is beneficial to the state budget, but extremely harmful to the producer. Depending on how synchronised the interests of producer and state are and how great are the chances to eliminate the mentioned antagonism, the conclusion is made how well the tax policy is adjusted to the interests of producers, whose activity determines the value of the tax base.

The point of extremum of the production function is called the Laffer point of the 1st kind – it is the value of the tax burden, at which the maximum output (GDP) is achieved. And the value of the tax burden, at which state revenues (tax revenues) are maximal, is called the Laffer point of the 2nd kind.

The author agrees with the opinion that at the tax rate of 100 % the tax revenues will not be zero in all cases. The zeroing of tax receipts at this rate may concern, for example, income related to labour costs. If a citizen is deprived of all their earnings, then there is a probability that instead of labour activity they will completely switch to leisure time or will transfer their source of income to the shadow sector.

The results of the Stockholm School of Economics in Riga study “Shadow Economy Index for the Baltic Countries” have shown that the size of the shadow economy in Latvia has increased by 1.6 % in 2020, reaching 25.5 % of gross domestic product (GDP). According to a study of the shadow economy index published since 2010, it is the highest figure for the size of the shadow economy in the country since 2011, when the shadow economy in Latvia reached 30.2 % of GDP.

According to calculations of the Shadow Economy Index, the size of Latvia’s shadow economy tended to increase from 2016 to 2018: 20.7 % of GDP in 2016, 22.0 % in 2017, and 24.2 % of GDP in 2018. In 2019, Latvia saw a slight decline in the shadow economy (23.9 % of GDP), and the latest survey data shows that the size of the shadow economy in Latvia continued to grow in 2020, reaching 25.5 % of GDP. The growth of the shadow economy in 2020 is also seen in Lithuania and Estonia, where the shadow economy increased by 2.2 % compared to 2019, reaching 16.5 % of GDP in Estonia and 20.4 % of GDP in Lithuania. In Lithuania, this is the highest size of the shadow economy since 2009, when the first shadow economy was measured in the Baltics. In Estonia, on the other hand, the shadow economy in 2020 returned to about the same level as in 2018, when it reached 16.7 % of GDP.

The 2021 study states: “At present, it is still relatively difficult to draw conclusions about the extent to which the COVID-19 pandemic has affected the performance of the shadow economy in 2020. However, as in last year’s study, it is safe to conclude that, despite the efforts of politicians, the size of Latvia’s shadow economy has not significantly decreased since 2012.

Unfortunately, the size of Latvia's shadow economy has not shrunk considerably during the period of economic growth when the shadow economy should have shrunk, because business people have an improved business environment and are more motivated to pay taxes. So, it is almost natural that the shadow economy grew during relatively difficult times."¹²⁴

This scenario of moving into the shadow economy is possible when a citizen has a single source of income. If the aggregate income is formed by several sources (under schedular taxation) and (or) includes a part of passive income, the situation becomes poorly predictable. It is difficult to estimate the behaviour of a concrete citizen at the tax rate equal or close to 100 %, as well as to forecast the size of tax revenues to the budget. There are cases when the marginal rate of certain taxes was close to 100 %. For example, at the end and after World War II in the United States the marginal maximum tax rate exceeded 90 %, and in Great Britain it was 98 %.¹²⁵

It should be noted that in the current century in a number of countries of the world the maximum tax rates on personal income exceed 50 %, which is much higher than the average European level. For example, such rates in 2021 are set in Austria, Finland, Denmark, Sweden, Belgium, Israel, Japan.¹²⁶ Under such conditions, if to follow the Laffer concept, a considerable growth of the shadow economy sector in these countries and mass migration is expected. However, these phenomena have not been recorded on a mass scale in these countries.

The analysis of the theoretical justification of the Laffer curve shows that it quite accurately illustrates the application of a progressive scale of tax rates. When a progressive scale is used there are negative incentives in the supply of labour associated with the fact that additional income is taxed at a higher rate. This system of income taxation was in effect in the United States at the time Laffer visualised the famous concept.

It should be noted that the Laffer curve does reflect the dependence of the budget revenue on the tax rate, implying a tax base, without which this function is not viable. However, this curve cannot account for changes in the tax base under the impact of any influences.

Thus, M. Kakaulina pointed out that despite all the variety of studies of the Laffer curve, none of them takes into account the influence of the foreign economic factor on the volume of tax revenues. That is meaning that it is initially assumed that the economy of an individual country is in complete or partial isolation.¹²⁷ Consequently, its tax base does not depend on the

¹²⁴ Sauka, A. and Putniņš, T. 2021. Shadow Economy Index for the Baltic Countries 2009–2020. *Stockholm School of Economics in Riga, 11. Ikgadējā ekonomikas konference*. 1–48.

¹²⁵ Alvaredo, F., Chancel, L., Piketty, T., Saez, E., and Zucman, G. 2018. *World Inequality Report 2018*. Cambridge: Belknap Press, 300.

¹²⁶ KPMG. 2021. Individual tax rates for 2011 – 2021. *Individual Income Tax Rates Table*. <https://home.kpmg/xx/en/home/>.

¹²⁷ Kakaulina, M. 2017. Visual Representation of Laffer Curve Factoring in Implications of Capital Outflow. *Journal of Tax Reform*. 3(2), 103–114.

foreign economic influence, and it is difficult to estimate this influence with the help of this curve at the stage of prospective planning.

The existence of a relationship between the parameters declared by Laffer (the tax burden and the volume of budget revenues) and the tax base is often mentioned by researchers.

For example, Kakaulina provided graphs of Volobuev, Balatsky and Mayburov, which show the qualitative relationship between the tax base and the tax burden.¹²⁸ At the same time, the dependence shown by Volobuev is most often cited in various works. For example, Sproģe and a number of other researchers also referred to it in their studies.¹²⁹ The analysis of this theoretical dependence shows that the tax base decreases with an increase in the tax burden (Figure A1.5, Annex 1B). Yet Mayburov and Balatsky suggested that this dependence is a parabola similar to the Laffer curve (Figure A1.6, Annex 1B).

At the same time, Mayburov (as well as Volobuev, Sproģe, etc.) depicted it in the fourth quadrant of the coordinate axes (Figure A1.6 – right, Annex 1B), but Balatsky turned it over and moved it to the first quadrant, placing it next to the Laffer curve (Figure A1.6 – left, Annex 1B). Balatsky explained the parabolic form of dependence of the tax base on the tax burden (actually repeating the classical Laffer curve) by the fact that, in his opinion, as the tax burden increases, the manufacturer increases its activity and increases output, since the increase in taxes reduce his profit and thereby stimulates the manufacturer to compensate for profit losses via the production growth. But he considered that this process is not unlimited, and after reaching a certain critical level of the tax burden, the manufacturer begins to understand the uselessness and unprofitability of compensatory efforts, as, anyway, everything that can be withdrawn from him will still be withdrawn, and at this moment the manufacturer begins to reduce his production activity and a recession sets in. If the drop in production is too large, it will lead to the fact that budget revenues will stop their growth and begin to decrease gradually. At the same time, Balatsky emphasised that these figures are only a scheme.¹³⁰

It should be noted that Kakaulina in the abovementioned study provided references and graphs of various researchers proving that the Laffer curve in practice often differs from the canonical form. In this case, the assumption of Mayburov and Balatsky that both dependencies in Figure A1.6, (Annex 1B) have a parabolic shape, according to the author's opinion, is sufficiently artificial, and is proposed since analytical research is more convenient in this case. However, significant assumptions lead to the fact that the determination of the maxima of

¹²⁸ Kakaulina, M. 2017. Visual Representation of Laffer Curve Factoring in Implications of Capital Outflow. *Journal of Tax Reform*. 3(2), 103–114.

¹²⁹ Sproģe, I. 2010. Nodokļu politika ekonomikas attīstības mainīgajos apstākļos: *promocijas darbs: specialitāte – ekonomika*. Rīga: Latvijas Universitāte, 213.

¹³⁰ Balatsky, E. 2004. On the nature of the insolvency of the Russian fiscal system. *Society and economics*. (11–12), 127–136.

parabolas has turned, rather not into an economic, but a mathematical analysis. At the same time, this analysis demonstrated only theoretical relation between the tax base and the tax burden, as well as tax revenues and the tax burden. It is difficult to establish a reliable correlation between the tax base and the tax burden in this way due to the large number of assumptions made by researchers in the model.

The attention to this is also drawn by Shcherbakov, who pointed out that “Balatsky’s assumption about the existence of a Laffer point of the second kind – the maximum of the Laffer tax curve – for a quadratic function defining the Laffer tax curve is fulfilled only when the coefficient in front of the squared variable is negative.”¹³¹ Also in the same study, Shcherbakov noted that in order for the function to acquire the necessary form, a number of restrictions of varying severity must be observed, and the justification for the existence of a certain lower limit of tax exemptions by the Balatsky’s model is natural, but primitive, since this model depends solely on the tax burden. Analysing the dependencies proposed by Balatsky, Shcherbakov has drawn attention to the difficulties of economic interpretation of the obtained results and has shown that in some cases it is impossible to do such an interpretation.

Based on the results of the analysis of Balatsky’s approach, Shcherbakov concluded that the choice of functions, which graphs are Laffer curves, remains an open problem.

Balatsky, evaluating the results of calculations using his methodology, pointed out that with the three-parameter method, Laffer points “are either absent or have unrealistic values”, and with the two-parameter method, they “improbably jump over the years.”¹³²

E. Balatsky and N. Ekimova, analysing similar approaches of I. Ananiashvili, V. Papava¹³³ and G. Loladze¹³⁴ concluded that all their approaches were based on the methodology of static functions, which led to serious computational difficulties and very questionable estimates, which results in either overestimated or underestimated fiscal parameters.¹³⁵

At the same time, the works in which Balatsky tried to describe the connection of the Laffer curve with the tax base had been already published by him in 1997.¹³⁶ Over the next quarter of a century, these studies have not received recognition due to significant and

¹³¹ Shcherbakov, G. 2019. Laffer points, area of fiscal contradictions and taxpayers’ acceptance power. *RUDN Journal of Economics*, 27(1), 49–62.

¹³² Balatsky, E. 2003. Invariance of Laffer fiscal points. *World economics and international relations*. (6), 62–71.

¹³³ Ananiashvili, I. and Papava, V. 2010. Macroeconomic equilibrium under the Laffer-Keynesian synthesis (in Georgian). *Journal Economist*. 5(10), 5–23.

¹³⁴ Loladze, G. 2002. About certain aspects of the Laffer curve (in Georgian). *Macro and microeconomics*. 9, 1–14.

¹³⁵ Balatsky, E. and Ekimova, N. 2011. Fiscal policy and economic growth. *Society and economics*. (4–5), 197–214.

¹³⁶ Balatsky, E. 1997. Fiscal regulation in inflationary environment. *World Economic and International Relations*. (1), 32–44.

controversial assumptions in the preparation of models and the lack of substantiated results, which, according to the author's opinion, is not related to the analytical part of the study (it is mostly correct), but namely is due to the prerequisites and economic interpretation of the intermediate and final results obtained is due to which this approach has not received a final implementation.

Kakaulina also referred to the works of Mayburov, in which he, analysing his own approach to the relationship of the tax burden – tax collection – tax base, and a similar approach of Balatsky, concluded that “the theory cannot give a reasonable multifactorial dependence and a satisfactory quantitative assessment of the optimal level of the tax burden yet.”^{137, 138}

It should be noted that, as already mentioned, many researchers, realising the importance of considering the connection of the three above parameters, depicted their theoretical dependence.

The author certainly agrees with the need to take into account the connections of these three parameters, but has to state that at the moment, there are no reliable methods implemented in the form of algorithms for computing these values. At the same time, attempts to establish a connection with the tax base were carried out on the basis of the curve proposed by Laffer, and not by developing other tools.

W. Heijman and J. van Ophem revised Laffer curve and considered that he explained the concept of his curve solely by changes in economic activity. These researchers have shown that part of the Laffer effect is a switch under the influence of an increasing tax rate from the official (white) sector to the unofficial (black, shadow) sector.¹³⁹

Therefore, in the author's opinion, the opinion that the Laffer curve concept does not take into account the presence of the shadow sector of the economy is not fully consistent with the reality, as found in a number of scientific publications. Thus, in A. Laffer's work, when arguing the effects of reducing the tax burden and stimulating economic growth, one of the factors noted is the probability of reducing the number of economic entities that evade taxes.¹⁴⁰

Ilze Sproģe, analysing the shadow economy, offered her explanation of the Laffer curve (Figure A1.5, Annex 1B) for allowed and forbidden zones in taxation.¹⁴¹

¹³⁷ Kakaulina, M. 2017. Visual Representation of Laffer Curve Factoring in Implications of Capital Outflow. *Journal of Tax Reform*. 3(2), 103–114.

¹³⁸ Mayburov, I. 2012. The Problem of Tax Expenditures Identification and Evaluation: Methodological Approach. *Problems of economics. Finance in banking*. (4), 187–193.

¹³⁹ Heijman, W. and Van Ophem, J. 2005. Willingness to pay tax: The Laffer curve revisited for 12 OECD countries. *Journal of Socio-Economics*. (34), 714–723.

¹⁴⁰ Laffer, A. 2004. The Laffer Curve: Past, Present and Future. *Executive Summary Backgrounder, The Heritage Foundation*. June 1(1765), 1–16.

¹⁴¹ Sproģe, I. 2010. *Nodokļu politika ekonomikas attīstības mainīgajos apstākļos: promocijas darbs: specialitāte – ekonomika*. Rīga: Latvijas Universitāte, 213.

She pointed out that the government, by raising tax rates, unknowingly encourages residents and entrepreneurs to operate in the shadow economy. As tax rates rise, businesses and citizens try to hide their income from the State Revenue Service. Not only does the shadow economy disrupt fair competition and discourage productivity and innovation, but it also reduces government revenues. The author agrees with I. Spróge, who noted that reducing the share of the shadow economy is an important reserve to use as an alternative to further increasing the tax burden.

Laffer and his supporters focused on the situation where a reduction in tax rates leads to an increase in the factors of production and its scale, the tax base and, consequently, tax revenues. This approach was adopted by the supporters of R. Reagan, and Laffer's idea became an important component of the economic theory of supply, very popular in the 1980s. Laffer assumed that the tax rates that existed in the US in the mid-1970s were too high. He believed that their reduction could greatly stimulate economic activity and help solve several problems at once: the budget deficit, unemployment, and inflation. This, of course, was politically very attractive at a time when the simultaneous existence of significant inflation and high unemployment has confounded many economists.

Among the tax reforms Laffer and his supporters paid special attention to the Harding–Coolidge (1925), Kennedy (1964), Reagan (1981) tax reforms – the latter already as an implementation of supply-side economics recommendations. Comparing the situation in the economy before and after the reforms, Laffer and his supporters found confirmation of their thesis about the significant stimulating effect of tax cuts.^{142, 143, 144} Thus, according to Laffer, the average growth rate of US real GDP in the four years prior to the Harding–Coolidge reform was 2 % and rose to 3.4 % after the reform; for real federal revenue growth, the numbers were 9.2 % and 0.1 %, respectively, and for the unemployment rate, 6.5 % and 3.1 %. A similar situation was observed after the Kennedy and Reagan reforms.¹⁴⁵ Laffer's success in the 1980s was determined not only by the depth, originality and probative power of his main idea, but by the successful combination of its scientific and simple nature, a certain political and ideological orientation and timeliness.

Laffer's idea reflected the sentiments of a certain part of American society, disillusioned with the “big” state and concerned about the low effectiveness of its economic policies.

¹⁴² Canto, V., Joines, D. and Webb, R. 1979. Empirical evidence on the effects of tax, rates on economic activity. *Proceedings of the Business and Economic Statistics Section (American Statistical Association, Washington, D.C.)*.

¹⁴³ Laffer, A. 1981. Government Exactions and Revenue Deficiencies. *Cato Journal*. 1(1), 1–21.

¹⁴⁴ Domitrovic, B. 2014. Tax Revolt! It's Time to Learn from Past Success. *Cato Policy Report*. January/February.

¹⁴⁵ Laffer, A. 2004. The Laffer Curve: Past, Present and Future. *Executive Summary Backgrounder, The Heritage Foundation*. June 1(1765), 1–16.

Fourth group

An important role was also played by the visual illustration that appeared in many popular publications. The Laffer curve is quite often mentioned in textbooks on macroeconomics and public finance, most often with cautious comments on its credibility.

Harvard economist Gregory Mankiw, a Republican who chaired the board of economic advisers under the second Bush presidency, wrote in his microeconomics textbook that subsequent history has not confirmed Laffer's hypothesis that lower tax rates lead to higher tax revenues. At the same time Mankiw pointed out that Laffer's argument was not entirely without merit. He said that Laffer's visualisation is fundamental and irrefutable mathematical idea as well as is undeniable as a matter of economic theory:¹⁴⁶ the relationship between taxation and tax revenues to the budget is inevitably nonlinear.

The caution of economics textbook creators in assessing the Laffer curve is not accidental – upon all the history of existing of the concept, it was often criticised.

Limitations of the Laffer concept

The modern stage of research into the relationship between tax revenues and the optimal structure of taxes and economic activity is marked by the influence of American economist A. Laffer and the curve of the same name, even if researchers do not agree with him and do not share his political-economic position. With the development of economic theory, the tools of analysis improved, but the degree of controversy has not decreased.

The reason here lies not only in the complexity of the problems or in the fact that even better tools usually do not provide unambiguous answers, but also in the fact that the question of taxes and, consequently, of the state is always ideologically and politically coloured.

Azlan Annuar, Isa, Ibrahim and Solarin rightly noted that the theoretical dependence of monetary income of the state on the average tax rate was known before Laffer. Therefore, it seems more correct to speak not about “Laffer curve”, but about “Laffer effect” or “Laffer concept”, meaning a non-linear feature of the fiscal function, according to which this dependence has a maximum point. The concept of the Laffer curve lies at the heart of supply-side economic theory, according to which marginal tax rates must be reduced in order to stimulate economic growth.¹⁴⁷ A similar position is held by I. Ananiashvili and V. Papava, as

¹⁴⁶ Mankiw, G. 2019. Snake-Oil Economics: The Bad Math Behind Trump's Policies. *Foreign Affairs*. 98(1), 176–180.

¹⁴⁷ Azlan Annuar, H., Isa, K., Ibrahim, S.A. and Solarin, S.A. 2018. Malaysian corporate tax rate and revenue: the application of Ibn Khaldun tax theory. *ISRA International Journal of Islamic Finance*. 10(2), 251–262.

well as R. Guesnerie, who called the dependence proposed by Laffer, “the Laffer effect” or “Laffer’s law”.^{148, 149}

The author does not share the position of researchers who completely deny the validity of the Laffer curve. This curve qualitatively illustrates the observations made by a large number of academic economists over a considerable time period. In this regard, as shown above, it is reflected in both academic and research literature. It should also be taken into account that many economists have tried to use this curve for practical purposes, often in ways that neither Laffer nor Wanniski suggested.

The author shares the viewpoint of T. Merkulova, who showed the most common misconceptions about the Laffer curve. In particular, she pointed out that Laffer did not argue that tax revenues will always increase when the rate is reduced. The Laffer curve only shows that an increase in revenues when the tax rate is reduced can only be expected if the original tax rate was greater than the optimal rate. Thus, one must first know this optimal rate and, by comparing it to the current rate, conclude that it is possible to reduce the latter. Second, this possibility is potential, and its realisation depends on a number of factors: the current tax system, the period of time, the ease of transition to the informal (shadow) economy, the level of tax rates, the availability of legal opportunities to avoid taxation (“tax holes”), factors of production.¹⁵⁰

Many economists have noted the difficulty and had disagreements in identifying the part of the curve that corresponds to the time of the study. In regard to this, the author shares the position of those specialists who agree that the dependence illustrated by Laffer does exist. At the same time, the author agrees with many critics who point to the impossibility of using this approach for practical purposes in a number of cases.

The Laffer curve is not a universal tool. Using it in the form proposed by Laffer can be difficult and not always giving reliable results, which is confirmed by numerous works in which the Laffer curve is criticised and modernised in an attempt to adapt it to specific conditions. One of the reasons for the critical attitude of a substantial part of economists to Laffer theory is the lack of facts confirming this theory, as well as the difficulty of fulfilling its conditions.

The studies associated with the modernisation of the Laffer curve and the methods proposed on their basis to assess the impact of the tax burden on tax collection, in the author’s

¹⁴⁸ Guesnerie, R. 1998. *A Contribution to the Pure Theory of Taxation*. Cambridge: Cambridge University Press, 316.

¹⁴⁹ Ananiashvili, I. and Papava, V. 2010. Macroeconomic equilibrium under the Laffer-Keynesian synthesis (in Georgian). *Journal Economist*. 5(10), 5–23.

¹⁵⁰ Merkulova, T. 2007. Snizhenie nalogovoi nagruzki i effekt Laffera: argumenti I zabluzhdenija. *Nalogooblozhenie: problem nauki I praktiki* [Tax burden lowering and Laffer’s effect: arguments and delusions]. *Kharkiv (Ukraine): ID „INZHEK”*. 28–42.

opinion, should be considered as independent tools based on dependencies known long before the appearance of the Laffer curve. From a formal point of view, the Laffer curve is a graphical model showing the hypothetical relationship between the value of the tax rate and the amount of tax revenue. Consequently, like any other economic and mathematical model, it must have an area in which the results obtained in its study are valid, and conditions under which it is valid, i.e., the limitations of the model. Since the Laffer curve describes the indirect response of the economic system (the volume of tax revenues) to changes in the model parameters (the size of the tax rate), the type of the studied tax (the study area) is quite essential for it. The concept of the Laffer curve cannot be universal for all types of taxes. Depending on the specificities of the studied tax (direct or indirect), the significance of the tax for the budget, the purpose of tax collection (fiscal or corrective), the subject of taxation (legal person or individual), the subject (object) of taxation, the type of the applied rate (progressive, regressive, proportional) significantly depends on the Laffer curve and even on the fact of its existence. The use of this curve is largely hampered by the fact that it actually takes into account the correlation of only two known parameters, while the tax base is not explicitly taken into account in the Laffer approach.

Studies and attempts to improve the Laffer curve, which were conducted for almost four and a half decades, showed that one of the drawbacks of the visualisation proposed by A. Laffer is that this approach initially involves only two variables independent (the tax rate) and dependent (tax revenues).

That's why it is possible to conclude that the visualisation proposed by Laffer has been sufficiently studied and has largely exhausted its possibilities. Many works formally related to modernisation of this curve are in fact independent, but solve a limited range of questions due to the fact that they are initially based on the approach proposed by Laffer and Wanniski. All this confirms the need for a different tool, allowing for taking into account more parameters in an explicit way.

At the same time, it should be noted that the Laffer curve can be used as one of the main tools (or as an additional tool along with those proposed in the Thesis) when conducting a comprehensive optimisation of taxation, which would allow to assess tax collection when modelling various tax burden possibilities.

In this case, the abovementioned disadvantages and limitations of the Laffer curve should be taken into account, or a better tool should be developed that allows to perform more precise assessment.

2 Analysis of the tax policy of Latvia as the EU member state

2.1 Tax policy in the European Union

The establishment of the European Union took place on February 7, 1992.¹⁵¹

European Union predecessor was a European Community – an economic association, established by Belgium, Germany, France, Italy, Luxembourg, and the Netherlands in 1957. In that time period, the basis of the national laws harmonisation of the Economic Community had been formed, as well as for the elimination of the inner barriers. In the tax policy, the main focus was on direct taxation (until Denmark and United Kingdom joined European Community). Harmonisation of direct taxation was suggested for the first time by the Neumark committee.¹⁵² Later, European Economic Community abandoned the idea of direct taxation harmonisation and moved to indirect taxation.

The program of the Commission of the European Economic Community, adopted in 1967, was focused on the solution of the following tasks:¹⁵³

- creation of conditions for ensuring the free movement of investment capital on the common market territory;
- ensuring tax neutrality when corporate structures carry out cross-border mergers and restructuring operations;
- creation of conditions for equal competition in the field of investments through the use of uniform tax calculation methods;
- elimination of differences in the field of taxation of assets of companies incorporated in the EU countries;
- use of a common methodology for determining the tax base for calculating income tax;
- application of unified methods for conducting tax audits and collecting taxes;
- elimination of double taxation;
- convergence of tax rates applicable to corporations in member states.

¹⁵¹ Office for Official Publications of the European Communities. 1992. Treaty on European Union. *Official Journal of the European Communities*. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:11992M/TXT>, 253.

¹⁵² Menéndez, A. 2015. *Neumark Vindicated the Europeanisation of National Tax Systems and the Future of the Social and Democratic Rechtsstaat*. Oslo: ARENA, Centre for European Studies University of Oslo, 57.

¹⁵³ European Economic Community Fiscal and Fin. Comm., Tax Harmonization in the Common Market. Newmark Report. July 9, 1967.

This program didn't manage to be fully implemented, as the state authorities of different EU countries actively defended their rights to preserve fiscal sovereignty in the field of direct taxation.

The sources of the content of European tax law are international legal acts (founding treaties of the EU and international treaties of the member states); regulations of EU institutions; acts of national law of the member states and jurisprudence. The very concept of tax law of the European Union includes a set of several provisions of the Treaty of Rome 1957 (primary law – before the Maastricht Treaty of 1992), provisions of acts of EU institutions adopted within their competence and powers in the EU (secondary law), as well as the results of practice of EU Courts and Courts of First Instance in the area of EU tax policy. Yet, only a part of the national law resulting from the implementation of integration legislation into the national legislation of the EU member states can, in a limited aspect, be recognised as part of EU tax law and only in the part that without distortions duplicates the provisions of integration tax law and is similar to them.¹⁵⁴

Of all the international unions, the EU is currently the most established and mature union in the world. In the process of convergence of the EU countries the tax policy at the EU level has been consistently changing.

The supreme executive body of the EU is the European Commission (EC). Its functions include preparing draft laws, implementing decisions of the European Parliament and the Council, monitoring compliance with EU treaties and other legal acts, as well as other current affairs of the Union.¹⁵⁵

From the moment of its creation to the present, the EU has been paying significant attention to tax policy issues in its activities.

The creation of a common tax policy was confirmed by the Treaty on the establishment of the EU¹⁵⁶ and European single market (providing the freedom for movement of goods, persons, services and capital). This document regulates the prevention of unfair and harmful tax competition of the jurisdictions of the member states, the prevention of tax discrimination in the domestic market, and also provides provisions for the creation of new principles and mechanisms for the elimination of double taxation, as well as measures to ensure the fight against tax violations.

¹⁵⁴ Wattel, P., Marres, O. and Vermeulen, H. 2018. *European Tax Law*. 7th edition. Alphen aan den Rijn: Wolters Kluwer, Kluwer Law International, 1012.

¹⁵⁵ European Commission. EU INSTITUTION European Commission. Retrieved: https://europa.eu/european-union/about-eu/institutions-bodies/european-commission_en.

¹⁵⁶ Office for Official Publications of the European Communities. 1992. Treaty on European Union. *Official Journal of the European Communities*. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:11992M/TXT>, 253.

The measures taken by the EU institutions, as well as by its member countries, have contributed to the elimination of tax barriers within the internal market, ensuring the freedom of movement of goods, persons, services and capital, the rejection of the use of unfair tax competition regimes of jurisdictions, the elimination of double taxation and the successful fight against tax offenses.

The transformation of taxation in the EU has its certain specifics. It should be taken into consideration that there are certain differences in the regulation of direct and indirect taxation of member countries. In the field of indirect taxation of the EU countries, a policy aimed at harmonisation is being carried out, and in the field of direct taxation, a coordination process is underway.

In this regard, within the framework of the European Union, the policy of coordinating tax systems is currently being executed, which provides an opportunity to influence the tax policy of member states while maintaining their fiscal sovereignty. The main directions of tax policy in the EU were the harmonisation of indirect taxes collection, as well as the unification of taxation of companies. To achieve this goal, it was necessary to unify the principles of accrual and ensure the convergence of rates in value added tax (VAT) and other indirect taxes.

The countries of the EU have the right and competence to implement an independent policy in the field of direct taxation, provided that it does not contradict the basic principles of the EU. The modern strategy of the EU, which allows to preserve the sovereignty of states when conducting a regulatory policy in the field of direct taxation, is economically justified. At the same time, the customs policy of the EU protects the interests of member states from external competitors. However, the foundation of the Customs Union and the formation of a Common Market have been accompanied by the elimination of tariff and quantitative restrictions within the EU.

It should be taken into account that the replacement of national currencies by a common collective monetary unit in the countries of the euro area does not allow to use effectively monetary and financial instruments to protect national economies. For this reason, a number of EU countries continue to use the national currency. For example, Denmark, Sweden, Czech Republic, Hungary, Croatia, Poland, Bulgaria, and Romania. The UK did not adopt the euro either.

The adoption of a common customs tariff has led to the expansion of sales markets for the most developed EU countries by reducing production in less competitive national economies.

With limited opportunities for the state in the field of customs and tariff and monetary regulation, it is especially important to maintain the effectiveness of fiscal policy, on which stability in the economies of the member states of the union largely depends.

The opinions of economists of various schools that study the impact of fiscal policy of the member states economies differ significantly.

So, P. Kenen argued that in the formation of economic and monetary unions, it is most expedient to concentrate fiscal powers at the level of supranational authorities.¹⁵⁷

R. Baldwin and C. Wyplosz, based on their research,¹⁵⁸ have come to the conclusion that a unified tax strategy within the framework of economic unions is appropriate if the tax policy of one state has a negative impact on the economies of other member states. Scientists have argued that the policy in the field of taxation, which is carried out at the level of supranational authorities, may be fruitless due to the fact that it will affect the state of the national economies and the social sphere of the member states in different ways. Often, issues related to the well-being of people are more effectively resolved at the state level.

T. Andersen has studied the stabilising effect of tax policy on the economies of member states of different economic unions.¹⁵⁹ Based on this analysis, the scientist concluded that the effectiveness of the tax policy of the countries of economic unions is significantly reduced in the absence of coordination in their actions.

M. Forni and L. Reichlin, using the theoretical model,¹⁶⁰ reasonably proved that the implementation of a common tax policy can smooth out the crisis in the economies of member states of various economic unions. In the studies of scientists, an indicator was presented by which the potential risk was assessed. In addition, an assessment was made of the share of risk that can be offset by a common fiscal system. According to the conclusions of the scientists, a common fiscal system in the conditions of the economic crisis, could smooth out up to 40 % of the initial decline in incomes of the population and business.

Competent management of the fiscal system during a crisis makes it possible to smooth out the fall in the personal incomes of the population and take measures to compensate for the budget losses.¹⁶¹

¹⁵⁷ Kenen, P. 1969. The Theory of Optimum Currency Areas: An Eclectic View. *Monetary Problems in the International Economy*. Chicago: University of Chicago Press. III, 41–60.

¹⁵⁸ Baldwin, R. and Wyplosz, Ch. 2012. *The Economics of European Integration*. New York: McGraw-Hill Education, 584.

¹⁵⁹ Andersen, T. 2005. Is there a role for an active fiscal stabilization policy? *CESifo Working Paper. Fiscal policy, macroeconomics and growth*. 1447 (5), 1–33.

¹⁶⁰ Forni, M. and Reichlin, L. 1999. Risk and Potential Insurance in Europe. *European Economic Review*. 43, 1237–1256.

¹⁶¹ Megersa, K. 2020. Tax Reforms After COVID-19 and Financial Crises. *Brighton, UK: Institute of Development Studies*. 1–34.

The author believes that during the formation of Common Market special attention should be paid to the harmonisation of legislation on indirect taxes, because these taxes have a significant impact on the formation of prices in mutual trade and make up a considerable part of the revenues to the budgets of member countries. At the same time, maintaining a certain independence in the field of direct taxation provides an opportunity at the state level to take measures necessary to maintain balance in national economies.

According to the author's opinion, the restriction of national sovereignty in the field of currency regulation can be partially offset by a competent tax policy. In this regard, in order to stabilise national economies and neutralise the negative impact of the external environment at the level of state governments, the instruments of fiscal regulation will acquire special significance.

Of course, it should be taken into account that the adjustment of the ongoing fiscal policy takes time, since the approval of the national budget is a rather lengthy process. In addition, the introduction of new provisions in tax legislation, as a rule, is not carried out immediately. Transparency and stability of tax policy implies a gradual change in tax rates and principles of taxation. However, as practice shows, the results of the impact of fiscal policy on the country's economy are noticeable already 6–12 months after the changes made. Meanwhile, a positive result from the application of monetary measures can be expected not earlier than in 12–14 months.¹⁶² This is the main advantage of fiscal regulation.

The strengthening of interdependence and complementarity of the economies of the EU countries necessitated not only the coordination of tax policy, but also the formation of a common budget. At present, the budget system of the European Union is the most developed of all existing ones.

The formation of a centralised budget was a unique joint project of the EU member states, which pooled part of their resources in order to provide funding for the costs necessary to solve common problems. The EU budget is adopted for seven years. In addition, a budget for the year is set at the beginning of the financial year.

The largest part of the income in the general budget of the EU is made up of contributions from member states, set as a percentage of their gross national income. Import duties, VAT, contributions from countries that are not EU members, taxes on the wages of employees of supranational institutions of the European Union, interest on bank deposits, as well as fines imposed on companies that violate EU law also make a significant share in the budget revenues.

¹⁶² Baldwin, R. and Wyplosz, Ch. 2012. *The Economics of European Integration*. New York: McGraw-Hill Education, 584.

The EU budget funds are mainly used to execute a unified policy in the field of agriculture, allocate assistance to problem countries and regions based on the Cohesion policy implementation, develop transport infrastructure, conduct scientific research and implement projects of regional significance. At the same time, no more than 5 % of budgetary funds are allocated to finance the administrative apparatus.

It should be noted that the reallocation of EU budget funds is often carried out in favour of countries with a serious level of problems, as well as new members of the European Union. Based on the calculation of the budget balance of each country, on the one hand, donor countries are distinguished, which currently include Germany, France, Great Britain, Italy, the Netherlands, and on the other hand, recipient countries. Issues of budget expenditures are the traditional centre of discussions, since the interests of donor countries and recipient countries often do not coincide.

It is noteworthy that European economists warned in advance about the occurrence of such negative trends in the formation of a common budget by the countries of the economic and monetary union. For example, countries whose economies are in a state of recession will cover their costs from the general budget,¹⁶³ which is previously studied by M. Obstfeld and G. Peri. Moreover, it may promote competition between the countries of the Union for budgetary resources to finance public spending.

The integration experience of the European Union, especially in the field of harmonisation of the tax systems of the member states and the formation of a common budget, is of theoretical and practical interest to other integration associations.

According to the World Bank assessment, there are currently about a hundred associations operating within the framework of free trade zones and customs unions, as well as those that have reached a higher level of integration. Depending on the goals of the member states of the associations, there is either further cooperation within the framework of agreements already reached, or a transition from one stage of integration to a higher level.

The transition from one stage of integration to another implies further liberalisation of economic cooperation based on the results achieved at the previous stage. A free trade zone ensures the free movement of goods between member states.

The Customs Union is aimed at implemented and maintaining a common customs and tariff policy in relation to third countries. The common market implies freedom of movement not only for goods, but also for services, capital, and labour. Economic unions operate on the

¹⁶³ Steinbach, A. 2014. *Economic Policy Coordination in the Euro Area*. 1st edition. London and New York: Routledge studies in the European economy, 212.

basis of a coordinated economic policy, harmonisation of financial systems and the replacement of national monetary units with a common regional one.

During the transition to a more advanced stage of convergence of national economies, the most important task is to coordinate national tax policies and convergence of taxation levels, as well as intensify the processes of formation and development within the framework of integration associations of supranational budgetary systems to finance joint projects.

When forming economic and monetary associations, it is rational to transfer part of the fiscal powers of state bodies to supranational structures that can ensure the coordination of the fiscal policy of the participating countries, taking into account common economic goals. However, it should be taken into account that the restriction of sovereignty in the field of tax regulation can have a serious negative impact on the economies of individual countries of the economic and monetary union.

The most important task in the formation of economic unions is the thoughtful distribution of fiscal powers between national and supranational regulatory bodies, which ensures the coordination of fiscal policy, taking into account the interests of all member states of the association.

The tax policy strategy of the EC was explained in the message of May 23, 2001 “Tax policy in the European Union – priorities for the coming years”.¹⁶⁴

It states that there is no need for universal harmonisation of the tax systems of member states, provided that they comply with EU rules. Member states are free to choose the tax systems they deem most appropriate and applicable based on their preferences. In addition, any proposal for EU tax action must take into account the principles of subsidiarity and proportionality. At the EU level, action is taken only when action by individual member states fails to provide an effective solution. According to the EC, many tax problems simply require better coordination of actions in national policy. The EC, as a priority task in the field of tax policy, regulates actions aimed at solving the problems of individuals and legal entities operating in the domestic market, such as removing tax obstacles for all forms of cross-border economic activity, combating harmful tax competition, and promoting cooperation between tax authorities in ensuring control and combating fraud.

Moreover, according to the European Economic and Social Committee it is necessary to strengthen the coordination of tax policy.¹⁶⁵ The most important goal of tax regulation in the

¹⁶⁴ Communication from the Commission to the Council, the European Parliament and the Economic and Social Committee - Tax policy in the European Union - Priorities for the years ahead. 2001. COM (2001) 0260 final. 10.10.2001. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52001DC0260>.

¹⁶⁵ Communication from the commission to the Council, the European Parliament and the European Economic and Social Committee - Coordinating Member States' direct tax systems in the Internal Market – Commission

EU is the desire of the member states to ensure that business entities are taxed in one of the countries, and double taxation is avoided.

In the EU countries, taxes are established on labour, consumption, property and capital. In fact, direct and indirect taxes are applied. Direct taxes (tax on income of individuals, also known as income tax; tax on profit of organisations, also known as corporate tax; property tax; etc.) provide for monetary withdrawals in favour of the state from the income of business entities and individuals, calculated according to certain rates from the amount of assessment of objects of taxation. Indirect taxes (value added tax (VAT), customs duties, excise taxes) are included by producers of goods, works and services in addition to their prices, therefore, they actually burden buyers, as they are the real payers.

In the period from 2012 to 2017, a clear trend in taxation in the EU was an increase in the VAT rate, as well as in corporate and income tax rates. VAT tax rates, thresholds and their application, as of January 1, 2021, are shown in Table 2.1.

Table 2.1

VAT rates and thresholds in EU

VAT rate	Threshold	Explanation
Standard rate	≥ 15 %	Each EU country has a standard rate which applies to the supply of most goods and services.
Reduced rate(s)	≥ 5 %	One or two reduced rates may be applied to supply of specific goods and services (based on the list in Annex III ¹⁶⁶ of the VAT Directive).
Super-reduced rates	≤ 5 %	Applied to the sales of a limited list of goods and services in certain EU countries (allowed to EU countries that were applying them on 1 January 1991).
Zero rates	= 0 %	Applied to certain sales by some EU countries. When a zero rate is applied the consumer doesn't have to pay any VAT, but you still have the right to deduct the VAT you paid on purchases directly related to the sale (allowed to EU countries that were applying them on 1 January 1991).
Parking rates (intermediary rates)	≥ 12 %	Applied by some EU countries to certain supplies of goods and services that aren't included in Annex III of the VAT Directive ⁶ (allowed to EU countries that were applying them on 1 January 1991).

Source: created by the author based on VAT rules and rates.¹⁶⁷

The diagram (Figure 2.1) shows the VAT rates applied by the EU member states as of January 1, 2021.

of the European Communities. 2006. COM (2006) 823 final. 15.01.2008. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52007AE1264%2803%29>.

¹⁶⁶ An official website of the European Union. 2006. Council Directive 2006/112/EC of 28 November 2006 on the common system of value added tax. 32006L0112. OJ L 347, 11.12.2006. <https://eur-ex.europa.eu/eli/dir/2006/112/oj>, 219.

¹⁶⁷ An official website of the European Union. VAT rules and rates. VAT. Retrieved: https://europa.eu/youreurope/business/taxation/vat/vat-rules-rates/index_en.htm.

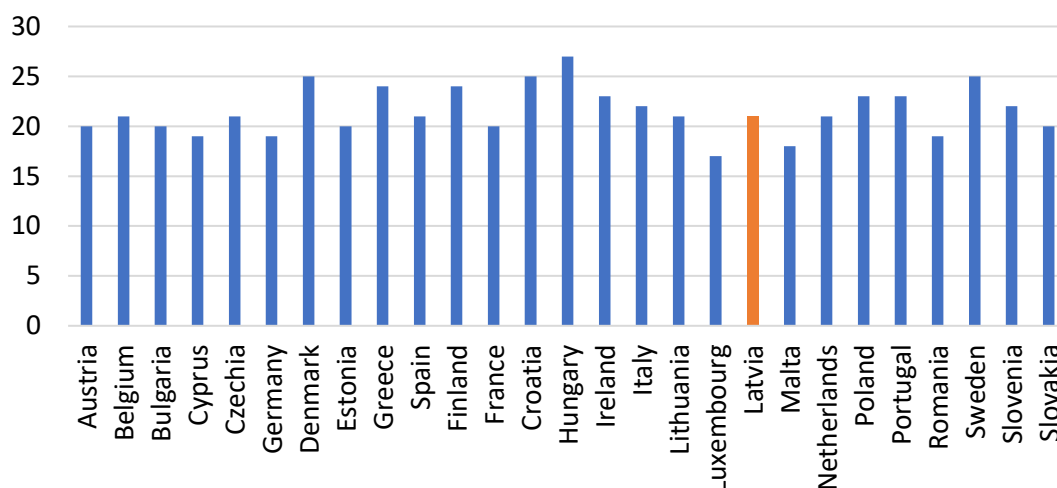


Figure 2.1 VAT rates in European Union (2021)

Source: compiled by the author based on VAT rules and rates.¹⁶⁸

The average standard VAT rate in the EU in 2021 varies from 17 % in Luxembourg to 27 % in Hungary and 25 % in Denmark, Sweden and Croatia. Latvia has 21 % standard VAT rate, which stays in the middle, and close to EU-average.

One of the important tasks that European countries are facing is to reduce greenhouse gas emissions and transfer to green economy. At the same time, it is necessary that the transition is socially fair, and the costs of it are fairly distributed among taxpayers. Concomitant tax changes and reduced financial incentives, such as fossil fuel subsidies, could negatively impact on the poorest part of the society. To mitigate these negative impacts, active labour market and education and retraining measures must be taken simultaneously to protect the most vulnerable in the restructuring of the fiscal system.

Incrementally, harmonised taxation of negative social and environmental externalities (negative externalities) in the EU Unified Market will be essential to move towards more efficient and sustainable economy and ensuring a level playing field for business.

However, today the EU legal framework used in the area of taxation related to various types of energy still contradicts the EU objectives in the field of environment and climate change.¹⁶⁹

As stated in “Reflection Paper Towards a Sustainable Europe by 2030”, the EU is eager to create a stronger, more sustainable and inclusive economy. Following the difficulties of the financial crisis, there has been a period of significant economic growth. The economy was expected to continue to expand in 2019 for the seventh year in a row, with real GDP growing

¹⁶⁸ An official website of the European Union. VAT rules and rates. VAT. Retrieved: https://europa.eu/youreurope/business/taxation/vat/vat-rules-rates/index_en.htm.

¹⁶⁹ European Commission. 2019. Reflection paper towards a sustainable Europe by 2030. COM (2019) 220. 30.01.2019. https://ec.europa.eu/info/publications/reflection-paper-towards-sustainable-europe-2030_en, 132.

in all member states. However, the COVID-19 pandemic intervened with these plans, and low productivity growth reduced the chances of long-term prosperity. The EU's level of innovation and investment remains too low (compared to its main trading partners) to change it.

Moreover, the fact that productivity growth is increasingly unevenly distributed across regions creates risks of loss of cohesion. Meanwhile, social inequality and regional disparities are a growing concern.

The macroeconomic impact of changes in taxation and tax reform also been a topic of interest in scope of the European Union. In the study,¹⁷⁰ where the main focus of the research is taxation fiscal function and related discretionary tax measures, it is stated, that ex-ante assessment of such changes, reforms and measures is infamously hard problem. Very precise analysis is needed, especially when introducing tax cuts. Demonstrated, that tax decreasing taxes (tax cuts) and increasing taxes (tax hikes) have different impact on the macroeconomic situation of the state. Another important aspect, mentioned in this research is that degree of planning and degree of anticipation of tax reforms have and asymmetric impact on the effectiveness of implemented changes – tax cuts and tax hikes.

However, various tax reforms are tending to stack on one another, leading to much more complicated tax system, its regulations and administrative processes of tax gathering and redistribution. It led to separate studies of the concept of tax system complexity. On the example from Greece and its tax system,¹⁷¹ three major directions of simplification were found out, namely technology, information systems and tax legislation. Improvement in these areas is the way to simplify the tax system, make it more understandable to the taxpayer – both for citizens and business. The tax awareness was determined not impactful on the complexity in general, yet it is related to the digitisation and information systems, thus providing an indirect impact.

The author thinks that complexity of the tax system should be taking into account on each of the levels related to the tax system functioning – international, state and local.

Tax policy plays a significant role in shaping the economy and society in the EU. It can stimulate investments, eliminate positive and negative externalities (such as limiting environmentally harmful activities), maintain employment, reduce inequality, and ensure that all taxpayers contribute their fair share to the state budget. The optimal structure of the tax system involves certain trade-offs and prioritisation according to national specifics and political choices. Also, it should be noted that public support is critical to the “legitimacy” of tax reforms.

¹⁷⁰ Van der Wielen, W. 2020. The macroeconomic effects of tax changes: Evidence using real-time data for the European Union. *Economic Modelling*. 90(9), 302–321.

¹⁷¹ Karagiorgos, A., Lazos, G., Lois, P., Katsifas, D. and Kasiouli, M. 2022. Simplification factors addressing tax systemic complexity during tax reform periods: Evidence from the Greek tax system. *Journal of Accounting and Taxation*. 14(2), 161–169.

In recent years EU pursuing the goal of a green economy – as part of the initiative to achieve the goal of reducing greenhouse gas emissions by 55 % by 2030 and reaching their zero level by 2050, on July 14, 2021, the European Commission presented a draft package of climate legislation,^{172, 173} including both new proposals and amendments to existing laws. In particular, among the proposed initiatives, it is planned to introduce a Carbon Border Adjustment Mechanism (CBAM), which provides for the sale, by a specially created authorised body, of certificates for carbon-intensive products imported into the EU according to an established list. CBAM will be introduced gradually: from 2023, it will operate according to a more simplified scheme, and the full implementation of the mechanism is planned to begin in 2026. So, from 2023, manufacturers will need to report on the size of the carbon footprint of their products, and from 2026 – to pay a fee.

At the moment, Latvia has not yet developed a precise plan that would allow the implementation of the tasks set by the European Commission in accordance with this project. However, options are already being considered, including such as a possible increase in the Vehicle Operation Tax and even a ban on the purchase of cars with certain types of engines, as well as reorientation of the country's residents to the priority use of public transport and electric vehicles.^{174, 175} At the same time, already during 2021, a number of reduced excise rates on fuel were cancelled, and increased rates were also introduced on it.¹⁷⁶ In addition, in 2021, changes were introduced in the Vehicle Operation Tax rates.¹⁷⁷

2.2 The tax system of Latvia in relation to the regional aspects

The term “region” nowadays is continuing to be a subject of discussions and debates among researchers focused on regionalism. Despite the globalisation processes, clearly emerging since the XX century, the term “region” is widely used at the various levels of the

¹⁷² European Commission, Secretariat-General. 2021. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. 'Fit for 55': delivering the EU's 2030 Climate Target on the way to climate neutrality. COM (2021) 550 final. 14.07.2021. <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52021DC0550>.

¹⁷³ European Commission. 2021. Delivering the European Green Deal. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/delivering-european-green-deal_en#documents.

¹⁷⁴ Ministru kabineta 21.12.2021 noteikumi Nr. 896 “Emisijas kvotu izsolīšanas instrumenta finansēto projektu atklāta konkursa “Siltumnīcefekta gāzu emisijas samazināšana transporta sektorā – atbalsts bezemisiju un mazemisiju transportlīdzekļu iegādei” nolikums”. *Latvijas Vēstnesis*, 249, 27.12.2021. Pieņemts: 21.12.2021.

¹⁷⁵ Latvijas Republikas Vides aizsardzības un reģionālās attīstības ministrija. 2021. Vides politikas pamatnostādnes 2021.–2027. gadam. *VPP2027*. [https://www.varam.gov.lv/media/download, 123](https://www.varam.gov.lv/media/download/123).

¹⁷⁶ Latvijas Republikas likums. Likums “Par akcīzes nodokli”. *Latvijas Vēstnesis*, 161, 14.11.2003. Pieņemts: 30.10.2003.

¹⁷⁷ Latvijas Republikas Valsts ieņēmumu dienests. 2021. Vehicle Operation Tax. *VID*. <https://www.vid.gov.lv/en/node/57244>.

academic community.^{178, 179, 180} Anssi Paasi and Jonathan Metzger showed, that: “Thus, regions appear to have persistent relevance and allure, both for academics and policy practitioners alike. Then again, understandings of what a region is and does have shifted considerably in the course of decades. The region is today generally conceptualised as a flexible, malleable and mutable object of analysis”.¹⁸¹ The author shares the position of these scientists, that the region could be various objects (e.g. territories), segregated by specific criteria, depending on the aim of the research and set tasks.

The Declaration on Regionalism in Europe was adopted on December 4, 1996 by more than 300 European regions with various territories, political and administrative structures, representing the interests of over 400 million of their citizens at that time.

The main motive for the adoption of the Declaration was the desire for further regionalisation within the institutional framework of their countries. The adoption of the Declaration was initiated by the Assembly of the Regions of Europe, which in its program of action seeks to recognise regionalism not only in the European Union, but also beyond its borders.

The Declaration states that the concept of “region” is an expression of a distinctive political identity that can take on a wide variety of political forms, reflecting the democratic will of each region to adopt whatever form of political organisation it deems preferable. The region itself elects its leadership and establishes the insignia of its representation.¹⁸²

Latvia, after joining the EU in 2004 following the requirements and rules related to the Regional and Cohesion policies of the EU and directives, related to the EU Regional policy, is currently revising the principles of territorial administration.

For example, Riga and the Riga region have always been characterised by a high concentration of social and economic activity. It is quite understandable that the country needs a regional policy that would help to equalise the standard of living between the regions.

Within the framework of the territorial division of the European Union, Latvia is one NUTS 2 (Nomenclature of Territorial Units for Statistics) regions. Since 2008, there has been an internal division into planning regions in Latvia, which basically coincides with the division into historical regions. Internal division of Latvia into planning regions corresponds to the

¹⁷⁸ Entrikin, J. (Ed.). 2008. *Regions: Critical essays in human geography*. London: Ashgate, 636.

¹⁷⁹ Fawn, R. 2009. ‘Regions’ and their study: Wherefrom, what for and where to? *Review of International Studies*. 35 (S1), 5–34.

¹⁸⁰ Harrison, J. 2008. The region in political economy. *Geography Compass*. 2(3), 814–830.

¹⁸¹ Paasi, A. and Metzger, J. 2017. Foregrounding the region. *Regional Studies Association*. 51(1), 19–30.

¹⁸² Assembly of European Regions. 1996. AER Declaration on Regionalism. *AER*. <https://aer.eu/aer-declaration-regionalism/>.

NUTS division of the 3rd level and forms six regions: Riga, Pierīga, Kurzeme, Vidzeme, Zemgale and Latgale.¹⁸³

Dynamics of population change in Latvia and NUTS level 3 planning regions in 2019–2021 are shown in Table 2.2.

Table 2.2

Population change in Latvia and NUTS level 3 planning regions

Population at the beginning of the year	2019	2020	2021
LATVIA	1919968	1907675	1893223
Riga region	632614	621120	614618
Pierīga region	370589	375612	378982
Vidzeme region	186095	185513	183399
Kurzeme region	240113	238584	236022
Zemgale region	230331	229658	227520
Latgale region	260226	257188	252682

Source: Created by the data of Oficiālās statistikas portāls Latvijas oficiālā statistika.¹⁸⁴

Analysis of the data given in Table 2.2 shows the trend of population decline in the country and in all regions, with the exception of the Pierīga region, which demonstrates population growth.

It should be noted that the principles of territorial administration within the framework of the European Union’s regional policy have also undergone changes over the past few decades. They mainly affected the distribution of financial resources, and also entailed a significant decentralisation of some functions of the state and their partial transfer to regional and local authorities. One of the main tasks of territorial administration can be called increasing investment attractiveness and creating such living conditions that could cause an influx of population to the region.¹⁸⁵

The priority is given to local and regional authorities, which independently distribute funds, implement social programs to support low-income groups of the population, provide the necessary social services, take care of environmental safety, etc.

Due to the trend towards decentralisation, i.e. transfer of some functions of the state to regional authorities, their responsibility is largely entrusted to the implementation of social guarantees for the population. The existing imbalances in the socioeconomic development of regions lead to the fact that the least developed regions cannot fully fulfil those social

¹⁸³ Ministru kabineta 21.12.2021 rīkojums Nr.271 “Par Latvijas Republikas statistiskajiem reģioniem un tajos ietilpstošajām administratīvajām”. *Latvijas Vēstnesis*, 69, 01.05.2004. Pieņemts: 28.04.2004.

¹⁸⁴ Oficiālās statistikas portāls. Iedzīvotāju skaits gada sākumā, tā izmaiņas un dabiskās kustības galvenie rādītāji reģionos, republikas pilsētās, novadu pilsētās un novados 1967 – 2021. *Iedzīvotāju skaits un raksturojošie rādītāji*. https://data.stat.gov.lv/pxweb/lv/OSP_PUB/START__POP__IR__IRS/IRS030/.

¹⁸⁵ European Commission. 2011. Territorial Agenda of the European Union 2020. Towards an Inclusive, Smart and Sustainable Europe of Diverse Regions. *EU 2011 HU*. https://ec.europa.eu/regional_policy/sources/policy/what/territorial-cohesion/territorial_agenda_2020.pdf, 11.

obligations that the state has declared as public. Thus, the principle of equal accessibility to the consumption of social goods and services is violated.

It should be noted, that in 1999 M. Jurušs has pointed out,¹⁸⁶ that principle of equality and fairness for taxpayers is not entirely followed in Latvia. He also pointed out that at that time the overall tax burden on high-income individuals was lower than on low-income individuals. Based on this fact, a conclusion was made about the necessity of changing the tax system of Latvia. M. Jurušs has proposed to force people with high incomes pay more taxes to even out the situation. It was suggested to implement this proposal in the following ways:

- by differentiating direct (income) taxes, i.e., by applying a progressive or differentiated tax rate and imposing higher taxes on people with higher incomes;
- by differentiating indirect (consumption) taxes, i.e., to create such tax system in which people with higher incomes would bear a higher tax burden in relation to consumption taxes;
- to use both abovementioned options jointly.

It was also proposed to introduce differentiated value-added tax rates: including lowered rates on food, the base rate on other goods, as well as changes in Personal Income Tax.

In June 2022, I. Šteinbuka, the Chair of the Fiscal Discipline Council (FDP),¹⁸⁷ said that the support of all without exception due to a sharp increase in energy prices would widen the gap between the rich and the poor. She noted that the state budget is limited. The very idea of compensating 50 % of the rise in prices was reasonable, but the entire population did not have to be supported.

According to her opinion, wealthy households could do without government support, but the poorer could not. It would be wise to give more to the poor and nothing to those with money.

The FDP Chair also added that the government has not developed a system of targeted support. The author agrees with the opinion of I. Šteinbuka and trusts that in order to implement targeted support for those who really need it, a certain system of criteria should be developed.

To solve this problem, within the framework of the European Union, instruments have been developed for the implementation of the principle of territorial cohesion, which are financed from the EU structural funds.

In Latvia, on January 1, 2018, a tax reform came into effect, and then reforms related to the change in the administrative-territorial division began. Meanwhile, when carrying out the tax reform, the future administrative-territorial reform (ATR) was not considered.

¹⁸⁶ Jurušs, M. 1999. *Nodokļu sistēmas teorētiskie pilnveidošanas aspekti*. Rīga: Rīgas Tehniskā universitāte, 174.

¹⁸⁷ Fiskālās disciplīnas padome. <https://www.fdp.gov.lv/lv/padome/inna-steinbuka>.

As evidenced by the conclusion of the Council on the administrative-territorial reform, during the preparation of the territorial reform, no economic research was carried out.¹⁸⁸ It is quite clear that territorial division by voting cannot be economically efficient for future new entities. Although the opinion of the residents, undoubtedly, should be taken into account, it is also necessary to bring to their attention the economic aspects of future transformations. Namely, what will be beneficial for them in this or that territorial division. Administrative divisions are directly related to the efficiency of the tax system around the world, despite the fact that the policy in the field of the budget process and the organisation of the budgetary structure in different countries differs significantly. For example, the state power structures in the United States, unlike in Latvia, have unprecedentedly wide powers, up to the establishment of their own tax system. Each of them decides what taxes and in what amount will be collected.¹⁸⁹

Of course, Latvia should not copy the American experience, but certain approaches can be taken into account.

There is a certain absurdity in the fact that money first flows to the centre and then returns back to the regions. Counterflows enrich the bureaucracy, since in the period before the return of funds, financial resources can be disposed of for own benefit. In addition, the funds returned to the territory are devalued by inflation, which means that the regions may incur real financial losses.

The second idea that should be taken into account when designing and running an ATR is the incentive nature of the budget. That is, it is necessary to give the regions their own tax base and, in the event of their successful work, to limit the federal centre in matters of withdrawing funds. Otherwise, the stimulation of the development of territories cannot be fully implemented.

As mentioned above, in November 2019, a council meeting dedicated to the country's upcoming ATR was held at the Latvian Academy of Sciences.¹⁹⁰

¹⁸⁸ Karnīte, R. 2019. Administratīvi teritoriālās reformas ieguvumi. Ziņojums. *Latvijas Zinātņu akadēmijas Humanitāro un sociālo zinātņu nodaļas ekspertu konsīlija*, 52.

¹⁸⁹ Moretti, E. and Wilson D. 2017. The Effect of State Taxes on the Geographical Location of Top Earners: Evidence from Star Scientists. *The American Economic Review*. 107(7), 1858–1903.

¹⁹⁰ The Council consisted of reputable scientists and specialists from Latvia (Inga Goldberga (Saeima), Artūrs Toms Plešs (LV Saeima), Viktors Valainis (Saeima, Association of Large Cities of Latvia (*Latvijas Lielo pilsētu apvienība (LLPA)*)), Dana Reizniece-Ozola (Saeima, ZZS); Andris Jaunsleinis; Arnis Šults (VARAM Head of Reforms Department); Gints Kaminskis and Māris Pūķis (LPS); Elita Eglīte (Chairperson of the Amata County Council); Māris Timermanis (Amatas novada executive director); Laimis Šāvējs (Chairman of Jaunpiebalga County Council); Māris Dadzis (Deputy Chairperson of the Ventspils County Council); Hardijs Entis (Chairman of the Pārgauja County Council); Gunta Auza (Education Department of Jelgava City Council); Jānis Turlajs (SIA “Karšu izdevniecība Jāņa sēta”); Ojārs Spārītis, Pēteris Trapencieris and Raita Karnīte (Latvian Academy of Sciences (LZA)); Baiba Rivža (Latvian University of Agriculture (LLU) and LZA); Lilita Seimuškāne and Andris Miglavs (LU Faculty of Business Management and Economics (LU BVEF), SIA EDO Consult economist); Pēteris Šķiņķis (LU Faculty of Geography and Earth Sciences (LU GZZF)).

The council prepared a conclusion, which indicated that despite a lot of work on the preparation of the proposed reform of the administrative-territorial division, its advantages, disadvantages, as well as its impact on the socio-economic development of the country are poorly substantiated. In addition, this reform has not been sufficiently explained to the public and therefore remains unclear to it.

The reform is likely to reduce financial costs as a result of downsizing municipal institutions and social infrastructure. But this cannot be objectively assessed, since the full benefits and losses of the reform have not been studied and compared in the long or short term. The impact of the proposed reform on the development of society has also not been assessed. The conclusion of the Council also indicates the indisputability of the fact that the centralisation of power and the concentration of finances will restrict local democracy, as well as the fact that in Latvia there is still no clear understanding of the desired administrative division and the structure of government of the country, so it can be assumed that the proposed reform will not be optimal and final. The reform does not entail significant changes in public administration, in social infrastructure, with the exception of school reform, and does not provide for the adaptation of the municipal financial equalisation system to the new situation.

Most of the experts came to the conclusion that the administrative-territorial reform in the form in which it was proposed will not be able to achieve the set goals and the promised results, since their formulations are vague and approximate. There are no proven ways to achieve them, as well as there are no indicators and methods for assessing the quality of life of the population.

The Council recommended postponing the introduction of the ATR until the reformers prepare a comprehensive analysis and explain the publicly substantiated proposals, at least in the following respects:

- the influence of the ATR on the development of society;
- changes in the quality of life of citizens and the business environment after the reform;
- connection of the ATR with other reforms: optimisation of the entire school network (not only secondary schools), decentralisation of public administration, development of health care systems, social protection and transport;
- balanced development of the territory and improvement of the well-being of the population of Latvia;
- precise instructions on the distribution of functions of the state (municipalities) and territorial units (or local governments);
- adjustment of the municipal system of financial equalisation after the reform;

- assessment of internal and external migration and its consequences;
- fair representation of the municipal periphery in the decision-making process;
- procedures (indicators and methodology) for assessing the results and effectiveness of the reform.

In the Council's conclusion, it was stated that in Latvia there was still no understanding of the desired administrative division of the country's territory and the management structure, therefore it could be assumed that this ATR would not be the last one.

In addition, in the materials of the Council in the section "State budget expenditures" it was indicated that the VARAM report "On the implementation of the administrative-territorial reform" submitted to the Chairman of the State Commission on Expenditures and Audit of the Saeima of the Republic of Latvia K. Ģirģens, contained information on the financing of the reform by the government from the state budget.

VARAM requested 9 326 028 euros from the state budget for the implementation of ATR from 2020 to 2021, and this was supported at the meeting of the Cabinet of Ministers on September 17, 2019.

In 2020, it was planned to spend 1 118 528 euros on the reform.^{191, 192}

1. 226 028 euros for the completion of the ATR, information campaign and communication:
 - for sociological research and expert opinions – 160 thousand euros;
 - for the development of a guide to the creation of municipalities – 25.5 thousand euros;
 - for an information campaign and a message about ATR – 10 thousand euros;
 - ATR by agreement and communication – 30.528 thousand euros.
2. Financing from the state budget of local governments for the implementation – 892.5 thousand euros:
 - 367.5 thousand euros for the development of administrative structures (merger) of 29 newly formed municipalities (the cost of one project is slightly more than 18 thousand euros);
 - for the development of a draft document for mutually integrated territorial planning for the development of 29 new municipalities – 525 thousand euros (the average cost of one project is slightly more than 36 thousand euros).

¹⁹¹ Ministru kabineta 18.09.2019 rīkojums Nr.445 "Par konceptuālo ziņojumu "Par administratīvi teritoriālo iedalījumu"". *Latvijas Vēstnesis*, 193, 23.09.2019. Pieņemts: 18.09.2019.

¹⁹² Helmane, I. and Dambe, A. 2019. Cik izmaksās administratīvi teritoriālā reforma. *Cilvēks-valsts-likums* 14(10). <https://lvportals.lv/skaidrojumi/309270-cik-izmaksas-administrativi-teritoriala-reforma-2019>.

In 2021, funding from the state budget of local governments for the implementation of ATR was planned in the amount of 8 207 500 euros:^{193, 194}

- for the development of projects of the administrative structure (merger) for 29 newly formed municipalities – 157.5 thousand euros;
- for the development of a draft document for mutually integrated territorial planning for the development of 29 new municipalities – 525 thousand euros;
- for a one-time payment to municipalities carrying out the ATR (social package for employees, replacement of forms, plates, etc.), including formed municipalities – 7 525 thousand euros:
 - a) when uniting up to three municipalities (13) – up to 155 thousand euros each, total – 2015 thousand euros;
 - b) when uniting four and five (12) municipalities – up to 31 thousand euros each, in total – 3720 thousand euros;
 - c) with the unification of more than six (15) municipalities – up to 447 thousand euros each, in total – 1790 thousand euros.

In a commentary on these budgetary expenditures, it was noted that they only take into account the main costs, and do not include additional costs associated with the possible unemployment of laid-off health and education workers. A one-time subsidy is calculated for municipalities, including a social security package for the chairman and employees.

Since the conclusion of the Council indicates that the estimated ATR will not be the last, the budgetary costs for its development and implementation will increase many times over. Therefore, during its development and implementation, the reliability assessment should also be carried out using a method similar to that developed by the author for assessing the tax system and given in Section 3.2.

An effective tax system can be built only taking into account the administrative and territorial features of any country. For Latvia, this is especially important due to the fact that in addition to the centralised state budget, a number of taxes (for example, Real Estate Tax) and their parts (for example, Personal Income Tax) remain directly in the budgets of local governments. When preparing for tax reforms, it is necessary to consider the peculiarities of territorial division, as well as the economic potential of the regions. And when preparing and conducting the ATR, it is necessary to take into account the economic characteristics of the

¹⁹³ Ministru kabineta 04.03.2021 noteikumi Nr. 142 “Kārtība, kādā pašvaldībām piešķir vienreizēju dotāciju, lai līdzfinansētu administratīvi teritoriālās reformas īstenošanas rezultātā radušos administratīvos izdevumus”. *Latvijas Vēstnesis*, 46, 08.03.2021. Pieņemts: 04.03.2021.

¹⁹⁴ Ministru kabineta 18.09.2019 rīkojums Nr. 445 “Par konceptuālo ziņojumu “Par administratīvi teritoriālo iedalījumu””. *Latvijas Vēstnesis*, 193, 23.09.2019. Pieņemts: 18.09.2019.

regions, changes in tax flows and, if and only if these factors are considered – proceed with its implementation. Otherwise, various unfavourable situations are possible, for example, with increased costs for tax administration and refinancing of certain regions, as well as other situations that reduce the efficiency of the tax system. The administrative-territorial division is unique for each country due to economic, social and other national characteristics. That is also why it is impossible to automatically transfer a “good” tax system of one country to another country. In Latvia, already at the stage of the ATR preparation, it was repeatedly criticised, and despite the fact that it was adopted, the Council, which was described earlier in this subsection, argued that it was insufficiently elaborated and justified.

The ATR, which came into force after the tax reform, can have a significant impact on both the efficiency of the tax system and its reliability, which will be shown in Section 4.1.

2.3 Analysis of the tax policy evolution in Latvia

At the beginning of the 90s of the last century, the creation of the foundations of a market economy began in Latvia. During this period, the country managed in a short time to create a stable macroeconomic environment, which served as the basis for fundamental economic development. It made possible to carry out the transition from a planned economy to a market one. An efficient and fairly fast transition and subsequent economic growth have become possible, inter alia, due to the country’s favourable geographic position and the high quality of the natural environment, which have always been the strengths of Latvia.

After Latvia became a member state of the European Union, new promising markets appeared, and provisions were introduced into the legislation aimed at adapting the national business laws to the European ones.

Studies have shown that simultaneously with this process, a number of accompanying negative factors arose – the opening of internal European borders entailed an outflow of labour, simplified the transition of business to other jurisdictions, increased intercountry competition, both external and domestic. At the same time, the sector of the shadow economy from 2004 to the beginning of the economic crisis of 2008–2009 officially continued to decline.¹⁹⁵

The formation and development of the modern Latvian tax system fell on the beginning of the 90s of the XX century, when the Declaration on the Restoration of State Independence

¹⁹⁵ Schneider, F. 2010. Size and Development of the Shadow Economy of 31 European Countries from 2003 to 2010. *Revised version*. 1–4.

of the Republic of Latvia was adopted.¹⁹⁶ After gaining independence, the Republic of Latvia needed to create its own state tax system as soon as possible.

The main problem during the creation of the national Latvian tax system at that time was that after May 4, 1990, when the Declaration on the Restoration of State Independence of the Republic of Latvia was adopted, the tax system of the USSR and its administrative structures were still operating at the territory of Latvia. As a result, the development of the tax system of independent Latvia began at the time of the operation of two laws simultaneously.^{197, 198}

The legal basis for the new unified state tax system was laid by the aforementioned decision of the Supreme Council of the Republic of Latvia of December 28, 1990, which established that a new tax system came into force in Latvia on January 1, 1991, eliminating the problem of two laws.

This decision was preceded by the adoption of a number of tax laws that predetermined its appearance. So, on December 12, 1990, several laws were adopted related to the tax area, like “On the State Enterprise” and “On Personal Income Tax from the Population”.

The law “On Personal Income Tax from the Population” was subsequently amended and supplemented several times until a new law was adopted on May 11, 1993, which corresponded to the situation relevant for that time. It entered into force on January 1, 1994, and has been repeatedly amended and supplemented to date.

The “Excise Tax Law” provided for a tax on the turnover of certain goods (for example, alcoholic beverages, tobacco products), and the “Natural Resources Law” provided for tax payments for the use of natural resources and the impact of any economic activity on the environment.

The “Value Added Tax Law” was adopted on December 14, 1990. After that, the new law was adopted on December 18, 1991, and then again replaced by the law of July 10, 1992.

The Property Tax Act of December 1992 and the Land Tax Act of December 20, 1990 provided taxes on real estate in urban and rural areas depending on their value, and the Income Tax Act of December 20, 1990 provided taxation of companies. The social tax was included in the tax system of the Republic of Latvia on December 18, 1990.

On February 13, 1991, the law “On Road Tax” was adopted, which provided for the payment of taxes on the sale of gasoline and diesel fuel, as well as on the use of motor vehicles and self-propelled machinery. However, less than a year later, this law became invalid after the

¹⁹⁶ Declaration of Supreme Council of Latvian SSR of restoring independence of the Republic of Latvia, Riga, 4th of May, 1990, <https://www.gorby.ru/userfiles/latvia.pdf>, 3.

¹⁹⁷ Urtāns, A. 2003. *Nodokļu un nodevu vēsture Latvijā*. Rīga: Valsts ieņēmumu dienests, 88.

¹⁹⁸ Latvijas Republikas Saeima. Latvijas Republikas Augstākās Padomes 1. sesijas pieņemtie normatīvie akti. *Latvijas Republikas Saeima*. <https://www.saeima.lv/4maijs/docs/1sesija.htm>.

decision of the Supreme Council of Latvia of January 14, 1992, with retroactive effect – from January 1, 1992. Consequently, the road tax in Latvia at that moment ceased to exist as an independent tax. It was included in the excise tax in accordance with the amendments of December 23, 1991 to the Law “On Excise Tax”.

The resumptive law “On Taxes and Duties” in the Republic of Latvia was adopted on December 28, 1990. It provided taxes and fees for all individuals and legal entities carrying out entrepreneurial activity or receiving income in the Republic of Latvia.

Latvian scientists noticed that from 1991, the tax system of Latvia started to transform, partially by copying tax systems of the West countries, however, the specificities of the national economy of Latvia were not always taken into account.¹⁹⁹

Significant role in creation and following development of the tax system of Latvia was played by the tax reform of 1995. The aim of the reform was to reach two main goals:

- Ensuring stable budget revenues for financing of the prioritised social and economic measures, and for decreasing budget deficit.
- Stimulating economic growth of the state, stimulating fair competition, renunciation of unjustified privileges and benefits, as well as renunciation of unreasonably high tax rates for certain sectors of the economy.

During the development of the tax reform of 1995, with the aim of stimulating the economic development, the main attention was focused on consumption, and not on the income taxation, to stimulate savings and encourage investment growth of the country.²⁰⁰

As part of mentioned tax reform, on April 1, 1995, a new law “On Taxes and Duties” in the Republic of Latvia came into force, which is still in force. Changes and additions were also made to it several times. The author’s research has shown that only one definition of “tax” in this law has undergone five revisions (table 2.3).

¹⁹⁹ Zelgalvis, E., Sproģis, A., Bondars, A., Keišs, S. u. c. 1997. Par Latvijas Republikas nodokļu sistēmu.. *Latvijas Vēstnesis* 02.07.1997. 169. <https://www.vestnesis.lv/ta/id/44178>.

²⁰⁰ Ministru kabineta 10.06.2003 rīkojums Nr.380 “Par Pamatnostādnēm nodokļu un nodevu sistēmas attīstībā”. *Latvijas Vēstnesis*, 88, 12.06.2003. Pieņemts: 10.06.2003.

Changes in the definition of “tax” in the Law “On Taxes and Duties” of Latvia

Period	Definition of the term “Tax”
From 1995 to 1997	Tax – a statutory obligatory payment to the State budget or local government budgets (general budget or special budget), which is not a payment for the purchase of a certain product or service, and does not constitute payment of fines and late payments.
From 1997 to 1998	Tax – a statutory obligatory payment to the State budget or local government budgets (general budget or special budget), which is not a payment for the purchase of a certain product or service, and is not a payment of fines, and is not a payment for the use of state capital or a part of it.
From 1998 to 2007	Tax – a statutory obligatory payment to the State budget or local government budgets (general budget or special budgets), which is not a payment for the purchase of a specific product or service, and does not constitute payment of fines, the main duty to increase money and does not constitute payment of fines, and also does not is a payment for the use of state capital or part of it. The mentioned term also applies to compulsory state social insurance contributions.
From 2007 to 2013	Tax – a statutory obligatory payment to the State budget or local government budgets (general budget or special budgets), which is not a payment for the purchase of a specific product or service, and does not constitute payment of fines and late payments, the main debt is to increase money and does not constitute payment of fines, and late payments, and also is not a payment for the use of state capital or part of it. The mentioned term also applies to compulsory state social insurance contributions, as well as to customs duty and other equivalent payments, which are established by the directly applicable normative acts of the European Union on customs matters.
From 2013 to the present time	Tax – a mandatory periodic or one-off payment laid down in law for ensuring the revenues of the State budget or local government budgets (general budget or special budget) and the funding of the functions of the State and of local governments. The payment of taxes does not imply any compensation to the taxpayer directly. The abovementioned term shall also apply to the mandatory state social insurance contributions, as well as customs duty and other equivalent payments, which are established by the directly applicable normative acts of the European Union on customs matters.

Source: Created by the author based on the tax Laws.²⁰¹

Moreover, in accordance with the Law of December 3, 1990 “On the State Financial Inspection of Latvia”, the rights, duties and responsibilities of tax administration institution were regulated. It was entrusted with three main operational functions, namely: administration of these taxes, the implementation of a number of fees established by government regulations, and other compulsory government payments (for example, payments for the use of state capital), as well as control over contributions and the application of fines in the event violations of tax laws.

At the time the Supreme Council of Latvia very quickly adopted the entire package of laws on business activities regulating the tax system, Latvian economist Evgeniya Zaitseva

²⁰¹ Latvijas Republikas likums. Likums “Par nodokļiem un nodevām”. *Latvijas Vēstnesis*, 7, 13.04.1995. Pieņemts: 02.02.1995.

claimed: “This package of laws was donated by Denmark, it was simply translated into Latvian, approved, published as a brochure – and everything went on.”²⁰²

Ainis Dābols, Chairman of the Board of Tax Advisers of Latvia, also points out that “copying the tax system from developed countries with established economies was not the best solution for Latvia as a new state with its transitional economy”.²⁰³

The author does not believe that there was a complete copying, since his research showed that the package of tax laws was developed at the Latvian Academy of Sciences in the period from 1989 to early 1990. At that time, 14 bills were initially prepared, which were considered by the working group of the Supreme Council of the country (in the summer of 1990). Then, discussions were held directly in the Supreme Council of the Republic of Latvia, which is confirmed by the corresponding transcripts.²⁰⁴ Artūrs Kodoliņš, who was elected a member of the Supreme Council of Latvia in 1990 and was also the Deputy Minister of Finance in early 1990 and head of Tax policy department, should be considered one of the main specialists who created the tax system in Latvia. His leading role is confirmed by the transcripts of the Supreme Council meetings of 1990 and subsequent years.²⁰⁵

In the first half of the 1990s, there were serious shortcomings in tax collection procedures. Einars Repše, who served as Governor of the Bank of Latvia in 1991–2001, stated that the main reason for the state budget deficit back then was tax evasion, which reached massive levels. This trend was observed in many countries of the world, which was due to the withdrawal of a significant share of the income of economic entities in the form of taxes, creating additional motivation for moving to the shadow sector. In many countries of the world, a vast number of consulting firms have opened, helping in various ways (legal, semi-legal, or completely illegal) to reduce the tax burden.

To solve these problems, the administrative system for collecting taxes was reformed – the Law “On the State Revenue Service” (November 28, 1993) was adopted, which regulated the priority tasks and main functions of the new state administration in the field of state revenues.

The main objectives set during establishment for State Revenue Service (SRS) were:

- to establish a fairer tax system;
- to improve collaboration with taxpayers;

²⁰² Odina, T. 2018. Ekonomika, prosto o slozhnom: SGD, nalogi i “navoznie zhuki”. *Ekonomika*. <https://rus.tvnet.lv/6469130/ekonomika-prosto-o-slozhnom-sgd-nalogi-i-navoznye-zhuki>.

²⁰³ Dābols, A. 2014. Nalogovie proverki v Latvii, presentation. *Latvijas Nodokļu konsultantu asociācija*. <http://www.myshared.ru/slide/666327/>.

²⁰⁴ Latvijas Republikas Saeima. 1990. gada 28. decembra sēdes stenogramma. Rīta sēde. *Latvijas Republikas Saeima*. https://www.saeima.lv/steno/AP_steno/1990/st_901228.htm.

²⁰⁵ Latvijas Republikas Saeima. 1991. gada 7. augusta sēdes stenogramma. Vakara sēde. *Latvijas Republikas Saeima*. https://www.saeima.lv/steno/AP_steno/1991/st_910807v.htm.

- to shape public opinion on the necessity for paying taxes;
- to establish proper customer service;
- to reduce the amount of bureaucratic processes and procedures;
- to cut administrative expenses.²⁰⁶

Simultaneously, the legislative base of the tax system was significantly revised in order, among other things, to bring taxation closer to the requirements of the European Union.

The taxes stipulated by the Law of the Republic of Latvia “On Taxes and Duties” are shown in Table 2.4.

In addition, this Table contains the main regulations governing the enforcement of the relevant tax, as well as additional information.

Table 2.4

Taxes of the Republic of Latvia, their regulation and characteristics (2019)

Tax	The legislative framework	Additional information (purpose, object, payer, characteristic, etc.)
Customs Duty	EU Customs Code, European Commission Regulations, Latvian Customs Law regulating a narrow range of issues that are not subject to EU regulations.	The purpose of the tax is to protect the internal market of the EU and European producers from intense competition with cheap goods from third countries.
Excise Duties	EU Regulations (binding), EU Directives (highly recommended), Law of the Republic of Latvia “On Excise Tax”. The Regulations are not included in the text of the national law and act directly. Regulatory acts of the Cabinet of Ministers of Latvia.	Seven groups of goods are levied: petroleum products, alcoholic beverages, tobacco products, liquid used in electronic cigarettes, coffee, soft drinks, natural gas.
Value-Added Tax	EU regulations and directives, laws and regulations of the Cabinet of Ministers of Latvia, as well as recommendations and methodological materials of the SRS. For taxpayers, the main document is the Value Added Tax Law, which includes EU norms.	$\text{Object} \times \text{Rate} - \text{Discounts (input tax)} = \text{payment according to declaration.}$
Electricity Tax	Introduced from 01.01.2007 at the request of the EU. Regulated by the Law of the Republic of Latvia “On Electricity Tax” and the rules of the Cabinet of Ministers.	The object of the tax is the delivered volume of electricity. The taxation period is 1 calendar month.

²⁰⁶ Latvijas Republikas Valsts ieņēmumu dienests. 2016. Establishment of SRS. VID. <https://www.vid.gov.lv/en/establishment-srs>.

Table 2.4 continued

Tax	The legislative framework	Additional information (purpose, object, payer, characteristic, etc.)
Subsidised Electricity Tax	Law of the Republic of Latvia “On Subsidized Electricity Tax”. It was noted in the text of the law that it was introduced temporarily – until the end of 2017.	Some energy producers receive subsidies from the state for the fact that they use organic raw materials for energy production. The state, in turn, acquires this energy for a guaranteed payment in a certain volume of public procurement. Consequently, in some cases, a tax is paid on the basis of such a subsidy.
Real Estate Tax	Law of the Republic of Latvia “On Real Estate Tax” and Cabinet of Ministers regulations, as well as local government regulations (for example, the Riga City Council regulations “On Real Estate Tax in Riga”).	The only tax that is calculated not by the taxpayer himself, but by the self-government. The object is real estate. Payers are all individuals, legal entities and other persons, residents and non-residents who own property, legal possess it or use, if the law does not exempt them from paying tax.
Natural Resources Tax	Many laws, among them the Natural Resource Tax Law, the Packaging Law and Cabinet of Ministers Regulations. Also, at the end of the text of the law, 13 EU directives are noted, which were included in the text and the list of regulations that were not included.	The purpose of the tax is to raise funds for the improvement of the environment. Tax is levied only on those persons (individuals, legal entities and others) who participate in environmental pollution and in the depletion of natural resources.
Vehicle Operation Tax	Law On Vehicle Operation Tax and Company Car Tax.	Annual duty (or transport tax charged upon vehicle registration and annual vehicle inspection).
Company Car Tax	Vehicle Operation Tax and Company Car Tax.	Introduced in 2011 for entrepreneurs who allow the use of company vehicles for personal purposes of employees and business owners.
Personal Income Tax	Personal Income Tax Law and Cabinet of Ministers Regulations.	Object of taxation minus non-taxable expenses, non-taxable minimum, dependents’ benefits × tax rate = calculated tax. The taxation object is divided into 4 groups: <ul style="list-style-type: none"> • income from business activities; • capital gains; • income from employment (salary); other income.
Mandatory State Social Insurance Contributions	EU normative acts in the social sphere regulating social security of persons traveling within the EU, the Law of the Republic of Latvia “On State Social Insurance”, Cabinet of Ministers rules and methodological materials of the SRS.	Five groups of payers – employer, employee, self-employed person, internal recipient of work with a foreign employer, foreign recipient of work with a foreign employer.

Table 2.4 continued

Tax	The legislative framework	Additional information (purpose, object, payer, characteristic, etc.)
Solidarity Tax	Law of the Republic of Latvia “On State Social Insurance”, “Law on Solidarity Tax”	The object is income exceeding the maximum amount of the object of compulsory state social insurance contributions established for the corresponding calendar year. Payers are employers, employees and others.
Corporate Income Tax	Corporate Income Tax Law and Cabinet of Ministers Regulations.	From 2018, profits are tax-free prior to distribution. New taxable base × tax rate = calculated tax.
Lottery and Gambling Tax	Law on Gambling and Lotteries, Law on Lotteries for Goods and Services, Law on Duty and Tax on Lotteries and Gambling, and Cabinet of Ministers Regulations.	The payer is the capital company, which has received a special permit for the lottery / gambling organisation. The object of the tax is play equipment. Charged for a calendar year. The object of tax for lotteries is income from the sale of lottery tickets. Duties from all types go to the State budget, 75 % of the tax – to the State budget, 25 % – to the local government budget
Microenterprise Tax	Microenterprise Tax Law, Cabinet of Ministers Regulations.	Represents a unified amount of payments, instead of: Personal income tax, Mandatory state social insurance contributions, Entrepreneurial risk duty, Corporate income tax (if the micro-enterprise is a legal entity). Object – annual gross income (turnover).

Source: created by the author based on the corresponding laws and book’s materials “Guide to Latvian tax legislation”.²⁰⁷

The taxes themselves and their values during the historical period under consideration have repeatedly changed both in essence and in size. This process continues at the present time. Thus, on January 1, 2018, a tax reform came into effect in Latvia, which was being prepared over the past several years. One of its goals was to reduce inequality in the distribution of incomes of various groups of the population. Changes to certain taxes were studied by researchers for some time before the major reform.²⁰⁸

The high level of income inequality in Latvia was blamed for insufficient tax-benefit redistribution system, thus it was assumed, that tax system should be changed to improve the redistribution, and the only valid measure for that would be a tax reform. The prepared reform

²⁰⁷ Lukashina, O. 2019. *Ceļvedis Latvijas nodokļu likumdošanā*. Rīga: Tehinform Latvia, 166.

²⁰⁸ Ketners, K. and Pētersone, M. 2014. Corporate income Tax reform possibilities for Latvia. *Economics and Rural Development*. (10), 14–22.

had to introduce long-awaited progressivity to Personal Income Tax, replacing the flat rate with 3 brackets based on the annual income, as well as introducing some other changes.

Changes in the tax system of the country took place in subsequent years. Unfortunately, this goal has not yet been achieved. Before the reform of 2018 entered into force, specialists of Baltic International Centre for Economic Policy Studies have studied possible consequences of the tax reform on income inequality distribution using EUROMOD – tax-benefit microsimulation model.²⁰⁹ They made a set of insightful conclusions: first of all, only a slight decrease of the Gini coefficient, but at maximum by 0.6 percentage points compared to prognosed values without a tax reform. Secondly, the reduction of the Gini coefficient is not fully related to the introduction of the 3 income brackets (on the contrary, they're assumed to be acting as a mean of increasing inequality, not decreasing it), but is mostly dependent on the non-taxable allowance changes. These preliminary evaluations are demonstrating that initial assessment of tax reform and its progressive approach was sceptical – tax burden on low-bracket earners would still be high and other method aimed on them would be preferable.

Post-reform evaluations are showing that the reform, indeed, did not achieve the goal of decreasing socio-economical stratification. According to Eurostat data for 2019, the Gini coefficient in Latvia remains very high in the EU. According to this indicator, in 2019 situation Latvia was better only in comparison to Bulgaria and Lithuania. The average value of the Gini coefficient for the EU in 2019 was estimated at 30.2. The dynamics of the Gini coefficient for Latvia is shown in Table 2.5.

Table 2.5

Latvia – Gini coefficient (2011–2020, scale from 0 to 100)

Region	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Latvia	35.7	35.2	35.5	35.4	34.5	34.5	35.6	35.2	34.5	35.7
Rīga region	34.2	33.7	34.3	33.7	33.6	32.2	34.1	33.9	33.8	35.8
Pierīga region	38.1	36.9	37.1	35.9	34.5	34.8	35.9	35.0	35.4	34.1
Vidzeme region	33.6	35.2	33.7	34.0	32.4	31.6	31.8	33.1	30.8	34.5
Kurzeme region	34.9	33.2	33.6	32.6	31.5	32.7	31.8	31.9	32.2	33.6
Zemgale region	34.8	32.1	32.0	34.2	31.5	33.2	32.7	32.0	30.4	31.8
Latgale region	31.6	31.9	31.9	31.0	31.5	32.3	36.4	33.3	31.3	30.6

Source: Eurostat²¹⁰ and Official statistics portal.²¹¹

²⁰⁹ Pluta, A. and Zasova, A. 2017. Latvia Stumbling Towards Progressive Income Taxation. *FREE Network Policy Brief Series*. 1–6.

²¹⁰ Eurostat. 2022. Gini coefficient of equivalised disposable income - EU-SILC survey. *EU*. https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ilc_di12.

²¹¹ Oficiālās statistikas portāls. Džini koeficients (procentos) 2004–2020. *Ienākumu nevienlīdzība (EU-SILC)*. https://data.stat.gov.lv/pxweb/lv/OSP_PUB/START__POP__NN__NNI/NNI030/.

As of 2020, Latvia ranks second in inequality, as measured by the Gini coefficient in the EU, behind only Bulgaria.

At the same time, the data in Table 2.5 show that there are regions in Latvia (Zemgale region and Latgale region) with the Gini coefficient values close to the EU average. However, in most regions and in Latvia as a whole, there is a tendency towards an increase in the Gini coefficient values.

To date, it is impossible to reliably assess the impact of tax system adjustments in 2020 – 2021 on the economic state of the country due to the lack of the necessary statistical material, as well as the distortions introduced by the COVID-19 pandemic.

The graphs (Figures 2.2–2.7) show the dynamics of changes in the main indicators of the tax system of Latvia from 2007 to 2019.

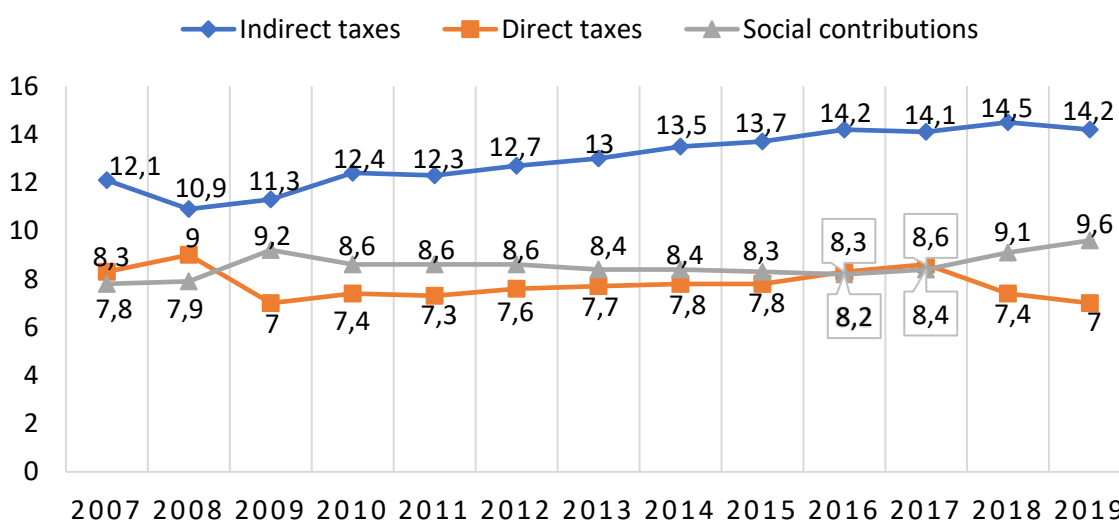


Figure 2.2 Tax revenues by type of tax as % of GDP in Latvia (2007–2019)

Source: created by the author based on the data from European Commission. 2021. Taxation Trends in the European Union.

The general structure of tax revenues as a percentage of GDP shows (Figure 2.2) that throughout the entire shown period (2007–2019), the share of indirect taxes dominates in Latvia, for 2019 the gap between the share of direct and indirect taxes became even more considerable. At the same time, after the 2018 reform, there has been a gradual decrease in the share of direct taxes in relation to GDP.

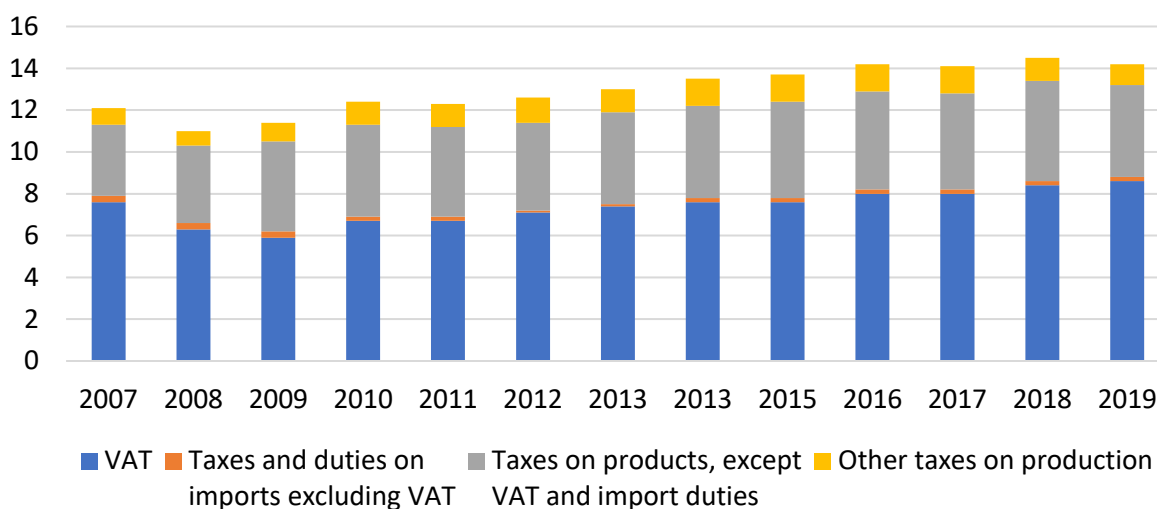


Figure 2.3 **Structure of indirect taxes as % of GDP in Latvia (2007–2019)**

Source: created by the author based on the data from European Commission. 2021. Taxation Trends in the European Union.

An analysis of the structure of indirect taxes showed that value added tax prevailed throughout the entire study period (Figure 2.3). In 2019, in Latvia, most of the tax revenues were provided through indirect taxes – 14.2 % of GDP (where VAT is 8.6 %, taxes and duties on imports excluding VAT are 0.2 %, taxes on products, except VAT and import duties – 4.4 %, other taxes on production – 1.0 %). The second place as a source of budget revenues is taken by social contributions – 9.6 % of GDP (employers account for 6.7 %, households – 2.9 %).

An analysis of the structure of direct taxes (Figure 2.4) showed that Personal Income Tax was and is the largest share of direct taxes. The corporate income tax was the second largest until 2018. Direct taxes make up the smallest share in the structure of tax revenues of the budget in 2019 – 7.0 % of GDP (of which 6.5 % are accounted for by Personal Income Taxes, 0.2 % – by corporate income taxes, and 0.4 % – by other taxes). In 2019, corporate income taxes share fell sharply, making this tax the most insignificant in the structure.

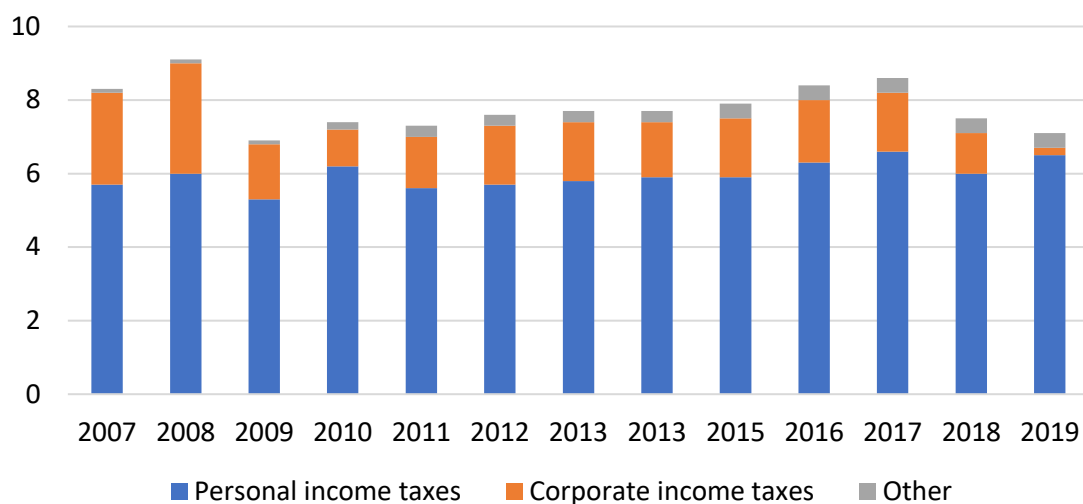


Figure 2.4 **Structure of direct taxes as % of GDP in Latvia (2007–2019)**

Source: created by the author based on the data from European Commission, 2021. Taxation Trends in the European Union.

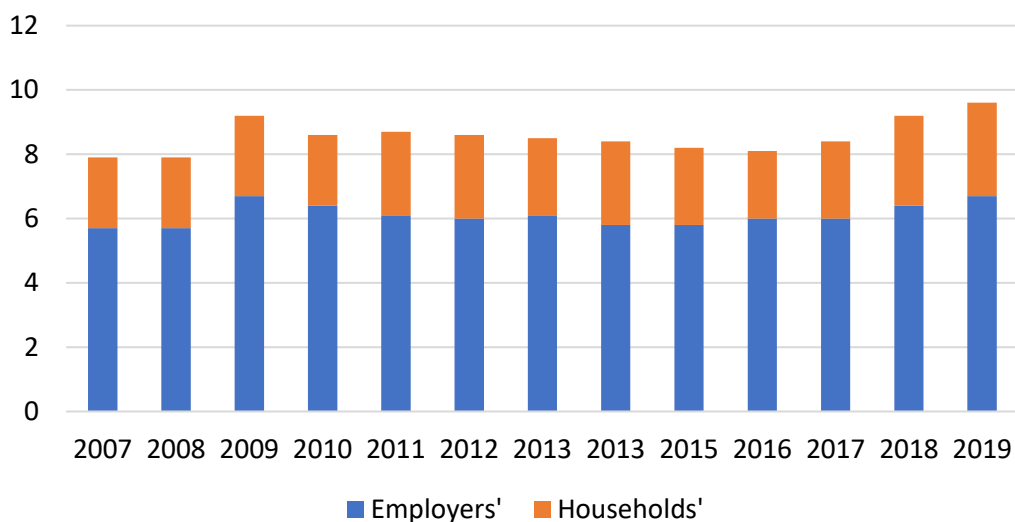


Figure 2.5 **Structure of social contributions as % of GDP in Latvia (2007–2019)**

Source: created by the author based on the data from European Commission, 2021. Taxation Trends in the European Union.

An analysis of the structure of social contributions as a percentage of GDP (Figure 2.5) showed that most of the costs are borne by the employer. Despite this, since 2016, the share of social contributions paid by households has increased from 2.1 to 2.9 % of GDP.

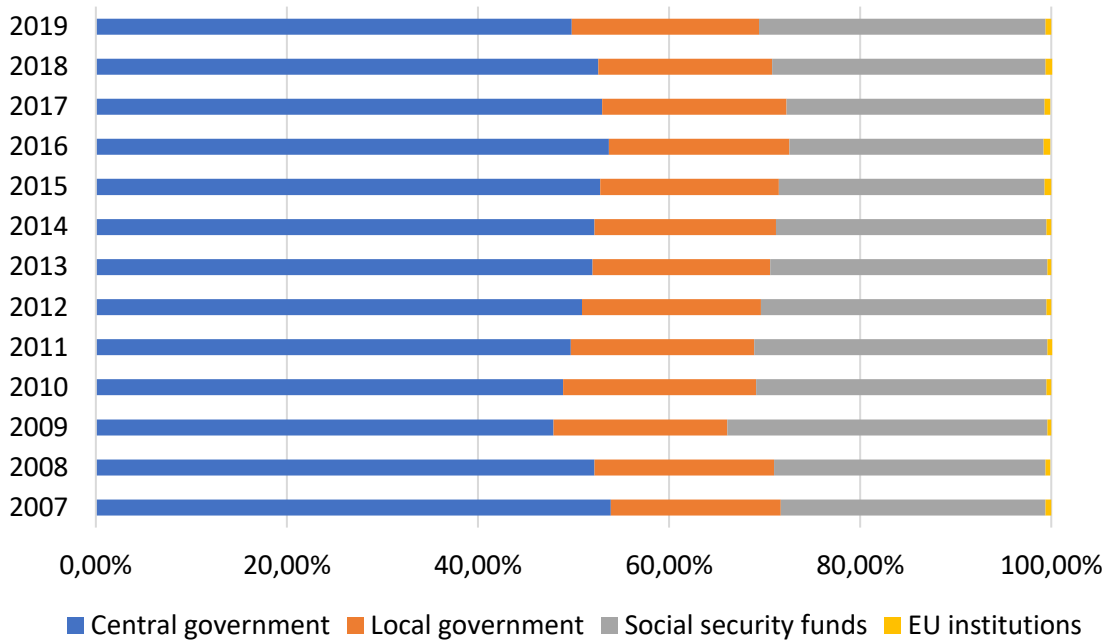


Figure 2.6 Tax revenue distribution by level of government in Latvia (2007–2019)

Source: created by the author based on the data from European Commission. 2021. Taxation Trends in the European Union.

An analysis of the distribution of taxes between budgets of different levels (Figure 2.6) showed that about half of all tax revenues get to the state budget, 30 % get to social funds, a little less than 20 % remains in regional budgets, and 0.6 % goes to EU institutions.

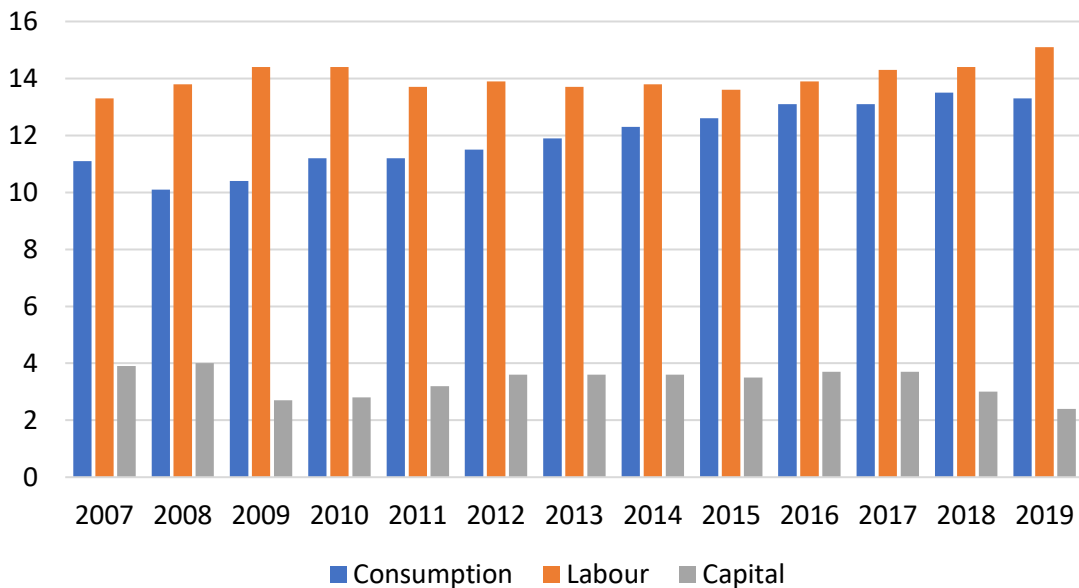


Figure 2.7 Structure by economic function as % of GDP in Latvia (2007–2019)

Source: created by the author based on the data from European Commission. 2021. Taxation Trends in the European Union.

An analysis of the structure of tax revenues (by type of tax, Figure 2.7) shows that tax revenues in Latvia differ significantly from the EU average (EU-27), where each source of tax revenues has approximately equal shares. In terms of the economic function of taxes, labour brings the most tax revenues in Latvia (15.1 % of GDP), while consumption is in second place with 13.3 %. Capital income tax accounts for 2.4 %.

Natural resource taxes in Latvia are 3 % of GDP. Moreover, 2.5 % of these 3 % accrues to energy, and 1.8 % of the indicated 2.5 % are taxes on transport fuels (which is the 6th indicator in the EU). In addition, the 3 % natural resource tax includes transport taxes, accounting for 0.4 %, while the pollution and resource tax accounts for 0.1 %.

Table A2.1 (Annex 2) shows the main changes in the tax legislation of Latvia in the light of tax reforms that came into force in 2020 and 2021.

The European Commission document on taxes shows the forecast trend for tax revenues as a percentage of GDP in 27 EU countries until 2022. According to it, Latvia is one of the four countries where an increase in tax revenues is projected.²¹²

In Latvia, during the preparation and implementation of measures to reform the tax system, a complex of problems of the financial and economic block arose, associated with the formation of the country's budget, taking into account efficiency and economic reliability.

When developing measures to change and (or) improve the tax system, the time factor is of great importance. For each newly created or modernised element of the tax system, new requirements are imposed, aimed at improving its fairness and efficiency. Each subsequent option should have a number of specific advantages over the previous one.

Efficiency of the state development is largely due to the extent to which each of its regions can realise its potential. The basis of the region's potential is formed by endogenous development assets at its disposal, as well as those ways of organising activities and management that prevail in making the most important decisions in order to use these assets in the best way possible. The territorial policy of the state is a complex set of measures aimed at the maximum possible development of all territories, while contributing to the equalisation of the standard of living, balanced settlement of people and the distribution of economic activity. Increasing investment attractiveness and creating such living conditions that could cause an influx of population into the region can be called one of the main tasks of territorial administration.²¹³

²¹² European Commission. 2021. Taxation Trends in the European Union. *Directorate-General for Taxation and Customs Union, European Commission, Publications Office of the European Union*. <https://op.europa.eu/en/publication-detail/-/publication/d5b94e4e-d4f1-11eb-895a-01aa75ed71a1>, 302.

²¹³ European Commission. 2011. Territorial Agenda of the European Union 2020. Towards an Inclusive, Smart and Sustainable Europe of Diverse Regions. *EU 2011 HU*. https://ec.europa.eu/regional_policy/sources/policy/what/territorial-cohesion/territorial_agenda_2020.pdf, 11.

As it was already mentioned, in the conclusion of the European Commission, which studied at the end of 2019 the results of the tax reform launched in Latvia on January 1, 2018, the need to reduce the tax burden on low-paid workers, large families and pensioners in order to reduce social inequality was noted.

Strong evidence is showing²¹⁴ that corporate tax cuts, are actually promoting the inequality – top income inequality increases as the result of such measures. Corporate tax cuts can be used as a mean to increase economic activity, but with a cost of top income inequality increment. Thus, it is making corporate tax cuts an inappropriate tool for both inequality reducing and boosting the economic activity at the same time. In this case, other approaches may be used, e.g. tax cuts to low-income earners,²¹⁵ which may increase the economic activity and at the same time help to reduce inequality and social-economic stratification.

This could be one of the reasons for not achieving the goal of reducing the inequality after the tax reform of 2018.

In the context of the continuing increase in the tax burden on the wealthy strata of society and the decrease in this burden on the poor, obvious difficulties arise, since it is quite understandable that there is a lower (upper) limit of the tax burden, at which the filling of the tax part of the budget significantly deteriorates, and the state's performance of its functions becomes difficult.

Budget revenues are made up of tax and non-tax receipts of funds. When designing the budget revenues, it is necessary to carefully compare the monetary funds entering the budget with the costs of their administration. Unfortunately, this issue is often not even considered. Other so-called incomes actually bring only losses because of excessive collection costs. In particular, it is relevant to research this issue for paid services of government agencies. Supposedly, some of them could be cancelled with a benefit to the budget. In some cases, processing a refund of an overpaid tax with its small volume entails disproportionately high costs for the state.

Discussing the problem of optimising the tax part of the budget, one should take into account the stimulating nature of the tax system. Excessively high tax withdrawals, on the one hand, oppress the economy, and on the other, they question the formation of an adequate income base.

²¹⁴ Nallareddy, S., Rouen, E. and Serrato, J. 2022. Do corporate tax cuts increase income inequality? *Tax Policy and the Economy*. (36), 35–91.

²¹⁵ Zidar, O. 2019. Tax Cuts for Whom? Heterogeneous Effects of Income Tax Changes on Growth and Employment. *Journal of Political Economy*. 127(3), 1437–1472.

When solving the issue of the sources of filling the budgets, one should start with the goals and objectives that face one or another of their levels. There are unconditional competences, for example, preserving the territorial integrity of the state, therefore, the prerogative function of the state budget is the cost of maintaining the army. Similar tasks include the maintenance of the state apparatus, the system of higher education, medicine, fundamental science, ensuring environmental safety and a number of other national expenditures.

Since 1990, the formation and improvement of the national tax system has been taking place in Latvia, which continues to this day. It should be noted that the search for a rational tax system is a task that not only Latvia, but most countries of the world are trying to solve. To accomplish this task, the author has proposed a set of tools (Figure 2.8).

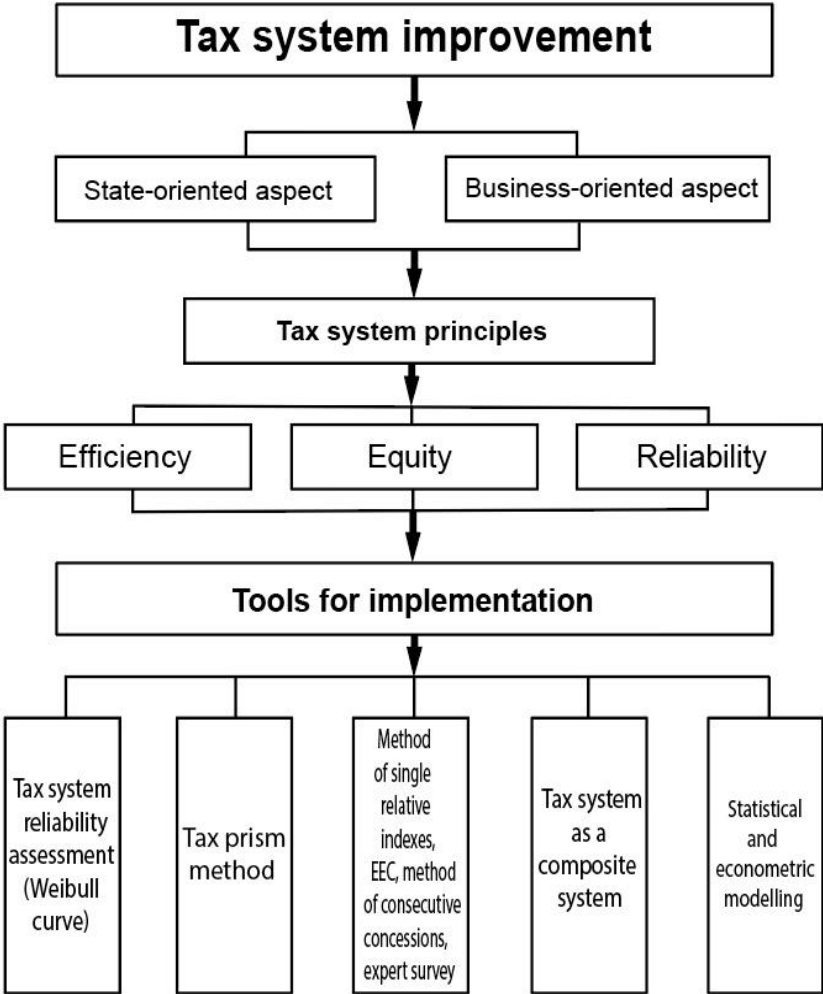


Figure 2.8 **Integrated approach to improving the tax system**

Source: created by the author.

Important works, related to research and development of the tax system of Latvia are done by K. Ketners. These works include books, related to the theory of state revenues, as well as to the development of the practical principles of taxation and its optimisation.^{216, 217, 218} Besides a significant number of monographs, K. Ketners has published also scientific articles, related to the Latvian tax system and principles of the taxation in EU.^{219, 220}

In the Latvian segment of works related to the tax system, modern textbooks, aimed at the students should be noticed – authored by Māris Jurušs “Taxation” and “Tax planning in Latvian and in the international environment”.^{221, 222}

The monograph by I. Sproģe is related to the assessment and improvement of the tax system of Latvia in the context of the shadow economy.²²³ In the context of responsibility for tax and fee evasion, there exists a monography authored by Ļ. Kovaļa.²²⁴ Studies of the tax system are contained in the works of Latvian scientists E. Brēķis,²²⁵ A. Joppe,²²⁶ E. Žubule,²²⁷ B. Pūle,²²⁸ A. Zvejnieks,²²⁹ I. Kodoliņa-Miglāne,²³⁰ A. Medne,²³¹ L. Kavale,²³² etc.

The author holds the opinion that it is possible to solve the problem of constructing an optimal tax system that meets the necessary criteria only by using an integrated approach. Meanwhile, borrowing any successfully functioning tax system of another state is futile in view of intercountry differences. The Thesis proposes an integrated approach to solving the task, including an assessment of the reliability of tax reforms and the tax system as a whole,

²¹⁶ Ketners, K. 2008. *Nodokļu optimizācijas principi*. Rīga: Merkūrijs LAT, 116.

²¹⁷ Ketners, K. 2018. *Nodokļi un nodokļu plānošanas principi*. Rīga: Tehnoinform Latvia, Info Tilts, 322.

²¹⁸ Ketners, K. 2013. *Nodokļi un nodevas Latvijā un Eiropā. Vispārīgie aspekti*. Rīga: Info Tilts, 289.

²¹⁹ Petersone, M., Ketners, K. and Abolina, I. 2018. Conceptualizing the Possible Implementation of Food Taxes in Developed Economies: Case of Latvia. *Ad Alta: Journal of Interdisciplinary Research*. 8(2), 193–197.

²²⁰ Ketners, K. and Pētersone, M. 2014. Corporate income Tax reform possibilities for Latvia. *Economics and Rural Development*. (10), 14–22.

²²¹ Jurušs, M. 2019. *Nodokļu*. Rīga: RTU Izdevniecība, 177.

²²² Jurušs, M. 2021. *Nodokļu plānošana Latvijā un starptautiskā vidē: mācību grāmata*. Rīga: RTU Izdevniecība, 209.

²²³ Sproģe, I. 2010. *Nodokļu politika ekonomikas attīstības mainīgajos apstākļos: promocijas darbs: specialitāte – ekonomika*. Rīga: Latvijas Universitāte, 213.

²²⁴ Kovaļa, Ļ. 2018. *Kriminālatbildība par izvairīšanos no nodokļu un tiem pielīdzināto maksājumu nomaksas: specialitāte – jurisprudences*. Rīga: Latvijas Universitāte, 256.

²²⁵ Brēķis, E. 2007. *Latvijas ēnu ekonomikas modelēšana: nodokļu politikas aspektā: promocijas darbs: specialitāte – ekonomika*. Rīga: Latvijas Universitāte, 145.

²²⁶ Joppe, A. 2008. *Nodokļu administrēšanas pilnveidošana: nodokļu politikas aspektā: promocijas darbs: specialitāte – ekonomika*. Rīga: Latvijas Universitāte, 207.

²²⁷ Žubule, E. 2012. *Valsts budžeta procesa analīze un pilnveidošana: promocijas darbs: specialitāte – ekonomika*. Rīga: Latvijas Universitāte, 219.

²²⁸ Pūle, B. 2014. *Uzņēmumu ienākuma nodoklis kā instruments Latvijas reģionu attīstības veicināšanai. Corporate income tax as a tool to promote the development of Latvian regions: promocijas darbs: specialitāte – ekonomika*. Jelgava: Latvijas Lauksaimniecības universitāte, 274.

²²⁹ Zvejnieks, A. 2003. Ekonomikas un sociālo procesu attīstība. *Uzņēmējdarbība un vadīšana*. 6 (2003), 148–156.

²³⁰ Kodoliņa-Miglāne, I. 2007. *Nodokļi Latvijā*. Rīga: Biznesa augstskola Turība, 105.

²³¹ Medne, A. 2012. *Nodokļi Latvijā*. Rīga: Biznesa augstskola Turība SIA, 118.

²³² Kavale, L. 2011. Tax Policy Under the Conditions of Globalization. *Applied economics: systematic research*. 5(2), 51–65.

a methodology for determining a rational combination of criteria for equity and efficiency, as well as a methodology that allows to consider the mutual influence of tax collection, the tax base and the amount of taxes, and a number of other aspects (Figure 2.8).

3 Tools for analysing and evaluating taxes and the tax system

3.1 Approaches for analysing taxes and the tax system

The role of taxes in modern economic systems is exceptionally great. They are not only the main channel of budget revenues, but are also included in all the main links of the financial system, form and mediate the main financial relations in society. The efficiency of the main parts of the economy, the development of entrepreneurial initiative and satisfaction of the basic needs of the state depend on the thoughtfulness and adequacy of the tax system to the existing economic conditions, the economic principles of the national economy of the country.

Since 2014, Latvia has had the Fiscal Discipline Council,²³³ whose main task is to ensure that the government's fiscal policy guarantees sustainable and balanced economic growth. According to the Fiscal Discipline Council, the main criteria for developing and improving the tax system in 2021 and beyond will be:²³⁴

- achieving an increase in total tax revenues in relation to gross domestic product (GDP);
- reducing the tax burden on the labour force and especially on low-income groups;
- abolishing inefficient tax incentives;
- ensuring fair competition in the business environment, equal tax requirements and equal social protection for employees.

Currently, the role of taxes and the tax system is particularly increasing due to the fact that it is one of the few real levers of regulation of economic and social processes that the state has in the context of the global economic crisis, exacerbated by the COVID-19 pandemic.

The assessment of the level of tax burden and the adequacy of the tax system, despite the fact that this topic has always been in the focus of attention of researchers, continues to be relevant. There are several reasons for this. First, there is no unanimity in views as to which approach to tax burden assessment is the best in methodological terms. Second, tax burden assessment, by and large, has not yet become the most important mechanism for ensuring the effectiveness of tax policy through the establishment of the optimal tax burden.

²³³ Latvijas Republikas Fiskālās disciplīnas padome. 2021. Padome. *Sākums*. <https://www.fdp.gov.lv/lv/nozares-politika/padome>.

²³⁴ Latvijas Republikas Fiskālās disciplīnas padome. 2018. 2018. gada nodokļu reformas rezultāti un kritēriji tālākai nodokļu sistēmas pilnveidošanai. *Fiskālās disciplīnas padomes viedoklis*. <https://www.fdp.gov.lv/en/media/2988/>.

The tax burden is a generalised characteristic of the tax system, determining, among other things, the level of responsiveness of the taxpayer. Most approaches to assessing the tax burden are based on measuring the amount of taxes paid by taxpayers and their financial capabilities (through the indicators of income, revenue, profits, etc.).

Measuring the tax burden has its own purposes at the level of taxpayers and at the level of the state.

Enterprises are interested in determining the level of tax burden for tax planning and financial optimisation purposes. The size of the tax burden can have a significant weight in the costs of the company and forecasting the tax burden for the future period is a necessary component of financial management. The process of preparing investment projects in certain areas of the company activity also includes consideration of the values of the tax burden for each of the activities. The comparison of the tax burden of a particular company with the average tax burden of the industry or region helps companies navigate the tax landscape and look for ways to optimise taxes by applying all available tax incentives or by reorganising the company.

Government agencies need information on the tax burden for the following purposes:

- conducting an effective tax policy and assessing its effectiveness (the introduction of new tax rates or benefits should be commensurate with the pressure they exert on the economy; the assessment of the effectiveness of the impact of the tax system on the socio-economic development of the country is also reflected by this indicator);
- control of tax revenues (significant deviations in the level of tax burden of an individual enterprise from the industry average provides information for a detailed analysis of the situation);
- obtaining forecast estimates of budget revenues (the tax burden indicator allows making quick forecast estimates of budget revenues);
- conducting a balanced regional policy (changes in the level of tax burden in individual regions is important information for the formation of effective inter-budgetary policy);
- control over the conditions of development of economic entities, because the tax burden largely determines the level and direction of investment.

The very functioning of the tax system cannot be effective without taking into account the impact of the tax burden on the economic and financial characteristics of economic entities, on the conditions and results of their activities. An effectively functioning tax system should not allow the oppressive impact of the tax burden on businesses. On the contrary, it should stimulate the development of those activities that are most promising and in demand. A. Smith wrote about the danger of excessive tax burden back in the 18th century, noting that an excessive tax burden can reduce or even destroy the funds that would enable them (people) to make these payments (taxes) with greater ease, and the ruin of companies due to excessive taxes leads to increased unemployment, which also makes it impossible to collect any tax money from the ruined, while their business development in more favourable conditions could bring its benefits for the economy of the country, including, in the form of the tax revenue.²³⁵

Modern macroeconomic theory deals with this problem using the example of the Laffer curve (graphically depicts the dependence of tax collections on tax rates) and the tax multiplier (shows that reducing the tax burden frees up additional funds from taxpayers, which are directed to consumption or investment, which stimulates economic development and leads to its growth).

American researchers C. Romer and D. Romer have shown that a tax increase of 1 % of GDP results in a decrease in GDP of almost 3 %.²³⁶

In addition to the reduction of investment in the case of an excessively high tax burden, there is also the problem of enterprises leaving for the shadow sector of the economy. The absence of tax burden in the shadow sector leads to the possibility of investing a greater part of their profits in the development of production, which causes much more comfortable conditions for the development of the shadow sector. This leads to the replacement of more and more parts of the legal sector by the shadow ones and to the growth of losses of the state budget.

In addition to taking into account these and other peculiarities of tax burden assessment, it is important to take into account all of available research and practical experience. The practical application of the new approach to estimating the tax (fiscal) burden will make it possible to obtain more objective relevant indicators.

In Section 1.2 the main criteria of tax systems were reviewed, where it was emphasised that among them, most often, the criteria of equity and efficiency are of utmost importance.

²³⁵ Smith, A. 1776 (2007). *An inquiry into the nature and causes of the wealth of nations*. (Soares, S. M., eds.), International Edition: MetaLibri, 754.

²³⁶ Romer, C. and Romer, D. 2010. The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks. *American Economic Review*, 100(3), 763–801.

Contradictions between equity and efficiency in tax policy have been repeatedly noted.^{237, 238} At the same time, the emphasis was placed on the fact that even in the most advanced tax systems, contradictions between these criteria take place and have a significant impact on both tax system and society.²³⁹

Experts also drew attention that most studies on tax reforms focus only on the aspect of tax efficiency and do not include the aspect of equity in the analysis.²⁴⁰

The author, having studied these scientific publications devoted to the study of the formation, development and reform of tax systems in different countries of the world, came to a similar conclusion.

The standard explanation for the need for a trade-off between efficiency and equity is that taxes needed to ensure a fairer outcome eventually distort incentives, which in turn leads to efficiency losses.²⁴¹

To determine terms equity and efficiency – the classification of tax law principles according to A. Wagner is used, where efficiency principle is a part of fiscal function and principle of equity (or fairness) is part of social justice of taxation.²⁴²

After studying these works, it can be concluded that the concepts of equity and efficiency are variable (variant) concepts that depend on many economic and political factors (both external and internal).

Moreover, even the parity of these criteria achieved at some stage cannot remain unchanged for a long time. Changes in the country's economy and in the financial policy often led to an imbalance in the efficiency-equity system. Therefore, a timely integrated response will allow to adapt it to the changes that have arisen in a short time.

Due to the fact, that tax system is playing a major role and in a very powerful regulator of the economic processes, its successful functioning is achieved through a balanced combination of all its functions, considering the interests of the state and taxpayers.

The problem of the stimulating effect of the tax system on the economic activity of enterprises solving, the development of production capabilities and the subsequent economic development is one of the priorities of any state.

²³⁷ Toader, S., Ungureanu, M., Predescu, I. and Predescu, A. 2011. Tax Efficiency vs. Tax Equity – Points of View regarding Tax Optimum. *Oeconomica*. 7(5), 44–51.

²³⁸ Bejakovic, P. 2020. How to Achieve Efficiency and Equity in the Tax System? *Revija za socijalnu politiku*. 27(2), 137–150.

²³⁹ Brendon, C. 2013. Efficiency, Equity, and Optimal Income Taxation. *European University Institute*. 22, 1–50.

²⁴⁰ Saez, E. 2001. Using Elasticities to Derive Optimal Income Tax Rates. *Review of Economic Studies*. 68, 205–229.

²⁴¹ Andersen T., Maibom J. 2020. The big trade-off between efficiency and equity – is it there? *Oxford Economic Papers*, 72(2), 391–411.

²⁴² Jarczok-Guzy, M. 2017. The Principles of Tax Law Equality in The Context of Direct Taxation. *Journal of Economics and Management*. (30), 70–84.

Effective taxation can be ensured by a rational combination of the chosen tax mechanism with the goals and objectives that the state sets. The efficiency of taxation, from one point of view can be determined by the ratio of tax revenues to budgets with the total costs of tax collection (including in relation to each specific tax). However, in general, the efficiency of taxation and tax system for the state can be defined as increasing budget revenues via tax revenues and growth of the tax base (the latter in many cases is not properly considered, forcing the tax system to be efficient only at a small period of the time).

From the point of view of the taxpayer, equity criterion means:

- for business entities – obtaining the maximum possible income (profit) while minimising tax payments;
- for the population – in obtaining sufficient income for satisfying needs after paying established taxes, through which the state provides the necessary social services.

In practice, equity can be vertical, horizontal, and also in some cases be associated with the shifting of the tax burden between the groups of taxpayers.

Changes in the economy of the country, and in the financial policy of the state, require appropriate transformations in the tax system. In other words, the tax system cannot be brought to any final form. It is only possible to adapt it to the economic development of the country and to the choice of ways to develop the economy in the future.

In order to take into account their impact in a particular situation most fully, later in this chapter, a method of relative single indexes is proposed for the application. During the formation of the relative single indexes, the most characteristic factors for a particular country and corresponding to a specific economic situation etc., can already be considered at a preliminary stage.

The efficiency and equity of taxes and tax policy can be characterised through the business-oriented optimisation aspect of taxation (equity) and the state-oriented aspect (efficiency).

Business-oriented aspect of tax optimisation

The business-oriented aspect of tax optimisation is defined as a set of measures used by the taxpayer (most often by an enterprise or an individual) or by an outsourcing firm serving them in order to reduce the tax burden in the short or long term or to postpone tax payments.²⁴³ The beneficiary of such actions are the taxpayers themselves.

²⁴³ Term “taxpayer” in Latvia is defined in the law “On Taxes and Fees”, Section 1. <https://likumi.lv/ta/en/en/id/33946>.

These activities can include legal and illegal tax optimisation, as well as leaving to other jurisdictions to reduce the tax burden, as well as in extreme cases – the complete cessation of activities due to the high value of the tax burden.

Competently conducted business-oriented tax optimisation involves reducing the relative and absolute tax burden on the taxpayer, *ceteris paribus*. In this case, the state receives less tax payments to the budget compared to the period before optimisation.

These activities must be carried out within the legal framework, but in some cases, intentionally or unintentionally may violate the law in force.

The business-oriented aspect of tax optimisation related to the criterion of equity, the numerical values of which can be obtained depending on the aim of the study and the available statistics.

There are not many research publications in Latvia, which quantitatively and qualitatively assess these activities in relation to the state under-receiving funds to the budget as a result of legal tax optimisation so far. At the same time, assessment of damage to the country's budget as a result of illegal actions to reduce the tax burden or complete tax evasion is carried out on a regular basis.²⁴⁴

A. Joppe, analysing the sums lost to the Latvian budget as a result of such actions, rightly called them a criminal offence and pointed out that it is important not to underestimate the damage caused to the state budget by unpaid taxes. She noted that state revenues are threatened, and the business environment is distorted as a result of illegal actions of taxpayers.²⁴⁵

In Latvia, there are many firms as well as individual private specialists offering comprehensive accounting services and other services related to the economic activities of companies. As a rule, the services include tax optimisation.

The author surveyed a number of firms providing financial services in Latvia regarding their interpretation of the concept of “tax optimisation” (table A3.1, Annex 3A). In addition, the study included firms offering training on the “tax optimisation” course.

As a result, it was found that some firms have their own websites, and some use the advertising sites *zl.lv* and *ss.com*, posting information about their services. A number of firms offering tax optimisation services explain in some detail on their websites what they mean by this process. Among such companies should be mentioned “ConsttaIns”., “Nodokļu likumdošanas izglītības centrs”, “Taxwise.lv”, “MG Alliance” (table A3.1, Annex 3A).

²⁴⁴ Latvijas Republikas Valsts ieņēmumu dienests. 2018. Nesamaksātās nodokļu summas turpina samazināties. *Aktualitātes, jaunumi*. <https://www.vid.gov.lv/lv/nesamaksatas-nodoklu-summas-turpina-samazinaties>.

²⁴⁵ Joppe, A. 2008. *Nodokļu administrēšanas pilnveidošana: nodokļu politikas aspektā: promocijas darbs: specialitāte – ekonomika*. Rīga: Latvijas Universitāte, 207.

The management of the Alzaro company described their approach to the optimisation of corporate taxation as follows: “Latvian legislation does not stipulate in detail all possible nuances of the tax system, while in many other EU countries all tax operations are stipulated to the smallest detail. Thus, in Latvia lawyers and tax consultants are free to interpret the law, which saves the company from unnecessary costs for taxes.”²⁴⁶

Some firms limited themselves to listing their activities for tax optimisation services. In the course of this study telephone conversations were conducted with representatives of these firms. Firms whose representatives did not provide answers to the requested information and offered to answer questions only at a personal meeting were not included in Table A3.1 (Annex 3A).

Analysing the results of this study, it is possible to conclude that the vast majority of firms offering the above services interpret tax optimisation solely as a process of minimising tax payments. In all cases, representatives of the firms emphasised that they will conduct these activities only within the legal framework.

All this confirms the author’s assumption that tax optimisation is carried out unilaterally and exclusively in the interests of enterprises. At the same time, the interests of the state and society, interested in receiving state support, are not taken into account.

The author shares the opinion of K. Ketners, who argues that tax optimisation is related to the desire of the taxpayer to avoid excessive taxes, which are stipulated by regulations. K. Ketners also points out that this desire often leads to optimisation of “aggressive” taxes, the main condition of which is “why pay more?”. At the same time, the taxpayer defines “suitable amount of taxes” as a value approaching to zero.²⁴⁷

The author has conducted a study of the programs of Latvian higher education institutions that train specialists with competence in tax optimisation. It was found out that a number of higher education institutions (for example, Riga Technical University, Turība, Banku augstskola and Šveices biznesa skola, etc.) offer or at different times have offered training in specialties related to tax optimisation. In general, during the studies, students acquire knowledge, skills and competences in calculating taxes, acquire practical skills in preparing reports and declarations, study the regulatory requirements of tax administration, learning responsibility in case of violation of tax payments. A graduate (bachelor) who has received such education, as indicated in the training programs, receives the following knowledge, skills and competencies, namely:

²⁴⁶ Finanšu aģentūra Alzaro. 2020. Uzņēmuma nodokļu sistēmas optimizācija. *Uzņēmuma nodokļu sistēmas optimizācija*. http://www.alzaro.lv/lv/services/uzmuma_nodoku_sistmas_optimizacija.html.

²⁴⁷ Ketners, K. 2008. *Nodokļu optimizācijas principi*. Rīga: Merkūrijs LAT, 116.

1. Is able to evaluate and apply the regulations governing the tax system, developing competencies of literature analysis.
2. Understands algorithms for calculating direct taxes, is able to calculate direct taxes and fill out reports, developing time management and teamwork skills.
3. Understands the algorithm for calculating indirect taxes, can calculate indirect taxes, and fill out reports.
4. Understands the basic principles of tax planning, practically calculates the volume of sales, cost and tax burden affecting the profit from the economic activity of the enterprise, formulates proposals to reduce the tax burden.
5. Understands the principles of tax planning internationally, developing reasoning competencies in articles.

In addition, a number of organisations hold special training seminars at which trainees representing Latvian companies are advised on various aspects aimed at reducing the tax burden in an ever-changing environment.²⁴⁸

At the same time, it should be noted that the study of training programs for specialists in higher and secondary educational institutions, which was mentioned above, showed a lack of educational programs and individual subjects, aimed at training specialists with skills to represent the state interests in the field of taxation. Therefore, it is necessary to create new specialties or to provide training areas for such specialists within the existing specialisations and programs. Analysis of the study programs offered by the Latvian universities in this area showed that only the training program offered by the Riga Technical University (Administration of Customs and Taxes), in a certain way, corresponds to the state-oriented aspect.

A. Joppe pointed out that there is a lack of theoretical knowledge that would help to create an effective methodology to combat tax evasion, to limit and eliminate all possibilities of tax evasion.²⁴⁹

At the end of 2020, with the cooperation of several ministries – Ministry of Finance, Ministry of the Interior, Ministry of Justice – as well as the competent authority and the Riga Business School, proposals were prepared on how to improve the qualifications of specialists whose responsibilities include combating money laundering. The creation of a special training centre was announced, the development of various training programs for members of the

²⁴⁸ Registreties.lv. Praktiskais nodokļu optimizācijas seminārs. “Nodokļu un komercdarbības plānošana. Izmaksu samazināšana un peļņas palielināšana. Attiecības ar VID + īsumā par aktuālākajiem nodokļu likumdošanas jaunumiem uz 2020. gada 1. maiju”. <http://registreties.lv/nodoklu-optimizacija>.

²⁴⁹ Joppe, A. 2008. *Nodokļu administrēšanas pilnveidošana: nodokļu politikas aspektā: promocijas darbs: specialitāte – ekonomika*. Rīga: Latvijas Universitāte, 207.

judiciary was proposed, so that judges, prosecutors or those working in this industry could work with these cases much more precisely and better – better understand these issues for further studies, to increase their competence in these matters.

Similarly, the training of specialists for state agencies dealing with tax issues in the interests of the state should be provided. Such training is possible both in the form of creating a separate specialisation, and as part of professional development of existing specialists.

Providing a skilled workforce is one of the key areas where investment is still very much needed.²⁵⁰

As mentioned above, the business-oriented aspect of tax optimisation, in addition to legal entities, also includes individuals. In the broad sense of the proposed term, any taxpayer can be considered from the point of view of the business-oriented aspect of tax optimisation. The proposed formalisation allows, depending on the purpose of the research, to use tools to study the problem and the degree of multidirectional of interests not only in the enterprise–state system, but also in the taxpayer-individual–state system. Such an approach allows to consider individual elements of the tax system not only in aggregate, but also targeted, and the proposed formalisation in the business-oriented aspect of tax optimisation is possible due to the fact that both companies and individuals, as rational agents, are aimed at maximising their own profit by reducing the amount of taxes paid.

State-oriented aspect of tax optimisation

The *state-oriented aspect of tax optimisation* is defined as the actions of authorities with special powers to regulate the process of taxation. These actions should be aimed at improving the business climate in the country and increasing the competitiveness of national business, as well as stimulating the creation and development of business in general. At the same time, the structure and administration of taxes are being improved, as well as the automation of tax administration.

Usually, two directions of government action in the field of taxation are distinguished:

- The first is the accumulation of tax payments and the formation of the tax part of the budget. This direction is directly related to the fiscal function of taxes, and usually consists in maximising tax revenues to match the revenue part of the budget to its planned expenditure part.

²⁵⁰ Eiropas Savienības Oficiālais Vēstnesis. 2019. PADOMES IETEIKUMS (2019. gada 9. jūlijs) par Latvijas 2019. gada valsts reformu programmu un ar ko sniedz Padomes atzinumu par Latvijas 2019. gada stabilitātes programmu. [https://eur-lex.europa.eu/legal-content/LV/TXT/PDF/?uri=CELEX:32019H0905\(14\)&from=EN](https://eur-lex.europa.eu/legal-content/LV/TXT/PDF/?uri=CELEX:32019H0905(14)&from=EN).

- The second is to stimulate, through leverage, certain economic activities or sectors of the economy. This direction is also related to the control and regulatory function of taxes.

Actions of the state within the framework of state-oriented optimisation affect the possibility of application of business-oriented optimisation by business entities, as well as the scale and intensity of its application.

The state-oriented aspect of tax optimisation related to the criterion of efficiency, the numerical values of which can be obtained depending on the aim of the study and the available statistics.

State-oriented optimisation does not always mean that after its implementation the tax burden and tax revenues to the budget will increase. In addition to the fiscal function, optimisation should affect the other functions of taxes – social, regulatory, and control.

Both considered aspects of tax optimisation are interconnected: state-oriented aspect of optimisation directly influences the possibility to apply legal business-oriented tax optimisation within the current jurisdiction. At the same time, the business-oriented aspect of optimisation, in its turn, has an opportunity to influence the state-oriented optimisation.

If the state is only interested in filling the budget and does not care about the interests of business, it can lead to the closure of the enterprises and / or capital flight from the country. This leads to a decrease in tax revenues to the budget, and most likely a subsequent liberalisation of tax laws to bring capital back, as well as to stimulate the creation of new businesses and jobs.

The study conducted by the author has shown that there is an imbalance in the training of specialists with the skills of state-oriented tax optimisation and business-oriented optimisation, in favour of the latter. This, in turn, affects the quality of tax reforms, the tax system itself, which should meet the challenges of modern economic development of society.

Insufficient consideration of economic prerequisites, politically motivated decisions affecting the sphere of taxation, and the exclusive focus on the performance of fiscal function lead to the low reliability of the tax system and entail frequent adjustments.

The division of approaches into state-oriented and business-oriented, proposed by the author, allows to consider the contradictions between the state and the taxpayer in order to find the most rational combination of the main problem of taxation – equity and efficiency. At the same time, the redistributive function of taxes as a tool of the state's social policy is not included in the state-oriented aspect, since it is often designed to correct the shortcomings (failures) of the tax system. To ensure proper implementation of the redistributive function, it is necessary to have a rationally structured functioning of the tax system within the state-oriented and

business-oriented aspects. A poorly functioning tax system that has an effective tax collection, but does not meet the criteria of equity, sooner or later will face high administrative costs associated with ensuring the work of the redistributive function.

3.2 Reliability as an evaluative characteristic of the tax system life cycle

Approaches to assessing the reliability of the tax system

In Latvia, during the preparation and implementation of measures to reform the tax system, a set of problems of financial and economic block has arisen, related to the formation of the budget of the country, taking into account the efficiency and economic reliability.

The tax reform enacted in 2018 did not achieve one of the main goals of increasing tax revenues relative to GDP, nor did it grow the tax base fast enough. To reduce inequality, the tax burden for low-wage workers was reduced, but it is still significant and higher than in Lithuania and Estonia. The reform improved capitalisation and profitability of companies, but did not lead to a significant increase in fixed capital accumulation and the corresponding expected economic breakthrough.²⁵¹

According to opinion of the Council of the European Union on the 2019 National Reform Program of Latvia and delivering Council opinion on the 2019 Stability Program of Latvia, Latvia's tax revenue share of GDP is low compared to the European Union average and to some extent limits the provision of public services, particularly health care and social integration. Capital and property taxes are relatively low, and freezing the value used to calculate land and property taxes will further reduce tax revenues. At the same time, the tax burden on low-wage workers remains high compared to the EU average, despite the decline. According to various estimates, the share of the informal economy has declined in recent years. However, the share of undeclared economic activity in Latvia is still higher than in the other Baltic countries. In particular, the failure to declare full wages ("envelope wages"), especially in the construction sector, constitutes a significant part of the shadow economy.

The Council also noted that Latvia faces difficulties in implementing a number of social protection and integration principles contained in the European pillar of social rights. There is high income inequality in Latvia because the level of redistribution using the tax and benefit system is low. Social benefits are still insufficient, and the impact of social transfers on reducing poverty and inequality is limited. Poverty risk among the elderly and people with disabilities is relatively high and increasing as the increase in benefits does not match the increase in wages.

²⁵¹ Latvijas Republikas Fiskālās disciplīnas padome. 2018. 2018. gada nodokļu reformas rezultāti un kritēriji tālākai nodokļu sistēmas pilnveidošanai. *Fiskālās disciplīnas padomes viedoklis*. <https://www.fdp.gov.lv/en/media/2988/>.

The poverty risk rate for seniors was 49.0 % in 2018 (EU average 18.2 % in 2017), while for people with disabilities it was 40.7 % in 2017 (EU average 29.3 % in 2017). State social benefits for the disabled and the minimum old-age pension have not been revised since 2006. The minimum income reform announced in 2014 has not been implemented and is negatively affecting the poorest households. Access to long-term care is also still insufficient.

Recommendations included the need for investment to address social exclusion, including nutrition and material assistance for the most disadvantaged. Investments are also needed, including in infrastructure, to improve access to childcare, long-term care, employment and other social services, and to ensure the integration of health and social services, including the transition from institutional to community-based care. The proportion of people with very serious housing problems is one of the highest in Europe (15.2 % compared to the EU average of 4.0 % in 2017), and there is a shortage of social housing. Investment is needed to improve the supply of affordable housing.²⁵²

At the same time, public materials concerning the budget process and the modernisation of the tax system lack a description of the specific economic and mathematical mechanisms and models used in the preparation of the tax system reform that began in 2018 and its subsequent adjustments.

It should be noted that there exist international methods for evaluating tax systems, including rating methods.

Thus, the International Country Rating of Doing Business has been conducted since 2004 by the World Bank and the PricewaterhouseCoopers (PwC) consulting company. It assesses the impact of government policies on business development. Paying Taxes report²⁵³ is a part of the rating used for comparative analysis of advantages and disadvantages of tax systems of individual states. The number of countries participating in this rating reaches 190. The basis of the study is the expert method, which relies on the construction of the taxation process of a small or medium-sized business in a time perspective (within 1 year) under different scenarios. The rating is supplemented by the results of surveys of experts who analyse the normative-legislative regulation.

The tax systems of countries are based on various combinations of direct and indirect taxes, taxes on individuals and legal entities, resident and territorial taxes, and the treatment of

²⁵² Eiropas Savienības Oficiālais Vēstnesis. 2019. PADOMES IETEIKUMS (2019. gada 9. jūlijs) par Latvijas 2019. gada valsts reformu programmu un ar ko sniedz Padomes atzinumu par Latvijas 2019. gada stabilitātes programmu. [https://eur-lex.europa.eu/legal-content/LV/TXT/PDF/?uri=CELEX:32019H0905\(14\)&from=EN](https://eur-lex.europa.eu/legal-content/LV/TXT/PDF/?uri=CELEX:32019H0905(14)&from=EN).

²⁵³ PwC. Paying Taxes. What we can learn from tax regimes in 191 economies around the world. *Study from PwC and the World Bank Group*. <https://www.pwc.com/payingtaxes>.

some of them has its own specifics. Such a variety of taxes and fees in different countries predetermines the use of classifiers.

The Paying Taxes study is based on the tax classification of international financial organisations (IMF, World Bank),²⁵⁴ according to which certain groups of taxes are identified.

This rating assesses the current tax system of the country, depending on the policy of the government at the moment: the state of tax legislation, tax administration management, the activity of tax audit, the size of tax rates and the number of taxes, methods and procedures for payment, etc.

However, the calculation methodology of the rating has a number of drawbacks and limitations. It does not take into account the taxation of individuals and enterprises – large taxpayers. The model used is that of small or medium-sized businesses. The developed scenarios do not assume international trade and, accordingly, do not take into account taxes on international trade, environmental taxes are not accounted for separately, despite the fact that ecologisation of the tax system is one of the rational ways to develop economic regulation.

According to the International Tax Competitiveness Index (ITCI), which ranks OECD member countries and their tax systems according to two main criteria – competitiveness (a competitive tax code – one that keeps marginal tax rates low as the main incentive for development), and neutrality (a neutral tax code – one that allows for the greatest profits with the least economic distortions. The more complex the law, the less neutral it is).²⁵⁵ The index considers Corporate Tax Rank, Individual Taxes Rank, Consumption Taxes Rank, Property Taxes Rank, and Cross-Border Tax Rules Rank, from which an overall score is generated. It mentions a separate importance of corporate tax. Latvia is in second place out of 37 OECD countries in the Index, while Germany, France and Italy are in 16th, 35th and 37th places, respectively.

These rankings aim to assess the current tax system as one of the conditions for successful business in the country, rather than to assess the effectiveness of the tax system as a source of budget revenue from the point of view of the state. To determine the average values within the rating, the geographical division is used, and it does not always determine the economic specifics of the nearby countries. The methodology used by the World Bank continues to evolve, with the introduction of an additional indicator from the 2017 report, which should lead to greater objectivity in the assessment of tax systems. Participation in the ranking

²⁵⁴ The World Bank. 2020. Ease of Doing Business rankings. *Doing Business 2020*. <https://taxfoundation.org/publications/international-tax-competitiveness-index/>.

²⁵⁵ Bunn, D. and Asen, E. 2021. International Tax Competitiveness Index (ITCI). *Tax Foundation*. <https://taxfoundation.org/publications/international-tax-competitiveness-index/>.

encourages governments to adopt and implement tax reforms that help improve the business climate in countries.

However, the aforementioned ratings do not allow to assess the reliability of tax reforms and the tax system of the country as a whole.

Over the past six decades, reliability theory has evolved into an independent discipline by drawing tools from several fields, including mathematics, statistical probability theory, and actuarial science. In the course of its development, reliability analysis has contributed to the development of many other subjects and disciplines, leading to the opening of new lines of research in a number of areas of scientific activity.²⁵⁶

The reliability of the tax system can be evaluated from different positions. The author proposes to evaluate it in two directions, namely:

- assess the reliability of the functioning of the fiscal system (in fact, the effectiveness of tax collection);
- assess the reliability of the tax reform (in fact, to assess the consistency of the reforms carried out with the goals declared in its design and implementation).

The category of economic reliability is considered as the opposite category of risk and as a systemic characteristic of decision-making and management.

It should be noted that it is possible that the fiscal component of the tax system may be formally reliable, but the goals set for the tax reform will not be achieved. Thus, according to the SRS, in 2018 the amount of budget revenues administered by it was 9.4 billion euros, 120 million more than originally planned, and the amount increased by 788 million euros over the year. Corporate income tax in 2018 compared to 2017 decreased by 120 million euros or 28.6 %, but it did not prevent the State Revenue Service from exceeding the plan to fill Latvia's budget.²⁵⁷ Statistical data indicates that the share of the UIN has gradually decreased in the share of all collected taxes (as well as in per cent of GDP). The share fell from 1.6 % in pre-reform 2017 to 0.2 % in after-reform 2019 and as of now remains on that level, making UIN one of the smallest major taxes collected.

At the same time, as already indicated, the European Commission, in its report on Latvia, published in February 2019, noted that the goals that were set for the 2018 tax reform had not been achieved.

²⁵⁶ Unnikrishnan Nair, N., Sankaran, P. G. and Balakrishnan, N. 2018. *Reliability Modelling and Analysis in Discrete Time*. London: Academic Press, 508.

²⁵⁷ Latvijas Republikas Valsts ieņēmumu dienests. 2019. Kopsavilkums par budžeta ieņēmumu daļas izpildi 2018. gada 12 mēnešos. *Nodokļu ieņēmumi*. <https://www.vid.gov.lv/lv/statistika/nodoklu-ienemumi>.

Therefore, both proposed directions of tax system reliability should be considered successively, implying that the reliability of tax reform can also be partly characterised by the reliability of the functioning of the fiscal system.

Analytical assessment of the reliability of the tax system

The reliability of any of these systems can be described by the following exponential formula:

$$R(t) = e^{-\lambda t} \quad (3.1)$$

In formula (3.1), e is the base of natural logarithms ($e = 2.71828\dots$), λ is a constant called intensity of sudden system failures, t is an arbitrary operation period for which system reliability R is determined. Reliability formula (3.1) is valid for a system that has undergone proper testing – run-in (for a fiscal system, the tax payment scheme has been worked out and taxpayers have adapted to it.²⁵⁸ The period of operation, for which this formula is valid, is called The period of normal functioning of the tax system. The parameter λ fully determines its reliability, and it is convenient to use the value β , inverse of the failure rate, called the mean time to failure, for the study as well. For the exponential case:

$$\beta = \frac{1}{\lambda} \quad (3.2)$$

This parameter, as well as the parameter λ , fully determines the reliability of the tax system under the exponential law of increasing failures. The reliability function or the no-failure function, therefore, can be written in the following form:

$$R(t) = e^{-t/\beta} \quad (3.3)$$

Figure 3.1 shows a graph of the probability $R(t)$ of the system's failure-free operation as a function of time. It should be noted that abscissa t is an arbitrarily chosen period of its operation, and the value $t = 0$ means the beginning of the period. In all cases, the parameter t in formula (3.3) is measured in units of time during the chosen period.

The initial assessment of the reliability of the tax system as a fiscal instrument should be made on the basis of the reliability of its constituent elements. As of the beginning of 2022,

²⁵⁸ The process of run-in is shown in section 4.1.

14 taxes are applied in Latvia.²⁵⁹ When assessing the reliability of functioning of the fiscal system, it is these taxes that will be the parameter under study.

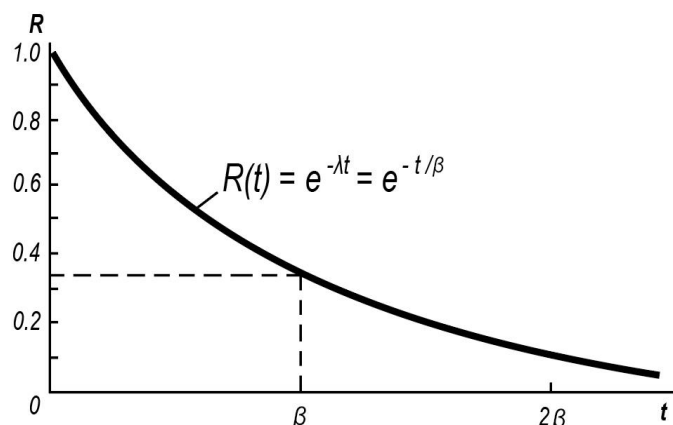


Figure 3.1 Standardised reliability curve²⁶⁰

Event A refers to the serviceable state of the element included in the fiscal system being evaluated (i.e., the performance of its functions by each of the 14 taxes N_i , where i lies in the range from 1 to 14). The event \bar{A} is understood as its failure, i.e. the cessation of its functions to fill the budget of the country at a given level. Accordingly, the reliability of the whole system can be estimated as the ratio of the number of taxes that perform their functions of filling the budget to the total number of taxes N_{Σ} . By the end of time t of functioning of a particular tax system it is necessary to identify N_f of serviceable elements (taxes faithfully performing their functions) and N_d , i.e. those taxes that do not ensure the collection of funds at the planned level. This refers to the moment when a certain model of the tax system comes to an end and a new one should replace it, or the moment of adjustment of any tax(s), their abolition, or the moment of introduction of new taxes.

Consequently, $N_{\Sigma} = N_f + N_d$ is constant over time t , because the number of taxes that have ceased to perform their functions N_d , increases by exactly the same amount as the number of taxes that faithfully perform their functions N_f decreases.

Detailed justification of all intermediate steps of reliability approach is shown in the Annex 3B.

This approach can be useful, for example, at the stage of introduction of measures envisaged by the new tax reform. If the system in the first part (performing its functions well) from $t = 0$ to $t = t_1$ has a failure rate λ_1 , and then, by the end of the life cycle of the system (for

²⁵⁹ Latvijas Republikas likums. Likums "Par nodokļiem un nodevām". *Latvijas Vēstnesis*, 7, 13.04.1995. Pieņemts: 02.02.1995.

²⁶⁰ Bazovsky, I. 1961. *Reliability theory and practice*. London: Prentice-Hall International, 376.

example, due to changes in external conditions), it becomes equal to λ_2 , then the reliability of the system for the interval $t_2 - t_1$ is equal:

$$R_{t_2-t_1} = e^{-\lambda_1 t_1} \times e^{-\lambda_2(t_2-t_1)} \quad (3.4)$$

If $\lambda_1 = 0$, then:

$$R_{t_2-t_1} = e^{-\lambda_2(t_2-t_1)} \quad (3.5)$$

At $\lambda_1 = \lambda_2 = \lambda$:

$$R_{t_2-t_1} = e^{-\lambda t_2} \quad (3.6)$$

In this case the situation was considered when all 14 taxes existing in Latvia have approximately equal importance for the budget filling. In fact, taxes have different weight in the fiscal aspect and, accordingly, their impact on the reliability of the fiscal system is different. Assessing the reliability of the most important taxes makes the task somewhat easier. Approaches to ranking the importance of taxes in Latvia are shown in Section 4.5.

A sudden decline in the effectiveness of any tax to the point of having a significant impact on budget revenues is called a “catastrophic failure”. Catastrophic decline in efficiency occurs unexpectedly without preceding symptoms to predict it. Such a situation occurs randomly, i.e., unexpectedly and irregularly.

Reliability assessment as a tool to prepare for tax reform

A methodology for assessing the reliability of the fiscal system as an element of the tax system was proposed above. Similarly, the reliability of the tax system can be assessed, the purpose of which is to comply with the basic requirements of the tax systems.²⁶¹

The notion of “reliability” of the tax system in aggregate is proposed to mean the probability that, during the process of reforms and after their completion, the tax system will fulfil all the requirements imposed on it for a given period of time. In most cases, the probability with which the tax system will perform its functions at a given level, i.e., its true reliability, is unknown. This means that the exact numerical value of the probability that the tax system will function satisfactorily is unknown. But numerical estimates close enough to the required value can be obtained by using statistical methods and probabilistic calculations.

Before implementing tax reforms or any adjustments affecting the tax field, it is important to make sure that:

- 1) these measures will really fill the budget in the necessary amount;

²⁶¹ OECD. 2015. *Addressing the Tax Challenges of the Digital Economy*. Paris: OECD Publishing. 1(2), 29–50.

- 2) they will not have a negative impact on the business, which could lead to its destruction.

The analysis should be carried out with the use of tax returns of previous periods.²⁶² The specified sample, with the help of which it is proposed to test the adequacy of the tax system to business conditions, is determined by both the availability of necessary data, and the computational technique and the mathematical apparatus used by the researcher.

In the proposed analysis, it is possible to take into account territorial peculiarities and the degree of tax burden on various types of business, as well as its industry affiliation by building a model of tax system reliability within a particular region (if the relevant statistical data are available). All this will make it possible to exclude the risk of business degradation in any regions and / or industries, which may arise due to the intervention in the tax system.

At the same time, the most important function of the tax system should be ensured, which is to guarantee that the budget is filled to the required extent. For this purpose, the reliability of various sources of revenue should be assessed through the analysis of statistical data related to budget filling. The reliability of the tax system should be considered as one of the characteristics of the quality of the revenue part of the budget.

In the process of tax reforms there can be significant changes in tax policy, which will indicate its complete change, or there can be a number of adjustments aimed at improving the current economic policy and increasing its effectiveness. In all cases, in order to exclude negative consequences of the conducted interventions in the tax system, whatever they may consist in, it is suggested to assess in advance the reliability of the tax system in the post-reform period.

In case of research, the tax system can be considered as a system consisting of the elements represented in the form of taxes stipulated by Article 8 of the Latvian Law “On Taxes and Fees”.²⁶³

The tax system can be considered reliable when the quality of the elements that make it up at the time of their entry into force is about the same. Here it should be noted that the taxes stipulated by the law “On Taxes and Fees” have different weight (rank) in the sense of their influence on the volume of the revenue part of the budget.²⁶⁴

²⁶² Latvijas Republikas Valsts ieņēmumu dienests. 2020. Nodokļu ieņēmumi. *Statistika*. <https://www.vid.gov.lv/lv/statistika/nodoklu-ienemumi>.

²⁶³ Latvijas Republikas likums. Likums “Par nodokļiem un nodevām”. *Latvijas Vēstnesis*, 7, 13.04.1995. Pieņemts: 02.02.1995.

²⁶⁴ Verovska, L. and Leontyev, A. 2015. Using of Variant Optimization Methods for Determination of Rational Taxation Amount. *XVIII International Scientific and Practical Conference “Taxes: Theory and Practice 2015”*. Brno: Akademie STING, 114–120.

In Section 4.1 the reliability of the tax system in Latvia is assessed, where the period of time since 2018 was chosen as the study period.

3.3 Tax prism method

For economic interpretation of the formation of the tax (revenue) part of the budget, for its assessment and research, as well as for analysis and business modelling of financial activities of enterprises, in order to make rational management decisions, the author proposes to introduce the concept of tax prism.

In Section 1.3, an analysis of the works devoted to the Laffer curve was carried out. A significant number of works have been studied, they have been systematised and divided into three main groups. The specified section contains an analysis of more than 50 works by different researchers. It was determined that in a number of works attempts to modernise the Laffer curve, attempts to establish a relationship between the dependence of the tax rate on the volume of taxes collected and the tax base (for example, M. Kakaulina, E. Balatsky and I. Mayburov, etc.) were made, but these attempts, so far, have not led to the creation of any methodology for practical calculations that allow to describe the relationship of the three above parameters quantitatively. As shown in Section 1.3, these researchers indicated that it has not been possible yet to create an appropriate dependency that allows for the necessary quantitative assessment. At the same time, as it was noted that these works were carried out by modernisation of the Laffer curve or other analytical actions based on this curve.

The author offers his own tool that is not related to the Laffer curve, while noting that the obtained results do not contradict both the theory of Laffer, Keynes, and other researchers who pointed out the existence of a relationship between the tax burden and the amount of taxes collected, as well as its specific nature. In addition, the author considers the need to take into account not only the qualitative, but also the quantitative relationship of these two parameters (tax rate and volume of tax revenues) with the tax base.

Economic interpretation of the tax prism

The tax prism²⁶⁵ is based on the property of a figure (rectangular prism with a square base) – created from a square of fixed (constant) dimension – first to increase its volume, and upon reaching a certain maximum – to reduce it, similar to the dependence proposed by Laffer and the observations of many other scientists on research that Laffer relied on (shown in Section 1.3).

²⁶⁵ The figure is also called a rectangular parallelepiped, at the base of which lies a square.

With the proposed approach, the side of the square L , from which the prism is created, corresponds to the tax base, the height of the edge of the prism characterises the size of the tax burden, and the volume of the prism V shows the change in the volume of tax (taxes) revenues.

Among the shortcomings of the Laffer curve, as noted earlier, the researchers indicated the absence of an explicit tax base in his approach and the difficulty in determining the location on the curve in any period. The latter led to disagreements and incorrect conclusions under the erroneous assumption of being on the ascending or descending part of this curve relative to its maximum (Laffer point).

The proposed tax prism tool eliminates these shortcomings, since unlike the Laffer curve, which functionally connects only two parameters (the tax rate and the amount of taxes collected), tax prism allows to simultaneously take into account the third parameter (tax base), as well as accurately determine the position on the ascending or descending branch of the dependence.

The general economic and geometric interpretation of the developed tool is shown in Figure 3.2.

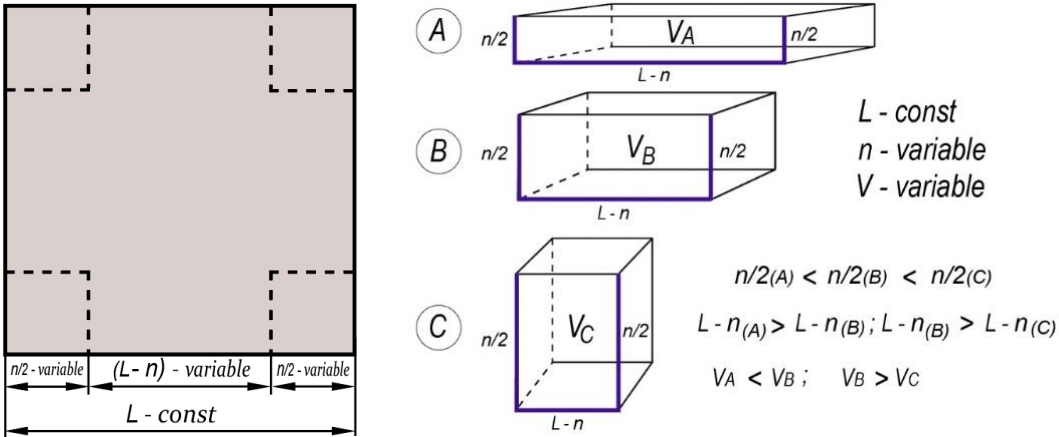


Figure 3.2 Economic interpretation of the “tax prism” tool

L – tax base; n – size of tax (tax burden); V – characteristic of the volume of the tax revenues.
Source: created by the author.

The tax prism is a geometrical figure whose volume V corresponds to dynamics of the amount of the taxes received by the state (depending on the aim of the research could be taxes payable for the enterprise or even for individuals) in the studied period and n corresponds to the cumulative amount of taxes (or separately a tax under study).

From the state-oriented aspect point of view, the tax prism is considered, in its base is a square (Figure 3.3).

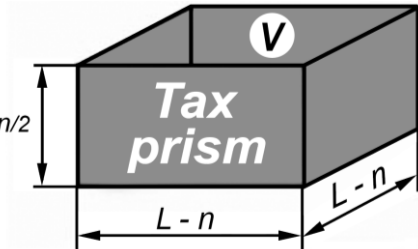


Figure 3.3 General form of the geometric interpretation of the tax prism

Source: created by the author.

On the one hand, the task of the state is to receive a maximum of taxes, from the other – not to put out of business the taxpayer, keeping his or her interest in profit earning by means of this type of activity. Therefore, the state shall also be engaged in taxation optimisation process.

This process can be considered by means of the offered tax prism. For tax prism creation there is a plane section with equal sides (square) $L \times L$, where L – the tax base (Figure 3.4).

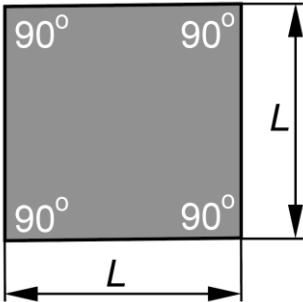


Figure 3.4 Interpretation of the tax base

Source: created by the author.

The task of optimisation consists in making of it a hollow prism which volume is equal to V (where V – the dynamics of the tax part of the state budget), by removing squares with area of $n/2 \times n/2$ from each of four corners (Figure 3.5), where n – the general tax load established by the state for taxation subjects.

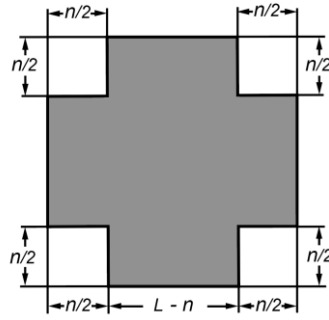


Figure 3.5 **Interpretation of the tax base and tax burden**

Source: created by the author.

It is necessary to determine the size of the general tax burden n which will correspond to the maximum size V .

V can be displayed as a function of n . The area of the basis of a tax prism (which serves as indirect parameter of forming V , while L , as indicated above is corresponding to the tax base) is equal to:

$$\left(L - \frac{n}{2}\right) \times \left(L - \frac{n}{2}\right) \quad (3.7)$$

The component of the state budget generated by taxes can be determined by the expression (3.8):

$$V = (L - n)^2 \times \frac{n}{2} \quad (3.8)$$

Value n has to be big enough so that value V would be maximum. However, it isn't necessary to go into extremes: when $n = 0$ and $n = 0.5 L$, budget revenues will be zero. At these values of the general tax burden n , the tax prism won't exist because $n/2$ in geometrical interpretation represents prism height.

This can be considered on small business enterprise, as these enterprises most vulnerable to the changes in the tax rate, as well as in most of the cases are seeking for tax optimisation from their side, and excessive tax burden may push them towards illegal tax avoidance (salary in envelopes etc.). If to limit only to one tax – Enterprise Income Tax, then as the tax base L would be considered enterprise income. As the tax base is set value of 120 000 EUR. In this case, the tax part of the state budget will be equal to:

$$V = (12 \times 10^4 - n)^2 \times \frac{n}{2} \quad (3.9)$$

Then, when $n = 0$ and when $n = 120\,000$, the budget won't be filled.

The optimum size V lies in the range bigger than 0 but smaller than 120 000.

The volume of the tax prism can be calculated using a definite integral, because it is a rectangular parallelepiped whose height is equal to $n/2$ (and is related to the amount of the tax (taxes)), and the base area $S(z) = S$ (Figure 3.6).

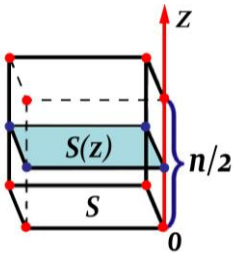


Figure 3.6 Calculating the volume of the tax prism using the definite integral

Source: created by the author.

The cross-sectional area of a rectangular prism does not change at any point of the segment from 0 to $n/2$ and is equal to the area of the base. Then, the volume of the tax prism under study is equal:

$$V = \int_a^b S(z)dx \tag{3.10}$$

If S is taken beyond the integral sign, then the volume of the tax prism is equal to:

$$V = \int_0^{n/2} S dx = S \int_0^{n/2} dx = S \times z|_0^{n/2} = S \times (n/2 - 0) = S \times n/2 \tag{3.11}$$

Graphoanalytic study of the tax prism

In order to use the graphic approach, function $y = (12 \times 10^4 - n)^2 \times \frac{n}{2}$ has to be visualised for n values within the range from 1 to 120 000 (Figure 3.7). For the convenience of the computations and visualisation, the value of L was divided by 10^4 to decrease the order of the resulted values. The interpretation and relations between factors remain the same.

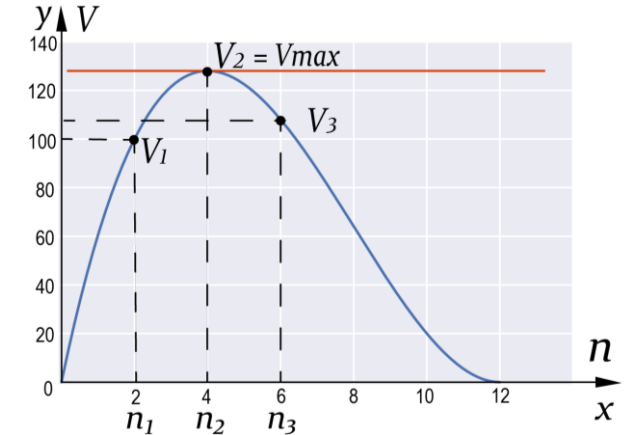


Figure 3.7 Graphical visualisation of the function

Source: created by the author.

In case of n_1 fill rate of the budget will be V_1 ; in the point n_2 the fill rate of the budget will be at $V_2 = V_{max}$; if move to the point n_3 – the fill rate of tax part of the budget will be $y = V_3$. Value n_2 looks promising for maximum of the function, but in the range of values n , the other valid value can appear which will correspond to the criterion of optimisation to a greater extent. It can be determined by analytical or graphic-analytical approaches.

These approaches are considered consequently.

The expression (3.9) is differentiated with usage of the rule of the derivative multiplication:

$$\frac{d}{dx}(f(x)g(x)) = f(x)\frac{d}{dx}g(x) + g(x)\frac{d}{dx}f(x) \quad (3.12)$$

In some cases, it is convenient to conduct the specified research using graphical-analytic approaches for descriptive reasons.

Graphical differentiation of a graph of a function can be done in order to determine an optimum combination of required size of the budget and the total tax load.

The method of graphical differentiation is based on geometrical interpretation of a derivative: the relation of an infinitesimal increment of function to an infinitesimal increment of an argument on a graphics represents the tangent slope ratio against this curve in the considered point.

$$tg \alpha_i = \frac{\Delta V}{\Delta n} \quad (3.13)$$

Graphical differentiation is carried out by the method of chords (Figure C3.1, Annex 3C).

For this purpose, the graph of differentiable function $y = (12 - n)^2 \times \frac{n}{2}$ is divided into identical areas with a step 0.5 (these areas are located between black points in Figure C3.1, Annex 3C) and chords are drawn by connecting the closest black points. The chord inclination angle with regard to abscissa axis matches a tangent inclination angle to graph of the function on the considered area. Axes of coordinates are placed under the graph in which will built a graph of the function $\frac{dV}{dn} = f(n)$.

Polar distance Hp is set, taking into account the desirable vertical clearance of future graph, and a pole is designated as P . The straight line parallel to the chord is drawn from a pole that connects two points limiting the specific area on which differentiation is carried out at the moment before it crosses the ordinate axis ($\frac{dV}{dn}$).

From the obtained point a straight line parallel to abscissa axis is drawn before it crosses the straight line levelled down from the middle of a chord to track dynamics of volume of gathered taxes and to verify where the maximum of the function is located for obtaining the inflexion point where volume of gathered taxes starts to decrease (analogous to Laffer's point). The middle of chords is marked by lilac points in Figure C3.1, (Annex 3C), which are designated by letters $a, b, c, d, e, f, g, h, i, j, k, l$.

Intersection points of the specified straight lines in Figure C3.1, (Annex 3C) are marked by blue points and letters $a', b', c', d', e', f', g', h', i', j', k', l'$.

As a result of differentiation, the parabola has been obtained which branches are directed to the up. Parabola intersection points $\frac{dV}{dn} = f(n)$ with abscissa axis specify points of maximum and minimum of differentiable function. In the point corresponding to n_{max} , the function derivative (the lower diagram in Figure C3.1, (Annex 3C)) moves from positive area to negative, and function changes from increase to decrease. Therefore, value of function when n_{max} is its maximum.

The horizontal tangent will pass through a point in which function $y = (12 - n)^2 \times \frac{n}{2}$ will reach the maximum value (it is shown in Figure 3.7).

To the left from a maximum function $V = f(n)$ grows, to the right – decreases. On the left the value of its inclination is positive, on the right – negative. In the most upper point nothing occurs. Therefore, it is possible to draw horizontal (i.e., with a zero inclination) tangent (Figure 3.7). It will also be optimum value of the total tax load of n giving the maximum value of assignments V to the state budget in case of which interests of taxpayers are observed.

It is obvious that the studied function has two extrema since the parabola, received by differentiation, crosses abscissa axis in two points. Therefore, when solving similar tasks, it is necessary to stipulate that the positive maximum of function shall be found. In the studied case, when tax value $n = 12$ production will become equal to zero that will lead to zero the size of a tax part of the state budget as it was stated above – when $n = L$, the tax prism does not exist. In the studied case, when $L = 12$, this value is $n = L = 12$.

It should be noted that on the falling part of function $V = f(n)$, located more to the right of maximum point occurs sharp reduction of business activity.

At the same time, withdrawal of a significant part of revenues from the taxpayer (approximately 30–40 %) is a threshold, after which incentives for entrepreneurial initiative and expansion of production are eliminated. Groups of taxpayers are being formed who are looking for methods of avoiding taxation and striving to concentrate financial resources in the shadow sector of the economy. So far exact threshold value of an effective rate in case of which

occurs destruction of business activity isn't found. However, Laffer's concept provides that already in case of a tax burden over 35–40 % the entrepreneur gets to "a tax trap".

As the tax prism (Figure 3.3) is filled with prisms of the smaller size which volume corresponds to the quantity of the taxes paid by each subject of the taxation, then for the business-oriented aspect of optimisation the size of the main tax prism is reducing.

Static and dynamic tax prism

It is offered to introduce the concept of a static and dynamic tax prism for assessing the decrease in the amount of the collected taxes due to the use of legal tax optimisation schemes by the taxpayers.

Static tax prism – a prism which volume V_{st} characterises a tax part of the budget without taking into account possible tax optimisation in the business-oriented aspect.

Dynamic tax prism – a prism which volume V_{dyn} characterises a tax part of the budget taking into account possible tax optimisation in the business-oriented aspect.

It is useful for comparative purposes: to evaluate how much optimisation measures can reduce tax collections – a static prism is needed. This will make it possible to establish acceptable limits for measures to reduce the tax burden (including the use of benefits, of which there are currently about 200 in Latvia), i.e. at the state level, to normalise the process of optimising taxation, which is aimed solely at reducing the tax burden from the point of view of the taxpayer.

$$V_{dyn} = k_{to}V_{st}, \quad (3.14)$$

where k_{to} – coefficient of tax optimisation ($k_{to} \leq 1$).

When $k_{to} = 1$ taxpayer didn't take actions directed to tax reduction, while all other conditions are unchanged. When $k_{to} < 1$ – such actions were taken, as always after optimisation, the amount of taxes collected decreases, but never increases.

Therefore, when taxpayers use tax optimisation the dynamic volume of a tax prism will be less than static:

$$V_{dyn} < V_{st}, \quad (3.15)$$

This model takes into consideration not only possible tax optimisation in the business-oriented aspect, but also a number of other factors influencing the tax part size of the budget.

For this purpose, it is necessary to introduce the corresponding raising or decreasing coefficients into a formula (3.14).

These coefficients must also take into account various force majeure circumstances. For example, a decrease in tax revenues in a number of industries due to the coronavirus pandemic.

It should be noted that this approach was developed by the author long before the pandemic.^{266, 267} Already at that time it was proposed to take into account the possible decrease in the volume of funds coming into the budget in the form of a dynamic prism, the volume of which decreases by a factor of k due to possible force majeure circumstances.

The use of the tax prism, unlike the Laffer curve, makes it possible to take into account explicitly not only the size of the tax(es) and the volume of funds coming into the budget, but also the size of the tax base. The application and options of interpretation of the results obtained with the help of the tax prism method are given in Section 4.3 of this Thesis.

Use of the tax prism concept and its division on static and dynamic versions allows to visualise the taxation optimisation process which is carried out by public authorities at defining the types and the amount of taxes both in short-term, and in long-term period, but make it more precise. When using this approach, it is possible to effectively improve tax legislation by simulating the qualitative and quantitative consequences of certain changes and innovations.

In research related to the business-oriented aspect of tax optimisation, the tax prism method can be used similarly to the above-shown approach. In this case, the income of the enterprise should be considered as the tax base.

3.4 The method of relative single indexes

The state benefits from increased budget revenues, including from taxes. This may allow for increased government spending, to stimulate economic growth and employment, for example, by creating new jobs. At the same time, an increase in the level of tax collections should not have a significant negative impact on business and / or bankrupt the taxpayer. In turn, the taxpayer, as a rational agent, finds only the lowest tax burden beneficial.

There are a number of requirements for tax systems, which ultimately will lead to two contradicted principles: economic efficiency and equity. The choice of the most appropriate tax structure implies that if one of the requirements is accepted as an optimisation criterion, the others must be taken into account in the form of restrictions.

²⁶⁶ Verovska, L. and Leontyev, A. 2017. Use of the tax prism method when forming tax part of the budget. *Economics and Culture*.14(1), 128–135.

²⁶⁷ Leontyev, A. and Verovska, L. 2018. Creation of the optimal tax part of the budget by using the tax prism method. *International Scientific Symposium “Economics, Business & Finance”, Institute of Research and International Symposiums “IRIS-ALKONA”*. 5–14.

The efficiency of the tax system to a greater extent characterises the state-oriented aspect of tax optimisation, while equity refers to the business-oriented aspect. These perceptions are fair under the rational behaviour of all economic agents.

It is appropriate to introduce the concept of the optimal (comfortable) value of equity and efficiency combination (EEC) in tax policy. Because of the above-mentioned tendency of inconsistency between the principles of equity and efficiency, the value of the EEC should be determined taking into account the main links of these criteria with specific taxes.

Choosing a rational EEC is a very complex multi-criteria task.

The assignment of this parameter, carried out intuitively on the basis of practical experience, requires numerous adjustments and does not always yield the desired result.

If the EEC is set rigidly with only one of the criteria in mind, then the consequences of such a decision are poorly predictable, despite the obvious trends and direction of the characteristics inherent in the selected criterion.

In this regard, a method is needed that would allow to make a sufficiently rational and reasonable choice of EEC to the greatest extent conducive to maintaining the required level of economic policy of the state and comfortable taxation of individuals and legal entities, i.e. taking into account both considered aspects of taxation optimisation.

The choice of an EEC from the experience of previous years is universal in its own way, however, it does not allow to choose its necessary value, actually vital in a particular period, with sufficient precision. Such assignment of EEC, like any other similar operation, represents a complex psychophysiological process of judgment production. To study such processes, special experiments were set up in which subjects determined the subjective probability of an event occurring. The experiments showed the following results: with a true probability of occurrence of the event about 2 %, the usual untrained subjects assigned a subjective probability of occurrence of the event equal to 40 %, and the values of subjective probability were several times lower in the specially trained group of persons than in the untrained ones. However, the absolute value of the error remained quite high.^{268, 269}

Persons who assign values of certain parameters, at the decisive lower limit of the latter, overestimate their values, subconsciously introducing coefficients of reserve. Although in practice there are the opposite cases (they are much smaller), when any factors are estimated incorrectly and underestimated values of parameters are assigned.

²⁶⁸ Kahneman, D. and Tversky, A. 1999. Prospect Theory: An Analysis of Decision under Risk. *Econometrica*. XLVII, 263–291.

²⁶⁹ Icard, T. 2016. Subjective Probability as Sampling Propensity. *Review of Philosophy and Psychology*. (7), 863–903.

Consequently, assigning EEC based on experience is not optimal and accurate, because the error of values can become quite significant.

In practice, in most cases, taxes are first set (their amount), and then only the impact on equity and efficiency is assessed.

The most characteristic feature of the establishment of optimal taxes in the system “equity – efficiency” is a constant search for compromise solutions ensuring the fulfilment of numerous contradictory requirements. This, in fact, is the main principle of systemic optimisation. Here the term “optimal” should be clarified. The Latin word “optimus” means “the best”. But by calling any solution optimal, it is often implied that it meets its purpose under certain conditions. Therefore, when solving the problem of choosing the EEC, it is necessary to clearly formulate the conditions under which the system “equity – efficiency” will work. In addition, it is necessary to find out whether a single solution to the problem is allowed, or whether variants are possible.

The Fiscal Discipline Council’s “Outcomes of 2018 Tax Reform and Criteria for Improving the Tax System”²⁷⁰ opinion listed the first two criteria for the government to consider when deciding which tax policy improvement proposals to support, as follows:

- achieve an increase in total tax revenues in relation to gross domestic product (GDP);
- reduce the tax burden on the workforce, and especially on low-income groups.

Obviously, the first criterion is aimed at improving the efficiency of the tax system, and the second – corresponds to the principle of its equity.

It is these criteria that can be used to assess the state of the “equity – efficiency” system.

As of July 1, 2021, changes in the taxation sphere concerning micro-enterprise taxpayers, persons carrying on business activities, recipients and payers of fees, as well as excise tax payers have come into force in Latvia. Many taxpayers perceived these changes negatively, with some indicating that the changes may be necessary but are premature at this point due to pandemic restrictions and worsening the situation for low-income workers.

At the same time, these same taxpayers consider state assistance during this period to be necessary.

²⁷⁰ Latvijas Republikas Fiskālās disciplīnas padome. 2018. 2018. gada nodokļu reformas rezultāti un kritēriji tālākai nodokļu sistēmas pilnveidošanai. *Fiskālās disciplīnas padomes viedoklis*. <https://www.fdp.gov.lv/en/media/2988/>, 41p.

Illustrating the inconsistency of requirements in the “equity – efficiency” system, it is useful to refer to the conclusion of the European Commission, which in late 2019 examined the results of the tax reform launched in Latvia since January 1, 2018, where was noted the need to reduce the tax burden on low-income populations and reduce social inequalities.²⁷¹

At the same time, it was noted that Latvia was close to its medium-term budget goal. This conclusion also reveals a contradiction in the “equity – efficiency” system.

To solve the problem of finding the zone of optimal solutions for a given system, it is advisable to use methods of mathematical programming (operations research), as the operations research is capable of giving a bad answer to a question that cannot be answered in any other way.²⁷²

As the author’s research has shown, the direct application of only the necessary features in the problem of finding the EEC does not give the necessary results.

First, a system of equations that follows from necessary signs is solvable only in the simplest cases. It is often easier to find the extremum of the target function than to solve such a system of equations. Moreover, this method does not guarantee finding a solution in all cases.²⁷³ Even if the composed system of equations is solved, the search for an absolute extremum of the target function requires a whole system of checks, which is more complicated the more arguments the function has.

Second, in some practical cases, the target function $f(x)$ cannot be differentiated at all, because most often the elements $x = \{x_1, x_2, \dots, x_m\}$ are not continuously changing, but discrete quantities (for example, when passing from one tax to another or calculating them at certain moments, at certain intervals).

All these circumstances lead to the fact that the application of classical methods of mathematical analysis or calculus of variations when solving the problem of EEC search turns out to be ineffective. In this case, the originally set problem of extremum search is reduced to such secondary problems, which turn out to be not simpler, but much more complicated than the original one.

²⁷¹ European Commission, Secretariat-General. 2019. Recommendation for a COUNCIL RECOMMENDATION on the 2019 National Reform Programme of Latvia and delivering a Council opinion on the 2019 Stability Programme of Latvia. COM (2019) 514 final. 05.06.2019. <https://eur-lex.europa.eu/legal-content/>, 8.

²⁷² Companysa, R. and Ribasb, I. 2015. Some Trends and Applications of Operational Research/Management Science to Operations Management. *International Journal of Production Management and Engineering*. 3(1), 1–12.

²⁷³ Monks, T. 2016. Operational research as implementation science: definitions, challenges and research priorities. *Implementation Science*, 11(1), 1–10.

Therefore, in this case it is most expedient to use the method of variant optimisation.^{274, 275} It is based on the choice of the best taxation scheme from a number of pre-calculated options with systematically changing elements. This approach makes it possible to obtain graphical dependences characterising different taxes from the optimised element (EEC).

The use of the method of variant optimisation for the problem of selecting the EEC is considered for obtaining a rational solution.

Before carrying out variant optimisation it is necessary for each specific case and time period to determine the numerical values of relative single indexes characterising “equity” and “efficiency” of tax policy of a specific state.

Numerical values of relative single indexes will be determined by the same scheme:

$$K_{ij} = P_{ij} / P_{i, bl} \text{ or } K_{ij} = P_{i, bl} / P_{ij}, \quad (3.16)$$

$$i = \overline{1, N}; j = \overline{1, M},$$

where:

K_{ij} – relative designation of relative single index;

P_{ij} – value of single index of researched characteristic (equity or efficiency);

$P_{i, bl}$ – value of single index taken as basic (possible) level;

i – name of the estimated characteristic;

j – the number of the variant;

N – the number of relative single indexes (in the studied case $N = 2$: equity and efficiency);

M – the number of researched variants.

For $P_{i, bl}$ are taken either the quality indicators of a particular option of taxation, which for a number of reasons can be considered the best, or the values of $P_{i, bl}$ can be determined by some other special considerations.

For the values of relative single indexes $P_{i, bl}$ can also be taken the extreme values of indicators of qualities of the considered variants of the system.

And, in all cases, when determining the values of relative single indexes from formulas (3.16), the one that corresponds to the improvement of the quality of the system of indicators when the single index increases is chosen.

²⁷⁴ Giannessi, F. and Maugeri, A. 2005. *Variational Analysis and Applications*. NOIA, Springer, (79), 1183.

²⁷⁵ Bryson, A. and Yu-Chi, Ho. 2017. *Applied optimal control. Optimization, estimation and control*. New York: Taylor & Francis Group, LLC (1975), Boca Raton, 496.

Relative single indexes of “equity” K_{eqj} and “efficiency” K_{effj} are formed so that their values lying in the range of values less than unity, reflect the unacceptable value of quality (their characteristics), and the acceptable values of K_{ij} are equal to unity or exceed it.

The application of the method of variant optimisation can lead to 3 major possibilities: having multiple suitable solutions, having one suitable solution and having no possible solutions.

Using the values of relative single indexes, calculated by formulas of the type (3.16), the dependences of these indices on EEC are plotted in the form of a combined diagram (Figure 3.8). EEC is plotted along the abscissa axis, and relative single unit indicators corresponding to EEC are plotted along the ordinate axis.

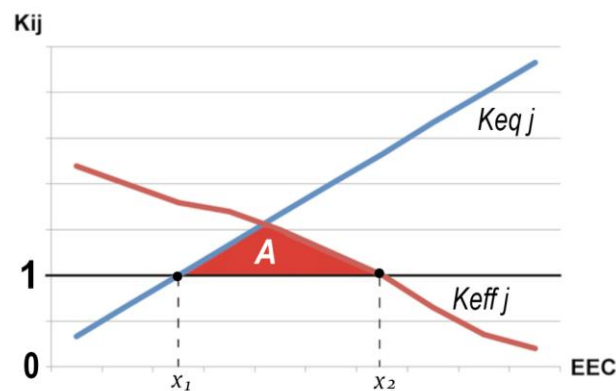


Figure 3.8 **Combined diagram of the dependence of relative single indexes on the EEC**

Source: created based on the author’s calculations.

The analysis of the combined diagram showed that the options with $EEC < x_1$ are not acceptable, because they correspond to unacceptable values (the values of relative single index that are in the area below 1) of the relative single index of equity K_{eqj} . The relative single indexes of efficiency K_{effj} for $EEC < x_1$ lies in the zone of acceptable values, but it significantly exceeds the base values, i.e., it is unreasonably overestimated. The option with $EEC = x_1$ is acceptable according to both indicators, but still overestimated almost twice as much according to the criterion of efficiency. Similarly, the other options analysed, the unsuitable ones discarded, and the area of acceptable values EEC_{opt} (Figure 3.8, highlighted by red background) was determined, within which a suitable EEC value can be chosen. Examination of this diagram confirms the untenability of assigning EEC only in terms of providing the necessary efficiency, without checking the characteristics of taxation that determine the criterion of equity.

If the found optimal option corresponds to a significantly overestimated value of any of the relative single indexes, it indicates the redundancy of the characteristics that determine it. If such an excess is not reasonable and necessary, measures should be taken to reduce its values, and then the correctness of the choice of the EEC should be evaluated once again in a comprehensive manner. In the options under consideration, the EEC area lies between x_1 and x_2 (Figure 3.8).

The proposed method of variant optimisation can be used to compare different taxation schemes as well as to perform inverse tasks.

The problem considered here is inherently nonlinear and, therefore, may have many solutions (and formally even an infinite number of solutions). Logical analysis contributes to obtaining a single solution, making it possible to select from the whole set of formally correct solutions the one most conveniently feasible solution and to discard the others.

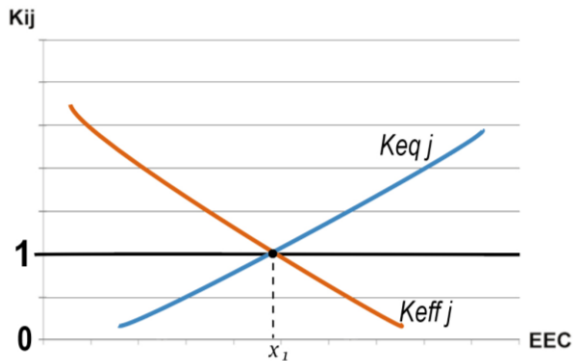


Figure 3.9 Combined diagram with the one suitable solution

Source: created based on the author’s calculations.

Another possible option may arise, when after performed analysis – only one suitable solution remains (Figure 3.9). In this case – there is no set of possible solutions, and the only suitable combination of efficiency and equity criteria is located at the intersection of the corresponding curves, where $ECC = x_1$.

The greatest difficulty is the situation when solving the problem under consideration for the search of EEC, after rejecting unacceptable solutions, no suitable one remains (such case is shown in the Figure 3.10). This means that the characteristics adopted during creation of the model are incompatible, and it is impossible to determine the value of the EEC, taking into account these constraints.

It is advisable to evaluate the compatibility of requirements at a preliminary stage. If this does not lead to the goal, then there is the incompatibility of the requirements of the task. In such a situation, in order to solve the problem by variant optimisation method, it is advisable to use the method of successive concessions. The description of this method can be found

in works.^{276, 277} According to the method of successive concessions for finding trade-offs, once the relative single indexes are formed, it is necessary to rank them in descending order of importance. After that, the maximum relative single index with the highest priority should be determined. Then the concession for the first criterion is assigned, then the concession for the second most important criterion in the range of the concession for the previous criterion is determined, and so on.

Next, was analysed a variant of the model where the relative single indexes of equity and efficiency are incompatible (Figure 3.10).

They have no compatibility area in the zone of acceptable values of relative indexes from one and above. If the priority in the ranking is given to K_{effj} , then the EEC values should be taken as left black point on the graph, and if K_{eqj} , then the right one. In the case of equal importance of the indicators, concessions should be made for both criteria simultaneously and an acceptable solution should be chosen.

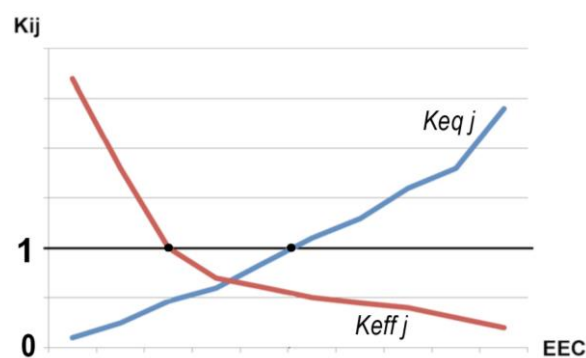


Figure 3.10 Example of incompatibility of relative single indexes

Source: created based on the author's calculations.

It is advisable to carry out the ranking by expert ranking methods (where a group of experts is invited to arrange any values of interest in terms of their significance, importance or rank in ascending or descending order) or, more preferably, by using a probabilistic approach. The ranking should take into account the stability of the indicators, i.e. the magnitude of their change relative to the EEC, as even a small change in the indicator can lead to significant changes in the parameter under correction. That is why methods of expert evaluation, are preferable to the general sociological survey.

²⁷⁶ Yokhin, M. and Stepanov, M. 2018. Application of the successive concessions method for optimizing the topology of information control systems with multiple-bus architecture. *IEEE Conference of Young Researchers in Electrical and Electronic Engineering*. 147–152.

²⁷⁷ Khachaturov, R. 2019. Generalized Equivalence Set Method for Solving Multiobjective Optimization Problems. *Journal of Computer and Systems Sciences International*. 58(6), 922–931.

After obtaining the most appropriate value of the EEC, in case of intractable compatibility of requirements, practical recommendations are given on the application of certain taxes and (or) the adoption of specific measures to adapt the budget to the new conditions.

The practical feasibility of the options depends on what types of direct or indirect taxes can actually be collected, as they have different possibilities in evasion. The acceptability of the options is determined, on the one hand, by the ability to accumulate the full amount of tax revenues and, on the other hand, by compliance with the principles of equity. The higher the tax revenues, the greater the excess tax burden, *ceteris paribus*. The requirements of equity, if they imply the achievement of full equality, can also come into conflict with the desire to reduce the excess burden.

If one is guided primarily by equity considerations and actively uses taxation for redistributive purposes, the cost of redistribution is very significant. The disincentive effect of taxes on labour effort is key, as it causes the efficiency losses associated with leisure substitution and economic activity, i.e., the productive use of resources.

A tax structure that is optimal in terms of efficiency and satisfies the constraints that characterise both the state's ability to collect taxes and the specific requirements for redistribution is called a Pareto-optimal tax structure. Finding just such zones constitutes the content of the tasks of tax optimisation.

A situation in which tax revenues are fully distributed among the population in the form of payments that reduce economic inequality is most consistent with progressive taxation. If all other factors are constant, the faster the average tax rate increases, the greater the equalisation of income.

The application of the relative single indexes method for determining the area of acceptable EEC values with respect to the Vehicle Operation Tax in force and tax costs related to the vehicle operation in Latvia is given in Section 4.4, and the use of the principle of successive concessions related to the ranking of relative single indexes by importance for incompatible requirements is given in Section 4.5.

Study of expert survey processing methods is shown in the Annex 3D.

3.5 Tax system as a composite system

In recent years the usage of the mathematical basics of the quantum mechanics is became a perspective direction of the research in various areas of economics: from economic theory to tools for risk assessment and measuring value of the financial instruments.²⁷⁸

These questions were additionally studied by the author during the completion of the Global Quantum Programming Workshops (QBronze and QSilver, Annex 11).

The tax system is a composite system consisting of various internal and external elements. Even though the tax system is rather complicated – still, abstractly it can be assumed, that such a system as the tax system consists of a number of basic elements (units) having the same type. For the tax system, such a basic unit is a tax itself, thus the tax system at the simplest representation of a composite system can be defined as a composite system consisting of taxes, which are its basic units.

Usually, the assessment of a tax system is quite vague from the formal point of view, it is trying to include various factors that are affecting the tax system, yet it's making the assessment ambiguous and qualitative, rather than quantitative.

Discrete assessment of a tax system at a certain moment of time can be called a state of the tax system and it depends on combined discrete assessment (state) of the system elements (taxes).

The problem is, however, in assessing elements and combining them into a single system. One of the very simple, yet efficient approaches is to use a 1-bit representation of the element of the system. As it is known – the bit is the basic unit in computing, which can have one of two values – either 0 or 1 . Vector-wise approach can be used to represent states of the element in the defined domain. The tax system domain can be defined by choosing two of the most widely used and popular characteristics of the tax system, which are contradicts each other by definition – efficiency and equity. By efficiency it is assumed, that tax is fully favourable to the government and its sole purpose is to fulfil its fiscal function, and by equity, it's meant that the tax (and regime set by the tax) is favourable to the taxpayer.²⁷⁹

Based on the representation of a single element with appropriate adjustments it is possible to create a deterministic, probabilistic and quantum composite system. Usage of this approach requires applying mathematical methods, including linear algebra, analytical geometry, as well as mathematical formulation of quantum mechanics.²⁸⁰ In order to handle

²⁷⁸ Hull, I., Sattath, O., Diamanti, E. and Wendin, G. 2020. Quantum Technology for Economists. *SSRN Electronic Journal*. 10.2139/ssrn.3745608, 1–106.

²⁷⁹ Duff, D. 2008. *Tax Fairness and the Tax Mix*. Oxford: The Foundation for Law, Justice and Society, 13.

²⁸⁰ Hooft, G. 2020. Deterministic Quantum Mechanics: The Mathematical Equations. *Frontiers in Physics*. (8), 1–26.

the models correctly and efficiently – programming skills for automatising calculations are required.

In order to distinguish tax system features, efficient tax is set to state 0 , and tax, that's following the principle of equity is set to state 1 (the tax cannot be at the same time in both states, or somewhere in-between in such system). Since the principles of equity and efficiency are considered as opposite (“programmed conflict”), it is considered in the deterministic approach that the tax cannot be both in the state of equity and in the state of efficiency – there is only one explicit state. The terms equity and efficiency are used within the framework of the state-oriented and business-oriented aspects of tax optimisation defined in Section 3.1, including their antagonistic nature. Using vectors, it is possible to represent both states:

$$\text{state } 0 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}, \text{state } 1 = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \quad (3.17)$$

Currently, the tax system of Latvia has 14 functioning taxes,²⁸¹ so each of them can be deterministically assessed and be in one of the two states – each of the taxes can be defined as a vector representing either efficiency or equity. Using a tensor product of vectors, it is possible to assess taxes as a composite system. This allows to comprehensively assess the tax system (or parts of it) to determine areas for further improvement, as well as predict the consequences of changes.

$$\begin{bmatrix} 1 \\ 0 \end{bmatrix} \otimes \begin{bmatrix} 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ 0 \\ 0 \end{bmatrix} \quad (3.18)$$

The resulted vector (expression 3.18) is showing the state of the overall composite system and is in the state 01 , showing that one tax is following the efficiency paradigm, another is aligned to the principles of equity. If to assess the tax system of Latvia – the resulted size of the vector (the result of tensor product of 14 tax states) will be $2^{14} = 16\,384$, as in Latvia there are 14 taxes and there are 2 possible states for each of them in deterministic approach, which makes harder computational and assessment process.

After having an assessment of the tax system state – it's possible to predict changes by defining corresponding matrix operator, which will change the state of the system, thus it will be possible to see to what state the tax system will transit to and which states of the taxes are

²⁸¹ Latvijas Republikas likums. Likums “Par nodokļiem un nodevām”. *Latvijas Vēstnesis*, 7, 13.04.1995. Pieņemts: 02.02.1995.

expected to occur. For example, it's assumed that the following matrix operator will be applied to the current tax system state after analysing proposed changes:

$$\begin{bmatrix} 0 \\ 1 \\ 0 \\ 0 \end{bmatrix} \times \begin{bmatrix} 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \end{bmatrix} \quad (3.19)$$

So, after applying the operator, it could be clearly seen, that the state of the tax system has changed from the state *01* to the state *10*, so now tax one following the principle of equity, while the tax number two is used for fiscal function solely.

The approach to the composite system creation can be greatly extended using a probabilistic approach for determining states. In the abovementioned way of constructing a composite system the state of the element (and the whole system) could not have in-between options, however, in real life, it is the most common situation, while extreme situations are rare.

Another possible approach is based on the probabilistic nature of features assessment. Efficient tax still has state *0*, and tax, that's following the principle of equity has state *1*. State *[0.5, 0.5]* will show the perfect balance between criteria of taxation, yet presumably, such a state will never be achieved.²⁸²

State *[0.6, 0.4]* will be more efficient-based, while state *[0.4, 0.6]* – more equity-based. These values can be interpreted as the probability of which of the states (equity or efficiency) the tax is in. It can also be interpreted as the compliance of the tax with certain criteria of the principles of equity and efficiency. The sum of the elements in the vector, however, is equal to 1 and cannot exceed it, as the approach is probabilistic, and probability cannot be greater than 1. Main operations for the probabilistic approach remain the same – tensor product for discrete assessment of the system and using probabilistic matrix operator to analyse changes. However, the interpretation and possibilities of analysis change greatly.

$$\begin{bmatrix} 0.6 \\ 0.4 \end{bmatrix} \otimes \begin{bmatrix} 0.2 \\ 0.8 \end{bmatrix} = \begin{bmatrix} 0.12 \\ 0.48 \\ 0.08 \\ 0.32 \end{bmatrix} \quad (3.20)$$

Now the vector (expression 3.20), denoting the state of the composite tax system, assessed using probabilistic approach shows, that with the probability of 48 % – the system is in the state *01* (indication that the first tax is in state 0 – efficiency and the second is in state 1 – equity), the probability of being in the state *11* (both taxes are in state of equity) is

²⁸² Plaskova, N., Prodanova, N., Leontyev, A., Ratnikova, et.al. 2019. Analysis of the economic efficiency criteria and equity while determining the taxes. *Opcion*. 35, 1451–1469.

32 %, in the state 00 (both taxes are in state of efficiency) is 12 % and in state 10 (the first tax is in state 0 – equity and the second is in state 1 – efficiency) is 8 %. So, most likely the tax system has first tax as efficient tax and second tax as an equity-based tax, yet the system also can be in the state 11, which will mean that both taxes when applied together are equity-based taxes. The probabilistic approach may not give a precise answer for the state of the system (unlike the deterministic approach) but is a more flexible and useful tool for prognosis of the state of the system and possible transitions to the other states.

Both probabilistic and deterministic approaches are showing the classical way of designing the system, depending on states of multiple separate elements, that acts together. This approach can be widened to the quantum-based approach, which will give even more flexibility in the analysis, than the classical probabilistic approach.

For creating a composite quantum system, it is still needed to represent a single element. It can be done by using qubit (quantum bit). And still, there is a necessity to define two basic states for the tax system $|0\rangle$ and $|1\rangle$.

$$|0\rangle = \begin{bmatrix} 1 \\ 0 \end{bmatrix}, |1\rangle = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \tag{3.21}$$

The states in the quantum approach are not denoting probabilities directly, yet they are showing the position of the element state on the unit circle and representing a value of cosine and sine on angle theta (Figure 3.11). The square of these values will denote probability and is equal to 1 (formula 3.23).

$$|\text{state}\rangle = \begin{bmatrix} \cos(\theta) \\ \sin(\theta) \end{bmatrix} \tag{3.22}$$

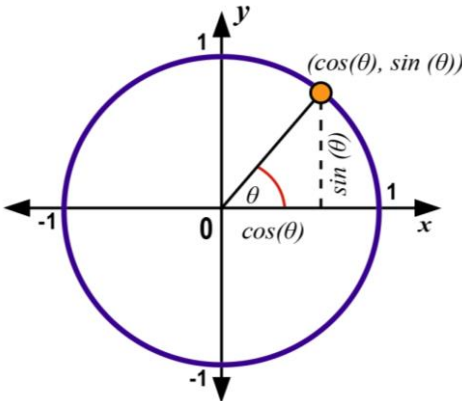


Figure 3.11 Geometrical representation of a quantum state on the unit circle

Source: created by the author.

Such an approach allows conducting a deeper analysis of the tax system, as the states can go to the quadrants where the values will be negative (probabilities will remain positive). This will give the possibility of a deeper analysis of the relations between taxes in the tax system. A tax that is in the negative quadrant—when any change is implemented—may result in a different equity or efficiency probability distribution than if it is in the positive quadrant.

$$|\text{state probability}\rangle = \begin{bmatrix} \cos(\theta)^2 \\ \sin(\theta)^2 \end{bmatrix} \quad (3.23)$$

State $[0.5, 0.5]$ from probabilistic approach, showing the perfect balance between the tax system chosen characteristics – equity and efficiency. It can be considered as an unattainable standard in most cases. However, unlike the probabilistic approach to modelling of the tax system, the quantum approach allows to see this balance in 4 different states, changes in which can lead to different results. This makes it possible to predict the negative or positive consequences of changes in taxes and the tax system as a whole. These states are:

$$|+\rangle = \begin{bmatrix} \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} \end{bmatrix}, |-\rangle = \begin{bmatrix} \frac{1}{\sqrt{2}} \\ -\frac{1}{\sqrt{2}} \end{bmatrix}, -|+\rangle = \begin{bmatrix} -\frac{1}{\sqrt{2}} \\ -\frac{1}{\sqrt{2}} \end{bmatrix}, -|-\rangle = \begin{bmatrix} -\frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} \end{bmatrix} \quad (3.24)$$

It gives extra flexibility between states transitions, and greatly enlarge tools for analysis of separate elements of the tax system, separately from the composite system. Creating the composite system in the quantum approach is the same as for others – by using tensor product on vectors, representing elements of the system. The same way operators can be applied to the system to make a transition from one state to another for modelling of the consequences of tax changes and their analysis (impact on the entire tax system).

Analytical assessment of the composite quantum system will allow to make a conclusion about the tax system, as well as its decomposition to separate elements will allow to study the impact of separate taxes and their behaviour in studied circumstances. It is also possible to assess visually any state of an element of the quantum system on the unit circle (Figure E3.1, Annex 3E), as well as create charts with respect to either state value or probability based on the changes of the state of an element (Figure E3.2, Annex 3E).

To change the resulting vector of states representing the tax system (or part of it), it is necessary to use matrix operators that change the state (and to what extent) of any individual tax or group of taxes. These standard operators, as well as those assigned manually, allow to establish relationships between individual elements of the system and consider it as a connected entity. Besides creating self-made operators to simulate transition between states –

quantum approach has a number of standard operators (gates), that may reflect the real changes in the tax system. All these operators can be a part of larger operator meant to be applied to the whole system.

The above-shown approach is the modification of quantum behaviour by its projection to 2D plane, which is more than an enough for most of the cases.

More sophisticated approach is involving usage of complex numbers and 3D quantum behaviour simulation, such as Bloch sphere (Figure E3.3, Annex 3E).

Introduction of the complex numbers and usage of two-dimensional quantum state will allow to take into account and model process of co-influence of states, representing taxes more deeply, as well as define global and local phase.

Deterministic, probabilistic and quantum approaches are allowing to see the tax system as a composite system, created from multiple elements – taxes. Each of the approaches looking at the tax system from a slightly different angle, thus allowing to carry out a more sophisticated analysis.

The quantum approach gives an opportunity to see more explicitly, with bigger sensitivity the changes in separate units and in the whole system, allowing to apply various quantum operators in appropriate situations to the tax system. The data gathered by the quantum approach can be later used in regression modelling and other available statistical tools for additional analysis and prognosis enhancement.

All of the shown approaches cannot be carried out manually, as the order of growth for such systems is 2^n , where 2 is a number of criteria – efficiency and equity, while n is the number of elements (taxes in the tax systems, or set of taxes of interest, which can be less than number of all taxes). The only way to apply methods in practice is to create a software that will carry out all basic operations with vectors and matrices, allowing to quickly work with data in the required format.

4 Improvement of the tax system of Latvia by applying integrated optimisation tools

The chapter is demonstrating the practical application of several methods (tools) intended for use in the process of tax optimisation during the integrated optimisation of the tax system

Earlier, in Chapter 3, the theoretical development of the tools was carried out. They are intended both for individual use (in solving discrete problems) and in combination with well-known methods that have proven their universality and applicability in solving economic problems related to the tax system.

The author in the Thesis proposed an integrated approach and developed the following tools:

The method (tool) for determining reliability – for assessing the life cycle of the tax system, as well as forecasting the life cycle of the changes (reforms) being developed.

The method (tool) of the tax prism – for determining the relationships, values, forecast and optimisation of the three-parameter system “tax rate – tax base – volume of collected taxes”, both from the point of view of a business-oriented approach and from the point of view of a state-oriented approach.

The method of relative single indexes in the “equity-efficiency” system – for obtaining zone of the most acceptable solutions when determining rational tax parameters in terms of criteria of equity and efficiency.

The composite system method – for describing and modelling the relationships between taxes and the impact of changes in some taxes on others, taking into account the criteria of equity and efficiency.

Also, in the Thesis were used:

The method of expert evaluation – for elimination of the incompatibility of requirements and for search of concessions in the “equity-efficiency” system.

Classical methods of statistical and econometric analysis are used to describe and forecast existing tax dependencies for scenario analysis in the absence of changes, as well as for indirect assessment of the reliability (predictability) of tax revenues.

In this Chapter the results of studies of the Latvian tax system are presented, obtained with the help of the set of abovementioned tools, based on the analysis of which conclusions are drawn and recommendations are given (Figure 4.1).

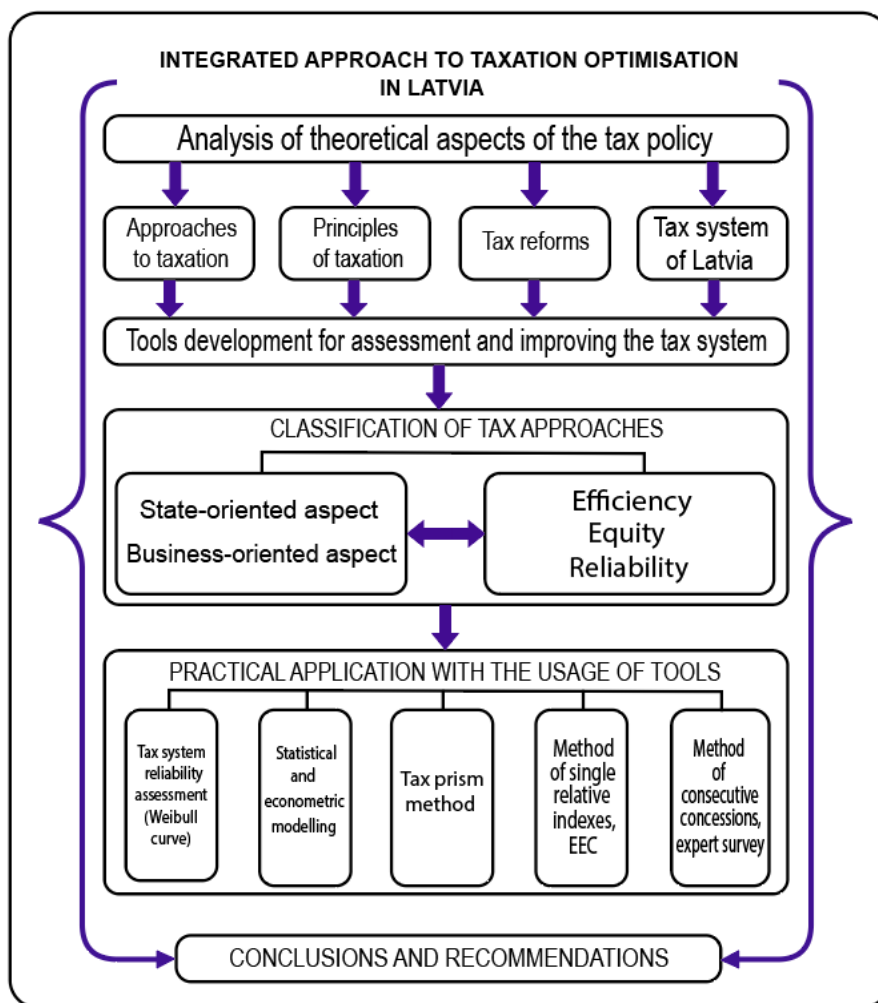


Figure 4.1 Integrated approach practical application scheme

Source: created by the author.

The successful implementation of integrated optimisation largely depends on the professional training of specialists (researchers and decision makers), who must have a clear understanding of the specific features of the tax system and be able to correctly set the task. The accuracy and correctness of task setting should be based on examples of successfully implemented developments and on a clear presentation of the advantages, disadvantages and specifics of the application of various tools used in the optimisation process.

Decision-making methods based on the optimisation of indicators are associated with finding the most rational option, based on the existing dependencies of various factors among themselves and the given restrictions. They are related to finding the best course of managerial actions in the case when certain dependencies act as the objective function and constraints.

The combination of participation of a specialist and software that allows formalising the application of the developed tools is the basis of an integrated approach to optimising the tax system.

4.1 Reliability assessment of the tax system

Chapter 3 (Section 3.2) proposed a methodology for assessing the reliability of tax reforms and the tax system as a whole. The reliability of the tax system is an important element that characterises its functioning and is intended for timely adjustment of the tax system, preparation of tax reforms and assessment of their subsequent life cycle. A tax system that meets the requirements of efficiency and equity, but is not sufficiently reliable, will function in the required mode without adjustments on various levels for a short period of time, and, consequently, will require additional costs. In addition, frequent changes in the tax system affect the trust of taxpayers.

To assess the results of their reliability, it is necessary to construct a failure rate curve λ as a function of the operation time T of a particular tax system for a fixed number of taxes in force in Latvia, based on experimental data. The Weibull distribution²⁸³ will allow to assess the reliability of the tax system, for example, after the major tax overhaul. The Weibull distribution, as it was justified in Chapter 3, was chosen as it is closely related to the reliability of the systems, and distribution allows to graphically track the dynamics of changes in the reliability of tax systems. The resulting curve showing the change in the reliability of the tax system in the form of the failure rate in the post-reform period is presented in Figure 4.2.

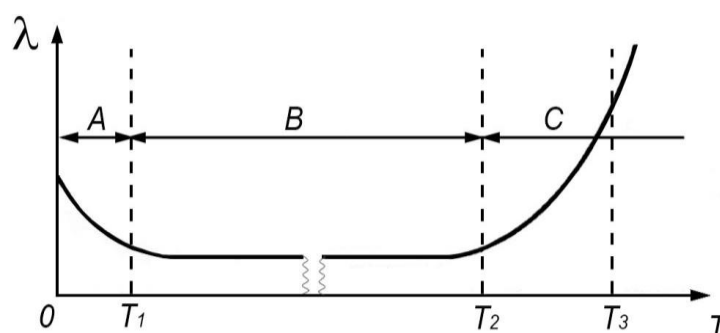


Figure 4.2 Changes in the reliability of the tax system as a time function

λ – failure rate; T – the tax system operation time; A – the tax system adaptation period; B – period of the normal functioning of the tax system (only occasional failures are possible); C – the period during which the tax system becomes obsolete and ceases to ensure the effectiveness of tax policy.

Source: interpreted by the author based on the Weibull distribution.

The tax system is enacted at a point in time $T = 0$ after the tax reform. The set of elements representing taxes (e.g., their collectability) may initially have a high failure rate.

²⁸³ Scholz, F. 2015. Inference for the Weibull Distribution. *Department of Statistics, University of Washington*. 11(3), 148–173.

Analysis of the situation determining the reliability of the tax system of Latvia in 2018–2021

Simultaneously with the enactment of the tax reform of 2018 and the adoption of the Law “On the Guiding Principles of State Tax Policy for 2018–2021”²⁸⁴ there were a number of problems associated with the lack of preparation of the administrative system for the transition to a progressive tax scale, as well as unpreparedness of the population to pay an increased amount of tax (to make an additional payment) to the state budget. At the time of the start of the filing process, the Electronic Declaration System (EDS) was unable to submit declarations due to the heavy workload. The State Revenue Service (SRS) public relations department reported that there were 26 500 simultaneous connections to the EDS just minutes after midnight, which caused the system to malfunction.²⁸⁵ Even though the system was down only by one day, the main point here is not in the number of days, but in the number of taxpayers who felt inconvenience and, as a result, doubted the reliability of the tax system, which led to dissatisfaction and the emergence of doubts about the adequacy of the tax system. In addition, the facts of insufficiently reliable work were numerous: similar situation had already occurred in previous years, although then the number of simultaneous connections was about half as many.

At the beginning of 2019, the situation with filing declarations was further complicated by the fact that data from the State Social Insurance Agency of the Republic of Latvia (SSIA) on pensions that SSIA sent to the State Revenue Service contained errors. Therefore, SRS asked pensioners not to rush with submitting declarations and paying debts until they received new data from SSIA.

The EDS is used by many Latvian taxpayers, as it is a convenient way to file all tax and information declarations, as well as applications addressed to the State Revenue Service by individuals and legal entities. In addition to the ability to file documents, the EDS provides online services such as electronic tax books, certificates for public procurement, and various kinds of reports on the data available to the SRS, such as information on the status of tax payments. Due to the coronavirus pandemic, when face-to-face customer service to the SRS was discontinued, the main burden fell on the EDS, where there is a section “Correspondence with the SRS” in case taxpayers have questions.

²⁸⁴ Ministru kabineta 24.05.2017 rīkojums Nr.245 “Par Valsts nodokļu politikas pamatnostādņem 2018.–2021. gadam”. *Latvijas Vēstnesis*, 105, 30.05.2017. Pieņemts: 24.05.2017.

²⁸⁵ Kinca, A. 2019. VID vadītāja aicina nesniegt elektroniskās deklarācijas tieši šodien – sistēma var neizturēt, Latvijas Sabiedriskie Mediji. *LSM.lv Ziņu redakcija*. <https://www.lsm.lv/raksts/zinas/ekonomika/vid-vaditaja-aicina-nesniegt-elektroniskas-deklaracijas-tiesi-sodien--sistema-var-neizturet.a311224/>.

The head of the State Revenue Service stated in 2019 that about 167 538 people in Latvia found themselves owed to the budget because of the tax reform, and no one expected that to happen. All of these 167 538 customers were unhappy, and this has become a problem for 140 SRS employees.²⁸⁶

Taxpayers also began to apply to the SRS in large numbers for explanations of arrears.

The period corresponding to the situations in which there was an adaptation to the new conditions caused by the tax reform enacted on January 1, 2018, in the graph shown in Figure 4.1 corresponds to the time interval from 0 to T_1 . Here are shown so-called “early failures”, which can be predicted in advance and, if the necessary measures are taken, quickly eliminated or, even better, not allowed to happen. Such a period is difficult to exclude and cannot characterise the tax reform as a failure. At the same time, it is quite possible to significantly reduce the early-failure period and / or minimise the number of failures between 0 and T_1 . And, although Ieva Jaunzeme, head of the SRS, said that the organisation she heads, assessed the situation and came to the conclusion that it is very expensive to significantly increase the capacity of the EDS, on 1 March 2020, the system worked smoothly and registered 237 000 applications in less than two days.²⁸⁷ Perhaps the system needed a little additional debugging, although the head of the SRS did not rule out cases of EDS failures in an avalanche of requests. At this stage it is advisable to use organisational and explanatory methods, reducing the peak loads on the system. Since such loads are mainly caused by the desire of taxpayers as soon as possible to get a refund of overpaid income tax for justified expenses. Currently, the SRS indicates that it considers the submitted declaration and returns the tax paid in excess by the taxpayer to their current account within three months of receipt of the declaration.²⁸⁸

To reduce the peak load, it is advisable to make a refund of overpaid tax after the end of the specified period of declaration submission and make it regardless of the date of the declaration submission. All interested persons should be informed about it.

²⁸⁶ Latvijas Sabiedriskie Mediji. 2019. Nodokļu parāds izveidojies 167 539 deklarāciju iesniedzējiem. *LSM.lv, Ekonomika*. <https://www.lsm.lv/raksts/zinas/ekonomika/nodoklu-parads-izveidojies-167-539-deklaraciju-iesniedzjiem.a322803/>.

²⁸⁷ Latvijas Sabiedriskie Mediji. 2020. SGD ne budet investirovat v EDS, chtobi ona “ne visla” c 1 marta. *LSM.lv, Sabiedrība*. <https://rus.lsm.lv/statja/novosti/obschestvo/sgd-ne-budet-investirovat-v-eds-chtobi-ona-ne-vislas-1-marta.a349487/>.

²⁸⁸ Latvijas Republikas Valsts ieņēmumu dienests. 2021. Iedzīvotāju ienākuma nodokļa pārmaxsa. *Nodokļu un nodevu atmaksa*. <https://www.vid.gov.lv/lv/iedzivotaju-ienakuma-nodokla-parmaksa>.

Usage of the Weibull curve and scenario analysis to assess the tax system of Latvia in 2018-2021

When tax reform is introduced, a period of uninterrupted operation of the tax system should be projected ($T_1 - T_2$). Since external conditions are constantly changing, after some time the tax system will no longer meet the objective realities, and another tax reform will be required (section $T_2 - T_3$ in Figure 4.2).

In the preparation of the tax reform and its subsequent implementation, it is necessary to strive for the horizontal section of the Weibull curve to be as close to the abscissa axis as possible.

This is symbolised by the blue arrow in Figure 4.3. In this case, the failure rate λ will be minimal, which will allow to consider the tax system reliable. And, of course, the length of the horizontal section (between points T_1 and T_2) should be long enough for the implemented tax measures to operate efficiently and reliably for a long time. This is shown by the red double-edged arrow.

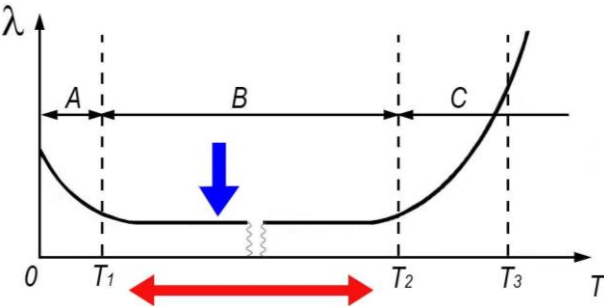


Figure 4.3 Minimisation of failures and increasing the life cycle of the tax system’s stable operation

Source: created by the author.

When the tax system is in the $T_2 - T_3$ area of the Weibull curve and, as mentioned above, it no longer fits the current situation, tax reform is necessary, which is always associated with significant costs. However, in certain cases, it is possible to do with less costly measures.

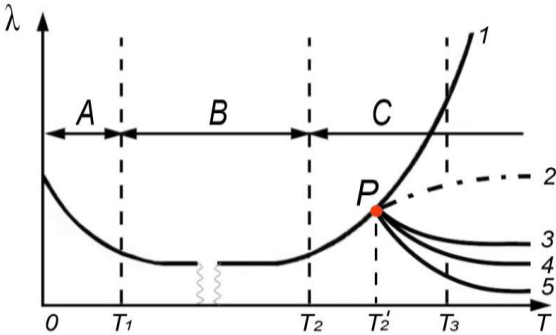


Figure 4.4 Decision options when the tax system is no longer appropriate to the current situation

Source: created by the author.

The sign that a particular tax system has become obsolete, and at least requires modernisation, is the transition of the horizontal part of the Weibull curve into a hyperbola (Figures 4.3 and 4.4). In this case, during the time period T_2' (corresponds to the point P on the Weibull curve) there is a possibility of several scenarios (indicated in Figure 4.4 by numbers 1 – 5):

- 1 – the creation of a new tax system to replace the current one;
- 2 – 5 – taking measures to upgrade the existing system and return it to normal operation.

Scenarios 2 and 3 imply some deterioration in the functioning of the tax system within the limits acceptable to the state and a taxpayer.

Scenarios 4 and 5 lead to improvements in the characteristics of the tax system.

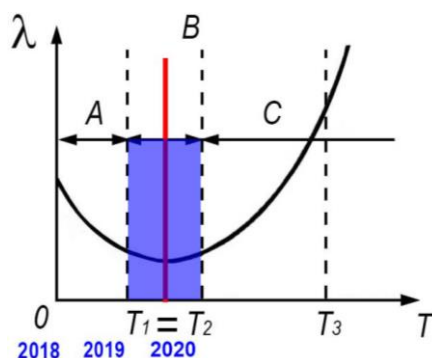


Figure 4.5 **Reliability of the tax system in Latvia after the tax reforms of 2018 and 2020s – an empirical analysis**

Source: created by the author.

In reality, in Latvia, the Weibull curve, also called the Weibull bathtub (or bathtub curve), degenerated into a parabola in the period since the beginning of 2018 (Figure 4.5). It was never possible to reach the horizontal section. It was not possible to create a stably operating fiscal system that would effectively perform its functions for a long time.

Analysis of the situation determining the reliability of the tax system of Latvia from 2021

The tax reform was introduced on January 1, 2018, and at the end of February 2019, the European Commission concluded that, on the one hand, Latvia was among the countries whose economy was fastest approaching the EU average, while, on the other hand, the problem of population reduction and the distribution of the benefits of economic growth to all segments of the population had not been solved. The tax reform that has been carried out has not made it possible to do this, said in the conclusion of the European Commission. As a result, new

measures began to be developed and the next significant changes in the tax legislation came into effect on January 1, 2021.

And then, as of July 1, 2021, the next tax changes came into effect. They concern employers, affect micro-enterprises (both business owners and employees), persons conducting business activities, recipients and payers of royalties, Excise Duty taxpayers.

Taxpayers of Latvia had a very negative attitude to these innovations. Public organisations, representatives of various Unions and associations, as well as the President of Latvia called for adjustment of tax changes for self-employed and part-time employees.^{289, 290}

Since that date, Latvia has introduced minimum mandatory state social insurance contributions. If an employee's quarterly salary is less than three minimum monthly salaries set by the Cabinet of Ministers (in 2021 – 500 euro per month, respectively 1500 euro per quarter), the employer must make the minimum mandatory contributions from its own funds on the difference between 1500 euro and the declared salary of the employee (object of mandatory contributions). The State Social Insurance Agency calculates the minimum mandatory contributions to be paid additionally by the employer.

As of July 1, 2021, the micro-enterprise taxpayer's payroll will be subject to a general labour tax, namely Personal Income Tax and mandatory state social insurance contributions (VSAOI) in full.

Self-employed persons who have opted for the Micro-enterprise Tax regime and whose income is less than the minimum monthly wage of 500 euro per month or 1500 euro per quarter, as established by the Cabinet of Ministers, are also required to make the minimum mandatory contributions. Micro-enterprise taxpayers who are employers will have to make these contributions both for themselves (if they do not work elsewhere) and for their employees.

If a micro-enterprise taxpayer, who is not at the same time an employee, forecasts that his / her income from economic activity in the following year will no longer reach 1500 euros in each quarter, he / she should submit to SRS a statement of planned income in the following quarter, and then the minimum mandatory contributions for the self-employed person (MUN holder) will not be charged and there will be no need to pay them.

It should be noted that under the economic crisis conditions exacerbated by the pandemic that intensified by the beginning of the fourth quarter of 2021, when the country was again in lockdown, requiring the taxpayer to plan their income is excessive.

²⁸⁹ Press. lv. 2021. Elina Egle o nalogovih izmenenijah: i mesiacā ne proshlo, no uzhe poniatno – nichego horoshego ne budet. *Press.lv, Atzinums*. <https://press.lv/post/elina-egle-o-nalogovyh-izmeneniyah-i-mesyatsa-ne-proshlo-no-uzhe-ponyatno-nichego-horoshego-ne-budet>.

²⁹⁰ Portāls nra.lv. 2021. Valsts prezidents Egils Levits: Šī nav pēdējā nodokļu reforma. *Nra.lv*. 26.07.2021. <https://nra.lv/latvija/353371-valsts-prezidents-egils-levits-si-nav-pedeja-nodoklu-reforma.htm>.

In addition, the self-employed must make VSAOI contributions to pension insurance at the rate of 10 % (instead of the previous 5 %).

The minimum mandatory contributions must also be made by self-employed persons whose income is less than 1500 euros per quarter. Self-employed persons who are employers must make these contributions both for themselves (if they do not work elsewhere) and for their employees.

If a self-employed person, who is not at the same time an employee, forecasts that his / her income from the economic activity will not reach 1500 euros per quarter, he / she submits to SRS a statement of planned income for the next quarter, and then the minimum mandatory contributions will not be charged and it will not be necessary to pay them.

As already mentioned, the possibility of planning, at least during the period under analysis is very difficult.

The situation with changes in the taxation of royalty recipients is also very ambiguous.

In November 2021 it was reported that self-employed persons receiving income from the intellectual property will be able to make mandatory contributions once a year.²⁹¹ However, for all other self-employed persons, no such indulgence is planned.

A petition to revise the changes enacted on July 1, 2021, gained 10,000 votes in a short period of time and was forwarded to the Saeima.²⁹²

Most likely, in the near future, it will be necessary to adjust the tax laws again, because the innovations do not correlate well with the current economic and epidemic situation in the world.

This situation is costly for the state because the funds spent on the development and implementation of the 2018 reform did not pay off themselves (they could not even reach the horizontal part of the Weibull curve, Figure 3.4). The second negative side of the lack of reliability of the tax reform is the discrediting of the fiscal system in the view of taxpayers. Concerns about the economic efficiency, fairness, and increasing complexity of the tax system cast doubt on its reliability. Taxpayers may doubt the fairness of the tax system because they do not know whether those who have the same ability to pay actually pay the same amount of tax.

²⁹¹ LETA. 2021. Vienojas ļaut ienākumus no intelektuālā īpašuma saņēmējiem pašnodarbinātajiem minimālās obligātās iemaksas veikt reizi gadā. *LETA nacionālā informācijas aģentūra*. https://webcache.googleusercontent.com/search?q=cache:Q2MbHmyIaeQJ:https://www.leta.lv/home/important/836B035D-4247-458E-966B-0A54B8C7D85A/+&cd=1&hl=ru&ct=clnk&gl=lv_

²⁹² Manabalss.lv. 2021. Par 2021.gada nodokļu reformas atcelšanu. *Iniciatīva ir iesniegta Saeimā*. <https://manabalss.lv/par-2021-gada-nodoklu-reformas-atcelšanu-dodmakslaieipot/show?locale=lv>.

Even under conditions of economic stability, the requirement to estimate own revenues is an extremely ambiguous practice, and in fact is an attempt to estimate “tax capacity”,²⁹³ as an ability to generate income. This approach is extremely difficult (if not utopian) to actually assess “tax capacity” in order to determine the value of the tax.²⁹⁴ In times of pandemic / crisis, this approach, in the author’s opinion, is not acceptable.

Public confidence in national tax laws and tax administration is crucial because any state relies to some extent on a system of voluntary compliance with tax laws.

The more time corresponds to the interval $T_1 - T_2$ on the Weibull curve, the more taxpayers trust the current system, the more understandable it is to them.

If taxpayers do not believe that the tax system is trustworthy, easy to understand, and fair to all, then the degree of voluntary tax compliance will obviously decrease. This is characterised by a higher failure rate λ on the section of the Weibull curve $T_1 - T_2$, compared to a tax system that has more trust from taxpayers. A higher failure rate, for example, may be reflected in a decline in the aggregate tax base (leaving for other jurisdictions, growth of the shadow economy, tax evasion, etc.).

Elīna Egle, chairman of the board of the Latvian Business Union and the Latvian Federation of Security and Defence Industries, in assessing the tax changes that came into force on July 1, 2021, said that the state administration is most concerned about the shadow economy aspect.²⁹⁵

The degree of interest in paying taxes and trust in the current tax legislation can also be assessed by the attitude of the population towards changes in the tax legislation. A survey conducted at the beginning of the year 2021 regarding the level of Latvian residents’ awareness of the tax changes introduced on January 1, 2021, has revealed that only 14 % of the respondents aged from 18 to 60 are well aware of the changes affecting them personally. 54 % of respondents said they had heard something about the changes, while 25 % said they were not aware of them. 3 % of residents believed that the tax changes will not affect them personally, and 4 % of the population did not know whether they will or will not be affected by these changes. However, such a survey would give more complete information if it was conducted at the end of the deadline for submission of annual declarations.²⁹⁶

²⁹³ Meade, J. 1978. *The Structure and Reform of Direct Taxation*. London: The Institute for fiscal studies, 533.

²⁹⁴ Banks, J. and Diamond, P. 2010. *The Base for Direct Taxation. Dimensions of Tax Design*. Oxford: Oxford University Press. 548–674.

²⁹⁵ Press. lv. 2021. Elina Egle o nalogovih izmenenijah: i mesiacā ne proshlo, no uzhe poniatno – nichego horoshego ne budet. *Press.lv, Atzinums*. <https://press.lv/post/elina-egle-o-nalogovyh-izmeneniyah-i-mesyatsa-ne-proshlo-no-uzhe-ponyatno-nichego-horoshego-ne-budet>.

²⁹⁶ Tv.3lv. 2021. Aptauja: cik labi iedzīvotāji ir informēti par jaunajām nodokļu izmaiņām? *Ziņas, aptaujas*. <https://skaties.lv/zinas/aptaujas/aptauja-cik-labi-iedzivotaji-ir-informeti-par-jaunajam-nodoklu-izmainam/>.

The author with the assistance of the specialists of the University of Latvia has conducted own research (Annex 9). It has shown the necessity of the further improvement of the tax literacy of the population of Latvia.

Multicriteria assessment of the reliability of the tax system of the Republic of Latvia

The system of rationing the level of reliability of the tax system (reforms, adjustments, changes) is designed to inform those involved in the development of tax reforms (adjustments, changes), as well as those who decide on the introduction of these developments, about the reliability of the tax system in previous periods, as well as the forecast reliability of the system when introducing specific changes.

The author proposes to use a three-tiered scale to classify the reliability of the tax system (reform, adjustments, changes):

- high degree of reliability;
- medium degree of reliability;
- low degree of reliability.

Factors affecting the reliability of the tax system can be divided into several groups: the reaction of taxpayers, additional changes in tax legislation, recommendations, reports, and requirements of EU structures, as well as the impact of changes on budget revenues.

Table A5.1 (Annex 5) shows the criteria for qualitative assessment of the tax system's reliability. Points are awarded both cumulatively and separately in each category. Based on this, it is possible to distinguish two types of reliability: local – when the tax system is reliable in any group of criteria, and global – showing the aggregate reliability of the tax system. Local reliability does not mean stability of the tax system in the long term. Depending on the group of reliability, the tax system may lose local reliability over time, or vice versa.

It should be noted that it is necessary to assess the frequency of changes in tax legislation. Insufficient design of the tax system and frequent changes in tax legislation have a negative effect on the relationship between the tax administration (government) and taxpayers, leading to the worse economic development of the state.²⁹⁷

Points are not accrued for the introduction of changes envisaged by the main reform (adjustment), in case of their gradual introduction, implemented in the initially planned terms under the condition of the aging process and the failure of the tax system.

²⁹⁷ Dimitrios, K., Zacharias, D., Athanasios, A. and Panagiotis, L. 2020. The multiplicity and the frequent changes of the tax legislation in the Greek Tax Administration. *Technium Social Sciences Journal*. 13, 395–407.

Points are not accrued when introducing changes caused by force majeure circumstances if they are aimed at reducing their negative impact.

In this case, it is possible to say about the insufficient readiness (adaptability) of the tax system to such situations. However, it should be taken into account that with a reliable tax system the probability of its critical failures under force majeure circumstances will be lower than with an unreliable tax system.

A comprehensive assessment of reliability according to the proposed criteria can be carried out using the following scale (table A5.2, Annex 5).

The analysis of the tax system's reliability since the 2018 tax reform took effect was based on the data of the Ministry of Finance on tax changes between 2018 and 2021.

The aim of the Latvian tax policy adjustment implemented through the tax reform, which entered into force on January 1, 2018, was to carry out activities to reduce the tax burden of workers, especially low-wage workers and families with children.²⁹⁸ The tax reform was developed in cooperation with state social and business partners.

The tax reform has affected virtually the entire population of Latvia – both working people and families with children, as well as retirees. As mentioned above, it has been stated that low-wage workers and families with children will benefit most from the tax reform.

Some of the changes in the tax sphere, introduced in 2019, were declared as a continuation of the tax reform, launched in 2018.²⁹⁹ Although already at that time its inefficiency was noted by economists both domestically and in the recommendations of the European Commission.

In evaluating the results of the 2018 reform, the Latvian Fiscal Discipline Council concluded that the reform did not achieve one of its main goals of increasing tax revenues relative to GDP, as well as growing the tax base fast enough.³⁰⁰ The Council noted that to reduce inequality, the tax burden for low-wage workers has not been reduced sufficiently, and it is still significantly higher than in Lithuania and Estonia. The reform has improved capitalisation and profitability of companies, but has not significantly increased fixed capital accumulation and the corresponding expected economic breakthrough. Latvia's tax burden is relatively low by international standards; as a result of the 2018 reform, it has fallen even further. As a result of the reform, the decrease in tax revenues (compared to the situation as it would have been

²⁹⁸ Latvijas Republikas Finanšu ministrija. 2020. Izmaiņas nodokļu jomā, sākot ar 2018. gadu. *Aktuālās nodokļu politikas izmaiņas*. <https://www.fm.gov.lv/lv/izmainas-nodoklu-joma-sakot-ar-2018-gadu>.

²⁹⁹ Latvijas Republikas Finanšu ministrija. 2020. Izmaiņas nodokļu jomā, sākot ar 2019. gadu. *Aktuālās nodokļu politikas izmaiņas*. <https://www.fm.gov.lv/lv/izmainas-nodoklu-joma-sakot-ar-2019-gadu>.

³⁰⁰ Latvijas Republikas Fiskālās disciplīnas padome. 2018. 2018. gada nodokļu reformas rezultāti un kritēriji tālākai nodokļu sistēmas pilnveidošanai. *Fiskālās disciplīnas padomes viedoklis*. <https://www.fdp.gov.lv/en/media/2988/>.

without the reform) was about 0.8 % of GDP in 2018 and 1.4 % of GDP in 2019. The Fiscal Discipline Council has recommended a moderate increase in the tax burden in the future.

As a result of the 2018 reform, the tax burden was shifted slightly from capital to consumption and from lower wages to higher wages. Entrepreneurs were the main beneficiaries of the 2018 reform, with low-wage workers, families with children, and retirees as planned. The Fiscal Discipline Council noted that the tax burden on labour should be further reduced by shifting it to taxes on capital, consumption, and environmental taxes, thereby pursuing policies to reduce inequality and increase competitiveness, as recommended by the Council of the European Union.³⁰¹

While some of the tax law changes in 2019 were attributed to a continuation of the tax reform that began in 2018, the changes introduced in 2020,³⁰² 2021³⁰³ and in 2022³⁰⁴ could well be attributed to standing alone.

When reforming the tax system, the author recommends that government agencies consider and evaluate the reliability of the resulting tax system to create a reliable functioning fiscal instrument.

Assessment of the reliability of the tax system should be carried out not only at the national level, but also separately at the regional level, since part of the tax revenues are administered and remain directly at the disposal of local governments. Conducting such evaluation activities and analysing their results can serve as one of the decisive factors for conducting the ATR (as mentioned in Section 2.2). The reliability assessment in these cases should also be carried out using an evaluation scale similar to that proposed in this Section for the general assessment of the tax system. Taking into account the regional characteristics of a particular territory, which are signature for assessing tax revenues, will increase the reliability and efficiency of the tax system, as well as stimulate the development of regions to the necessary extent and improve the situation of the population with low incomes.

The creation of the apparatus of budget formation within the framework of the state tax policy with the specified characteristics of economic reliability and efficiency within the framework of reforming a particular tax system is possible if there is an adequate database for

³⁰¹ Eiropas Savienības Oficiālais Vēstnesis. 2019. PADOMES IETEIKUMS (2019. gada 9. jūlijs) par Latvijas 2019. gada valsts reformu programmu un ar ko sniedz Padomes atzinumu par Latvijas 2019. gada stabilitātes programmu. <https://eur-lex.europa.eu/legal-content/LV/>, 5.

³⁰² Latvijas Republikas Finanšu ministrija. 2020. Izmaiņas nodokļu jomā, sākot ar 2020. gadu. *Aktuālās nodokļu politikas izmaiņas*. <https://www.fm.gov.lv/lv/izmainas-nodoklu-joma-sakot-ar-2020gadu>.

³⁰³ Latvijas Republikas Finanšu ministrija. 2020. Izmaiņas nodokļu jomā, sākot ar 2021. gadu. *Aktuālās nodokļu politikas izmaiņas*. <https://www.fm.gov.lv/lv/izmainas-nodoklu-joma-sakot-ar-2021gadu>.

³⁰⁴ Latvijas Republikas Finanšu ministrija. 2021. Izmaiņas nodokļu jomā, sākot ar 2022. gadu. *Aktuālās nodokļu politikas izmaiņas*. <https://www.fm.gov.lv/lv/izmainas-nodoklu-joma-sakot-ar-2022gadu>.

a long period. This process also requires the development of two-level economic-mathematical models and appropriate software.

4.2 Statistical analysis of tax revenues to the budget

It is possible to use statistical models to estimate both total tax revenues and the level of collection of individual taxes. One of the classical options that is widely used in economic modelling is regression analysis. However, in case of analysis of statistical data of the tax system of Latvia it is encountering several important difficulties.

The major of them is a small number of observations for creation of precise and sophisticated models – most of the statistical data is available annually, which leads to approximately 20 valid observations. If to take into account possible structural breaks in the data (e.g. 2004, when Latvia joined EU, 2008–2009, when financial crisis took place and 2020, when COVID-19 pandemic hit the world), the number of observations for specific time interval is becoming dramatically small. It leads only to an opportunity to create assumption models, which can be used to estimate certain relations and trends but cannot be efficiently used for prognosing.

It is not all the problems, that regression modelling would encounter during the corresponding analysis of the tax system. In case of multiple regression analysis, because of the nature of economic data and their interconnectedness, cases of multicollinearity are possible, which significantly degrade the quality of the models. Getting rid of multicollinearity often leads to the removal of important explanatory variables. In the states with specific socio-economic factors the emergence of a spurious correlation may happen. One example is the ratio of tax revenues to population in countries with declining populations, including Latvia. In such cases, there is a significant negative correlation between these factors, illustrating the correlation: e.g. “the smaller the population, the higher the tax collections”, which is false assumption from the economic point of view. The significant lag that occurs due to the gap between data releases may not allow for timely forecasts, which is also can be considered as a narrow place of regression modelling. Perhaps government agencies do not face the latter problem.

In addition to the regression analysis, the study of tax revenues to the budget can be based on the analysis of time series. In this approach, Autoregressive Integrated Moving Average (ARIMA) and Seasonal Autoregressive Integrated Moving Average (SARIMA) models can be distinguished. Their variations with exogenous variables ARIMAX and SARIMAX can also be used in some cases.

The advantage of this approach is the absence of additional variables that can introduce noise into the model and also have a high correlation between each other.

Another advantage of the proposed approach is the ability to extract monthly tax revenues data of the Latvian budget for each of the studied taxes, which gives more observations than the analysis of annual tax revenues that are usually used in classical regression models.

ARIMA model is consisting of three parts *AR*, *I*, *MA*.³⁰⁵

The first part is *AR* (autoregression), which means applying a linear regression algorithm using one observation and its own lagged observations as training data. The *AR* model uses formula (A4.10, Annex 4A).

The second part is *I* (integrated). For creation of ARIMA model time series has to be stationary or can be made stationary (the time series is stationary, if its mean and variance doesn't change over time). Time series can be made stationary through a transformation that uses differencing of the log between an observation and the one before that (formula A4.11, Annex 4A). The degree of differencing is defined by parameter *d*.

The third part is *MA* (moving average). The *MA* model uses the residual error from the mean of the current observation and the weighted residual errors of the lagged observations and is defined by formula (A4.12, Annex 4A).

The SARIMA model adds seasonality, compared to ARIMA model, and can be in general defined by formula (A4.13, Annex 4A).³⁰⁶

The aforementioned models are used to forecast both total tax revenues and individual tax revenues. The author used the Python programming language and its packages (statsmodels, matplotlib, tensorflow for statistical analysis and modelling, openpyxl and camelot, numpy, pandas for data processing and supportive data structures) to process information and automate analysis of the obtained data.

As an illustration of the application of the models, the analysis of VAT and its forecasting is conducted. Data on other tax payments are given in the Annex, as well as they are aggregated in Table 4.1.

As the study period was selected period between the beginning of 2016 till the end of 2020. Cumulative VAT tax revenues to the budget of Latvia were taken according to the State Revenue Service data,³⁰⁷ in the following format: for each month of the year, the report showing cumulative tax revenues for all passed months of the year. Such a format of data representation

³⁰⁵ O'Reilly. 2021. Time series forecasting using the ARIMA model. *O'Reilly media*. <https://learning.oreilly.com/library/view/data-analysis-with/9781789950069/ch08s04.html#ch08lv13sec12>.

³⁰⁶ Korstanje, J. 2021. *Advanced Forecasting with Python*. 1st ed. New York: Apress, 316.

³⁰⁷ Latvijas Republikas Valsts ieņēmumu dienests. 2020. Nodokļu ieņēmumi. *Statistika*. <https://www.vid.gov.lv/lv/statistika/nodoklu-ienemumi>.

required additional processing. For the automation of data processing, the author has created a parser, allowing extraction of necessary data and its transformation into valid time series in the study period.

Monthly collections to the budget are presented in the graph shown in Figure A6.1 (Annex 6). Visual analysis confirms the assumption of seasonality in VAT collection.

Seasonal decomposition using a moving average is carried out.

The resulting visualisations (Figure A6.2, Annex 6) show:

- on the first subgraph – the real dynamics of the studied time series;
- on the second subgraph – the trend component of the time series – it is present, growth is mostly positive, with a slight dip at the beginning of 2020 due to the pandemic;
- on the third subgraph – the seasonal component of the time series. The analysis shows that it is present;
- the fourth subgraph shows the residuals, i.e. the so-called random noise, which remains after the exclusion of the trend and seasonality, and which has an impact on the time series. In general, these residuals are close to zero, but there are “outliers” (in 2020 because of the pandemic, as well as in 2017).

Using the Augmented Dickey-Fuller test (ADF), time series stationarity was examined.

The following hypotheses were tested:

- the null hypothesis (H_0): the time series contains non-stationarity;
- alternative hypothesis (H_1): the time series is stationary.

The Kwiatkowski-Phillips-Schmidt-Shin test (KPSS) was also used to test for stationarity.

The following hypotheses were tested:

- the null hypothesis (H_0): the time series is stationary;
- alternative hypothesis (H_1): the time series contains non-stationarity.

The following criteria were used to process the results:

- if the P-value is < 0.05 – the null hypothesis is rejected and the alternative hypothesis is accepted;
- if the P-value is > 0.05 – there is no reason to reject the null hypothesis.

The ARIMA model was used to study and forecast VAT. ARIMA takes 3 parameters (besides the time series itself):

p – the number of lags of observations in the model (order of lags);

d – the order of differentiation of the original series;

q – the size of the moving average.

The coefficient d was determined by the degree of differentiation of the series. On the basis of processing the results of ADF and KPSS tests (Figure A6.3, Table A6.1, Annex 6) the degree of differentiation of the studied time series was determined for the obtaining of stationarity $d = 1$.

Next, the order of lags p was selected. This parameter was determined from the partial autocorrelation graph. According to the significance of the lags, the value $p = 1$ was taken. The q parameter (moving average) was determined on the basis of the analysis of the partial autocorrelation graph. According to the significance of lags, $q = 1$ is selected.

The ARIMA model with coefficients (1,1,1) is suitable for the studied time series created from VAT data (Figure A6.4, Annex 3).

It should be noted that all coefficients in the resulting model are statistically significant, because $p > |z| < 0.05$.

The residuals and the density of the distribution are shown on the graphs (Figure A6.5, Annex 6). The errors of the residuals, despite certain outliers, are close to zero and have a fairly uniform variance.

Figure A6.6 (Annex 6) shows a comparison of the real data with the model calculations, as well as a forecast for the next 12 months in graphical and numerical format. The grey area on the graph indicates the 95 % confidence interval. Since ARIMA does not take into account seasonality of data, the resulting forecast curve is close to a straight line.

In order to test the model, the data were divided into “training” and “test”. The forecast for 2019 (Figure A6.7, Annex 6) and 2020 (Figure A6.8, Annex 6) based on previous observations was performed separately.

As it follows from the graph, the prediction trend does not fully coincide with the actual changes in 2020. In order to determine the accuracy of the model (as well as to be able to compare it with other models) a number of indicators were calculated. To determine the accuracy of the model in previous periods, MAPE (Mean Absolute Percentage Error) was used.

In 2019, it was 0.0638. This means that the 12 forecasts made for 2019 are 93.62 % accurate. In 2020, the MAPE = 0.17. This means that the model forecast accuracy for this period is 83 %. However, it should be taken into account that the forecast accuracy for 2020 was strongly influenced by the COVID-19 pandemic because of its shocking effect on the economy.

Next, a seasonal SARIMA model was constructed. In addition to the parameters p , d , q , it used:

P – order of the seasonal component;

D – order of transformation of the seasonal component;

Q – order of the seasonal component;

s – seasonality dimension.

For all tax revenues the size of seasonality will be equal to 12, i.e. one calendar year. The automatic selection of coefficients for SARIMA was applied. The resulting model has the form SARIMA(0, 1, 0) \times (1, 1, 0, 12) (Figure A6.9, Annex 6).

The graphical forecast of VAT collection for the next 12 months is shown in Figure A6.10 (Annex 6).

The resulting model was also tested on historical data. The forecast for 2019 is shown in Figure A6.11 (Annex 6), the forecast for 2020 – in Figure A6.12 (Annex 6).

The calculated MAPE coefficient was also used to assess the accuracy of the predictions. The MAPE indicator for 2019 was 0.0987. This means that all 12 forecasts made in 2019 have a combined accuracy of 90.13 %. In 2020, the MAPE indicator was 0.11674. This means that this model in the study period has an accuracy of 88.33 %.

The SARIMA model was also built in semi-automatic mode, using the statsmodels package, with manual selection of parameters. The AIC (Akaike information criterion) was taken as the main criterion. According to this criterion: the best model is the one with the smaller value of AIC.

For the VAT, this model is SARIMA (2, 1, 1) \times (1, 0, 0, 12) (Figure A6.11, Annex 3).

The model coefficients are either statistically significant ($p < 0.05$) or very close to this range and, accordingly, have a tendency to be significant. The forecast for the next 12 months was made with the help of this model (Figure A6.14, Annex 6).

The model was also tested and validated for previous periods. The results obtained for 2019 and 2020 are shown in Figures A6.15 and A6.16 (Annex 6), respectively.

The MAPE indicator for 2019 was 0.05444. This means that the 12 forecasts made for 2019 are 94.56 % accurate. In 2020, the MAPE was 0.09728. This means that the model for that period is 90.27 % accurate. Each of these models can be used for forecasting, so if it is difficult to choose between close candidate models, it is possible to make a model that is an approximation of previously obtained models (Figure A6.17, Annex 6).

Similarly, the time series of the following taxes and their aggregated values were analysed: Enterprise Income Tax (UIN), Excise Duty (AN), Lotteries and Gambling Tax (AIN), Electricity Tax (EN), Vehicle Operation Tax (TEN), Company Car Tax (UVTN), Customs Duty (MN), State Compulsory Social Security Contributions (VSAOI), Natural Resources Tax (DRN), Personal Income Tax (IIN), Micro-Enterprise Tax (MUN), as well as total SRS administrated income. The data of processing is shown in Annex 6 (Figures A6.1–A6.218, Tables A6.2–A.6.13).

A similar analysis was conducted for each of the taxes available from the SRS report. The results of this analysis are aggregated in Table 4.1.

The MAPE indicators in Table 4.1 are divided into four categories, highlighted in colour, which means the following:

- the results with acceptable accuracy are highlighted in green (MAPE<0.3), i.e. the prediction accuracy is at least 70 %;
- yellow colour marks the results, the accuracy of which lies in the range from 50 to 70 %;
- results with an error of more than 50 % are marked in red;
- cases where it is not possible to apply the model with appropriate parameters for testing on previous periods (due to the identified non-stationarity of the time series) are marked in blue.

Models with both approbation results highlighted in green may be recommended for use. However, it is preferable to combine the application of the time series analysis models as a part of the integrated approach together with taking into account the reliability, as good predictability itself may characterise the reliability partially, but does not provide the full answer to this question.

Table 4.1

Time series modelling application for all taxes and cumulative tax income data

Indicator	ARIMA			SARIMA			Semi-auto SARIMA		
	Coefficients	MAPE 2019	MAPE 2020	Coefficients	MAPE 2019	MAPE 2020	Coefficients	MAPE 2019	MAPE 2020
Value Added Tax	(1,1,1)	0.063	0.17	(0,1,0)x(1,1,0)	0.099	0.117	(0,1,1)x(0,2,1)	0.054	0.097
Corporate Income Tax	(1,1,1)	1.502	0.898	(1,1,0)x(0,1,1)	3.172	0.691	(0,1,0)x(0,1,1)	3.292	0.769
Excise Duties	(1,0,0)	0.111	0.108	(0,1,0)x(0,1,2)	0.063	0.076	(0,1,0)x(2,1,0)	0.059	0.066
Lottery and Gambling Tax	(2,0,0)	0.141	1.43	(2,0,0)x(0,1,1)	0.181	1.869	(2,1,2)x(0,1,1)	0.25	1.739
Electricity Tax	(0,1,0)	0.107	0.145	(0,1,1)x(2,1,0)	0.632	0.692	(0,1,2)x(3,1,0)	0.608	0.678
Vehicle Operation Tax	(0,0,0)	0.130	0.095	(0,1,2)x(0,1,0)	0.058	0.064	(2,1,3)x(0,1,0)	0.058	0.067
Company Car Tax	(0,0,0)	0.101	0.082	(0,1,2)x(0,1,0)	0.042	0.051	(0,1,2)x(3,1,0)	0.059	0.061
Customs Tax	(0,1,1)	0.217	0.191	(1,0,1)x(0,1,1)	0.104	0.101	(0,1,3)x(0,1,1)	0.188	0.095
Mandatory State Social Insurance Contributions	(0,0,0)	0.427	0.316	(0,0,0)x(0,1,1)	0.396	0.178	(0,1,3)x(0,1,1)	0.439	0.511
Natural Resources Tax	(5,1,1)	Non-stationary	Non-stationary	(0,1,2)x(0,1,0)	0.296	0.467	(2,1,0)x(2,1,1)	0.277	0.205
Personal Income Tax	(2,0,1)	0.17	0.272	(1,2,1)x(0,1,0)	0.436	0.472	(0,1,0)x(0,1,0)	0.106	0.468
Microenterprise Tax	(3,1,1)	0.717	0.703	(3,0,1)x(0,1,1)	0.476	0.352	(2,1,1)x(0,1,1)	0.417	0.288
Cumulative Administered Revenues	(1,0,2)	0.119	0.274	(0,1,0)(1,1,0)	0.036	0.136	(0,1,0)x(0,1,0)	0.036	0.136

Source: created by the author.

4.3 Application of the tax prism method

One of the instruments of tax policy analysis is the tax prism. The theoretical aspects of the tax prism, and its advantages over the Laffer curve, are presented in Chapter 3.

Specifics of subdivision of the tax prism into state-oriented and business-oriented

Depending on the objectives of the study in Chapter 3, the author proposed to use the concepts of state-oriented tax prism and business-oriented tax prism.

The state-oriented tax prism is a geometric figure whose volume V_{so} corresponds to the volume of taxes received by the state in the current (reporting) period, and its height n_{so} corresponds to the total amount of taxes.

The business-oriented tax prism is a figure, the volume V_{bo} of which is equal to the volume of taxes paid by the enterprise to the state budget. The height of the prism n_{bo} is the total tax burden of the enterprise. In this section n_{so} and n_{bo} corresponds to the value $n/2$ defined in the Section 3.3.

In determining the rational value of taxation, it is necessary to conduct a comprehensive study using data from both the state-oriented tax prism and the business-oriented tax prism. To do this, a combined diagram should be created with graphs $V=f(n)$, plotted for state-oriented indicators $V_{so} = f(n)$ and for business-oriented indicators $V_{bo}= f(n)$ (Figures 4.6–4.10). Parameters V and n are chosen based on the goal of the study. Combined diagrams can differ significantly from each other, and the most typical variants of such diagrams are considered below.

If the graph of function $V_{so}=f(n)$ coincides completely with the graph of function $V_{bo}=f(n)$ or is close to it (Figure 4.6) or is inside it (Figure 4.7), then the size of tax burden optimal for both parties can be easily determined. In the situation shown in Figure 4.6, the areas of optimal values almost completely coincide. In this figure, the area of the most acceptable options is highlighted in green.

In the case shown in Figure 4.7, despite the fact that the optimal value areas do not overlap, the state imposes even fewer financial requirements on the taxpayer than the amount of taxes that corresponds to their comfortable tax burden. In the situations shown in Figure 4.6 and Figure 4.8, the ranges n set by the state and acceptable to the taxpayer are almost identical.

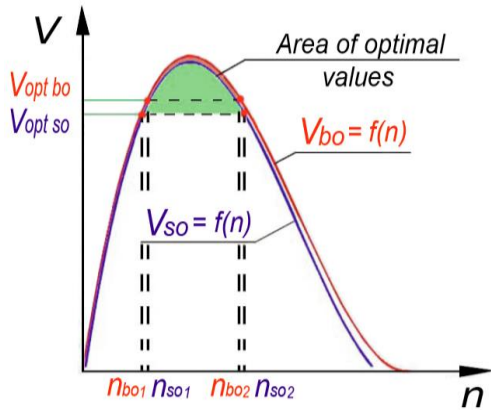


Figure 4.6 **Combined diagram with $V_{bo} \approx V_{so}$ and $n_{bo} \approx n_{so}$**

Source: created by the author.

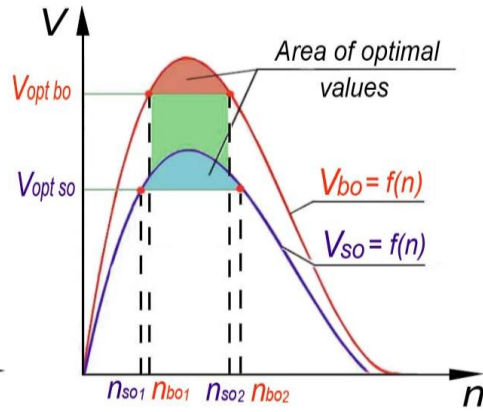


Figure 4.7 **Combined diagram with $V_{bo} > V_{so}$ and $n_{bo} \approx n_{so}$**

Source: created by the author.

It is somewhat more difficult to make a decision in the situation when both functions are shifted along the abscissa axis relative to each other, but have a significant area of mutual intersection formed by areas of optimal value areas for $V=f(n)$ functions plotted by state-oriented indicators $V_{so}=f(n)$ and by business-oriented indicators $V_{bo}=f(n)$ (Figure 4.7) or when the graph of the function $V_{bo}=f(n)$ is inside the graph of the function $V_{so}=f(n)$ (Figure 4.9). In Figure 4.8, the area of the most acceptable options is highlighted in green. The compromise tax area of the diagram is located in the range n_{so1} and n_{bo2} .

In the situation shown in Figure 4.9, the state imposes excessive tax requirements, but since the values of n_{bo1} and n_{so1} and n_{bo2} and n_{so2} , respectively, are close to each other, some slight adjustment to the requirements is necessary in order for the function graphs to match or overlap in the area highlighted in green.

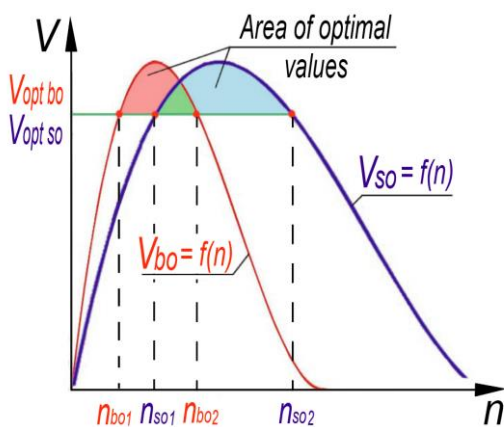


Figure 4.8 **Combined diagram with $V_{bo} = V_{so}$ and $n_{bo} < n_{so}$**

Source: created by the author.

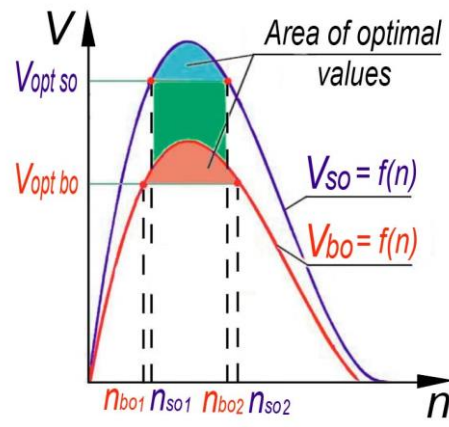


Figure 4.9 **Combined diagram with $V_{bo} < V_{so}$ and $n_{bo} \approx n_{so}$**

Source: created by the author.

The most difficult situation will arise in cases where the graphs of these functions will have no intersection (unification) at all in the zones optimal for both subjects of the study (Figure 4.10).

In this case, a serious adjustment of requirements is necessary.

If the adjustment does not lead to the goal, then there is a case of the incompatibility of the requirements of the task. To solve the problem by variant optimisation method it is reasonable to use the optimisation method of successive concessions.³⁰⁸

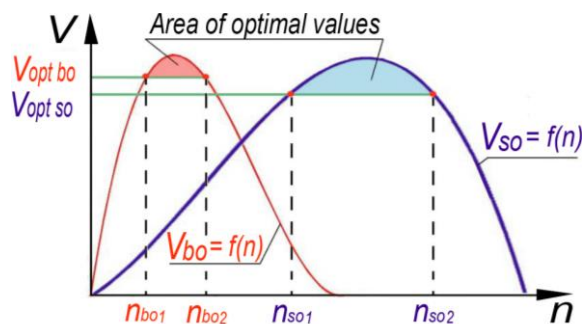


Figure 4.10 **Combined diagram with $V_{bo} > V_{so}$ and $n_{bo} < n_{so}$**

Source: created by the author.

This will also require forming a hollow prism, the volume of which is equal to V (where V is the amount of taxes paid by the enterprise to the state budget), by cutting off a square characterising a tax burden of the enterprise, from each of the four corners. Such a tax prism will be called business-oriented.

Construction of the tax prism and options for its interpretation

During the study of the economic activity of the enterprise proposed eight ways of financial optimisation: A, B, C, D, E, F, G, H .

Each method of financial optimisation corresponds to a certain aggregate tax paid by the enterprise, graphically shown in Figure A7.1 (Annex 7).

The business-oriented tax prism is constructed for each of the options under consideration (Figures 4.11–4.18).

The height of an edge of such a prism $AA_1 = BB_1 = CC_1 = DD_1$ is a graphical interpretation of the specified tax.

In this case, the base area of the prism allows to give a qualitative assessment of the profit of the enterprise, remaining after the payment of the required taxes.

³⁰⁸ Brodeckij, G., Gusev, D., Mazunina, O. and Fel, A. 2017. Possibilities of the Method of Successive Concessions when Selecting for Many Criteria. *Logistics and supply chain management*. 80(3), 91 – 105.

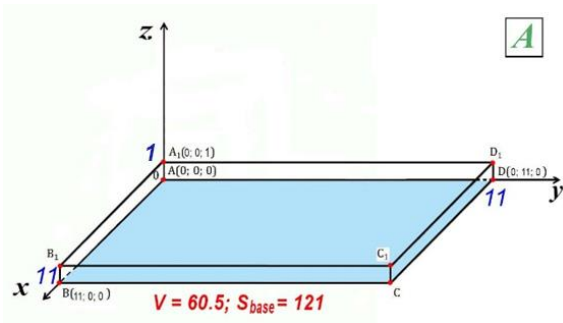


Figure 4.11 Tax prism under the A optimisation option

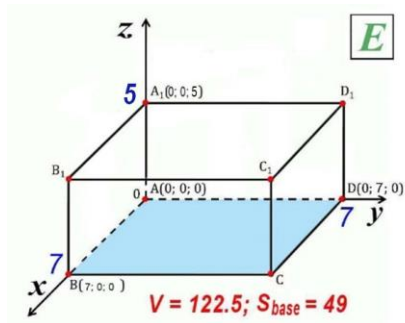


Figure 4.15 Tax prism under the E optimisation option

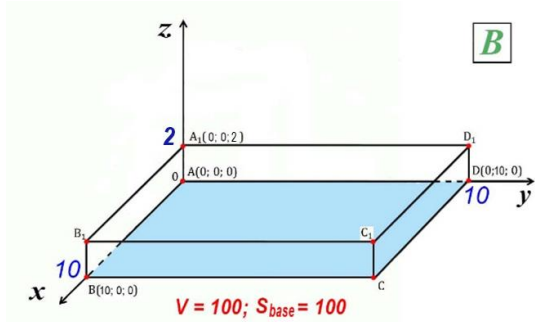


Figure 4.12 Tax prism under the B optimisation option

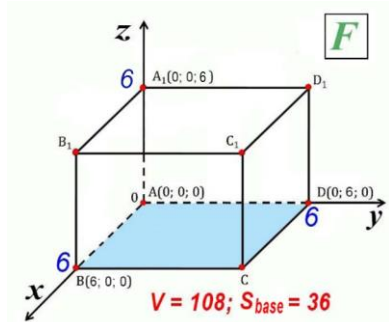


Figure 4.16 Tax prism under the F optimisation option

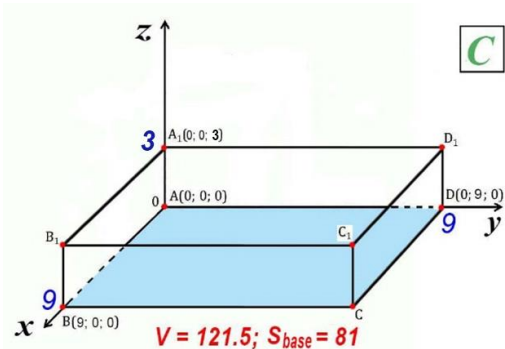


Figure 4.13 Tax prism under the C optimisation option

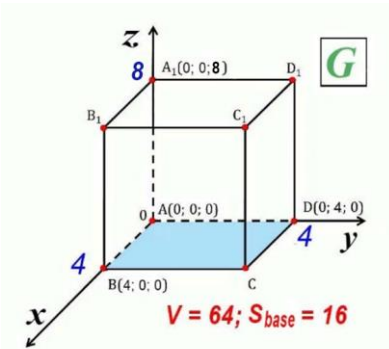


Figure 4.17 Tax prism under the G optimisation option

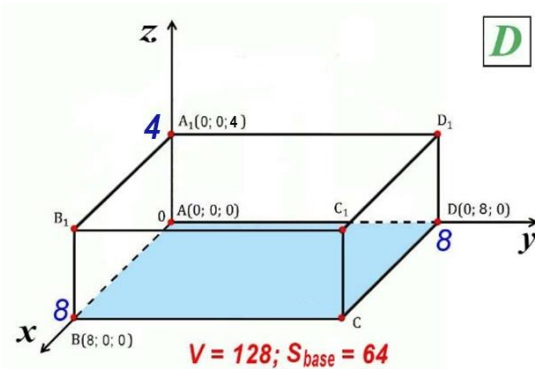


Figure 4.14 Tax prism under the D optimisation option

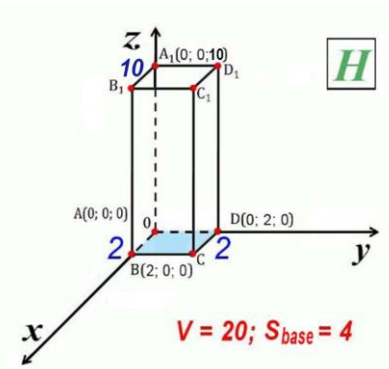


Figure 4.18 Tax prism under the H optimisation option

Source: created by the author.

The *A* optimisation option (Figure 4.11) is very profitable for the enterprise, but the excessively low amount of taxes paid is unlikely to satisfy the controlling authorities, who may suspect tax evasion. Even in spite of the legal ways of tax optimisation used, the scrutiny of the regulator will have a negative impact on day-to-day business operations. In *B*, *C*, and *D* options (Figures 4.12–4.14), there continues to be a sequential increase in the size of taxes and a decrease in enterprise profits, which leads to an increase in the volume *V* of the tax prism. In *E*, *F*, *G*, *H* options (Figure 4.15–4.18), despite the continuing increase in taxes, the volume *V* of tax prism begins to decrease. This means that the tax burden for this enterprise becomes too high, which makes its activity unprofitable.

Automating the use of the tax prism method

For visual interpretation and simplification of calculations, the author proposed and developed applied software using the Python programming language. This program calculates the visualisation of the tax prism for the given parameters of the tax base and tax, as well as calculates the optimal tax prism for the given size of the tax base. In addition, a graphical interpretation of the ratios of the prism volume when the tax changes (while keeping the tax base unchanged) is available. For this type of visualisation, a comparison of the real and optimal tax size is available (Figures A7.2, A7.3, Annex 7).

The author recommends using the tax prism method to study the relationship “tax base – tax volume – tax amount” in the development of tax reforms and other adjustments to the tax system. This approach allows to study not only the tax system as a whole, but also to conduct a discrete analysis of individual taxes.

It is advisable to use the tax prism method as an instrument to analyse the tax system not only at the state level, but also at the regional level, which can be useful for government agencies, for example, to more accurately stimulate regional development through the establishment of additional benefits for certain types of business.

Separately, the possibility of using the business-oriented tax prism when analysing the activities of enterprises should also be noted. The author applied this methodology to analyse and develop the economic policy of SIA “Trade Hub Productions”, where he worked as a financial analyst.

In addition, the author created software based on the method of tax prism, which was used in the work of the economic departments of CJSC RIC “Human and medicine”, Autonomous educational centre “Magistral”, Leon News Agency spol. s.r.o. and SIA “Trade Hub Productions”. Positive reviews were received (Annex 10).

4.4 Application of the relative single indexes and the successive concessions method in the analysis of the Vehicle Operation Tax and tax costs related to the vehicle operation

Currently, Latvia's taxation system is being improved. At the same time, the directions of its reform are mainly related to solving problems that affect the interests of the two main participants in tax relations: the state and taxpayers. The reform of the country's tax system, which began in 2018, did not directly affect the Vehicle Operation Tax, but this reform provided for a certain correction, which, of course, applies to all vehicle owners: both individuals and legal entities.

For the study, Vehicle Operation Tax has been selected in combination with the tax costs related to the vehicle operation, as such combination is the most representative way (both direct and indirect) affects a number of other major taxes such as Value Added Tax, Company Car Tax, Excise Duties, and, in specific cases – others.

The relation between an increase in transport fuel prices and the increase in food and manufactured goods prices has been repeatedly substantiated both in scientific research and in discussions with the media.^{309, 310, 311, 312}

Road transport is a strategic sector of the economy of both Latvia and the entire EU. It has a direct impact on the daily lives of all EU citizens and ensures the flow of goods from more than 11 million producers to consumers, supporting the proper functioning of the European Common Market.³¹³

Road transport infrastructure, as well as related logistics services, have a direct impact on competitiveness and economic growth, creating prerequisites for the development of other industries and attracting investment, providing significant revenues from export services, and having a positive impact on the development of the state.

Road transport has close links to policy areas such as the environment, growth and employment. This sector, which has a multiplier effect on other sectors of the economy, for example, ensures the flow of raw materials and finished products between suppliers of raw

³⁰⁹ Taghizadeh-Hesary, F., Rasoulinezhad, E. and Yoshino, N. 2019. Energy and Food Security: Linkages through Price Volatility. *Energy Policy*. (128), 796–806.

³¹⁰ Stevens, P. 2022. Rising fuel costs are a massive problem for business and consumers – Here's why they're so high. <https://www.cnn.com/2022/05/19/fuel-is-a-problem-for-business-and-consumers-why-prices-are-so-high.html>.

³¹¹ J.P. Morgan. 2022. Why Are Gasoline And Food Prices Rising? <https://www.jpmorgan.com/insights/research/gasoline-food-prices-rising>.

³¹² TVNET/LETA. 2022. Energoresursu un pārtikas cenu pieaugums var paaugstināt gada inflāciju līdz 10%, prognozē FM. <https://www.tvnet.lv/7472748/energoresursu-un-partikas-cenu-pieaugums-var-paaugstinat-gada-inflaciju-lidz-10-prognoze-fm>.

³¹³ Eiropas Revīzijas palāta. 2018. Ceļā uz veiksmīgu transporta nozari Eiropas Savienībā: risināmās problēmas. https://www.eca.europa.eu/Lists/ECADocuments/INLR_TRANSPORT/INLR_TRANSPORT_LV.pdf.

materials, industrialists and traders, exporters and importers, increases mobility and labour productivity, provides more opportunities for tourism, mail, courier services, etc.

In the study on the role of the transport sector in the national economy of Latvia, the main benefits for the Latvian economy from the development of the transport sector are mentioned:³¹⁴

- GDP: +1% growth in the transport sector increases the total value added by 0.2% or 41.6 million euros;
- employment: +1% growth in the value added of transport increases total employment by 0.2% or 1.6 thousand people;
- export: +1% growth in the export of transport services increases the total export of goods and services by 0.125% or 18.7 million euros.

In Latvia, road transport as of mid-2022 has a leading position in the overall transport infrastructure of the country. Personal motor transport also plays a significant role in the mobility of society.

Since 2016, there has been a steady increase in the number of vehicles registered in Latvia. From the end of 2016 to the beginning of 2022, the number of registered vehicles in the country increased by almost 150 000 vehicles and amounted to 1 018 175 units.³¹⁵ At the same time, the results of the Latvian population census of 2021 recorded the presence of 1 893 223 citizens.³¹⁶ The well-being of every inhabitant of Latvia is connected with the availability of road transport. In this case, it is mostly related to the Vehicle Operation Tax, which has increased significantly in recent years, and the cost of fuels and lubricants, and primarily fuel. Therefore, in this section, a study is conducted in the aggregate of the Vehicle Operation Tax and the conditional generalised fuel indicator.

In the cost of any product there is a share that falls on fuel and lubricants. Partially, the rise in the price of gasoline and diesel fuel will affect the cost, in particular of agricultural products, both grown in Latvia and exported to the country.

The growth in the cost of fuel triggers inflationary processes, as a result, a noticeable cumulative effect arises along the entire chain of production, transportation, storage, and sale of goods. At the same time, it is also necessary to take into account the costs of the most buyers on transporting purchases from malls and retail outlets to their homes.

³¹⁴ Transporta attīstības pamatnostādnes 2021. – 2027. gadam 4.pielikums. *Latvijas Vēstnesis*. 207, 26.10.2021.

³¹⁵ CSDD. 2022. Transportlīdzekļu sadalījums pa pilsētām un novadiem. *Transportlīdzekļi. Statistika*.
https://www.csdd.lv/transportlidzekli/transportlidzeklu-sadalijums-pa-pilsetam-un-novadiem_

³¹⁶ Centrālā statistikas pārvalde. 2021. Demogrāfija. *Tautas skaitīšana 2021, Rādītāji*.
<https://www.csp.gov.lv/lv/demografija>.

Kpodar K. and Liu B. indicated that the purchasing power of all households declines as fuel prices rise.³¹⁷ When this trend occurs, there are many negative phenomena, one of which is a decrease in the amount of VAT collected.

As already shown, the EC has repeatedly drawn attention to the fact that one of the goals of tax reform in Latvia was to reduce inequality between the richest and poorest, which was not achieved.

Wang, B., Liu, C. and Zhang, H. considered one of the ways to reduce the above inequalities to be the promotion of greater equality of transport opportunities among disadvantaged groups.³¹⁸

The study of the Vehicle Operation Tax in conjunction with the costs of their operation will also make it possible, if necessary, to provide a qualitative and quantitative forecast for the implementation by Latvia of the tasks set in accordance with the objectives of the EU climate agenda.³¹⁹ This is especially true, because Latvia has a significant share of used cars.

In 2019, transport consumed 31% of total final energy consumption, and consumption is on an upward trend. In turn, out of the total volume of energy resources used in transport in 2019, 83.5% accounted for energy consumption in road transport, 12.2% for international air transport and 4% for rail transport, 0.25% for water transport, and the rest – for the energy used in domestic air transport and pipeline transport.³²⁰ Diesel fuel was the main energy resource used in transport, and its share in 2019 was 64.9%. Statistics show that as of 10.01.2020, more than 94% of the Latvian car park consisted of vehicles running on fossil fuels (petrol, diesel), of which 66.6% are diesel vehicles. Almost all fuel consumed in transport is imported into Latvia (with the exception of a part of biofuels).

Study of the Vehicle Operation Tax in Latvia and tax costs related to the vehicle operation

As part of the study, the sources of normative, reference and scientific literature on the organisation of vehicle taxation in Latvia and other countries of the European Union were analysed. Based on the analysis of regulatory documentation the current method of calculating

³¹⁷ Kpodar, K. and Liu, B. 2021. The Distributional Implications of the Impact of Fuel Price Increases on Inflation. *International Monetary Fund*. 271, 1–34.

³¹⁸ Wang, B., Liu, C. and Zhang, H. 2022. Where are equity and service effectiveness? A tale from public transport in Shanghai. *Journal of Transport Geography*. 98(1), 1–15.

³¹⁹ Latvijas Republikas likums. Par Latvijas Nacionālo enerģētikas un klimata plānu 2021.–2030. gadam. *Latvijas Vēstnesis*, 29, 11.02.2020. Pieņemts: 04.02.2020.

³²⁰ Centrālā statistikas pārvalde. 2020. Latvijas energobalance 2019. gadā. *Enerģētika, Publikācijas un relīzes*. <https://www.csb.gov.lv/lv/statistika/statistikas-temas/vide-energetika/energetika/meklet-tema/429-latvijas-energobalance-2019-gada>.

the Vehicle Operation Tax in the Republic of Latvia was analysed, identified shortcomings and areas for improving it.

Vehicles in most countries of the world are subject to taxation, bringing a certain share of money to the state budget. The main source of revenue generation in the budget system of the Republic of Latvia is taxes and receipts, in particular, the Vehicle Operation Tax.³²¹ This tax, like every other, is individual, since it assumes its own legal structure.

At the same time, since 2020 in Latvia, several taxes are addressed to owners of vehicles.^{322, 323, 324, 325, 326, 327}

The document published by the Ministry of Finance of the Republic of Latvia “Guidelines for state tax policy for 2018–2020” indicates that a number of measures were planned to mitigate the negative impact of the tax reform (which was put into effect from the beginning of 2018), including the following in the aspect of this study: increasing excise tax rates (including on fuel for vehicles), limiting the rights to benefits, maintaining the current payment system for collecting tax on vehicle operation.³²⁸

Indeed, at the beginning of 2020, the principle of levying a Vehicle Operation Tax remains unchanged.

Since January 2017, a tax has been imposed on vehicles with foreign licence plates travelling in Latvia, if their owners are persons whose place of residence is declared in Latvia.³²⁹ Many residents of Latvia registered their cars in Lithuania and Estonia in order to avoid paying the Latvian Vehicle Operation Tax. At the same time, they used the road infrastructure along with other residents of the country.

To combat this phenomenon, amendments were adopted to the Road Traffic Law and to the Law on the Vehicle Operation Tax and Company Car Tax. According to them, owners

³²¹ Latvijas Republikas likums. Likums Transportlīdzekļa ekspluatācijas nodokļa un uzņēmumu vieglo transportlīdzekļu nodokļa likums. *Latvijas Vēstnesis*, 206, 30.12.2010. Pieņemts: 20.12.2010.

³²² Latvijas Republikas likums. Likums “Dabas resursu nodokļa likums”. *Latvijas Vēstnesis*, 209, 29.12.2005. Pieņemts: 15.12.2005.

³²³ Ministru kabineta 22.02.2011 noteikumi Nr. 135 “Noteikumi par nolietotu transportlīdzekļu pārstrādi un apstrādes uzņēmumiem noteiktajām vides prasībām”. *Latvijas Vēstnesis*, 32, 25.02.2011. Pieņemts: 22.02.2011.

³²⁴ Latvijas Republikas likums. Likums “Pievienotās vērtības nodokļa likums”. *Latvijas Vēstnesis*, 197, 23.11.2012. Pieņemts: 29.11.2012.

³²⁵ Latvijas Republikas likums. Likums “Par iedzīvotāju ienākuma nodokli”. *Latvijas Vēstnesis*, 32, 01.06.1993. Pieņemts: 11.05.1993.

³²⁶ Latvijas Republikas likums. Likums “Uzņēmumu ienākuma nodokļa likums”. *Latvijas Vēstnesis*, 156, 08.08.2017. Pieņemts: 28.07.2017.

³²⁷ Latvijas Republikas likums. Likums “Autoceļu lietošanas nodevas likums”. *Latvijas Vēstnesis*, 200, 23.12.2008. Pieņemts: 11.12.2008.

³²⁸ Ministru kabineta 24.05.2017 rīkojums Nr.245 “Par Valsts nodokļu politikas pamatnostādņem 2018.–2021. gadam”. *Latvijas Vēstnesis*, 105, 30.05.2017. Pieņemts: 24.05.2017.

³²⁹ Latvijas Republikas likums. Likums Transportlīdzekļa ekspluatācijas nodokļa un uzņēmumu vieglo transportlīdzekļu nodokļa likums. *Latvijas Vēstnesis*, 206, 30.12.2010. Pieņemts: 20.12.2010.

of vehicles of categories M1 (passenger cars used for transportation of passengers, the number of seats of which, excluding the driver's seat, does not exceed eight) and N1 (vehicles intended for transportation of goods and whose gross weight does not exceed 3.5 tons), who have declared their place of residence in Latvia, when operating these vehicles, if they are registered abroad, are obliged to pay the following operating tax: for one day – 10 euros; for a month – 250 euros; for six months – 600 euros; for a year – 1000 euros. The penalty for evading this tax is between 140 and 400 euros.

This tax according to the Ministry of Transport for the first year after its introduction brought in the state budget a little less than 800 000 euros, then its amount began to decrease slightly, and the number of registered vehicles,³³⁰ compared to 2016, increases annually.

However, at the beginning of 2020, the European Commission pointed out to Latvia that the amounts charged in accordance with the abovementioned amendments are several times higher than the tax levied on registered cars. Latvia was ordered to rectify this situation. And in the version of the law “Law on the Vehicle Operation Tax and Company Car Tax”³³¹ (Section 9.1 Payment of the Vehicle Operation Tax for a Vehicle Registered in a Foreign Country), in force from January 1, 2021, this tax has been abolished.

This method solved one of the so-called “free-rider problem”, i.e. the situation when a consumer of a public good tries to avoid paying for it.³³²

Starting from January 1, 2020, the excise tax on fuel has been increased in Latvia. The rates of this tax and the objects of taxation are determined by the law of the Republic of Latvia “On Excise Duties”.³³³

It should be noted that according to CSDD data as of 1 January, 2020, the average age of passenger cars registered in Latvia is 14.20 years, commercial vehicles – 11.97 years, and buses – 12.51 years.³³⁴

All this leads to the fact that for a part of the population, the maintenance and operation of vehicles, based on their total costs, becomes difficult. In this regard, when introducing taxes and fees related to the operation of a vehicle, it is advisable to conduct special analytical studies.

³³⁰ CSDD. 2020. Reģistrēto transportlīdzekļu skaits. *Transportlīdzekļi*. <https://www.csdd.lv/transportlidzekli/registreto-transportlidzeklu-skait>.

³³¹ Latvijas Republikas likums. Transportlīdzekļa ekspluatācijas nodokļa un uzņēmumu vieglo transportlīdzekļu nodokļa likums. *Latvijas Vēstnesis*, 206, 30.12.2010. Pieņemts: 20.12.2010.

³³² Kharevich, G. 2017. About the Free-Rider Problem in Post-Industrial Society. *Interactive science*. 9(19), 73–80.

³³³ Latvijas Republikas likums. Likums “Par akcīzes nodokli”. *Latvijas Vēstnesis*, 161, 14.11.2003. Pieņemts: 30.10.2003.

³³⁴ CSDD. 2020. Visi transportlīdzekļi, 1900–2020, pēc ražotāja. *Uzskaitē esošie transportlīdzekļi, Statistika*. <https://www.csdd.lv/transportlidzekli/transportlidzekli-vizualizacija>.

It is proposed to use a system of relative single indexes for variant optimisation used to determine the tax base of Vehicle Operation Tax.

Identification of the requirements of incompatibility zone

Before carrying out variant optimisation, it is necessary to determine the numerical values of relative single indexes that characterise the “equity” and “efficiency” of the tax policy for each specific case and time period.

The terms equity and efficiency are used within the framework of the state-oriented and business-oriented aspects of tax optimisation defined in Section 3.1, which correspond to the criteria of efficiency and equity. In the framework of the study of Vehicle Operation Tax and related costs, efficiency means maximising budget fees from the corresponding types of taxes and fees related to transport, while equity means the permissible level of tax burden on the taxpayer. Later in this Section, the fuel equivalent, which is a measure of equity for the taxpayer, is determined.

It is advisable to determine the numerical values of relative single indexes using this scheme for Vehicle Operation Tax:

$$K_{ij}^{vt} = \frac{P_{ij}^{vt}}{P_{i, bl}^{vt}} \text{ or } K_{ij}^{vt} = \frac{P_{i, bl}^{vt}}{P_{ij}^{vt}} \quad (4.1)$$

$$i = \overline{1, N}; j = \overline{1, M},$$

where:

K_{ij}^{vt} – relative designation of relative single index of Vehicle Operation Tax;

P_{ij}^{vt} – value of single index of researched characteristic (equity or efficiency) of Vehicle Operation Tax;

$P_{i, bl}^{vt}$ – value of single index taken as basic (possible) level of Vehicle Operation Tax;

i – name of the estimated characteristic;

j – the number of variant;

N – the number of relative single indexes;

M – the number of researched variants.

In all cases, when determining the values of relative single indexes from the formulae (4.1), the one that corresponds to the improvement of the quality of the index system with an increase in the single index is selected.

When determining the optimal values of the Vehicle Operation Tax from the point of view of the “efficiency” criterion of taxation, it is advisable to assign $P_{i, bl}^{vt}$ values after

calculations made according to the CSDD data on the number and types of registered vehicles, taking into account the forecast of the dynamics of their change. Further, depending on the required share of funds received in the budget for the implementation of this tax, it is necessary to distribute the tax burden for specific types of transport, which will allow to select the necessary $P_{i,bl}^{vt}$ value.

Relative single indexes of “equity” K_{eqj}^{vt} and “efficiency” K_{effj}^{vt} are formed in such a way that their values, which lie in the range of values less than one, reflect an unacceptable value of quality (their characteristics), and acceptable values of indexes K_{ij}^{vt} are equal to or exceed one.

In accordance with the provisions set out in 2015,³³⁵ the EU has the opportunity to improve the efficiency of its economy and reduce greenhouse gas emissions from transport.

As a result of this program, the excise rate for lead-free petrol (the use of tetraethyl lead has been banned in the EU since 2000) increased from 476 euros per 1000 litres to 509 euros. The excise tax on diesel fuel increased from 372 euros per 1000 litres to 414 euros, and on liquefied gas used for refuelling vehicles—from 244 euros to 285 euros per 1000 litres.³³⁶ As a result, when refuelling, in addition to VAT, the consumer pays the new price in accordance with the increased excise tax. It was assumed that after the increase in this excise tax, the price of a litre of petrol will increase by approximately 0.04 euros, diesel fuel by 0.05 euros, and liquefied gas by 0.03 euros. However, in fact, fuel prices in Latvia have increased more, and this is due not only to an increase in the excise tax, but also to an increase in the price of oil (at the end of November 2019, a barrel of oil cost slightly less than 61 euros, and at the beginning of 2020, its price increased to almost 69 euros).

At the same time, a situation arose that requires a separate study: fuel prices in Latvia at the beginning of 2020 were the highest among the countries of the Baltic region, even though the road tax is included in the cost of fuel in Lithuania. As a result, residents of border areas started refuelling in neighbouring countries. These budget losses in Latvia require a separate study. Budget losses are also related to the fact that residents of the country’s regions bordering non-EU countries, having a simplified border crossing regime, refuel their vehicles abroad, where fuel prices are much lower. At the same time, customs regulations allow them to import into the territory of Latvia a vehicle with a fully filled tank and an additional 10 litres in a canister. Therefore, before rationing the Vehicle Operation Tax rates and adjusting the

³³⁵ United Nations, Economic and Social Council. 2015. Transport developments in the European Union. *Economic Commission for Europe, Inland Transport Committee*. Geneva. ECE/TRANS/2015/23, 20.

³³⁶ Latvijas Republikas likums. Likums “Par akcīzes nodokli”. *Latvijas Vēstnesis*, 161, 14.11.2003. Pieņemts: 30.10.2003.

excise tax rates, it is necessary to study the budget implications arising from the reduction of the total amount of fuel sold for vehicles in the territory of the Republic of Latvia.

Among other problems faced by vehicle owners in Latvia, there is an increase in the volume of bio-additives for diesel fuel from 5 % to 7 %, and for 95 petrol from 5 % to 10 % (E10). However, not all petrol engines of vehicles can run on fuel with a high content of bio-additives (E10). This applies primarily to older vehicles. As already noted, the average age of passenger cars registered by CSDD in Latvia exceeds 14 years. To maintain the performance of their engines, owners will have to switch to a more expensive brand 98 petrol, which does not contain bio-additives.

As a result, owners of vehicles with low and medium incomes have to revise the mode of operation of their vehicles in the direction of its reduction.

According to studies conducted in 33 European countries in 2019, which estimated the amount of fuel for a vehicle that can be purchased for one average salary, Latvia was in the 30th place.³³⁷

This is one of the reasons why it is difficult for residents of Latvia to accept EU requirements for improving the environmental situation, which lead to higher fuel prices and an increased tax rate on vehicles that do not meet strict environmental standards.

The average annual cost of maintaining a used car in Latvia is between 500 and 600 euros.³³⁸ According to official data from the Latvian Central statistical bureau, the average salary in Latvia in 2018 after taxes was 737 euros, in 2019 it increased slightly, and as a result, the employee received about 800 euros.³³⁹

In this study, the calculations were based on the conditional fuel equivalent, i.e. the maximum amount of fuel that can be purchased for an average salary in Latvia.

One of the options for a possible approach to the formation of a relative unit tax when assessing and assigning a Vehicle Operation Tax was considered. After processing data on the most popular brands of passenger cars registered in Latvia,³⁴⁰ it was found that in fuel equivalent, the owner of a passenger vehicle spends an average of 5 to 8 litres of petrol per month on the Vehicle Operation Tax. At the same time, it would not be burdensome to spend no more than 7 litres of fuel per month on the tax under study.

³³⁷ Tvnet.lv. 2020. Valstu reitingā ar pieejamāko benzīnu Latvija atrodas vienā no pēdējām vietām. *TVNET Auto*. <https://www.tvnet.lv/7027648/>.

³³⁸ Berzins, A. 2017. How Much Does the Maintenance of the Used Car Cost in Latvia? *BigBank Research*. <http://ru.focus.lv/news/issledovanie-bigbank-skoljko-stoit-soderzhanie-poderzhanogo-avto-v-latvii?14999>.

³³⁹ Latvijas statistikas gadagrāmata 2019. Statistical Yearbook of Latvia. 2020. *Centrālā statistikas pārvalde*. www.csb.gov.lv, 228.

³⁴⁰ CSDD. 2020. Visi transportlīdzekļi, 1900 – 2020, pēc ražotāja. *Uzskaitē esošie transportlīdzekļi, Statistika*. <https://www.csdd.lv/transportlidzekli/transportlidzekli-vizualizacija>.

In this situation, it is assumed that in order to replenish the budget, the state needs each owner to contribute at least 9 units of fuel equivalent to the budget on average. Based on these assumptions, Table 4.2 was formed, and the relative single indexes of equity and efficiency for different tax options for persons operating vehicles were calculated using formulas (4.1).

When analysing this optimisation model, it turned out that the relative single indexes of equity $K_{eq j}^{vt}$ and efficiency $K_{eff j}^{vt}$ that characterise the Vehicle Operation Tax were incompatible (Figure 4.19).

Table 4.2

Determination of relative single indexes of equity and efficiency (first controlling case)

Number of variant	1	–	5	6	7	8	9	10	11	–	13	14
$P_{eq j}^{vt}$	610	–	606	605	604	603	602	601	600	–	598	597
$P_{eq, bl}^{vt}$	605											
$K_{eq j}^{vt}$	1.008	–	1.002	1.000	0.998	0.997	0.995	0.993	0.992	–	0.989	0.987
$P_{eff j}^{vt}$	2	–	6	7	8	9	10	11	12	–	14	15
$P_{eff, bl}^{vt}$	9											
$K_{eff j}^{vt}$	0.222	–	0.667	0.778	0.889	1.000	1.111	1.222	1.333	–	1.556	1.667

Source: created based on the author’s calculations.

In such a situation, if it is impossible to change the calculation conditions, it is necessary to determine the importance of each criterion. If the relative single index of effectiveness $K_{eff j}^{vt}$ is given priority in the ranking, then option 8 or subsequent options located to the right of this option on the abscissa axis (to the right of point B) should be selected as acceptable.

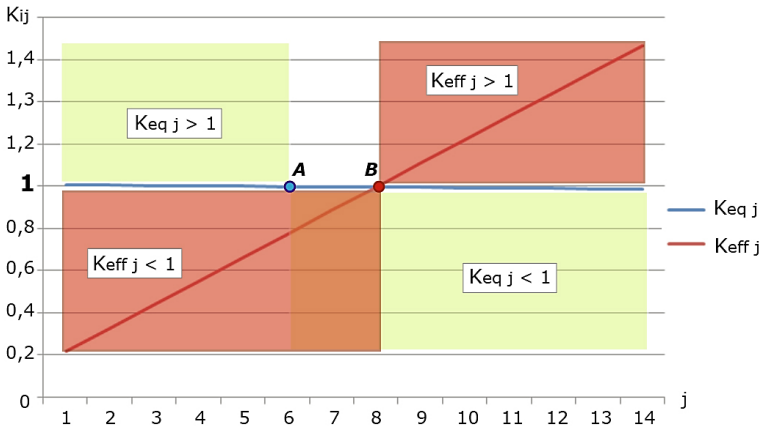


Figure 4.19 Combined diagram of relative single indexes of equity and efficiency (the first controlling case is incompatibility of requirements)

Source: created based on the author’s calculations.

If priority is given to the relative single index of equity $K_{eq j}^{vt}$, then acceptable values fall on options 1 – 6, located to the left of point A. It is possible that if the indexes are equally

important, it will be necessary to make concessions on both criteria at the same time and choose the most appropriate solution. Ranking should be done using expert methods or, more preferably, using a probabilistic approach. The process of ranking and the use of the method of consecutive concessions in similar situations is shown in the works.^{341, 342}

Identification of the requirements of compatibility zone

Several more possible situations were covered. If the Vehicle Operation Tax calculated in fuel equivalent is sufficient for the budget in the amount of 8 units, and this amount will not be burdensome for vehicle owners (Table 4.3), then the combined diagram shown in Figure 4.19, is converted to the diagram shown in Figure 4.20.

Table 4.3

Determination of relative single indexes of equity and efficiency (second controlling case)

Number of variant	1	–	6	7	8	9	10	11	12	13	14
P_{eqj}^{vt}	610	–	605	604	603	602	601	600	599	598	597
$P_{eq, bl}^{vt}$	604										
K_{eqj}^{vt}	1.010	–	1.002	1.000	0.999	0.997	0.995	0.993	0.992	0.990	0.998
P_{effj}^{vt}	2	–	7	8	9	10	11	12	13	14	15
$P_{eff, bl}^{vt}$	8										
K_{effj}^{vt}	0.250	–	0.875	1.000	1.125	1.250	1.375	1.500	1.625	1.750	1.875

Source: created based on the author's calculations.

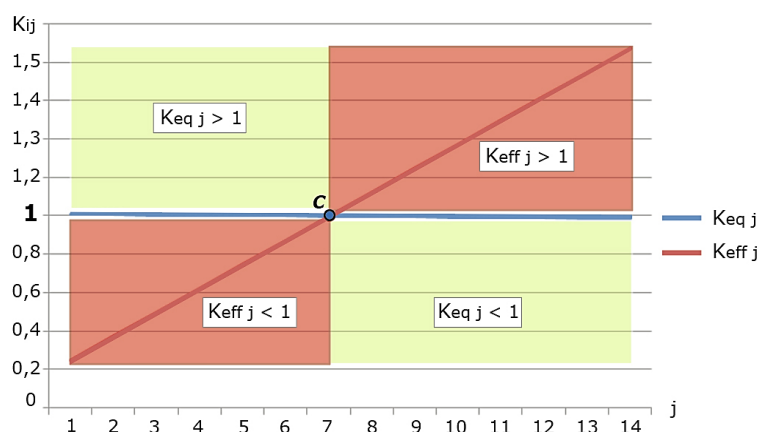


Figure 4.20 Combined diagram of relative single indexes of equity and efficiency (the second controlling case is the only solution)

Source: created based on the author's calculations.

³⁴¹ Plaskova, N., Prodanova, N., Leontyev, A., Ratnikova, et.al. 2019. Analysis of the economic efficiency criteria and equity while determining the taxes. *Opcion*. 35, 1451–1469.

³⁴² Akhmetshin, E., Plaskova, N., Iusupova, I., Prodanova, N., Leontyev, A. and Vasilev, V. 2019. Dataset for determining rational taxation value with incompatible criteria of economic efficiency and equity. *Journal Data in Brief*. 26(104532), 1–11.

In this case, one option that meets the criteria of equity and effectiveness (7 option corresponding to point *C* in Figure 4.20) is available. It should be noted that the accuracy of this study is not in doubt when analysing past periods. In studies that cover the forecast period, there is always the possibility of changes in the economic environment that affect the combination of relative single indexes K_{eqj}^{vt} and K_{effj}^{vt} that characterise the Vehicle Operation Tax. Point *C* on the combined diagram shows, that vehicle taxation becoming optimal, yet any change in tax rates or procedures separately will lead to ineffective or unfair solutions.

After adjusting the values taken as basic (reference) values, Table 4.4 was created and the combined diagram was built again (Figure 4.21). The resulting combination of relative single indexes is the most preferable, since it is not the only possible option, but the area of acceptable values located between the points *D* and *E* in the range of values K_{eqj}^{vt} and K_{effj}^{vt} from one and higher.

Table 4.4

Determination of relative single indexes of equity and efficiency (third controlling case)

Number of variant	1	–	4	5	6	7	8	9	10	–	14
P_{eqj}^{vt}	610	–	607	606	605	604	603	602	601	–	597
$P_{eq, bl}^{vt}$	602										
K_{eqj}^{vt}	1.013	–	1.008	1.007	1.005	1.003	1.002	1.000	0.998	–	
P_{effj}^{vt}	2	–	5	6	7	8	9	10	11	–	15
$P_{eff, bl}^{vt}$	7										
K_{effj}^{vt}	0.286	–	0.714	0.857	1.000	1.143	1.286	1.429	1.571	–	2.143

Source: created based on the author's calculations.

To achieve optimum zone, which lies between points *D* and *E*, it is recommended to establish a tax on the use of Latvian roads for owners of passenger cars that are not declared in Latvia. This applies to owners of passenger vehicles who come to the Republic of Latvia from countries that are part of the European Union or outside its borders. At the moment, they do not pay tolls for driving on Latvian roads. This tax is easy to implement, because Latvia has experience of collecting a similar tax, for example, from owners of cargo transport with a gross weight of more than 3000 kg, and from vehicles registered outside of Latvia, whose owners have declared their place of residence on its territory. Similar taxes exist in a number of EU countries and are approximately equal to 12.5 euros for 10 days of road use, 18 euros for a month, and 60 euros for a year. Such actions at the same time will allow slightly to decrease a burden for local taxpayers, making it closer to the desired 7 relative litres of the tax burden, but it is not yet achieved, but tax burden could be redistributed on foreigners.

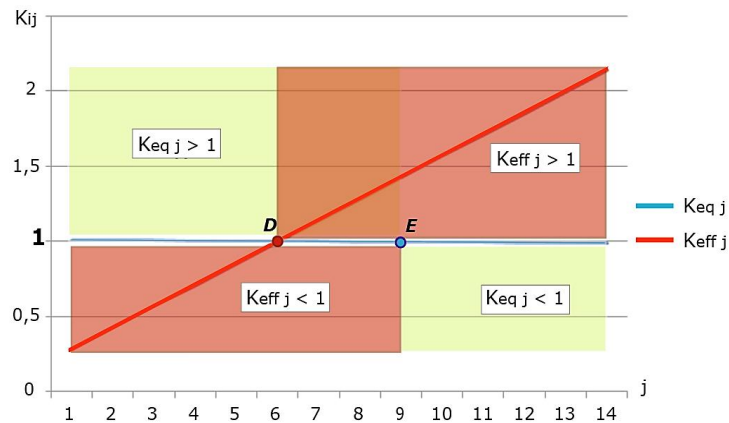


Figure 4.21 **Combined diagram of relative single indexes of equity and efficiency (the second controlling case is a set of possible solutions)**

Source: created based on the author's calculations.

If it is necessary to adjust the amount of fuel equivalent when searching for suitable solutions using the proposed combined diagram, the following options can be considered as a measure that allows the state to reduce the amount of tax burden imposed on persons who operate vehicles belonging to them.

While adjusting the tax in the optimum zone, it is advisable to establish a correlation with the vehicle's annual mileage. It can contribute to a fairer principle of charging a Vehicle Operation Tax. When implementing this principle, those who drive less – pay less tax (except for owners of premium and sports cars). Gradation is also possible in terms of vehicle engine capacity. For example, only owners of vehicles with an engine capacity of up to 180 hp may fall under this proposal, other vehicles are taxed at a fixed rate.

Such changes will be inside of the optimum zone, yet they will set equity as primary criterion, which will lead to decrease of poverty and social stratification, achieving the recommendation of the European Commission. If the global situation changes and economy will need extra tax revenues, the regulator will know to what extent tax rates could be changed or establishing of the new taxes in vehicle taxation could be carried out to be comfortable enough for the taxpayer, not making taxpayer search for opportunities to use tax evasion.

Taxation of vehicles (including not only taxes, but also special charges on their owners) in Latvia is not currently in the comfort zone for a number of categories of taxpayers (the first controlling case). And most of this applies to people with low incomes who operate fairly old vehicles and persons who have a residence permit in Latvia, whose vehicles are permanently registered outside the European Union.

The increase in excise tax rates not only makes positive sense, but also has negative onerous consequences for many taxpayers. At the same time, no administrative measures will

ensure the completeness of tax revenues to the budget if the tax mechanism adopted by law is not adequate to the state of the economy and politics.

It should be noted that Latvia in 2017–2020 has successfully coped with the “free-rider problem” in relation to persons declared in Latvia whose vehicles are registered in other EU countries. However, as mentioned earlier, this tax has been abolished. In this regard, in order to make up for these budget losses, the author proposes to introduce a fee for vehicles of categories M1 and N1, obliging their drivers to pay a tax on the use of the country’s roads when crossing the borders of Latvia (both external and internal), similar to how it was done in most EU countries. When entering the country, drivers purchase a vignette (in a form of stickers or in electronic form), the cost of which varies depending on the time the vehicle has been in the country. Based on the experience of the EU countries, the following terms can be recommended: 10 days, 1 month, 3 months and 1 year. This approach is also relevant for Latvia due to the increasing importance of the “green” policy of the EU. The operation of vehicles on the roads of Latvia, not registered in it, leads not only to additional deterioration of the road surface, but also to increased environmental pollution.

It is necessary to link tax administration with tax innovations. Otherwise, “tax holes” may appear, in which only those who have achieved virtuosity in avoiding taxes win, and the entire economy loses.

Using the methods of variant optimisation and tax prism will allow to visualise the process of modelling various situations when searching for the fairest and most effective model of taxation of vehicle owners.

A complete rejection of the tax in question through its inclusion in the cost of petrol for Latvia is difficult to implement, since the analysis of fuel prices for the last three years shows that fuel prices in Latvia are somewhat higher in relation to Lithuania and Estonia. This, as already mentioned, leads to the fact that some car owners refuel their vehicles on the territory of these countries.

Fixing the value of the annual mileage of vehicles can be carried out both during technical inspection, and using special GPS navigation systems, or using special devices.³⁴³

At the same time, it is necessary to regulate the tax on vehicles registered in Latvia but used on the territories of other countries, as well as the cost of creating a system for collecting such taxes.

It should be noted that the Ministry of Transport of the Czech Republic has allocated about 16 million euros for the creation of similar systems in the Czech Republic. Within a few

³⁴³ Loccate. 2017. How to Control Mileage and Fuel Consumption of a Car Using GPS. *Uncategorized*. Retrieved: <https://www.loccate.com/blog/control-mileage-and-fuel-using-gps/>.

days, a team of IT specialists from the Czech Republic created a state service platform and delivered it to the government for free. As a result, the Czech Transport Minister was dismissed, since the creation of such services does not currently involve significant financial costs.³⁴⁴

Overall, when applying the relative single indexes method for Vehicle Operation Tax and tax costs related to the vehicle operation in Latvia the following can be noticed:

- 1) The method of variant optimisation using relative single indexes for optimal vehicle taxation is a powerful tool that could be used as an anchor to see the current situation and a consequence of possible changes in tax legislation. As a relative index used a relative coefficient of fuel equivalent basing on an average salary, which could show over time dynamic of the situation with the vehicle taxation.
- 2) The analysis of the controlling cases, acquired by the usage of the method of variant optimisation using relative single indexes showed that in the first controlling case the tax policy efficiency is incomparable with equity criterion, so it eventually leads to loss of budget revenues and at the same time stimulates impoverishment of the population. In the second controlling case there is only one optimal point, that complies with the criteria of equity and efficiency. It should be used by state authorities to set appropriate taxes and adjust tax policy. In the third controlling case there is the area of optimal combination of equity and efficiency. The government has wide amount of options of possible tax rates, that could be used to adjust tax policy and be a reference to a long-term planning.
- 3) Latvia currently has incomparability zone, meaning the taxation of vehicles is not optimal for most of the taxpayer with low or average income. To move from the incomparability to the zone of optimum it recommended to establish a tax on the use of Latvian roads for owners of passenger cars that are not declared in Latvia (e.g. in the form adopted in various EU member states – vignette). This applies to owners of passenger vehicles who come to the Republic of Latvia from countries that are part of the European Union or outside its borders. This tax is easy to implement, because Latvia has experience of collecting a similar tax, for example, from owners of cargo transport with a gross weight of more than 3000 kg, and from vehicles registered outside of Latvia, whose owners have declared their place of residence on its territory.

³⁴⁴ Novinky.cz. 2020. Za jedenvikend a zdarma. Vyvojarispustili system, za ktery chtel stat utratit 400 milionu [For One Weekend and Free. Developers Launched a System for Which the State Wanted to Spend 400 Million]. *Ekonomika*. Retrieved: <https://www.novinky.cz/ekonomika/clanek/vyvojari-predstavili-system-zdarma-za-ktery-chtel-stat-utratit-400-milionu-chybi-mu-jedina-funkce-40311233>.

- 4) When zone of optimum will be reached it is advisable to establish a correlation with the vehicle's annual mileage, which can contribute to a fairer principle of charging a Vehicle Operation Tax. When implementing this principle, those who drive less – pay less tax (except for owners of premium and sports cars). Gradation is also possible in terms of vehicle engine capacity. For example, only owners of vehicles with an engine capacity of up to 180 hp may fall under this proposal, other vehicles are taxed at a fixed rate. Such changes will be inside of the optimum zone, yet they will set equity as primary criterion, which will lead to decrease of poverty and social stratification.
- 5) A complete rejection of the tax Vehicle Operation Tax by including it in the price of petrol for Latvia is difficult to implement, because an analysis of fuel prices over the past three years shows that fuel prices in Latvia are slightly higher compared to Lithuania and Estonia. This leads to the fact that some car owners refuel their vehicles in these countries. Fixing the value of the annual mileage of vehicles can be carried out both during technical inspection, and using special GPS navigation systems, or using special devices. In this case, it is necessary to regulate the tax on vehicles registered in Latvia, but used in other countries, as well as the cost of creating a system for managing such taxes.

4.5 Application of expert evaluation for the elimination of requirements incompatibility

The use of the optimisation method of successive concessions in the case of irreducible incompatibility of the requirements of the system “equity – efficiency” is inevitably associated with the ranking of relative single indexes, as well as taxes that are associated with them, in descending order of their importance. If accurate statistics are available, a probabilistic approach can also be used for ranking in some cases.

Aspects of the application of the expert evaluation method, the formation of an expert group

The study using the method of expert evaluations was conducted in three stages.

At the first stage, statistical and expert evaluation methods were used. To date, a large number of different methods for making decisions based on expert survey data have been developed. Only strict ranking was allowed, in which evaluated elements were assigned different ranks.

At this stage, the objectives of this local study were defined and set in the form of prioritising (ranking by importance) the relative single indexes that characterise the criteria of tax policy, namely: equity, certainty and accuracy of taxes, ease of collection of taxes for taxpayers, efficiency and obligation. Besides, the ranking of taxes stipulated by the legislation of the Republic of Latvia was carried out using this approach.

The method of obtaining expert information is a direct interview with a group of experts. Processing method is decision making by vector criteria. In this case different possible solutions are directly ranked by preference (indicators are ranked by importance) for further implementation of the method of successive concessions in cases of incompatibility of requirements described in Section 3.4.

The expert group was formed from professors, teachers, employees, master's and PhD students from a number of Latvian universities, as well as from the staff who provide accounting services to firms operating in Latvia. The total number of experts was 26. In order to avoid conformism in the survey, the interaction of experts with each other was excluded.

At the second stage, the quality of the resulting data set was assessed. To concretely determine the necessary combination of equity and efficiency (with irreducible contradictions of these criteria), expert survey data were processed. There are various methods for processing the results of ranking variables to determine the significance and subsequent operations on these variables (described in Annex 3D). As a method was chosen Kendall's Concordance Coefficient W .

In this study, the author asked a group of 26 experts to rank the elements $a_1, a_2, a_3 \dots a_{14}$ and $b_1, b_2, b_3 \dots b_5$. As a result, different variants of the ranking were obtained. In order to process them, element ranks were introduced. The rank x_j of element a_j or b_j indicates the number of that element in the ranking list. The element in the first place has a rank equal to one. For example, if the elements in the ranking list are distributed in the following order: a_3, a_1, a_2 , then respectively $x_3 = 1, x_1 = 2, x_2 = 3$.

The tabular representation is made in the form of a sequence of ranks.

$$\left. \begin{array}{l} x_{11}, x_{12}, \dots, x_{1n} \\ x_{21}, x_{22}, \dots, x_{2n} \\ \dots \dots \dots \\ x_{m1}, x_{m2}, \dots, x_{mn} \end{array} \right\} \quad (4.2)$$

After that it is necessary to assess the degree of consistency of the experts' opinions. It is possible to assess the consistency with the help of rank correlation coefficients, but it is more convenient to use a special coefficient of concordance (consistency). For that, the concordance coefficient W proposed by Kendall is used. Details of its application is shown in the Annex 4B.

As a result, at this stage were obtained summary sheets of experts, with the calculated indicators.

At the third stage, the results were evaluated for consistency. The experts' opinion is considered to be consistent if the value of the concordance coefficient is greater than 0.6. In case of revealed inconsistency of expert opinion, measures were taken to eliminate it by dividing the group of experts into subgroups and calculating the indicators for each of the subgroups.

Ranking of taxes of the Republic of Latvia

The results of the survey on the priority of taxes of the Republic of Latvia after the expert survey were summarised in Table A8.1 (Annex 8).

The values of x^j for the survey related to the ranking of taxes are shown in Table A8.1 (Annex 8).

For the obtained data, the average value of the sum of ranks $\bar{x} = 195$.

The sum of the squares of the deviations x^j from the mean value \bar{x} for the data given in Table 8.1 (Annex 8) – $S_w = 129764$.

For the studied data – $S = 153790$.

For the data from the survey of tax ranking experts, the coefficient of concordance $W = 0.84$.

The experts' opinion should be considered consistent if the value of the concordance coefficient is greater than 0.6. Consequently, the experts' opinion on this issue should be considered coherent. The results of the ranking of taxes in force in Latvia according to the opinion of the expert group are given in Table A8.2 (Annex 8).

It should be noted that in order to obtain more accurate results, the expert group should be enlarged and formed from highly qualified specialists in the field of economics. Nevertheless, even in a current expert group, the results of this ranking for many criteria present a fairly objective picture, especially for those taxes whose sum of rank x^j differs significantly from the nearest. But the taxes whose rank sum x^j differs from each other insignificantly can probably swap places with each other with a more careful selection of experts.

For example, the Electricity Tax has a rank sum of 328, while the Solidarity Tax has a rank sum of 334.

Ranking of taxation criteria

In addition, the same group of experts was asked to rank the following criteria of taxation:

- the criterion of equity;
- the criterion of certainty and accuracy of taxes;
- the criterion of ease of collection of taxes for taxpayers;
- the criterion of efficiency;
- the criterion of obligation.

As in the previous survey, it was necessary to rank the criteria of taxation by degree of importance, assigning them numbers from 1 to 5, where 1 – the most important criterion, 5 – the least important criterion. Also, only a strict ranking was allowed.

The survey data and their processing are shown in Table A8.3 (Annex 8).

The average value of the sum of ranks \bar{x} , determined by the formula (A4.15, Annex 4B), is $\bar{x} = 78$.

The sum of squares of deviations x^j (calculated by formula (A4.14, Annex 4B)) from the mean value \bar{x} , (calculated by formula (A4.15, Annex 4B)) was determined by formula (A4.16, Annex 4B): $S_w = 2640$.

The sum of the squares of their deviations from the mean \bar{x} was determined by formula (A4.17, Annex 4B).

For the studied case $S = 6760$.

The concordance coefficient (A4.18, Annex 4B) for the Table (table A8.3, Annex 8): $W = 0.39$.

As mentioned above, the experts' opinions are consistent if the value of the concordance coefficient is greater than 0.6. Since in this case the value of $W < 0.$, the experts are divided according to their opinions (according to the degree of agreement) into two groups (the number of groups may be larger).

The first subgroup included 12 experts (table A8.4, Annex 8) and the second subgroup included 14 (table A8.6, Annex 8).

For the group of 12 experts (according to Table A8.4, Annex 8): $\bar{x} = 36$, $S_w = 912$, $S = 1440$.

The concordance coefficient calculated by the formula (A4.18, Annex 4B): $W = 0.63$ (i.e. more than 0.6). Consequently, the experts' opinion is agreed upon. Accordingly, the criteria of taxation are ranked by importance in the order shown in Table A8.5 (Annex 8).

For the group of 14 experts (according to Table A8.6, Annex 8): $\bar{x} = 42$, $S_w = 1274$, $S = 1960$.

The concordance coefficient calculated by the formula (A4.18, Annex 4B): $W = 0.65$ (i.e. more than 0.6).

Consequently, the experts' opinion is concordant. Accordingly, the criteria of taxation are ranked according to their importance in the order shown in Table A8.7 (Annex 8).

It should be noted that, despite the different opinions of the two subgroups of experts into which the overall group of experts had to be divided, both subgroups prioritised the criterion of equity in tax collection over the criterion of efficiency.

Analysis of the results and conclusions on the application of the expert evaluation method

The combination of equity and efficiency in tax policy poses a serious problem that to date has no definitive solution.

It is possible to state the fact that in the sphere of taxation there is a choice between the conflicting goals of equity and efficiency. The situation is aggravated by the fact that there are still no generally accepted criteria of efficiency (although this criterion lends itself to a simpler scheme of mathematical description and is less controversial among specialists) and equity.

A "good" tax system is considered one that:

- 1) does not impede or distort the efficient allocation of resources;
- 2) is fair to the various individuals.

Most often in reality there are situations where the tax system improves the welfare of some while worsening the welfare of others. And exactly the condition of optimal, from the point of view of society, taxation – tax justice – that will help to solve the question of the acceptability or unacceptability of a given tax system for society.

To resolve the problem of fairness and effectiveness of tax policy, it is necessary to establish and quantify all connections of fairness and effectiveness with taxes applied in a particular country and, using the method of variant optimisation proposed in the thesis, to create a system for determining the optimal parameters of taxation, allowing to establish a taxation scheme accepted by most members of society.

Since the results of the expert survey largely depend on the composition of the expert group, it might be useful to create an automatic expert system for assessing taxes and tax criteria. Such an expert system is an artificial intelligence system (for example, a neural network), which is capable of automatically assessing, as well as performing ranking of the necessary requirements for analytical decision making. Among the advantages of such a system

are autonomy, high speed of the obtained results, more comprehensive possibilities for taking into account additional economic indicators, as well as lowering time lag of assessment and reducing possibility of bias.

Conclusions and recommendations

Based on the results of the research, the following conclusions were made:

1. Methods of tax systems analysis mostly cover particular aspects of taxation, either from the point of view of the state or from the point of view of taxpayers. Furthermore, the criterion of the tax system includes special cases of equity and efficiency. In theoretical and applied studies of the tax, concepts and tax system requirements, a number of researchers stressed the need for an integrated approach to the tax system optimisation. Thus, there is an objective need for the theoretical ground for an integrated approach to tax optimisation. The integrated approach is elaborated in the Thesis from the point of view of both the taxpayer and the state.
2. The Laffer curve is very topical in scientific debates. However, the Laffer curve is not a universal tool, and its application is difficult due to many limitations, practical application difficulties and not always yield reliable results. The studies that attempted to introduce an additional parameter in the form of a tax base, to date, have not led to the creation of a generally recognised universal methodology that gives adequate results.
3. Decisions aimed at the tax system improvement (including by adjusting its fiscal function) based on the analysis and modification of any discrete parameter (or group of the same type of parameters) often do not yield the desired result. Such decisions exert a negative impact on other following choices and can also be a consequence of populist decisions. It is necessary to create a technique that allows analysis and modelling using an integrated approach.
4. For justification of the most appropriate solution for improving the tax system process of optimisation should be used, which is related to the application of scientific methods, named “operations research”, i.e. application of mathematical, quantitative methods to justify and develop solutions. The reform has to be planned in one or several successive stages with an appropriate breakdown by goals, means and methods.
5. For the creation of a new improved model of tax system optimisation is necessary to consider mutual interactions in the “state – taxpayer” system, which depend on the position of state authorities, and the position of a taxpayer (legal entity or individual), i.e. a state-oriented aspect and a business-oriented aspect.
6. The state-oriented aspect of tax optimisation defined by the author as the actions of the authorities with special powers to fulfil the fiscal function and regulate the

taxation process, aimed at improving the state of the business climate in the country and stimulating the establishment and development of the business which allows formalising the trade-off in the “equity – efficiency” system aimed from the position at of the efficiency.

7. The business-oriented aspect of tax optimisation defined by the author as a set of measures used by a taxpayer (an enterprise or an individual) in order to reduce the tax burden in the short or long term and allows to formalise the trade-off in the “equity – efficiency” system from the position of equity.
8. The improvement of the tax system should be carried out not only considering the tasks of the state and local level, but as well as at the international level, because regulations related to the EU competences are obligatory (e.g. related to restrictions on environmentally harmful activities). These tasks require developing timely compensatory measures to keep the budget revenues at the necessary extent.
9. The differences in territorial division in Latvia and economic potential of regions, should be further studied and considered when planning tax reforms. The implementation of the administrative-territorial reform should be based on economic characteristics of the regions, changes in tax flows and evaluation of the impact of tax reform on the efficiency, equity and reliability of the tax system.
10. The reliability as a tool for predicting the life cycle of both the current and the modernised tax system allows to prepare compensatory measures and minimise possible failures in the functioning of the tax system.
11. The tax reforms implementation started in 2018 did not create a stably operating fiscal system that would effectively perform its functions for a sufficiently long time. As a result, the irrational use of public funds spent on further improvement of the reforms did not permit the foreseen objectives which required additional costs for their adjustment. The lack of reliability of the tax reform discredits the fiscal system and significantly increases the probability of failures.
12. The tax prism method is introduced by the author for economic interpretation of the formation of the budget revenues, its assessment and research, which allows to control the dynamics of the volume of taxes received by the state in the studied period, tax rate and their relation to the tax base. The tax prism is also applicable in research conducted from a business-oriented perspective.
13. The tax prism subdivision into static and dynamic versions allows assessing the decrease in the amount of collected taxes, which occurs due to the use of legal tax optimisation schemes by taxpayers. Static and dynamic tax prisms make it possible

to visualise the process of tax optimisation carried out by state authorities, when establishing the types and determining the size of taxes both in the short term and in the long term, making it more accurate. When using static and dynamic tax prisms, it is possible to effectively enhance tax legislation by simulating the qualitative and quantitative consequences of specific changes and innovations.

14. The use of the variant optimisation method in finding compromise solutions in case of contradictions between the main criteria of the tax system, such as equity and efficiency, allows to carry out a qualitative and quantitative analysis. It provides an appropriate assessment of each criterion, and to assign the most rational and reasonable taxation parameters corresponding to a particular situation.
15. The analysis of the case of the Vehicle Operation Tax and tax costs related to the vehicle operation has shown that they are not optimal in Latvia, due to the incompatibility of the requirements between the criteria of equity and efficiency. Eliminating the incomparability of the requirements between these criteria and prioritising the criterion of equity will reduce social inequality.
16. The method of successive concessions with a preliminary ranking of taxes and tax criteria in order to identify criteria by which concessions allows to determine the most rational compromise solution if significant incompatibility of requirements in the “equity – efficiency” system is identified.
17. Implementation of the successive concessions method by ranking based on an expert survey has to be accompanied by a careful selection of a group of experts. A preliminary assessment of experts’ belonging to the appropriate position (business-oriented or state-oriented) and verification of the consistency of opinions within each of the groups is required.
18. The tax system representation as a composite system, where each of the taxes characterises the element of the system allows to assess criteria in the “equity – efficiency” system and the relationship between taxes. The composite system approach makes possible to obtain more accurate results when assessing both one specific tax and the entire tax system as a whole.
19. Time series analysis models (ARIMA and SARIMA) do not always accurately describe all taxes due to the impact of tax reforms and the COVID-19 pandemic. At the same time, most of the taxes can be predicted quite accurately by the developed models (with level of accuracy more than 70–80%). Based on the results of the analysis, it is reasonable to apply an averaging of the obtained models

(stacked model). The ability of the model to accurately describe changes in the specific tax income is partially determining the reliability of the concrete tax.

20. An integrated approach to optimising the tax system is successfully implemented, only with the combined use of all the developed and proposed tools, with regards to the most important criteria affecting its quality: efficiency (state-oriented aspect), equity (business-oriented aspect), reliability (as a criterion of the life cycle of the tax system).

The tasks set in the Doctoral Thesis were completed, and the aim has been achieved. The research and analysis carried out in the Thesis confirm the hypothesis that the use of the integrated approach for substantiation of tax policy measures permits rational decision making. A rational combination of the principles of efficiency and equity, as well as compliance with other criteria of taxation, will allow authorities in Latvia to create a tax system that meets the defined interests of both the state and taxpayers.

Based on the conclusions, the author formulated the following **proposals**:

To the Ministry of Finance of the Republic of Latvia:

1. Constant monitoring of the reliability of the tax system is recommended in order to make timely decisions on modernisation and reform of the tax system, avoiding a time lag.
2. Assessment of the reliability of the tax changes is suggested on the preparatory stage, introduced both in the short- and long-term period, before adopting them.
3. Application of the tax prism method is recommended for a comprehensive analysis of the “tax base – tax amount (tax rate) – collected amount of tax” relation when monitoring and making changes to the tax system.
4. Assessment of the impact on the tax system from the point of view of efficiency and equity in the preparatory stage of a tax reform is recommended by applying methods of relative single indexes and successive concessions in cases where there is an incompatibility of studied criteria.
5. The tax on the use of roads in Latvia for owners of vehicles of categories M1 and N1 that are not registered in the country (e.g. in a form of a vignette, with a suggested duration of 10 days, 1 month, 3 months and 1 year) is recommended. Introduction of the tax allows to reduce incomparability between equity and efficiency and to reduce the burden on low-income groups of the population, partially shifting the tax burden from a vulnerable group. The principle “who drives

less, pays less tax” for Vehicle Operation Tax is another option to further promote equality between the social groups.

To the Ministry of Environmental Protection and Regional Development of the Republic of Latvia:

6. Regional specificities of taxation and its modelling for assessing changes in reliability and collectability are recommended to consider during the development and implementation phases of future administrative-territorial changes.
7. Cooperation of the Ministry of Environmental Protection and Regional Development with the Ministry of Finance could lead to the effective implementation of tax reforms and would be beneficial on a regional level.

To the State Revenue Service (SRS) of the Republic of Latvia:

8. Two options are suggested: first, the refund period should be established after the last annual filing date of declarations and is not associated with a specific moment of filing the declaration within the specified time period, in order to prevent overloading and failures of the electronic declaration system; second, to divide taxpayers into several groups, according to a certain classification criterion, and for each group to set their own deadlines for filing a declaration. This information should be brought to every taxpayer.

To the Saeima of the Republic of Latvia:

9. The opinion of specialists from the Ministry of Finance and other competent institutions, justifying specific impact on the budget of possible changes is necessary to acquire before considering issues that affect the budget revenues directly or indirectly. This will allow to make more balanced and efficient decisions. In cases where political goals prevail over economic feasibility, to timely develop compensatory measures to keep budget revenues at the required level.

To the Ministry of Education and Science of the Republic of Latvia:

10. In the curricula of educational institutions engaged in advanced training of government officials related to the improvement of the tax system it is advisable to include the conceptual theoretical and practical principles elaborated in the Doctoral Thesis.
11. Advanced educational programs or courses to train specialists, acquiring new knowledge and competences in effective management of the state tax system, is essential. It is necessary to provide funding for implementation of such type of training.

12. The training programs for specialists in tax policy should include special in-depth IT-training, which allows to create and use computer programs in determining the reliability of tax reforms, as well as for assessing previous periods and forecasting future ones.

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Annexes

General tax properties and their effects

Table A1.1

Overview assessment of tax categories³⁴⁵

Tax	Efficiency	Distributive effects	Administration / compliance
Labour income taxes	<ul style="list-style-type: none"> • May distort labour demand through increased labour costs and labour supply through reduced work incentives. • However, empirical research suggests very low labour supply elasticities, with the exception of low-income and second earners. 	<ul style="list-style-type: none"> • If designed progressively, represent the primary tax instrument for direct redistribution, taking into account the ‘ability to pay’ principle. • Specific design features (e.g. joint taxation) might discourage second earners (still primarily female) from taking up work, which bears the risk of maintaining a wide gender gap in employment rates, thus contributing to the gender pay gap. 	<ul style="list-style-type: none"> • Withholding taxes (WHTs) on labour substantially facilitate tax administration and compliance. • Non-standard employment and the rise of (online) platform work create challenges for efficient administration of earned income. • However, technology (in particular, platforms) may also provide opportunities for more efficient tax administration.
Corporate income taxes (CITs)	<ul style="list-style-type: none"> • May distort capital formation, investment decisions and productivity in several ways. • Distortions may vary considerably with certain features, e.g. destination-based cash-flow taxation does not distort behaviour (including investment decisions). • Economic integration and digitalisation pose particular problems for the international CIT framework, as they distort investment location and magnitude, and the playing field between businesses. 	<ul style="list-style-type: none"> • CIT is often seen as an instrument for taxing corporations’ shareholders, thereby contributing to fairer burden sharing among taxpayers. • The challenges of the international corporate tax framework contribute to a shift of the tax burden to less mobile tax bases (e.g. labour, consumption), with consequences in terms of inequality and burdens haring. 	<ul style="list-style-type: none"> • Companies’ compliance costs are high due to complex accounting standards and tax provisions (e.g. deduction rules). • In particular, compliance is increasingly complex for businesses operating across borders (different tax rules). • Loopholes in and mismatches between corporate tax systems create substantial opportunities for tax avoidance.

³⁴⁵ European Commission, Secretariat-General. 2020. Tax policies in the European Union. 2020 survey. SWD (2020) 14 final. 30.01.2020. <https://data.consilium.europa.eu/doc/document/ST-5695-2020-INIT/en//>. 124.

Table A1.1 continued

Tax	Efficiency	Distributive effects	Administration / compliance
Capital income taxes (households)	<ul style="list-style-type: none"> • May distort investment decisions if different forms of capital income (e.g. from dividends, interest, sale of capital shares) are not taxed in the same way. • May discourage saving and investment. • As dividends are often taxed both at company and shareholder level, the tax burden may be higher than in the case of other capital income ('economic double taxation'). 	<ul style="list-style-type: none"> • Typically, capital income increases as a proportion of total personal income towards the top of the income distribution. • Under the 'ability to pay' principle, all personal income from different sources (labour, capital etc.) should be taxed to the same degree. 	<ul style="list-style-type: none"> • Taxing capital income at source (WHT) eases the administrative and compliance burden. • WHT at source (e.g. through banks or companies issuing shares) reduces the risk of fraud or evasion.
Taxes on immovable property	<ul style="list-style-type: none"> • If designed as recurrent taxes, the distortive impact is limited compared to other taxes. • If designed as transaction taxes, they may create a lock-in effect that reduces labour mobility. 	<ul style="list-style-type: none"> • Distributional implications depend on distribution of property ownership and specific design of the tax. 	<ul style="list-style-type: none"> • Valuation can be complex, but is considered less costly than in the context of net wealth taxes. • Due to visibility and immobility, evasion and avoidance opportunities are limited.
Net wealth taxes	<ul style="list-style-type: none"> • May discourage savings. • May decrease the level of investment. 	<ul style="list-style-type: none"> • If designed with appropriate thresholds and (possibly) progressively, may make a significant contribution to reducing wealth inequality. 	<ul style="list-style-type: none"> • May encourage people to move their wealth offshore. • Substantial avoidance opportunities, particularly for the very rich. • Difficult to trace ownership; annual valuation of privately held wealth is costly. However, appropriate design and technological progress can cut valuation costs and administrative complexity substantially.

Table A1.1 continued

Tax	Efficiency	Distributive effects	Administration / compliance
Inheritance / gift taxes	<ul style="list-style-type: none"> • Can reduce the incentive to save among those who may want to leave an estate to the next generation, or on the contrary can increase saving by donors to pass on sufficient estate to next generation. • Incentives increase for heirs to work and save, in view of a lower inheritance. 	<ul style="list-style-type: none"> • Can help reduce wealth inequality. • Can support social mobility by reducing the extent to which wealth inequalities are transmitted from one generation to another. 	<ul style="list-style-type: none"> • Since assets are valued only once, administrative costs are less than those for net wealth taxes. • Avoidance and evasion opportunities depend on the design and the scope of exemptions.
Value-added tax (VAT)	<ul style="list-style-type: none"> • Considered to be among the less distortive taxes, as it does not distort production decisions. • It may increase prices, reducing the purchasing power of real after-tax wages and thereby indirectly reducing labour supply. 	<ul style="list-style-type: none"> • Generally, the distributional impact is either regressive or proportional. • Reduced rates are not effective in terms of redistribution, as they cannot target a specific (e.g. low-income) population. 	<ul style="list-style-type: none"> • Compliance costs for companies are lower for indirect taxes (such as VAT) than for direct taxes. • Considerable scope for tax evasion and fraud (e.g. VAT gap), notably due to the break in the fractioned collection of VAT when it comes to intra-EU business-to-business (B2B) transactions.
Environmental taxes	<ul style="list-style-type: none"> • Considered to be among the less distortive taxes. • Primary objective is to correct behaviour to internalise negative externalities and thereby create overall welfare gains. • Concerns over carbon leakage (domestic reductions in greenhouse gas emissions are counterbalanced by increases elsewhere) and competitive disadvantages for domestic firms following unilateral action in a given country; can therefore justify international coordination. 	<ul style="list-style-type: none"> • Many types of environmental taxes are typically regressive, so their increased use should be accompanied by mitigating policy measures. However, environmental taxes can support intergenerational fairness, as behavioural change will probably reduce costs for future generations of mitigating impact of climate change. 	<ul style="list-style-type: none"> • Administrative complexity shapes the options for implementing environmental taxes, e.g. a carbon tax. • Ideally, would take the form of a tax on each unit of measured emissions (e.g. CO₂, NO_x) according to social cost. • However, depending on the pollutant and type of tax, the information requirements can be very high. As a result, taxes are often imposed on a proxy for the pollutant, e.g. volume of fuel placed on the market. • Difficult to evade.

Source: Tax policies in the European Union. 2020 survey.

Lorenz and Laffer curve variants

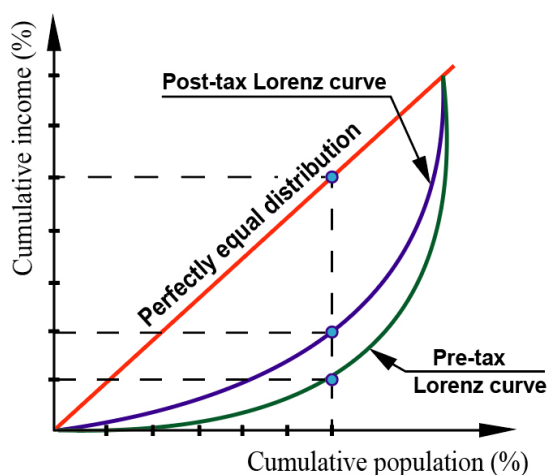


Figure A1.1 Graphical representation of Lorenz curve

Source: Costa, R. and Pérez-Duarte, S. 2019. *Not all inequality measures were created equal. The measurement of wealth inequality, its decompositions, and an application to European household wealth*. European Central Bank: Statistics Paper Series. 31(12), 57.

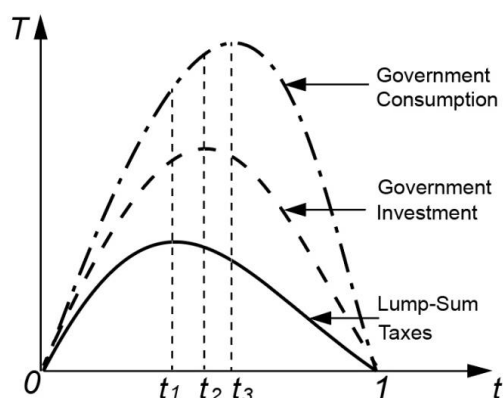


Figure A1.2 Laffer Curves under alternative spending arrangements

Source: Becsi, Z. 2000. *The Shifty Laffer Curve*. *Federal Reserve Bank of Atlanta. Economic review*. 85(3), 53–64.

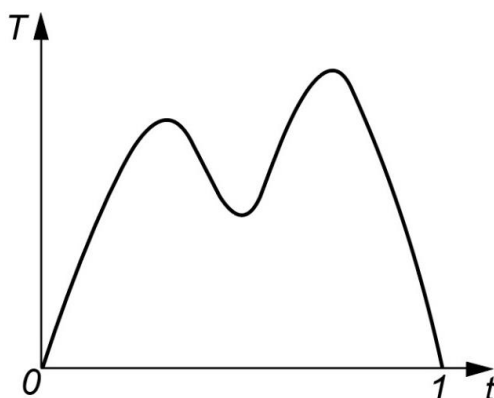


Figure A1.3 Graphical representations of Laffer curves with several inflection points: Henderson’s version

Source: Henderson, D. 1981. *Limitation of the Laffer curve as a justification for tax cuts*. *Cato Journal*. 1(1), 45–52.

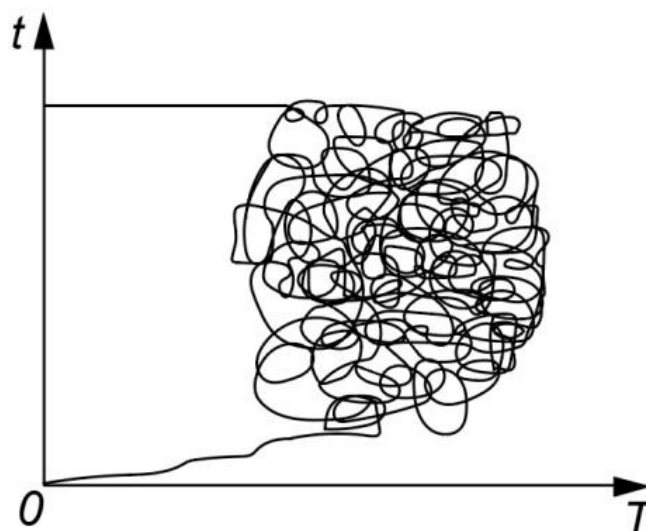


Figure A1.4 **Neo-Laffer curve by M. Gardner**

Source: Gardner, M. 1981. Mathematical games.
 The Laffer curve and the other laughs in current economics.
Scientific American. (245), 18–31.

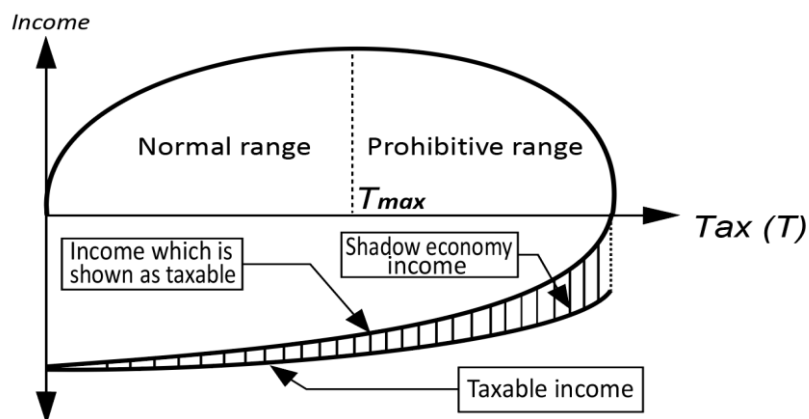


Figure A1.5 **Characterisation of the shadow economy by the Laffer curve**
 Source: Sproģe, I. 2010. *Nodokļu politika ekonomikas attīstības mainīgajos apstākļos: promocijas darbs: specialitāte – ekonomika.* Rīga: Latvijas Universitāte, 213.

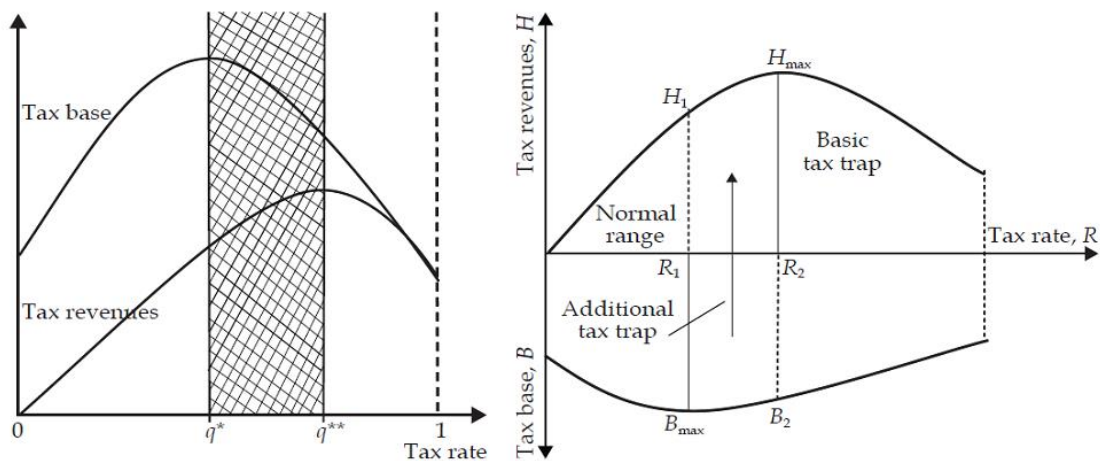


Figure A1.6 Laffer curve by Balatsky (left) and Mayburov (right)

Source: Kakaulina, M. 2017. Visual Representation of Laffer Curve Factoring in Implications of Capital Outflow. *Journal of Tax Reform*. 3(2), 103–114.

Balatsky, E. 1997. The Laffer points and their quantification. *World Economy and International Relations*. 12, 85–94.

Recent changes in tax legislation and the tax system of Latvia

Table A2.1

Main changes in the tax legislation of Latvia (2020–2021)

Description of measure	Change	Date
<i>Personal income tax: Earned income</i>		
Increase of threshold to which PIT differential non-taxable minimum is applied up to EUR 1 800	Base decrease	Announcement: 17-11-2020 Legislation: 22-09-2020 In force from: 01-01-2021
<i>Personal income tax: Unincorporated businesses / Self employment income</i>		
Self-employed personal income tax advance payments deferred for 2021	Neutral	Announcement: 22-12-2020 Legislation: 18-12-2020 In force from: 23-12-2020
<i>Value-added tax</i>		
The excess VAT is refunded to taxable person within 30 days without accruing them until the end of the tax year; in force as of 1 January 2021	Neutral	Announcement: 11-12-2020 Legislation: 24-11-2020 In force from: 01-01-2021
Simplification of VAT application rules in the field of e-commerce: from 2021, the scope of application of the special VAT regime will be extended, creating the possibility to register in one Member State and pay VAT for any transactions performed in the e-environment within the framework of the special VAT regime; in addition, from 2021, the VAT exemption for shipments of low value goods in the amount of 22 euros will be abolished.	Base increase	Announcement: 21-10-2020 Legislation: 15-10-2020 In force from: 01-01-2021
The reduced 5 percent VAT rate on fresh fruit, berries and vegetables typical of Latvia will be maintained until 31 December 2023	Rate decrease	Announcement: 11-12-2020 Legislation: 24-11-2020 In force from: 01-01-2021
<i>Environmentally-related taxes</i>		
Temporary reduction of tax rate on natural gas used as propellant	Rate decrease	Announcement: 11-12-2020 Legislation: 24-11-2020 In force from: 01-01-2021
Increase of natural resources tax rates on waste disposal, air pollution and category C polluting activities and abolition of exemption for CO ₂ emissions for the use of peat in stationary technological equipment	Rate increase; base increase	Announcement: 11-12-2020 Legislation: 23-11-2020 In force from: 01-01-2021
Abolish the reduced rates of excise duty on fuel E85 and B100 and abolish the reduced rates of excise duty on fuels containing bioproducts, as well as set a minimum rate of excise duty on biodiesel derived entirely from biomass and on paraffined diesel derived from biomass used as fuel.	Rate decrease	Announcement: 17-12-2020 Legislation: 29-12-2020 In force from: 01-02-2021
<i>Health-related taxes</i>		
Increase of excise duty rates on all tobacco products and liquids used in e-cigarettes	Rate increase; base increase	Announcement: 11-12-2020 Legislation: 24-11-2020 In force from: 01-01-2021

Table A2.1 continued

Description of measure	Change	Date
<i>Other taxes</i>		
Extension of tax payments up to 3 years on request by the company till 30.06.2021.	Neutral	Announcement: 22-12-2020 Legislation: 18-12-2020 In force from: 23-12-2020
Decrease of social security contributions` rate by 1 percent point (from 35.09 % to 34.09 %)	Rate decrease	Announcement: 11-12-2020 Legislation: 27-11-2020 In force from: 01-01-2021
Introduction of minimum social contribution payments (enters into force on 01.07.2021) and reorganization of alternative tax regime (including Micro-enterprise tax)	Rate increase; base increase	Announcement: 11-12-2020 Legislation: 27-11-2020 In force from: 01-01-2021
The Indexation of company car tax rates and determination of a new rate for vehicles with an engine capacity exceeding 3000 cubic centimetres	Rate increase	Announcement: 11-12-2020 Legislation: 30-11-2020 In force from: 01-01-2021
Changes in Vehicle Operation Tax rates	Rate increase	Announcement: 11-12-2020 Legislation: 30-11-2020 In force from: 01-01-2021
Redistribution of PIT between local government / state budgets from 80 %/20 % to 75 % / 25 %	Neutral	Announcement: 11-12-2020 Legislation: 23-11-2020 In force from: 01-01-2021

Source: Taxation trends in European Union.³⁴⁶

³⁴⁶ European Commission. 2021. Taxation Trends in the European Union. *Directorate-General for Taxation and Customs Union, European Commission, Publications Office of the European Union*. Retrieved: <https://op.europa.eu/en/publication-detail/-/publication/d5b94e4e-d4f1-11eb-895a-01aa75ed71a1>. 298.

Companies offering tax planning services in Latvia

Table A3.1

Study of Latvian companies offering tax optimisation services

Name of the company and its website	Description of the offered services
“Constanta inc.” https://constanta.lv/lv/gramatvedibas-apkalposana/nodoklu-optimizacija	Tax optimization is such a process, that allows to minimize tax payments to the budget, while a properly executed procedure does not have any legal nature, negative consequences.
“Nodokļu likumdošanas izglītības centrs” http://registreties.lv/nodoklu-optimizacija	Tax optimization is one of the most important issues facing both entrepreneurs and employees. The purpose of tax optimization is to reduce the amount payable in taxes by legal methods, using the possibilities provided for in regulatory enactments. However, tax optimization is not as simple as it sounds – it requires excellent knowledge of tax and accounting regulations. Also, organizing seminars.
“Taxwise.lv” http://taxwise.lv/tax-optimization/	To optimize taxes. Tax planning means the use of different strategies in order to reduce tax burden. In comparison to tax evasion, tax planning means the reduction of tax payments in a legal way.
“MG Alliance” https://www.mg-a.lv/lv/nodoklu-optimizacija-lv-p	Tax optimization is an activity aimed at reducing tax payments through legal actions of the taxpayer, involving the fullest possible use of all benefits provided by law, tax exemptions and other legal methods.
“Investors” http://www.investors.lv/blog/bistamak-as-shemas-nodoklu-samazinasanai/	... legally ensure to pay less taxes ...
“Ari Accounting Service” http://wowo.lv/eng/about_figures	Tax optimization (minimizing absolutely via legal ways).
“FinServices” http://www.finservices.lv/lv/gramatvedibas-konsultacijas	Tax optimization, refund of overpaid taxes (minimizing absolutely via legal means).
“Ilear” http://www.ilear.lv/en/	We offer: tax optimization.
“Consulting Pro” http://www.consultingpro.lv/?lang=lv	To optimize expenses and taxes for all who has applied.
“Lielā Ina, individuālā darba veicēja” http://www.ilgak.lv/en/start-page/	We help in finding the most suitable solutions in tax optimization.
“Breicis” http://breicis.com/en/	We help our clients to lower tax burden.
“IR ACCOUNTING” At the time of the research, the company did not have its own website. https://infolapa.zl.lv/ir-accounting-ik/	Tax optimization.
“Grāmatvedības un juridiskais birojs” At the time of the research, the company did not have its own website. https://infolapa.zl.lv/gramatvedibas-un-juridiskais-birojs-sia/	Tax optimization.

Table A3.1 continued

Name of the company and its website	Description of the offered services
<p>“BP FINANSES” http://www.bpfinanses.lv/lv/par-mums</p>	<p>We give advice on tax optimization. Experience allows us to be ahead of all events and advise the best tax solutions, as well as quickly respond to changes in taxation and select the most profitable solutions for each client.</p>
<p>“Aktīvs GIS” At the time of the research, the company did not have its own website. https://infolapa.zl.lv/aktivs-gis-sia/</p>	<p>Tax optimization.</p>
<p>“Kamelota” https://www.kamelota.lv/en/services/tax-consulting-services/</p>	<p>It is our knowledge and 20+ years of work experience in tax consulting services that help to find the most suitable solutions to each company and organize tax matters in line with the existing legislation.</p>
<p>LBM Management http://www.lbm-management.eu/services/tax/en/taxes-are-viewed-easily-and-clearly.html</p>	<p>Tax planning, which means careful analysis of the existing tax imposition, the development and implementation of tax arrangements, the appliance of prescribed tax allowances, and the regulation and supervision of tax burdens; you will obtain an effective system of tax payments that can guarantee economic and legal security for your company as a result of the tax-optimisation procedure.</p>
<p>“Tilders” http://www.tilders.lv/services_en.html</p>	<p>Tilders specialists explains to the Client nature of taxes and their implementation in practice, as well as helps finding the most suitable solution for optimal tax payments.</p>
<p>“Dalon” https://dalon.lv/pakalpojumi/gramatve-dibas-pakalpojumi/</p>	<p>Control and tax optimization.</p>
<p>“Finansu konsultants” https://finansukonsultants.lv/en/services/financial-analysis/</p>	<p>Recommendations to improve financial state.</p>
<p>“Alzaro” http://www.alzaro.lv/lv/services/uzmu-ma_nodoku_sistmas_optimizcija.html</p>	<p>Optimization of the tax system of the enterprise. Latvian legislation does not stipulate in detail all sorts of nuances of the tax system, while in many other EU countries all tax operations are stipulated to the smallest detail. Thus, in Latvia, lawyers and tax consultants can interpret the law quite freely, which allows the company to avoid unnecessary tax costs.</p>

Source: created by the author.

Taxation and reliability – theoretical justification

Reliability (or the probability of performing the functions assigned to the system to fill the budget) in accordance with the classical definition of probability³⁴⁷ at any point in time on the interval t is determined by the following relation:

$$R(t) = \frac{N_f}{N_\Sigma} = \frac{N_f}{N_f + N_d} \quad (\text{A3.1})$$

If over the period t the value of N_f decreases due to the fact that more and more taxes cease to perform their functions, the reliability of the entire fiscal system decreases proportionally.

Similarly, the probability of failure (or unreliability) of the tax system under study can be determined.

$$P(t) = \frac{N_d}{N_\Sigma} = \frac{N_d}{N_f + N_d} \quad (\text{A3.2})$$

For any point in time of the fiscal system the following equation is true: $R + P = 1$. The events “the tax performs its functions” and “the tax does not perform its functions” are mutually exclusive, or opposite events.

The number of taxes, which properly perform their functions during the whole action time t , is equal to $N_f = N_\Sigma - N_d$. Consequently, the reliability of the whole tax system can also be written in the form:

$$R(t) = \frac{N_f}{N_f + N_d} = \frac{N_\Sigma - N_d}{N_\Sigma} = 1 - \frac{N_d}{N_\Sigma} \quad (\text{A3.3})$$

Differentiating both parts of expression (A3.3) by t , obtained (since N_Σ is constant):

$$\frac{dR}{dt} = \frac{d(1 - \frac{N_d}{N_\Sigma})}{dt} = -\frac{1}{N_\Sigma} \frac{dN_d}{dt} \quad (\text{A3.4})$$

From the obtained expression (A3.4) the rate at which taxes stop performing their functions (failure rate) can be predicted:

$$\frac{dN_d}{dt} = -N_\Sigma \frac{dR}{dt} \quad (\text{A3.5})$$

³⁴⁷ Gorroochurn, P. 2012. Some Laws and Problems of Classical Probability and How Cardano Anticipated Them. *Chance*, 25(4), 13–20.

Since $N_d = N_{\Sigma} - N_f$, then:

$$\frac{dN_d}{dt} = \frac{d(N_{\Sigma} - N_d)}{dt} = -N_{\Sigma} \frac{dN_f}{dt} \quad (\text{A3.6})$$

The formula (A3.6) also characterizes the “survival rate” (i.e., the faultless performance of the taxes of their functions), which is equal to the failure rate with the opposite sign.

By dividing both parts of (A3.6) by N_f , the failure rate λ is obtained:

$$\lambda = \frac{1}{N_f} \frac{dN_d}{dt} = -\frac{N_{\Sigma}}{N_f} \frac{dR}{dt} \quad (\text{A3.7})$$

Since $R = N_f/N_{\Sigma}$, then $N_{\Sigma}/N_f = 1/R$, and by substituting this value into (A3.7), obtained:

$$\lambda = -\frac{1}{R} \frac{dR}{dt} \quad (\text{A3.8})$$

The formula (A3.8) is the most general expression for the intensity of the cessation of the necessary functions of taxes, it is valid for both exponential and nonexponential laws. In the general case, λ is a function of the system action time t , since both R and dR/dt are functions of time. Only in one case, in the exponential law of reliability, the value of λ in formula (A3.8) is constant. Dividing the variables and integrating, from (A3.7) is obtained:

$$\lambda dt = -\frac{dR}{R} \quad (\text{A3.9})$$

$$\int_0^t \lambda dt = -\int_1^R \frac{dR}{R} = -\ln R \quad (\text{A3.10})$$

$$\ln R = -\int_0^t \lambda dt \quad (\text{A3.11})$$

Since at $t = 0$ obtained $R = 1$, then solving with respect to R :

$$R(t) = \exp\left[-\int_0^t \lambda dt\right] \quad (\text{A3.12})$$

Since no constraints are imposed on the failure rate λ , it can be any integrable function of time t . Consequently, the function $R(t)$ in formula (A3.12) expresses reliability in the most general form, which can be applied to all possible kinds of distribution of failures of any taxes.

If in (A3.12) λ is assumed constant:

$$-\int_0^t \lambda dt = -\lambda t, \quad (\text{A3.13})$$

From which is obtained an exponential reliability formula similar to expression 3.3, Section 3.2:

$$R(t) = e^{-\lambda t} \quad (\text{A3.14})$$

The above conclusion makes it possible to measure the failure rate of each tax.

If λ in formula (A3.7) is constant, then the product $(1/N_f)(dN_d/dt)$ should also be constant over the lifetime of a particular fiscal system. This means that $1/N_f$ and dN_d/dt must either decrease at the same rate or be held constant throughout the life cycle of the system.

The simplest way to measure the constant failure rate is to keep the number of taxes in the study process constant by immediately replacing taxes that have ceased to perform at a given level with new ones. The number of taxes, faithfully performing their functions N_f throughout the study will be equal to N_Σ , i.e. will always be equal to the original value (if a new tax is to be introduced, or the existing tax is to be completely eliminated, the reliability model of the tax system must be recalculated with the new value N_Σ). Consequently, $1/N_f = 1/N_\Sigma$ is constant, and dN_d/dt in this study must also be constant if the intensity of tax failures is constant. But dN_d/dt will be constant only if the total number of taxes N_d that have ceased to function at a given level increases in proportion to time during the study, i.e., according to a linear law. If N_d taxes failed in time t (at a constant rate), then the number of taxes that failed per unit time is N_d/t and in this study dN_d/dt can be replaced with N_d/t , and $1/N_f$ with $1/N_d$. Then:

$$\lambda = \frac{1}{N_f} \frac{dN_d}{dt} = -\frac{1}{N_o} \frac{N_d}{t} \quad (\text{A3.15})$$

Thus, it is required to calculate only the number of failed taxes N_d and the operating time t . Then the constant failure rate will be determined by the ratio of the number of taxes which have ceased to perform the given functions to the product $N_\Sigma t$. Of course, this way of determining the failure rate is possible only if $\lambda = \text{const}$.

If only any one tax is studied ($N_\Sigma = 1$), but it is recovered so that the study can continue after each failure, then $\lambda = N_d/t$, where t includes only the immediate investigation time.

Formula (A3.15) is showing that the tax failure rate has the dimension ‘‘number of failures over a period of time’’.

The derivative dR/dt was introduced into formula (A3.4), the meaning of which is worth explaining. It follows from Figure 3.1 (Section 3.2), where the graph of the reliability function is shown, that dR/dt is the slope of the curve R at any point t . This slope is negative everywhere and decreases from the initial value $-1/\beta$ (at $t = 0$) to 0 (at $t = \infty$). The negative sign of the slope follows from formula (A3.4):

$$\frac{dR}{dt} = -\frac{1}{N_{\Sigma}} \frac{dN_d}{dt} \quad (\text{A3.16})$$

In the formula (A3.16), dN_d/dt is the frequency with which tax failures occur at any given time in studies conducted without replacing the failed taxes. If dN_d/dt is plotted as a function of t , the distribution of failures of all initial taxes N_{Σ} is obtained. The graph $(1/N_{\Sigma})(dN_d/dt)$ illustrates the distribution of failures over time, referring to the number of initial taxes which performed their functions at a given level, or the failure rate curve. Consequently, the graph of the function $(1/N_{\Sigma})(dN_d/dt)$ will have the same character as the graph of dN_d/dt , only all its ordinates will be divided by a constant number N_{Σ} . This function is the probability density of tax failures:

$$f(t) = \frac{1}{N_{\Sigma}} \frac{dN_d}{dt} = -\frac{dR}{dt} \quad (\text{A3.17})$$

The total area bounded by the corresponding curve is equal to 1. The failure rate in (A3.8) can be written in the form:

$$\lambda = -\frac{1}{R(t)} \frac{dR}{dt} = -\frac{f(t)}{R(t)} \quad (\text{A3.18})$$

It means that the tax failure rate for any time t is equal to the value $f(t)$ divided by the reliability taken for the same value of t . Formula (A3.18) is valid for all possible distributions both exponential and nonexponential.

In the case where λ is constant:

$$f(t) = -\frac{dR}{dt} = -\frac{d}{dt}(e^{-\lambda t}) = \lambda e^{-\lambda t} \quad (\text{A3.19})$$

The same result can be obtained if formula (A3.2) is used to derive the probability density of failures. Then:

$$f(t) = -\frac{1}{N_{\Sigma}} \frac{dN_d}{dt} = \frac{dP}{dt}, \quad (\text{A3.20})$$

since $P(t) = N_d/N_{\Sigma}$. By integrating (A3.20), obtained:

$$P(t) = \int_0^t f(t)dt. \quad (\text{A3.21})$$

This means that the probability of failure P in time t is equal to the area under the density curve $f(t)$ in the interval from 0 to t . This area increases as the operating time t increases, and hence the probability of failure also increases with time. Thus, $P(t)$ represents the integral distribution function of failures.

Naturally, the probability of the fiscal system functioning properly, or reliability, should decrease as time t increases. Since $R = 1 - P$, then:

$$R(t) = 1 - \int_0^t f(t)dt, \quad (\text{A3.22})$$

and, given that $\int_0^{\infty} f(t)dt = 1$, it is possible to write:

$$R(t) = \int_0^{\infty} f(t)dt - \int_0^t f(t)dt = \int_t^{\infty} f(t)dt. \quad (\text{A3.23})$$

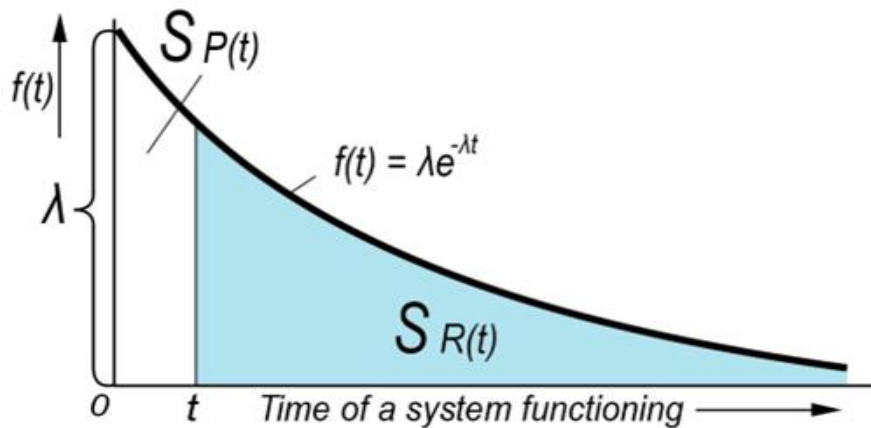


Figure B3.1 Exponential density function³⁴⁸

³⁴⁸ Bazovsky, I. 1961. *Reliability theory and practice*. London: Prentice-Hall International, 376.

This means that the probability of faultless operation of the system decreases according to the decrease of the area under the density curve $f(t)$, as shown in Figure B3.1, which shows the probability density curve for the exponential case. The total area $S_{P(t)} + S_{R(t)}$ under this curve is always equal to one:

$$S_{\Sigma} = \int_0^{\infty} f(t)dt = \int_0^{\infty} \lambda e^{-\lambda t} dt = [e^{-\lambda t}]_0^{\infty} = 1. \quad (\text{A3.24})$$

This also applies to the general case where:

$$f(t) = -\frac{dR}{dt} = -\frac{dP}{dt}; \quad (\text{A3.25})$$

then:

$$S_{\Sigma} = -\int_0^{\infty} \frac{dR}{dt} dt = -\int_0^{\infty} dR = -[R(\infty) - R(0)] = 1. \quad (\text{A3.26})$$

Similarly, the identity is always true regardless of the type of distribution:

$$S_{\Sigma} = \int_0^{\infty} f(t)dt = \int_0^t f(t)dt + \int_0^{\infty} f(t)dt = P(t) + R(t) = 1. \quad (\text{A3.27})$$

The failure rate can also be expressed in terms of P :

$$\lambda = \frac{f(t)}{R(t)} = -\frac{f(t)}{1-P(t)} = \frac{1}{1-P(t)} \frac{dP}{dt} = \frac{1}{R(t)} \frac{dP}{dt}. \quad (\text{A3.28})$$

Here it is important to note that the failure rate is always equal to the ratio of density to reliability. In the exponential case this ratio is constant. In all other cases it changes in time, and the failure rate is then a function of time.

In some cases, the probability of uninterrupted functioning of the fiscal system over a short period of time from t_1 to t_2 may also be of interest in predictive studies. If the duration of the study is equal to t , then $R(t)$ is the reliability of performing the given functions. The reliability with which the system will function in the interval from t_1 to t_2 , distant from the initial moment $t = 0$ can be determined.

The probability density allows to determine a priori the probability of failure between t_1 and t_2 as follows:

$$P_{t_2-t_1} = \int_{t_1}^{t_2} f(t)dt = [P(t)]_{t_1}^{t_2} = P(t_2) - P(t_1). \quad (\text{A3.29})$$

The probability that the system will not fail in this interval is equal:

$$Q_{t_2-t_1} = 1 - P(t_2) + P(t_1) = 1 - [R(t_1) - R(t_2)]. \quad (\text{A3.30})$$

This expression does not give a value of reliability of functioning of the system, because the system can fail earlier, before the moment t_1 , i.e. in the interval from $t = 0$ to $t = t_1$. The value $Q_{t_2-t_1}$ means only the a priori probability that the system will not fail in this interval, but does not express the probability that the system will work in this interval, and it is the latter that means the reliability of the system. In the probabilistic formulation, the reliability of the system is the probability that the system will not fail until t_2 , i.e., the probability that the system will not fail between $t = 0$ and $t = t_1$ and, moreover, will not fail between t_1 and t_2 . Hence:

$$R_{t_2-t_1} = R(t_1) \times R(t_2 - t_1) = R(t_2). \quad (\text{A3.31})$$

Tax prism - graphical differentiation

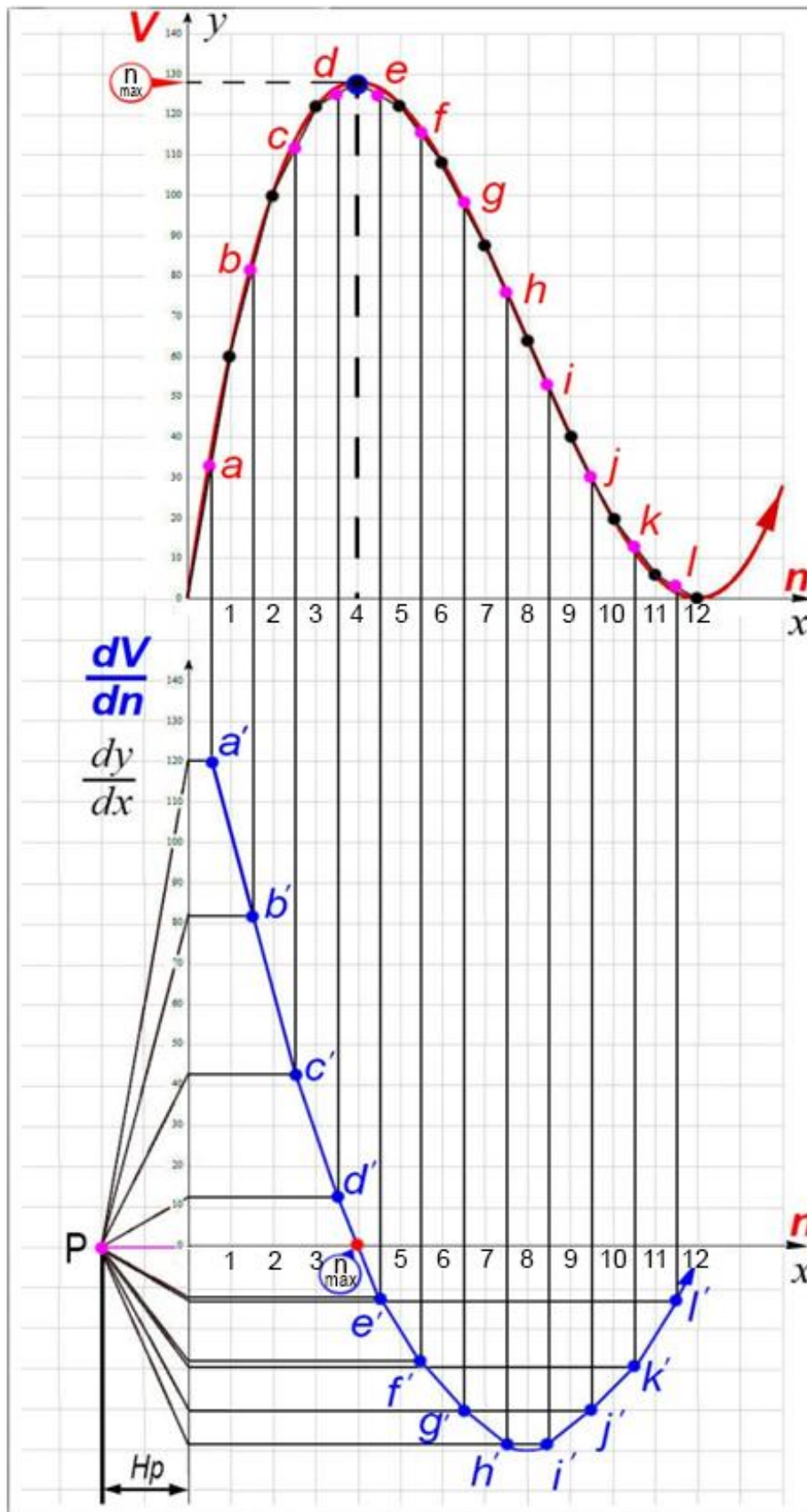


Figure C3.1 Graphical differentiation of the function

Source: created by the author.

Expert survey processing methods

As was shown in Section 3.4 when creating the optimisation model, there may be cases when relative single indexes of equity and efficiency are incompatible, because there is no compatibility area in the zone of acceptable values of relative single indexes from one and above (Figure 3.8).

As already indicated, in the case of equal importance of the indicators, it is advisable to make concessions on all of them simultaneously and choose an acceptable solution. However, in practice such cases are rare. Therefore, to resolve the situation related to the incompatibility of relative unit indicators, it is necessary to resort to their ranking.

It is advisable to carry out the ranking by expert methods or by using a probabilistic approach. The ranking should take into account the stability of the indicators, i.e. the magnitude of their change relative to the EEC.

If the optimisation model is quite complicated and the mathematical formalisation of the solution process is difficult, it is necessary to use the recommendations of competent specialists (experts). Their solution of the problem, reasoning, formation of quantitative estimations, processing of the latter by formal methods constitute the method of expert assessments. The results obtained are influenced by the competence of the persons who make up the expert group. There are special recommendations and methods designed to evaluate the specialists who are planned to be included in the expert group, as well as ways to improve the quality of decisions made.³⁴⁹

Expert assessments can be divided into two main groups:

- individual assessments, which are based on the use of the opinions of individual experts who are independent of one another;
- collective assessments based on the use of the general opinion of experts.

Experts may be asked to make an assessment in one of the following ways:

1. Ranking. It consists in arranging the assessed objects in ascending or descending order of some inherent property. Ranking makes it possible to choose the most significant factor from the studied set.
2. Pairwise comparison. It involves establishing a preference for objects by comparing all possible pairs. Here it is not necessary, as in ranking, to order all objects, it is necessary to identify the more significant object in each of the pairs or to establish their equality.

³⁴⁹ Herowati, E., Ciptomulyono, U., Parung, J. and Suparno, S. 2016. Expertise-based Ranking of Experts: An Assessment Level Approach. *Fuzzy Sets and Systems*. 315(2017), 44–56.

3. Direct assessment (score method) – used when it is necessary not only to arrange (rank the objects of analysis), but also to determine how one factor is more significant than the other (others). In this case the range of change of object characteristics is divided into separate intervals, each of which is assigned a certain grade (score), for example, from 0 to 10.

Various methods of mathematical statistics are used to analyse the results, which can be combined and varied depending on the type of task.

The process of forming a generalised assessment: a group of experts assessed a research object, then x_j is the assessment of the j -th expert, where m is the number of experts. To form a generalised assessment of a group of experts, average values are most often used.

If it is necessary to determine how important (essential) a particular factor (object) is in terms of a criterion, then the weight of each element should be determined.

In this case, there are methods that allow determining the coefficient of competence of an expert, as well as establishing the degree of consistency of their opinions. If several experts participate in the survey, discrepancies in their assessments are inevitable, but the magnitude of this discrepancy is significant. A group assessment can be considered sufficiently reliable only if the opinions of the individual experts are in good agreement.

To analyse the spread and consistency of opinion, statistical characteristics – measures of dispersion or statistical variation – are used.

To estimate the measure of spread:

$$\text{Variation range:} \quad R = x_{max} - x_{min}, \quad (\text{D3.1})$$

$$\text{Mean deviation:} \quad a = \frac{1}{n} \sum_{i=1}^n |x_i - \bar{x}|, \quad (\text{D3.2})$$

$$\text{Standard deviation:} \quad \sigma = \sqrt{\frac{1}{n} \sum_{i=1}^n (x_i - \bar{x})^2}, \quad (\text{D3.3})$$

$$\text{Variance:} \quad \sigma^2 = \frac{1}{n} \sum_{i=1}^n (x_i - \bar{x})^2, \quad (\text{D3.4})$$

Spearman's rank correlation coefficient:

$$\rho = 1 - \frac{6 \sum_{i=1}^n (x_{ij} - x_{ik})^2}{n(n^2 - 1)} = 1 - \frac{6 \sum_{i=1}^n d_i^2}{n(n^2 - 1)}, \quad (\text{D3.5})$$

where:

x_{ij} – rank (importance) assigned to the i -th object by the j -th expert,

x_{ik} – rank assigned to the i -th object by the k -th expert,

d_i – difference between the ranks assigned to the i -th object.

The Spearman's rank correlation coefficient (value ρ) can range from -1 to $+1$. When the experts' opinions (expert assessments) coincide completely, Spearman's coefficient is equal to one. At the maximum inconsistency of the experts' opinions this coefficient takes a value of minus 1.

Also exists the Kendall Rank Correlation Coefficient.³⁵⁰ As Jeremy M. G. Taylor describes: Kendall's tau is commonly used nonparametric method of detecting associations between two variables. Its use is usually restricted to a single block.³⁵¹ The Kendall rank correlation coefficient evaluates the degree of similarity between two sets of ranks given to a same set of objects. This coefficient depends upon the number of inversions of pairs of objects which would be needed to transform one rank order into the other.³⁵²

In general, Kendall Rank Correlation Coefficient is more robust and efficient than Spearman's Rank correlation coefficient, so usage of Kendall correlation is more preferred when there are small samples or samples may contain outliers. The interpretation of Kendall's tau in terms of the probabilities of observing the agreeable (concordant) and non-agreeable (discordant) pairs is straightforward.

There are also various methods of processing ranking results to determine the significance of variables and subsequent operations on them. Among the many systems for determining the winner in voting, for example, the Schulze method³⁵³ is well known. When it is used in the ballots, the interviewees indicate their preferences concerning the candidates, ranking them, (including a strict ranking is possible). The result is a list in which the candidates are ranked in decreasing order of importance (rating).

³⁵⁰ Kendall, M. 1948 (1975). *Rank correlation methods*. London: Published by C. Griffin, 202.

³⁵¹ Taylor, J. 1987. Kendall's and Spearman's Correlation Coefficients in the Presence of a Blocking Variable. *Biometrics*. 43(2), 409–416.

³⁵² Abdi, H., Williams, L. J., and Valentin, D. 2013. Multiple factor analysis: Principal component analysis for multitable and multiblock data sets. *Wiley Interdisciplinary Reviews: Computational Statistics*. 5(2), 149–179.

³⁵³ Schulze, M. 2018. *The Schulze Method of Voting*. Eprint arXiv:1804.02973. <https://arxiv.org/abs/1804.02973>.

Kendall's Concordance Coefficient W is used to determine the consistency of expert opinion in a given sample. It can take values in the range from 0 to 1. In case of complete agreement of experts' opinions, the concordance coefficient is equal to one, in case of complete disagreement – to zero.

There are also other methods for processing expert opinions. The author used Kendall's concordance coefficient when processing the results of expert surveys (Section 4.5).

Tax system as a composite system: quantum approach visualisation

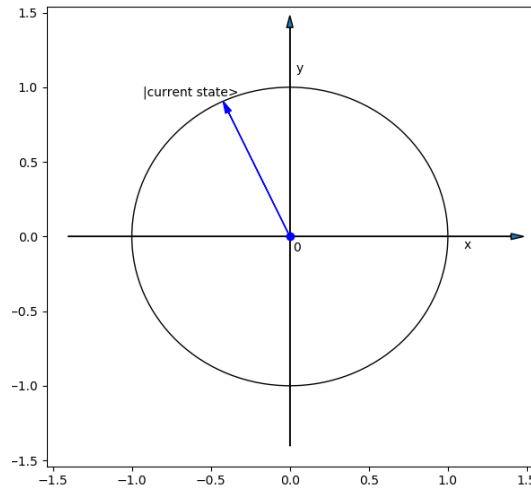


Figure E3.1 Current state of an element of quantum system representation

Source: created by the author.

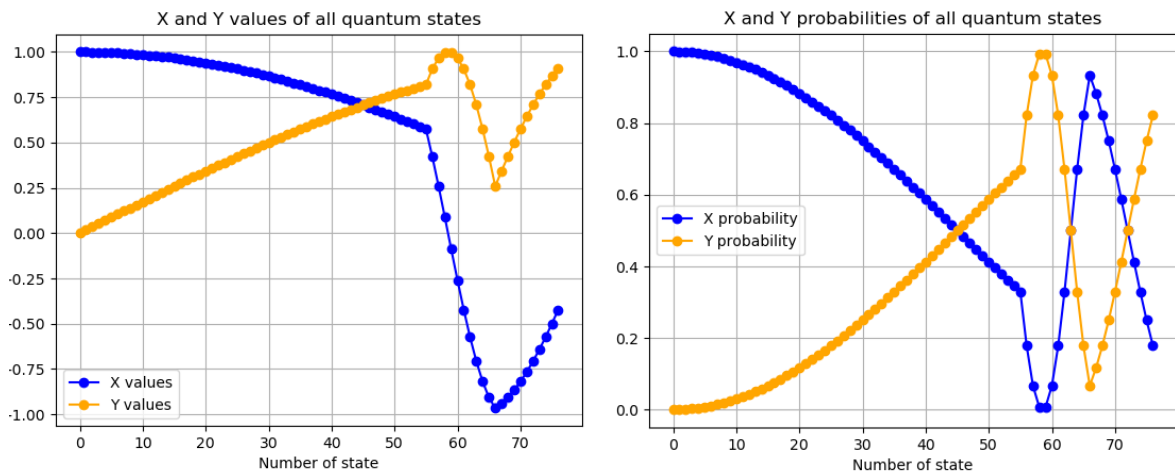


Figure E3.1 Analysis of changes of single element in quantum system (state and probability)

Source: created by the author.

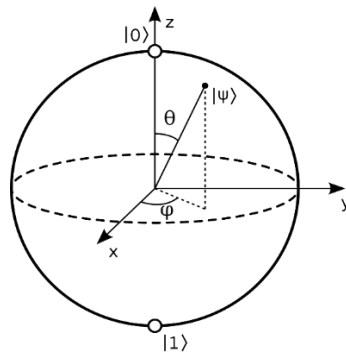


Figure E3.3 Bloch sphere

Source: Kockum, A. and Nori, F. 2019. Quantum Bits with Josephson Junctions. In book: *Fundamentals and Frontiers of the Josephson Effect*, ResearchGate. 9(17), 703–741.

Time series analysis mathematical apparatus

$$Y_t = \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \dots + \phi_p Y_{t-p} + \varepsilon_t \quad (\text{A4.10})$$

$$Z_t = \log Y_t - \log Y_{t-1} \quad (\text{A4.11})$$

$$Y_t = \mu + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \dots + \theta_q \varepsilon_{t-q} \quad (\text{A4.12})$$

where:

μ – is the mean of the time series.

ε_t – are the residual errors in the series.

θ_q – are the weights for the lagged residual errors.

q – is the size of the moving average window.

$$\varphi_p(L)\tilde{\phi}_p(L^S)\Delta^d\Delta_S^D u_t = A(t) + \theta_q(L)\tilde{\theta}_q(L^S)\zeta_t, \quad (\text{A4.13})$$

where:

φ_p – is the regular AR part;

$\tilde{\phi}_p$ – is the seasonal AR part;

θ_q – is the regular MA part;

$\tilde{\theta}_q$ – is the seasonal MA part;

d – is the regular order of integration;

D – is the seasonal order of integration;

S – is the coefficient of seasonality.

Kendall's concordance W mathematical apparatus

In order to find out a Kendall's concordance W a following procedure is required. Firstly, the sum of the ranks by the following expression (A4.14) is determined:

$$x^j = \sum_{i=1}^m x_{ij} \quad , \quad j = \overline{1, n} \quad (\text{A4.14})$$

where:

m – number of experts;

n – number of elements in the ranking.

Since only strict ranking was allowed in the survey, the average value of the sum of ranks \bar{x} was determined by the formula:

$$\bar{x} = \frac{1}{n} \sum_{i=1}^m \sum_{j=1}^n x_{ij} = \frac{m(n+1)}{2} \quad (\text{A4.15})$$

The sum of the squares of the deviations x^j from the mean value \bar{x} was calculated by the formula:

$$S_w = \sum_{j=1}^n (x^j - \bar{x})^2 \quad (\text{A4.16})$$

For strict ranking, the sum of the squares of their deviations from the mean $\bar{x} = 0,5m(n + 1)$ will be:

$$S = \sum_{j=1}^n \left(jm - \frac{m(n+1)}{2} \right)^2 = \frac{1}{12} m^2 n (n^2 - 1) \quad (\text{A4.17})$$

The concordance coefficient is determined by the formula:

$$W = \frac{S_w}{S} \quad (\text{A4.18})$$

Tax system reliability assessment pattern

Table A5.1

Criteria for qualitative assessment of the tax system reliability

No.	Criterion	Points
I Taxpayer reaction		
1	Changes that provide for taxpayers to forecast their income, in situations where they cannot reliably make such a forecast	6
2	After the introduction of changes, taxpayers have unsolvable problems with the filing of declarations and reports at the fault of the SRS	6
3	Changes in tax system requiring changes in the number of employees of enterprises	5
4	Taxpayers are dissatisfied with the changes, as evidenced by petitions that have collected more than 10,000 signatures	4
5	Changes affecting the structure of enterprises	4
6	After the introduction of changes, taxpayers have problems with understanding the changes	2
II Additional changes in the tax law		
1	Additional changes not previously enacted are made within less than 30 days of the introduction of the tax reform	7
2	Additional changes not previously enacted are made within less than 6 months of the introduction of the tax reform	6
3	Additional changes not previously enacted are made within less than 12 months of the introduction of the tax reform	5
4	Additional changes not previously enacted are made within less than 18 months of the introduction of the tax reform	4
5	Additional changes not previously enacted are made within less than 24 months of the introduction of the tax reform	3
6	Additional changes not previously enacted are made within less than 30 months of the introduction of the tax reform	2
7	Additional changes not previously enacted are made within less than 36 months of the introduction of the tax reform	1
III Recommendations, reports, and requirements of EU structures		
1	Competent authorities of the country and/or the EU recognised the measures introduced as completely ineffective	7
2	Competent authorities of the country and/or the EU recognised the measures introduced as partially ineffective	3
IV Requirements (recommendations) of the country's leadership for change		
1	Requirements (recommendations) of the country's leadership for changes (improvement) of the tax system after the introduction of the next changes, after no more than 6 months, in cases not related to the occurrence of force majeure	5
2	Requirements (recommendations) of the country's leadership for changes (improvement) of the tax system after the introduction of the next changes, after no more than 12 months, in cases not related to the occurrence of force majeure	4
V Impact on budget revenues		
1	Collection of funds in the budget is less than planned not more than 20 %	7
2	Collection of funds in the budget is less than planned not more than 10 %	6
3	Collection of funds in the budget is less than planned not more than 5 %	4
4	Collection of funds in the budget is less than planned not more than 2.5 %	2
5	Collection of funds in the budget is less than planned not more than 1 %	1

Source: created by the author.

Comprehensive assessment of the tax system's reliability

Degree of reliability	Number of points
High	Up to and including 10
Medium	11 to 30
Low	Over 30

Source: created by the author.

Time series analysis of taxes in Latvia and their aggregations



Figure A6.1 Monthly PVN collections in Latvia in 2016–2020

Source: created by the author based on the SRS data.

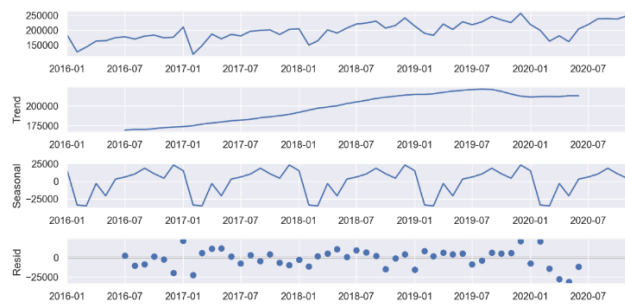


Figure A6.2 Seasonal decomposition of PVN time series

Source: created by the author.

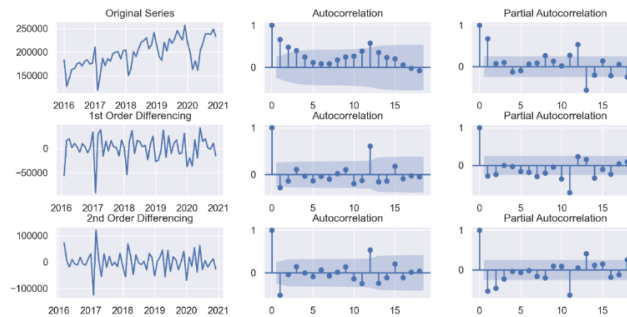


Figure A6.3 ACF and PACF plot of original and differentiated PVN time series

Source: created by the author.

Table A6.1

ADF and KPSS stationarity tests for VAT time series

Time series	ADF Statistic (p-value)	KPSS Statistic (p-value)	Stationarity
Original series	0.32	0.02284	Non-stationary time series
First order differencing	0.02115	0.1	Stationary time series
Second order differencing	2.43947e-10	0.09530	Stationary time series

Source: created by the author.

ARIMA Model Results

Dep. Variable:	D.PVN (fakt, men)	No. Observations:	59
Model:	ARIMA(1, 1, 1)	Log Likelihood	-672.064
Method:	css-mle	S.D. of innovations	20861.174
Date:	Sun, 17 Oct 2021	AIC	1352.127
Time:	18:48:57	BIC	1360.437
Sample:	02-01-2016	HQIC	1355.371
	- 12-01-2020		

	coef	std err	z	P> z	[0.025	0.975]
const	1159.3453	264.404	4.385	0.000	641.123	1677.568
ar.L1.D.PVN (fakt, men)	0.4333	0.120	3.596	0.000	0.197	0.669
ma.L1.D.PVN (fakt, men)	-0.9985	0.048	-20.833	0.000	-1.092	-0.905

Roots

	Real	Imaginary	Modulus	Frequency
AR.1	2.3081	+0.0000j	2.3081	0.0000
MA.1	1.0015	+0.0000j	1.0015	0.0000

Figure A6.4 ARIMA model for PVN time series

Source: created by the author.

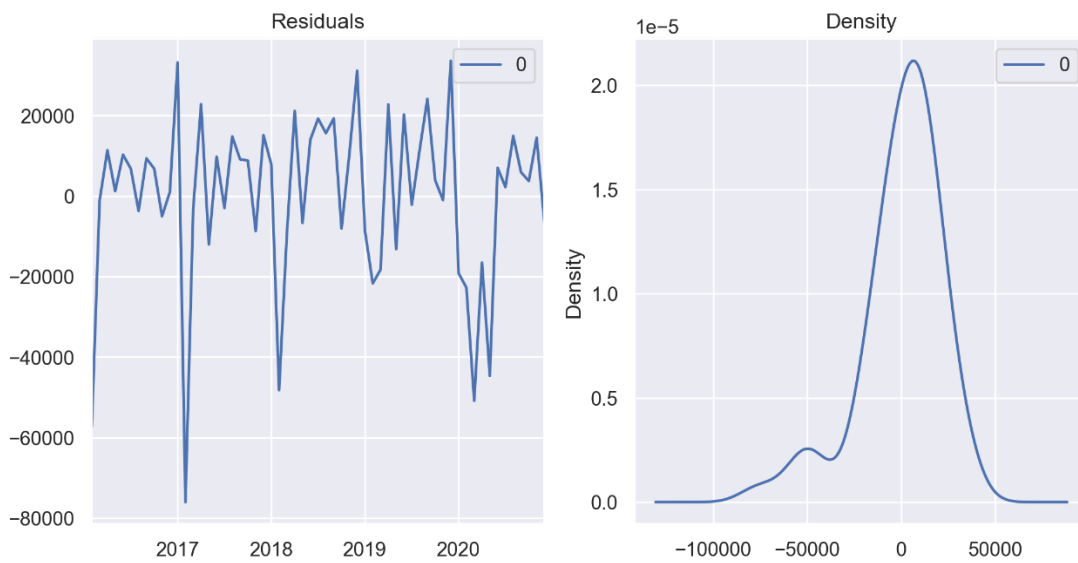


Figure A6.5 Residuals and density plots for PVN time series

Source: created by the author.

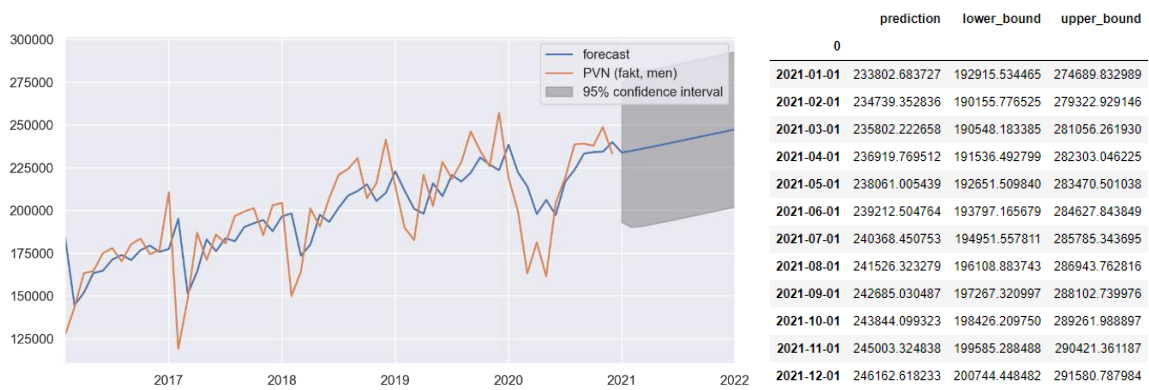


Figure A6.6 ARIMA model prediction for PVN time series for next 12 months

Source: created by the author.

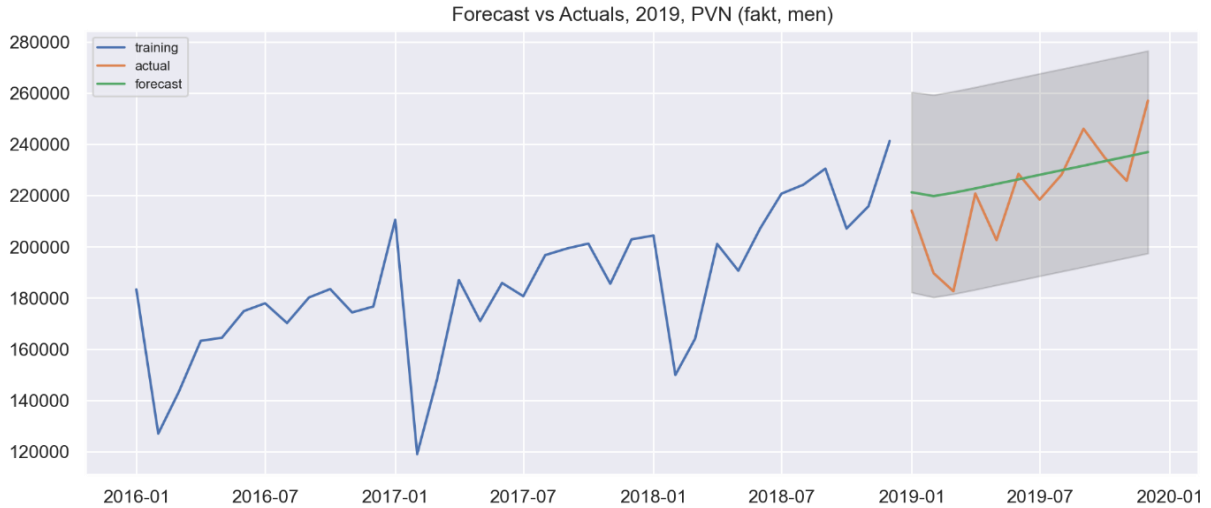


Figure A6.7 ARIMA model prediction for PVN time series for 2019

Source: created by the author.

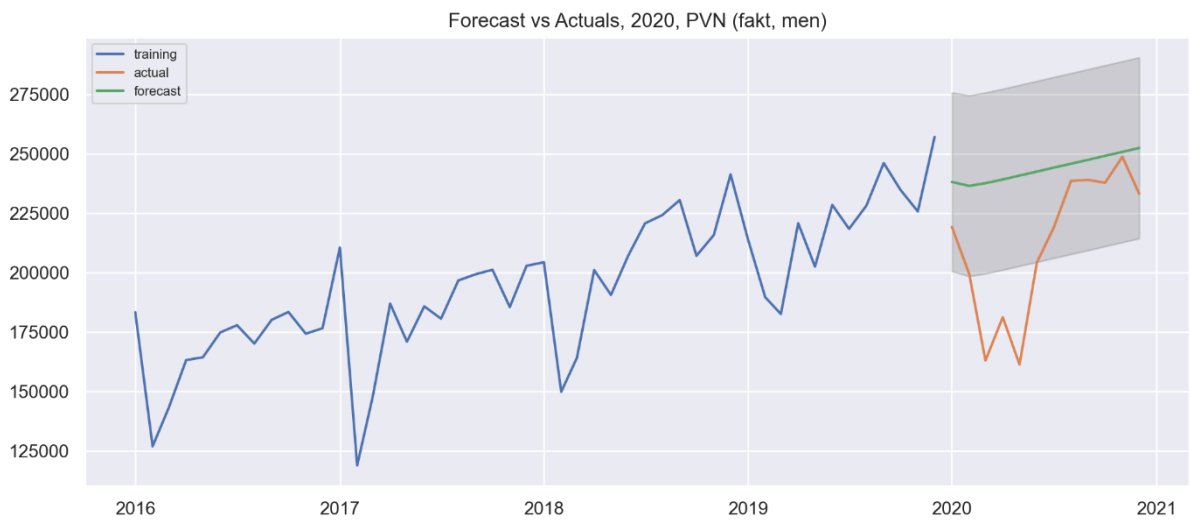


Figure A6.8 ARIMA model prediction for PVN time series for 2020

Source: created by the author.

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=====
SARIMAX Results
=====
Dep. Variable:          y          No. Observations:      60
Model:                 SARIMAX(0, 1, 0)x(1, 1, 0, 12)  Log Likelihood         -527.570
Date:                  Sun, 17 Oct 2021                AIC                   1059.141
Time:                  20:13:54                       BIC                   1062.841
Sample:                0                             HQIC                  1060.533
Covariance Type:      opg
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
ar.S.L12      0.1677      0.115      1.458    0.145    -0.058    0.393
sigma2        3.519e+08    5.12e-11    6.87e+18    0.000    3.52e+08    3.52e+08
=====
Ljung-Box (L1) (Q):          5.21    Jarque-Bera (JB):          0.17
Prob(Q):                     0.02    Prob(JB):                  0.92
Heteroskedasticity (H):      1.38    Skew:                      -0.10
Prob(H) (two-sided):         0.53    Kurtosis:                  2.79
=====

```

Figure A6.9 SARIMA model for PVN time series

Source: created by the author.

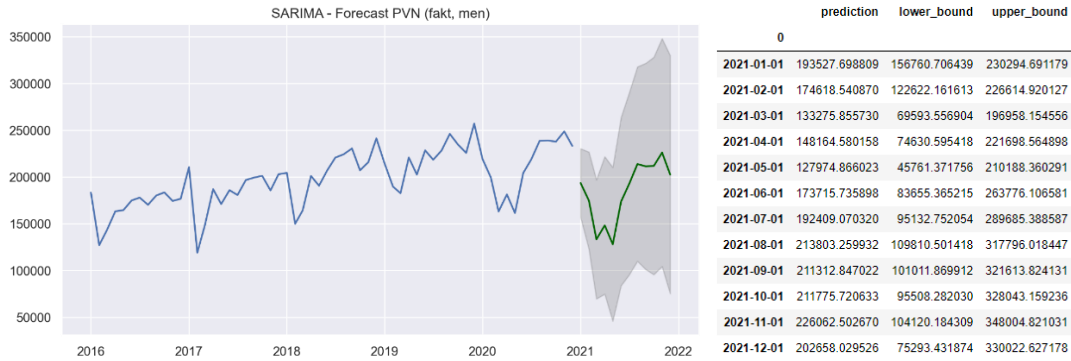


Figure A6.10 SARIMA model prediction for PVN time series for next 12 months

Source: created by the author.

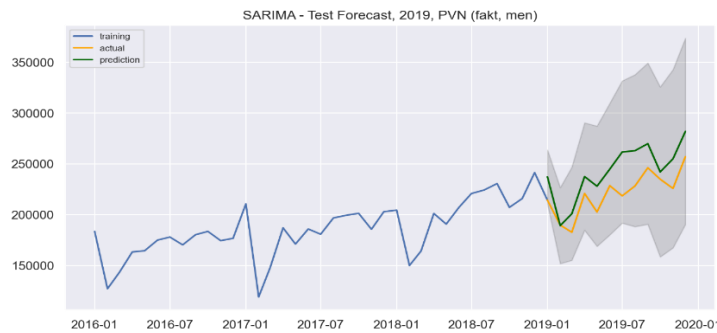


Figure A6.11 SARIMA model prediction for PVN time series for 2019

Source: created by the author.

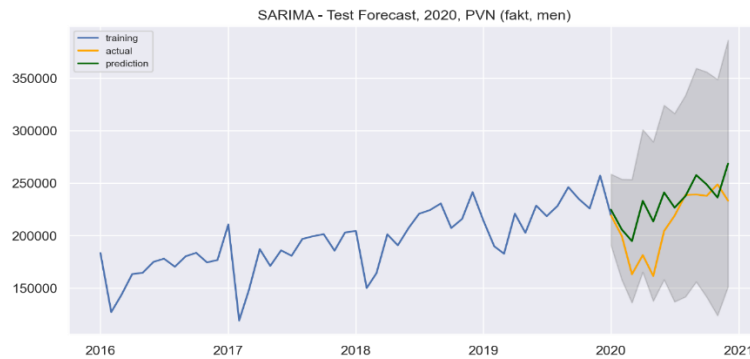


Figure A6.12 SARIMA model prediction for PVN time series for 2020

Source: created by the author.

```

=====
SARIMAX Results
=====
Dep. Variable:          PVN (fakt, men)      No. Observations:      60
Model:                 SARIMAX(0, 1, 1)x(0, 2, 1, 12)  Log Likelihood         -393.725
Date:                  Sun, 17 Oct 2021          AIC                    793.450
Time:                  21:57:03                 BIC                    798.116
Sample:                01-01-2016              HQIC                   795.060
Covariance Type:      opg
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
ma.L1         -0.8930         0.092      -9.716      0.000      -1.073      -0.713
ma.S.L12      -0.5705         0.396      -1.442      0.149      -1.346      0.205
sigma2        4.691e+08      3.05e-10      1.54e+18      0.000      4.69e+08      4.69e+08
=====
Ljung-Box (L1) (Q):          1.99      Jarque-Bera (JB):          0.26
Prob(Q):                     0.16      Prob(JB):                  0.88
Heteroskedasticity (H):     2.83      Skew:                      -0.13
Prob(H) (two-sided):        0.08      Kurtosis:                  2.66
=====
    
```

Figure A6.13 SARIMA model (semi-auto) for PVN time series

Source: created by the author.

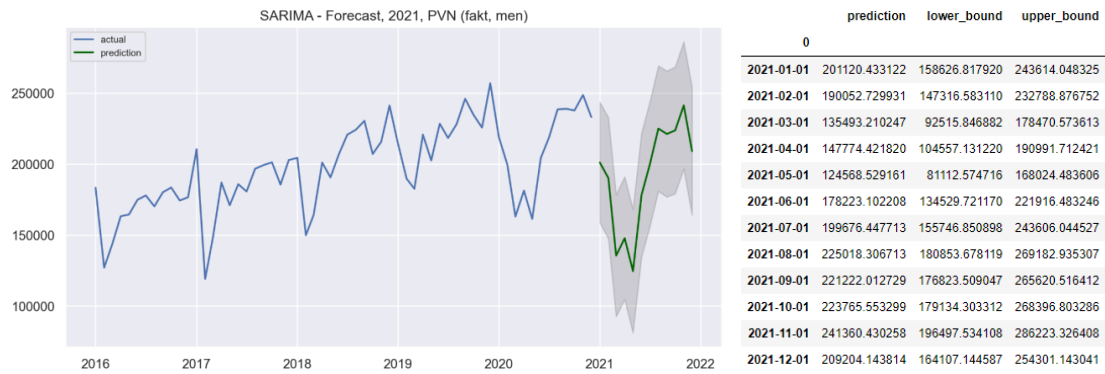


Figure A6.14 SARIMA model (semi-auto) prediction for PVN time series for next 12 months

Source: created by the author.

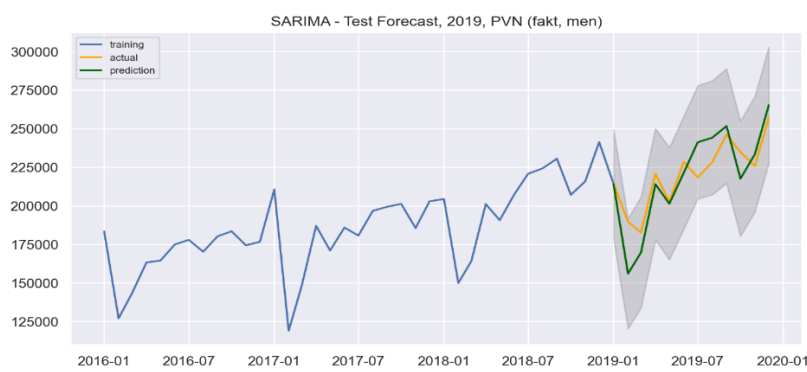


Figure A6.15 SARIMA model (semi-auto) prediction for PVN time series for 2019

Source: created by the author.

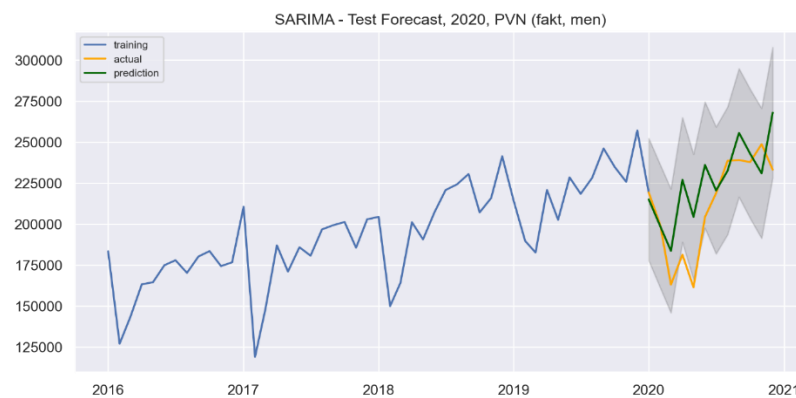


Figure A6.16 SARIMA model (semi-auto) prediction for PVN time series for 2020

Source: created by the author.

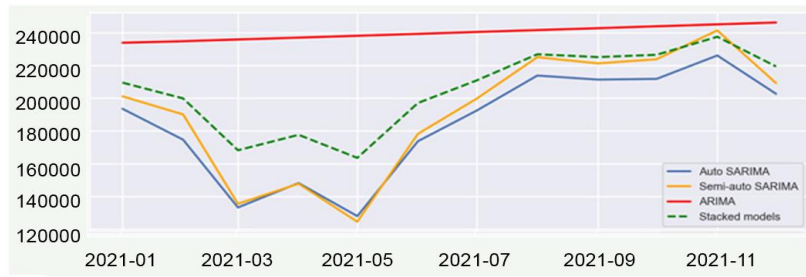


Figure A6.17 ARIMA, SARIMA, semi-auto SARIMA and stacked model comparison for PVN time series

Source: created by the author.

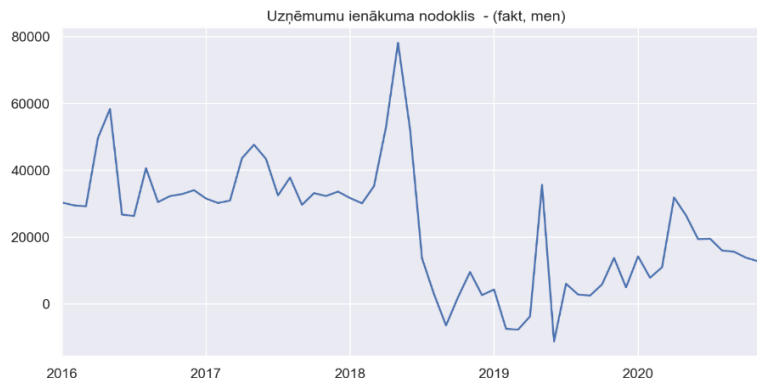


Figure A6.18 Monthly UIN collections in Latvia in 2016–2020

Source: created by the author based on the SRS data.

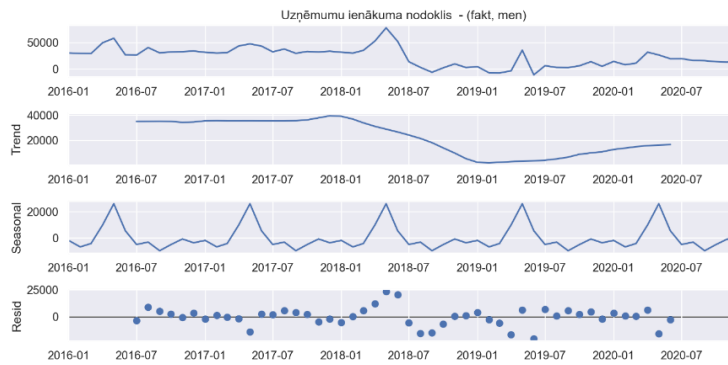


Figure A6.19 Seasonal decomposition of UIN time series

Source: created by the author.

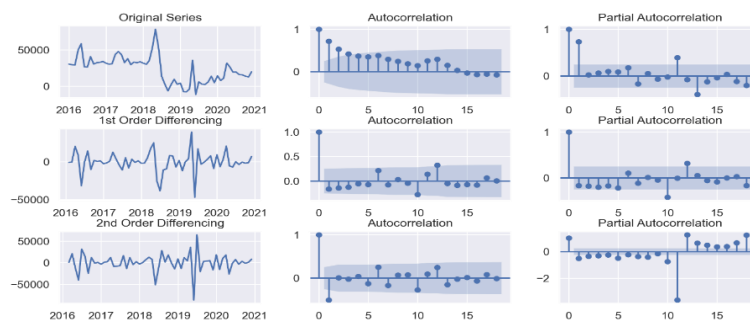


Figure A6.20 ACF and PACF plot of original and differentiated UIN time series

Source: created by the author.

ADF and KPSS stationarity tests for UIN time series

Time series	ADF Statistic (p-value)	KPSS Statistic (p-value)	Stationarity
Original series	0.03067	0.08012	Stationary time series
First order differencing	1.88377e-14	0.1	Stationary time series
Second order differencing	3.69094e-05	0.1	Stationary time series

Source: created by the author.

```

=====
SARIMAX Results
=====
Dep. Variable:          y          No. Observations:          60
Model:                 SARIMAX(0, 1, 0)  Log Likelihood             -645.152
Date:                 Wed, 22 Sep 2021  AIC                        1292.305
Time:                 14:53:42         BIC                        1294.382
Sample:               0                HQIC                       1293.116
Covariance Type:      opg
=====
              coef  std err      z      P>|z|    [0.025    0.975]
-----
sigma2      1.811e+08  2.06e+07  8.776   0.000   1.41e+08  2.22e+08
=====
Ljung-Box (L1) (Q):          1.68   Jarque-Bera (JB):          26.73
Prob(Q):                    0.19   Prob(JB):                  0.00
Heteroskedasticity (H):     2.22   Skew:                      -0.67
Prob(H) (two-sided):        0.08   Kurtosis:                  6.01
=====
    
```

Figure A6.21 ARIMA model for UIN time series

Source: created by the author.

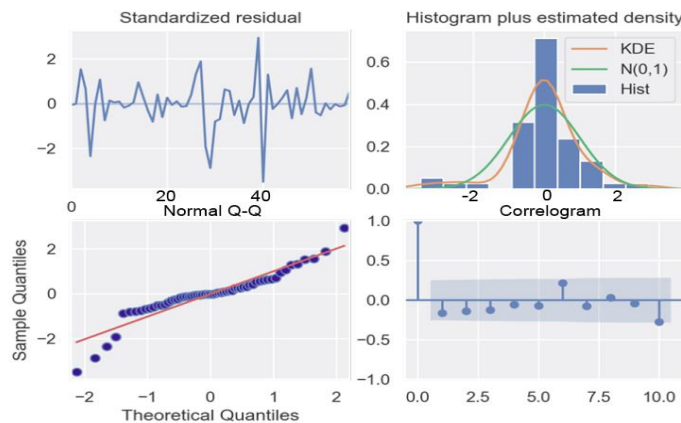


Figure A6.22 Residuals and density plots for UIN time series

Source: created by the author.

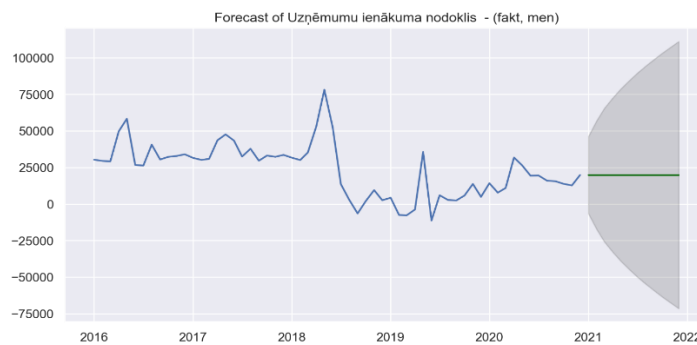


Figure A6.23 ARIMA model prediction for UIN time series for next 12 months

Source: created by the author.

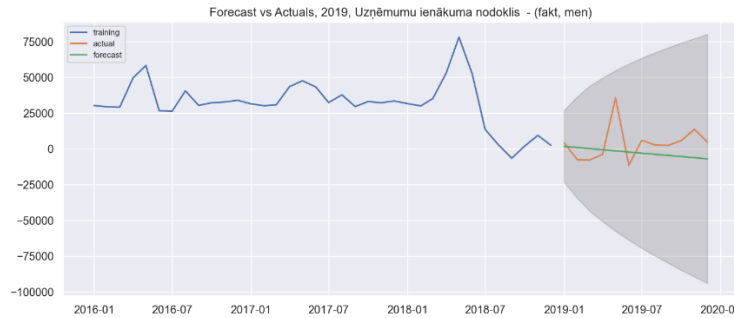


Figure A6.24 ARIMA model prediction for UIN time series for 2019

Source: created by the author.

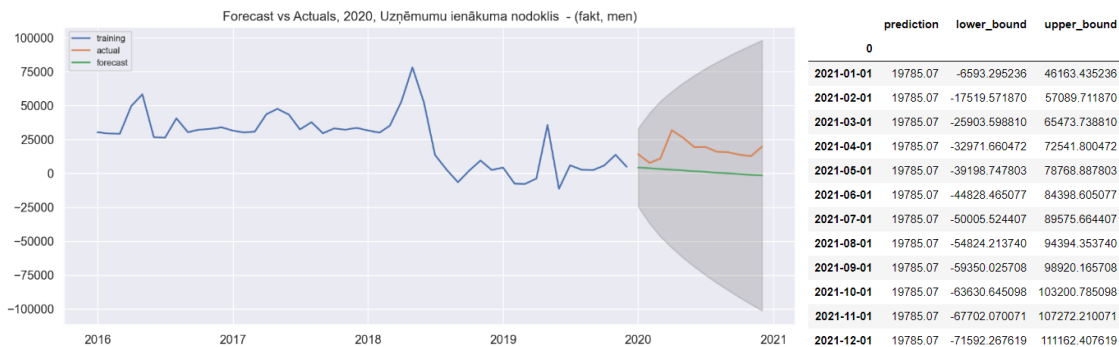


Figure A6.25 ARIMA model prediction for UIN time series for 2020

Source: created by the author.

```

=====
SARIMAX Results
=====
Dep. Variable:          y          No. Observations:          60
Model:                SARIMAX(1, 1, 0)x(0, 1, [1], 12)  Log Likelihood             -511.329
Date:                 Wed, 22 Sep 2021                AIC                       1028.659
Time:                 14:53:52                       BIC                       1034.209
Sample:               0                               HQIC                      1030.747
Covariance Type:     opg
=====
              coef    std err          z      P>|z|    [0.025    0.975]
-----
ar.L1         -0.2879    0.163       -1.770    0.077    -0.607    0.031
ma.S.L12      -0.7168    0.224       -3.201    0.001    -1.156    -0.278
sigma2        2.34e+08    4.06e-10    5.76e+17    0.000    2.34e+08    2.34e+08
=====
Ljung-Box (L1) (Q):           0.00    Jarque-Bera (JB):           5.61
Prob(Q):                     0.99    Prob(JB):                   0.06
Heteroskedasticity (H):       1.24    Skew:                       -0.47
Prob(H) (two-sided):          0.67    Kurtosis:                   4.40
=====
    
```

Figure A6.26 SARIMA model for UIN time series

Source: created by the author.

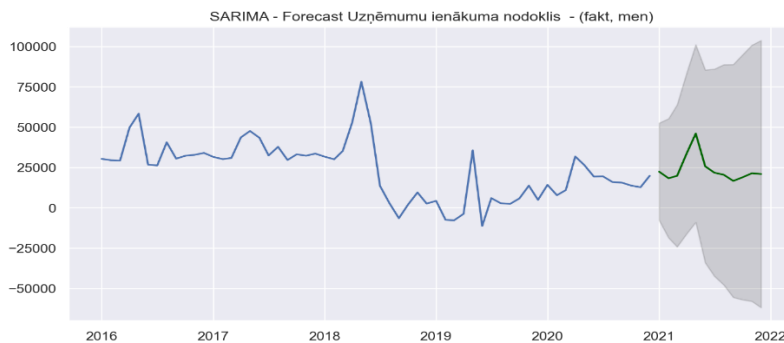


Figure A6.27 SARIMA model prediction for UIN time series for next 12 months

Source: created by the author.

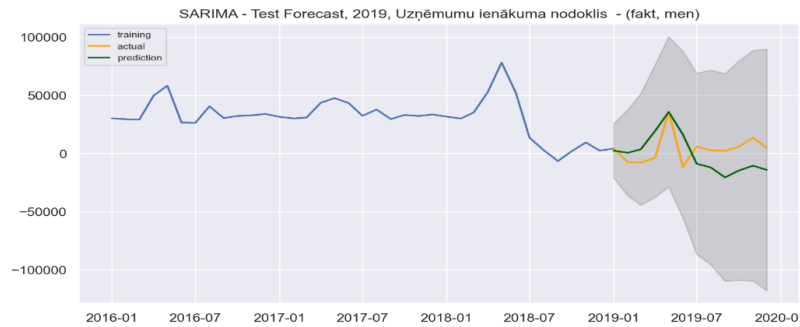


Figure A6.28 SARIMA model prediction for UIN time series for 2019

Source: created by the author.

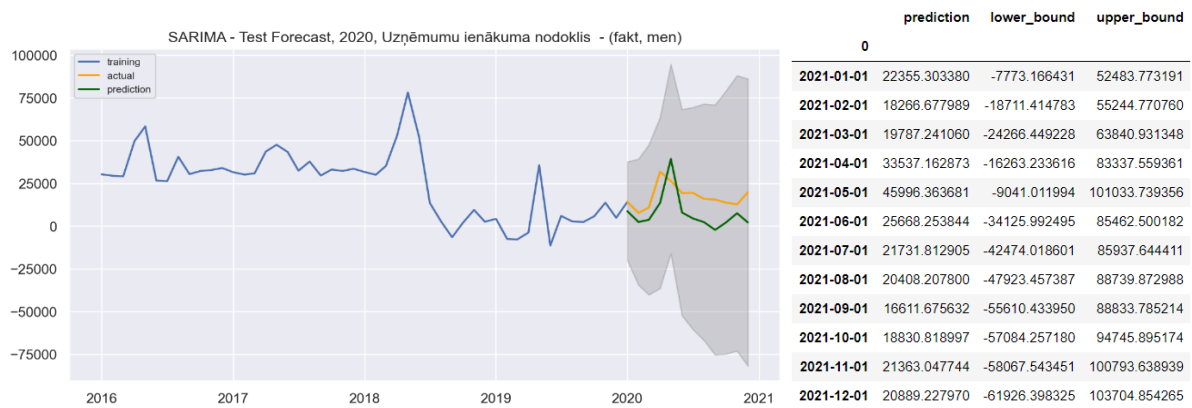


Figure A6.29 SARIMA model prediction for UIN time series for 2020

Source: created by the author.

```

=====
SARIMAX Results
=====
Dep. Variable:    Uzņēmumu ienākuma nodoklis - (fakt, men)    No. Observations:    60
Model:           SARIMAX(0, 1, 0)x(0, 1, [1], 12)          Log Likelihood       -509.461
Date:            Wed, 22 Sep 2021                          AIC                  1022.923
Time:           14:58:43                                    BIC                  1026.623
Sample:         01-01-2016                                HQIC                 1024.315
                - 12-01-2020
Covariance Type: opg
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
ma.S.L12     -0.9925     0.156     -6.370     0.000     -1.298     -0.687
sigma2       1.166e+08    1.35e-09    8.64e+16    0.000    1.17e+08    1.17e+08
=====
Ljung-Box (L1) (Q):           4.43    Jarque-Bera (JB):           4.90
Prob(Q):                      0.04    Prob(JB):                   0.09
Heteroskedasticity (H):       1.45    Skew:                       -0.14
Prob(H) (two-sided):          0.47    Kurtosis:                   4.56
=====
    
```

Figure A6.30 SARIMA model (semi-auto) for UIN time series

Source: created by the author.

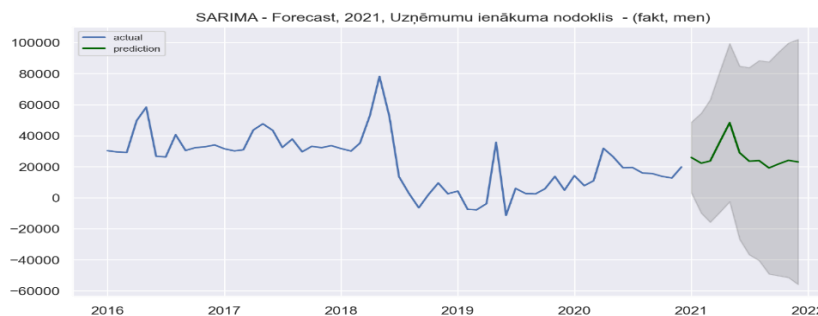


Figure A6.31 SARIMA model (semi-auto) prediction for UIN time series for next 12 months

Source: created by the author.

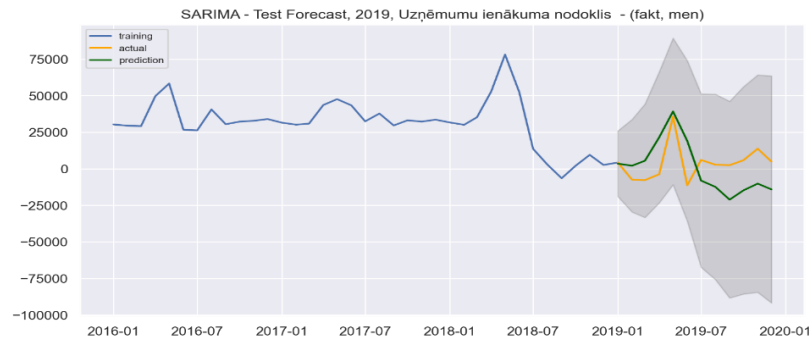


Figure A6.32 SARIMA model (semi-auto) prediction for UIN time series for 2019

Source: created by the author.

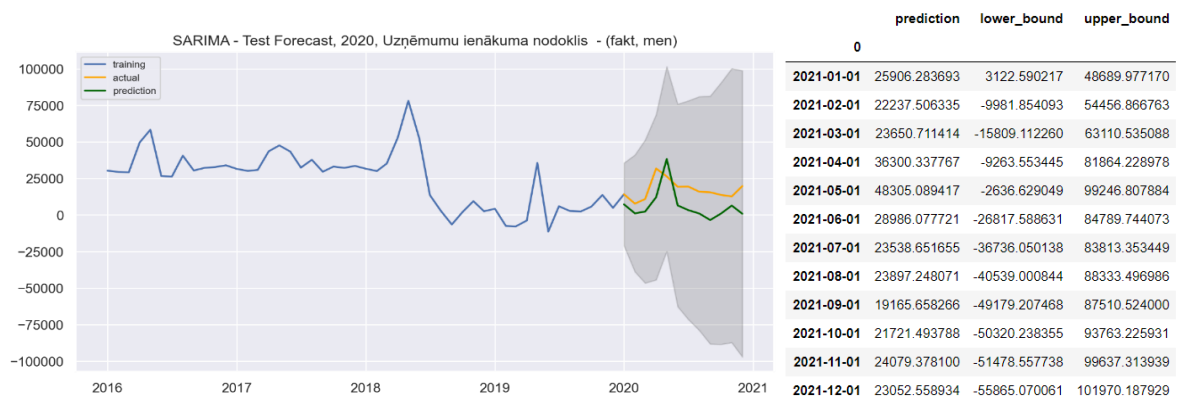


Figure A6.33 SARIMA model (semi-auto) prediction for UIN time series for 2020

Source: created by the author.

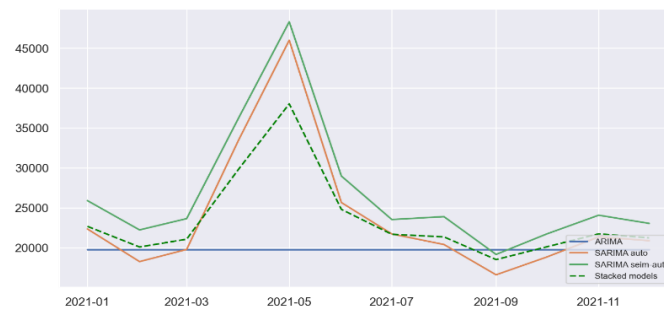


Figure A6.34 ARIMA, SARIMA, semi-auto SARIMA and stacked model comparison for UIN time series

Source: created by the author.

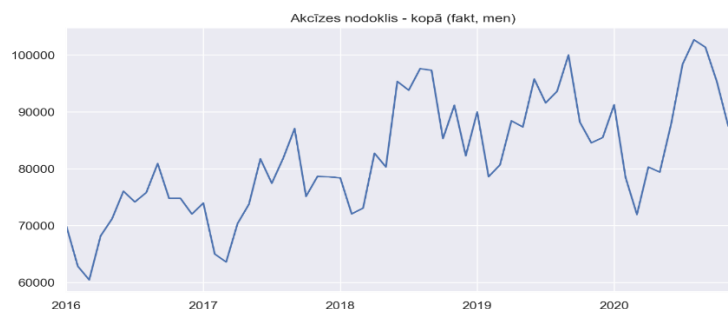


Figure A6.35 Monthly AN collections in Latvia in 2016–2020

Source: created by the author based on the SRS data.

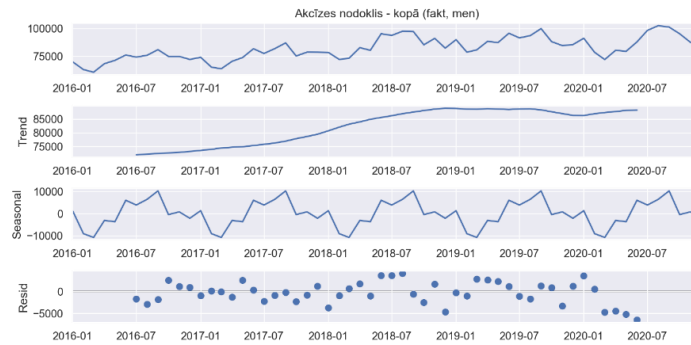


Figure A6.36 Seasonal decomposition of AN time series

Source: created by the author.

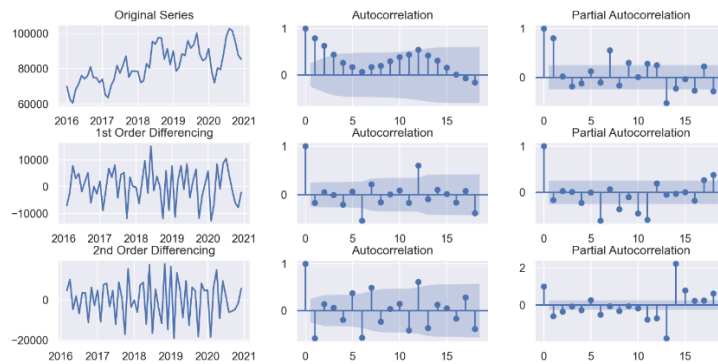


Figure A6.37 ACF and PACF plot of original and differentiated AN time series

Source: created by the author.

Table A6.3

ADF and KPSS stationarity tests for AN time series

Time series	ADF Statistic (p-value)	KPSS Statistic (p-value)	Stationarity
Original series	0.49396	0.0247	Non-stationary time series
First order differencing	0.06931	0.1	Non-stationary time series
Second order differencing	5.99994e-10	0.1	Stationary time series

Source: created by the author.

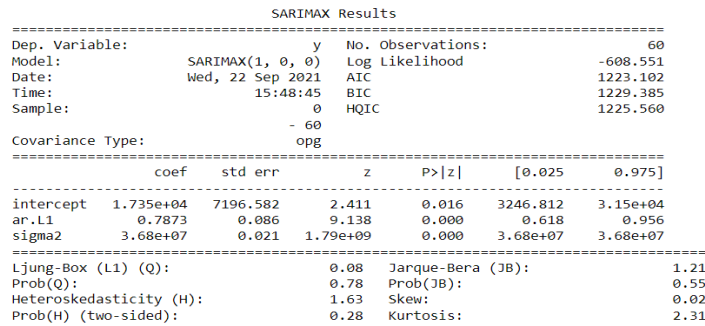


Figure A6.38. ARIMA model for AN time series

Source: created by the author.

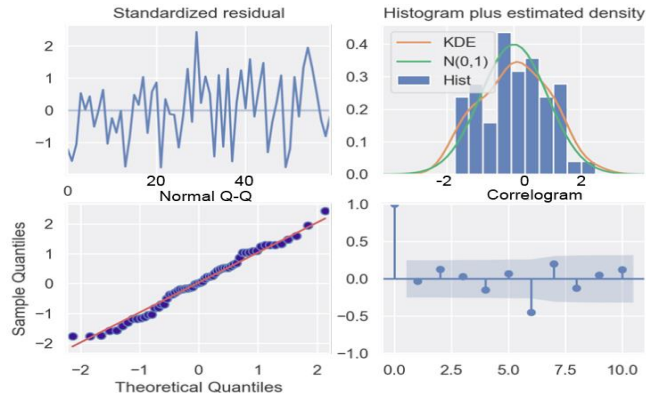


Figure A6.39 Residuals and density plots for AN time series

Source: created by the author.

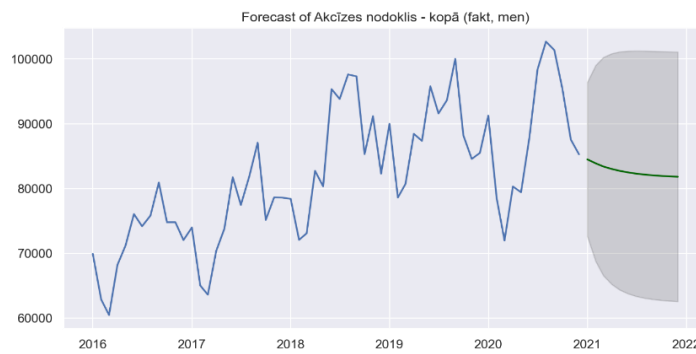


Figure A6.40 ARIMA model prediction for AN time series for next 12 months

Source: created by the author.

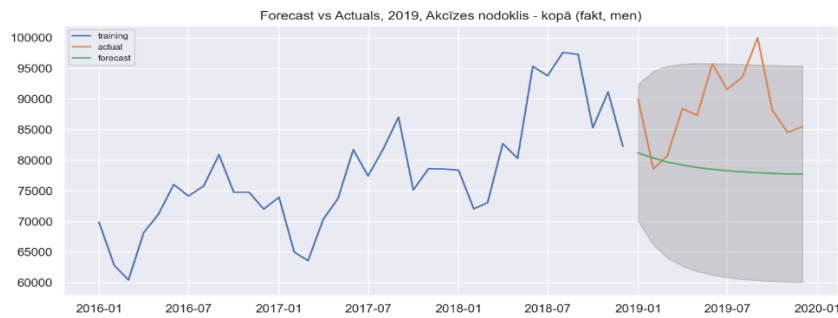


Figure A6.41 ARIMA model prediction for AN time series for 2019

Source: created by the author.

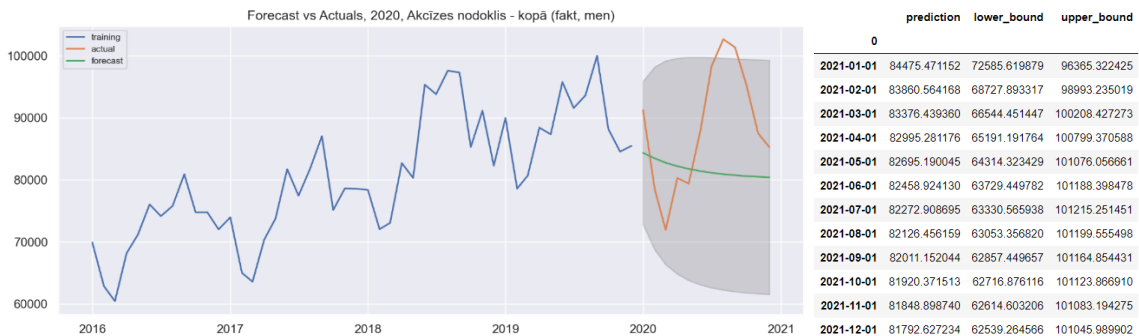


Figure A6.42 ARIMA model prediction for AN time series for 2020

Source: created by the author.

```

=====
SARIMAX Results
=====
Dep. Variable:          y                      No. Observations:      60
Model:                 SARIMAX(0, 1, 0)x(0, 1, [1, 2], 12)  Log Likelihood         -463.199
Date:                  Wed, 22 Sep 2021              AIC                    932.397
Time:                  15:50:23                     BIC                    937.948
Sample:                0                            HQIC                   934.486
Covariance Type:      opg
=====
              coef      std err      z      P>|z|      [0.025      0.975]
-----
ma.S.L12      -0.2212      0.168      -1.315      0.189      -0.551      0.109
ma.S.L24      -0.1742      0.152      -1.149      0.250      -0.471      0.123
sigma2        2.267e+07      3.39e-09      6.69e+15      0.000      2.27e+07      2.27e+07
=====
Ljung-Box (L1) (Q):      1.83      Jarque-Bera (JB):      4.40
Prob(Q):                0.18      Prob(JB):              0.11
Heteroskedasticity (H): 3.67      Skew:                  0.57
Prob(H) (two-sided):    0.01      Kurtosis:              3.97
=====

```

Figure A6.43 SARIMA model for AN time series

Source: created by the author.

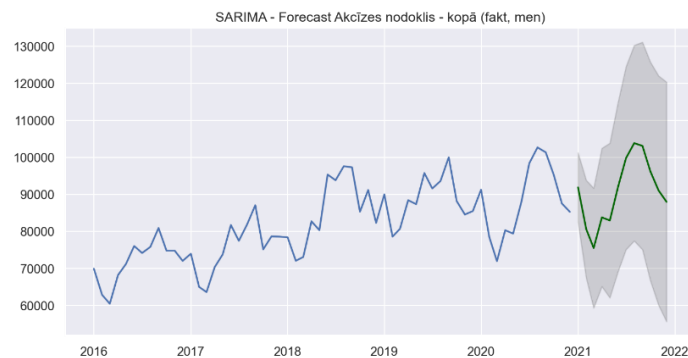


Figure A6.44 SARIMA model prediction for AN time series for next 12 months

Source: created by the author.

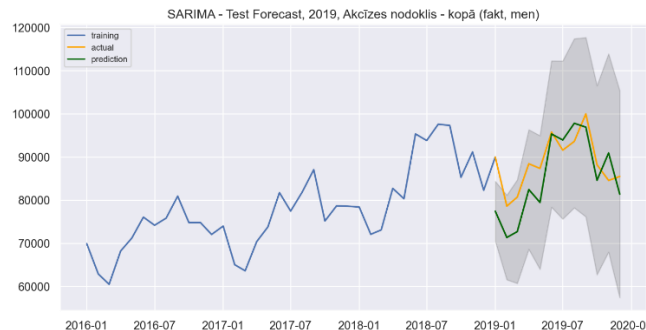


Figure A6.45 SARIMA model prediction for AN time series for 2019

Source: created by the author.

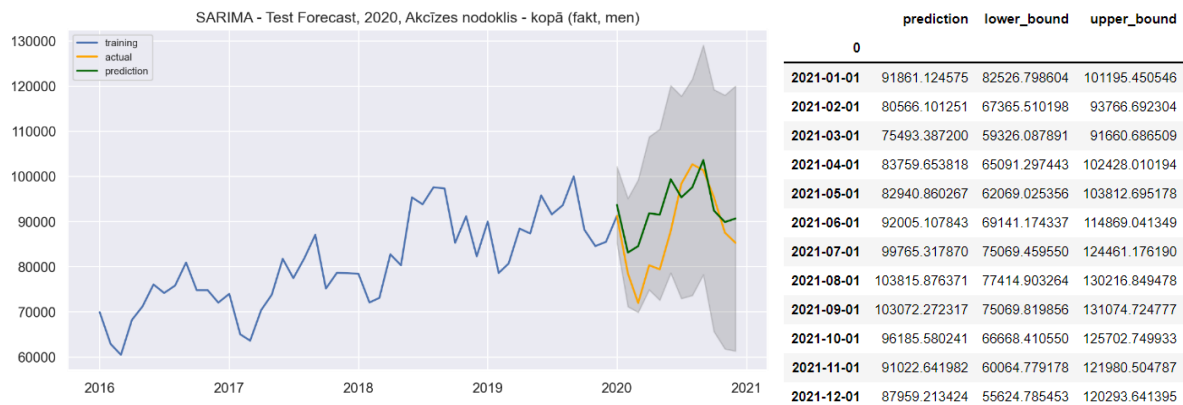


Figure A6.46 SARIMA model prediction for AN time series for 2020

Source: created by the author.

```

=====
SARIMAX Results
=====
Dep. Variable: Akcizes nodoklis - kopā (fakt, men) No. Observations: 60
Model: SARIMAX(0, 1, 0)x(2, 1, 0, 12) Log Likelihood: -463.587
Date: Wed, 22 Sep 2021 AIC: 933.174
Time: 15:54:20 BIC: 938.725
Sample: 01-01-2016 HQIC: 935.263
- 12-01-2020
Covariance Type: opg
=====
coef std err z P>|z| [0.025 0.975]
-----
ar.S.L12 -0.1467 0.159 -0.920 0.357 -0.459 0.166
ar.S.L24 -0.1343 0.169 -0.795 0.427 -0.466 0.197
sigma2 2.346e+07 1.69e-09 1.38e+16 0.000 2.35e+07 2.35e+07
=====
Ljung-Box (L1) (Q): 2.27 Jarque-Bera (JB): 4.40
Prob(Q): 0.13 Prob(JB): 0.11
Heteroskedasticity (H): 3.86 skew: 0.54
Prob(H) (two-sided): 0.01 Kurtosis: 4.03
=====

```

Figure A6.47 SARIMA model (semi-auto) for AN time series

Source: created by the author.

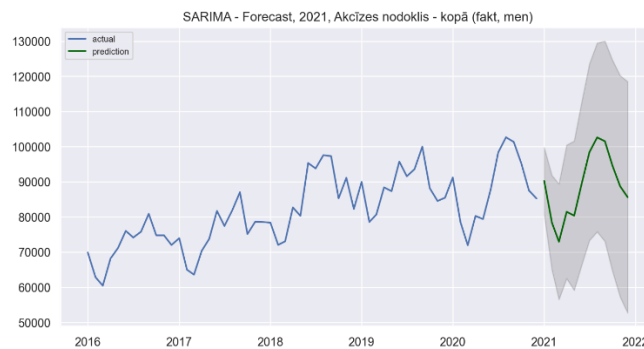


Figure A6.48 SARIMA model (semi-auto) prediction for AN time series for next 12 months

Source: created by the author.

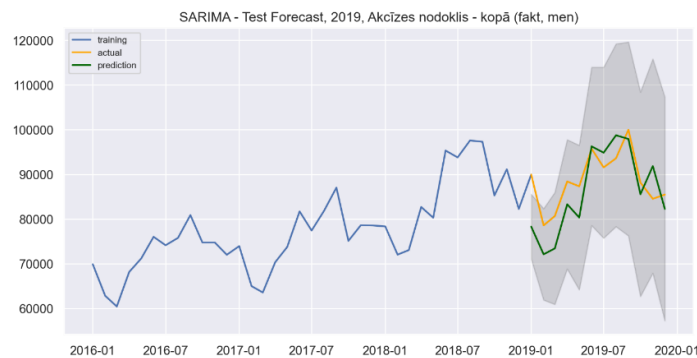


Figure A6.49 SARIMA model (semi-auto) prediction for AN time series for 2019

Source: created by the author.

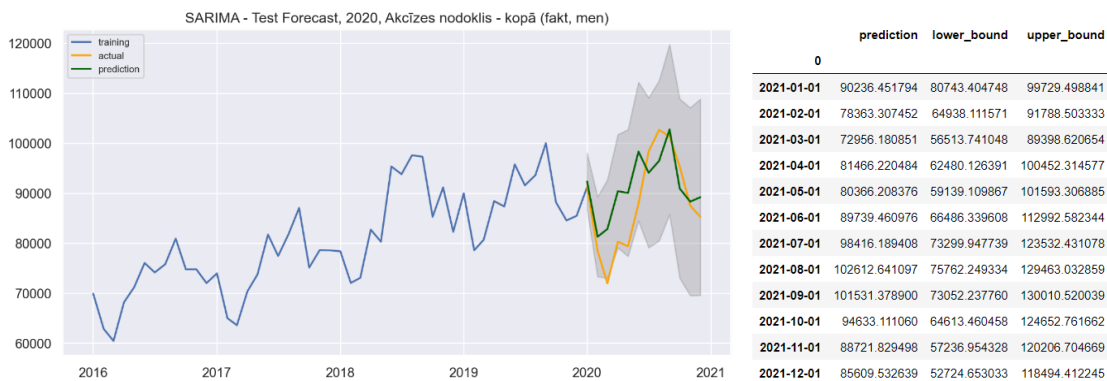


Figure A6.50 SARIMA model (semi-auto) prediction for AN time series for 2020

Source: created by the author.

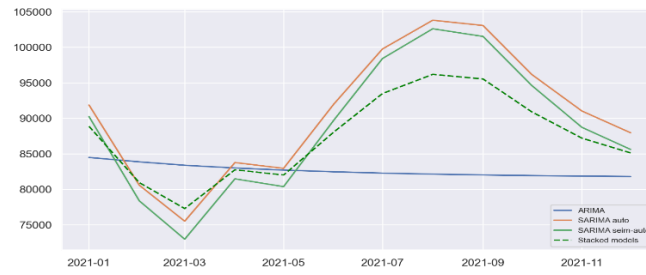


Figure A6.51 ARIMA, SARIMA, semi-auto SARIMA and stacked model comparison for AN time series

Source: created by the author.

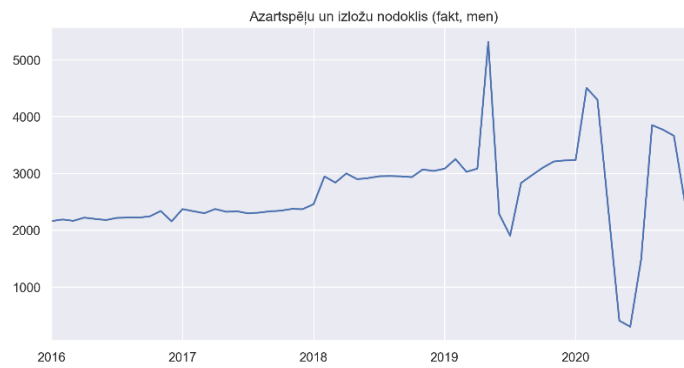


Figure A6.52 Monthly AIN collections in Latvia in 2016–2020

Source: created by the author based on the SRS data.

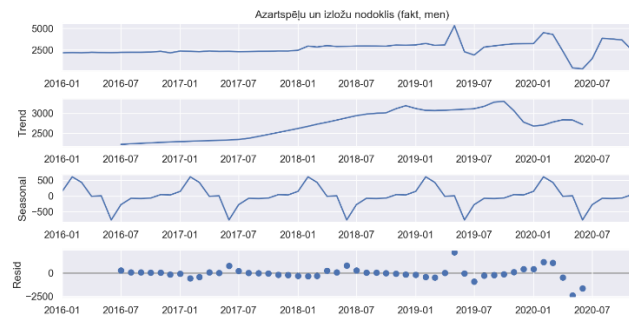


Figure A6.53 Seasonal decomposition of AIN time series

Source: created by the author.

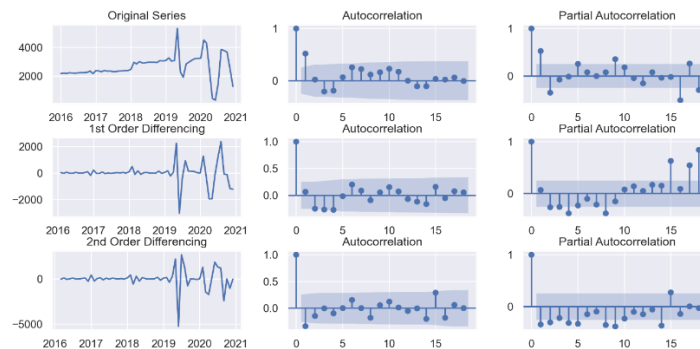


Figure A6.54 ACF and PACF plot of original and differentiated AIN time series

Source: created by the author.

ADF and KPSS stationarity tests for *A/N* time series

Time series	ADF Statistic (p-value)	KPSS Statistic (p-value)	Stationarity
Original series	1.24584e-05	0.1	Stationary time series
First order differencing	0.97178	0.1	Stationary time series
Second order differencing	9.93196e-06	0.1	Stationary time series

Source: created by the author.

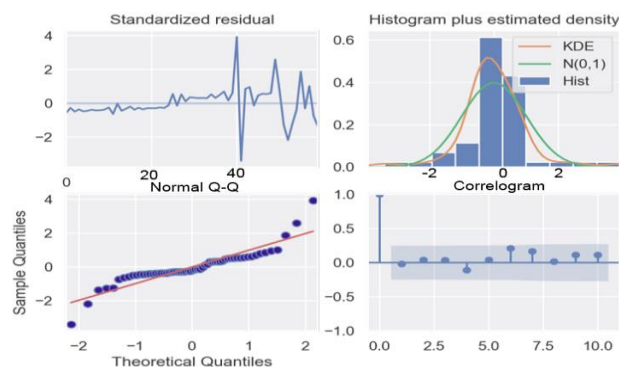
```

SARIMAX Results
-----
Dep. Variable:          y          No. Observations:          60
Model:                SARIMAX(2, 0, 0)  Log Likelihood:          -471.943
Date:                 Wed, 22 Sep 2021  AIC:                951.887
Time:                 18:02:41         BIC:                960.264
Sample:               0              HQIC:              955.164
Covariance Type:     opg
-----
coef    std err    z      P>|z|    [0.025    0.975]
-----
intercept  1671.5045   359.547    4.649    0.000    966.805   2376.204
ar.L1      0.7414     0.080     9.278    0.000    0.585    0.898
ar.L2     -0.3766     0.097    -3.867    0.000   -0.567   -0.186
sigma2     4.039e+05   4.67e+04   8.651    0.000   3.12e+05  4.95e+05
-----
Ljung-Box (L1) (Q):          0.02   Jarque-Bera (JB):          70.72
Prob(Q):                    0.89   Prob(JB):                  0.00
Heteroskedasticity (H):     16.94   Skew:                      0.54
Prob(H) (two-sided):        0.00   Kurtosis:                  8.21
-----

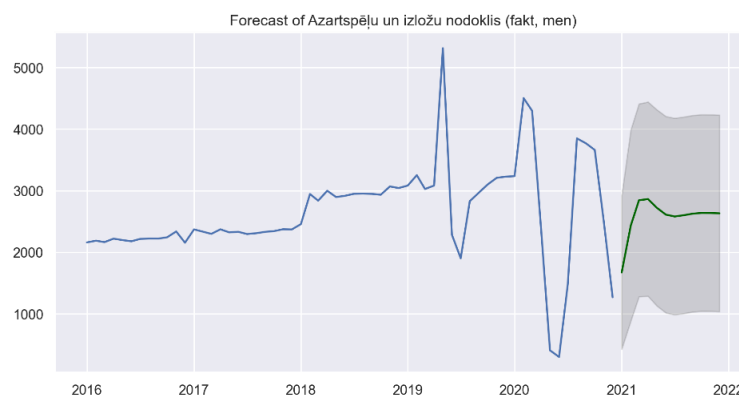
```

Figure A6.55 ARIMA model for *A/N* time series

Source: created by the author.

Figure A6.56 Residuals and density plots for *A/N* time series

Source: created by the author.

Figure A6.57 ARIMA model prediction for *A/N* time series for next 12 months

Source: created by the author.

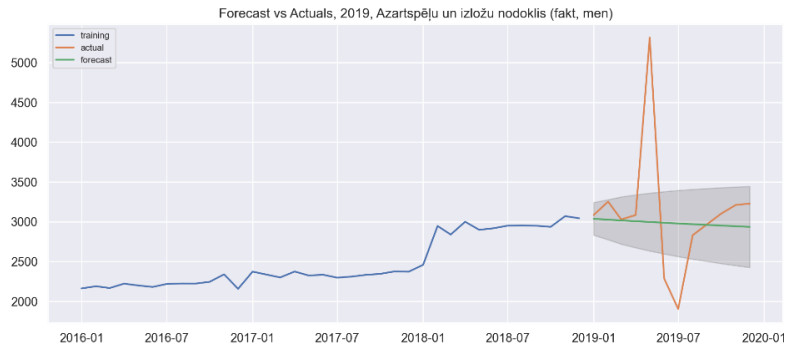


Figure A6.58 ARIMA model prediction for AIN time series for 2019

Source: created by the author.

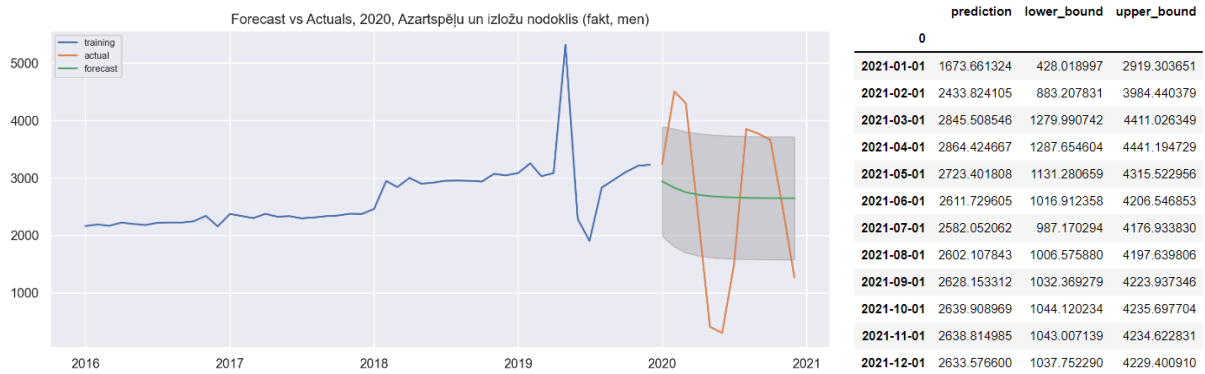


Figure A6.59 ARIMA model prediction for AIN time series for 2020

Source: created by the author.

```

=====
SARIMAX Results
=====
Dep. Variable:          y                No. Observations:          60
Model:                 SARIMAX(2, 0, 0)x(0, 1, [1], 12)    Log Likelihood            -388.681
Date:                  Wed, 22 Sep 2021                    AIC                      787.363
Time:                  18:03:57                             BIC                      796.719
Sample:                0                                 HQIC                     790.899
Covariance Type:      opg
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
intercept    195.1312    90.078      2.166    0.030    18.582    371.681
ar.L1         0.7337     0.098      7.500    0.000     0.542     0.925
ar.L2        -0.3722     0.146     -2.542    0.011    -0.659    -0.085
ma.S.L12     -0.7743     0.374     -2.068    0.039    -1.508    -0.041
sigma2       5.184e+05    1.65e+05    3.141    0.002    1.95e+05  8.42e+05
=====
Ljung-Box (L1) (Q):          0.00    Jarque-Bera (JB):          41.74
Prob(Q):                    0.95    Prob(JB):                  0.00
Heteroskedasticity (H):     8.79    Skew:                     -0.99
Prob(H) (two-sided):        0.00    Kurtosis:                  7.11
=====
    
```

Figure A6.60 SARIMA model for AIN time series

Source: created by the author.

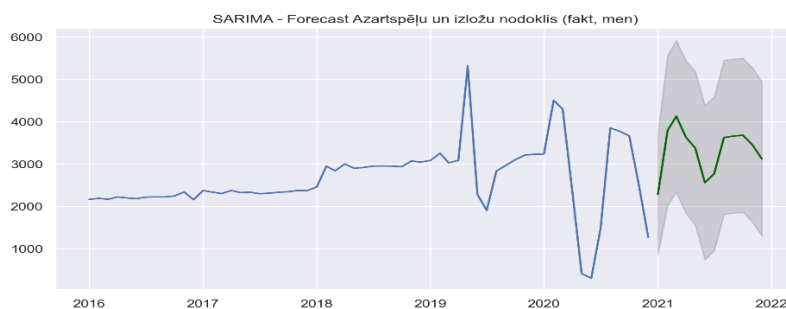


Figure A6.61 SARIMA model prediction for AIN time series for next 12 months

Source: created by the author.

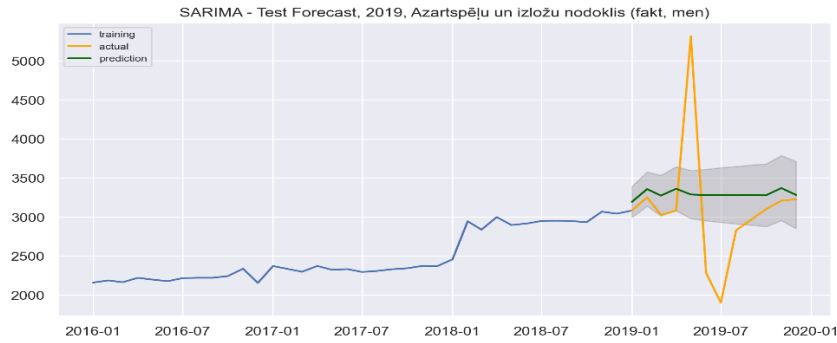


Figure A6.62 SARIMA model prediction for AIN time series for 2019

Source: created by the author.

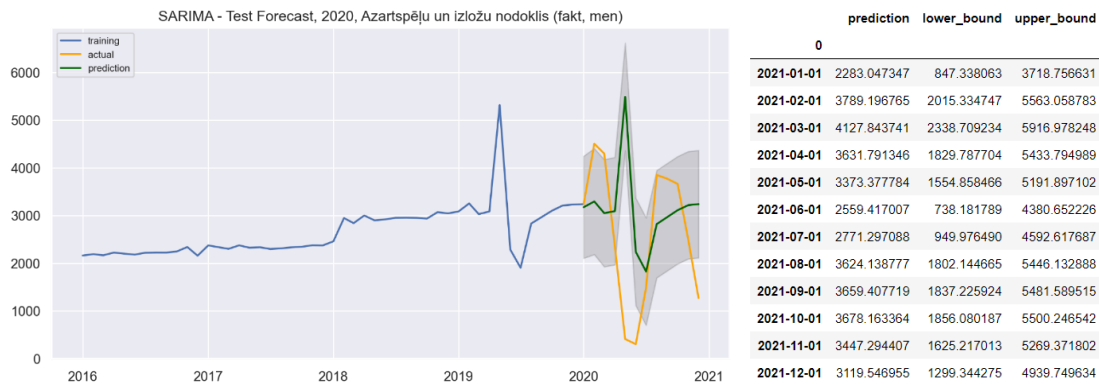


Figure A6.63 SARIMA model prediction for AIN time series for 2020

Source: created by the author.

```

=====
SARIMAX Results
=====
Dep. Variable:      Azartspēju un izložu nodoklis (fakt, men)    No. Observations:      60
Model:             SARIMAX(2, 1, 2)x(0, 1, [1], 12)           Log Likelihood         -377.353
Date:              Wed, 22 Sep 2021                             AIC                    766.705
Time:              18:09:25                                    BIC                    777.806
Sample:            01-01-2016                                 HQIC                   770.883
                   - 12-01-2020
Covariance Type:  opg
=====
coef    std err      z    P>|z|    [0.025    0.975]
-----
ar.L1    1.3918    0.240    5.806    0.000    0.922    1.862
ar.L2   -0.8134    0.189   -4.309    0.000   -1.183   -0.443
ma.L1   -1.8289    1.821   -1.004    0.315   -5.398    1.740
ma.L2    0.9905    2.047    0.484    0.628   -3.021    5.002
ma.S.L12 -0.9733    1.814   -0.537    0.591   -4.528    2.581
sigma2   3.684e+05  2.01e-06  1.83e+11  0.000   3.68e+05  3.68e+05
=====
Ljung-Box (L1) (Q):      0.01    Jarque-Bera (JB):      49.72
Prob(Q):                 0.94    Prob(JB):              0.00
Heteroskedasticity (H): 13.89    Skew:                  -0.50
Prob(H) (two-sided):    0.00    Kurtosis:              7.94
=====
    
```

Figure A6.64 SARIMA model (semi-auto) for AIN time series

Source: created by the author.

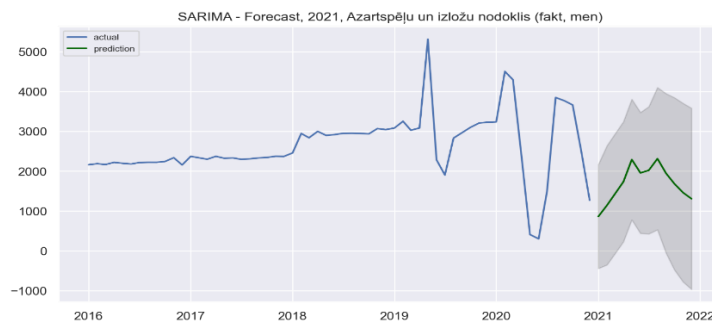


Figure A6.65 SARIMA model (semi-auto) prediction for AIN time series for next 12 months

Source: created by the author.

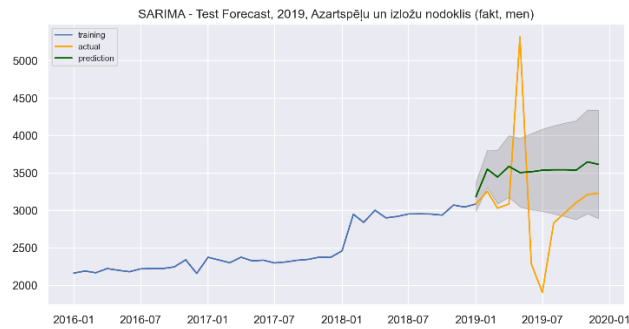


Figure A6.66 SARIMA model (semi-auto) prediction for AIN time series for 2019

Source: created by the author.

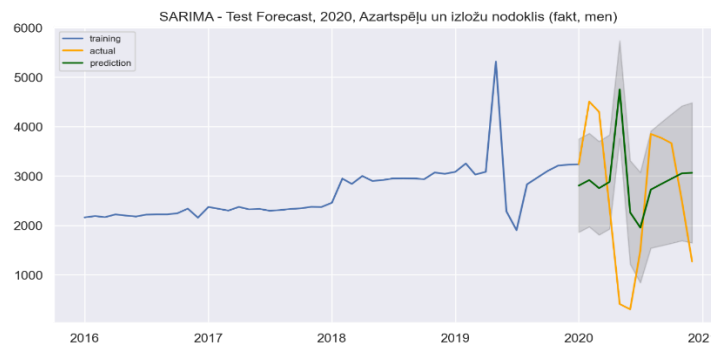


Figure A6.67 SARIMA model (semi-auto) prediction for AIN time series for 2020

Source: created by the author.

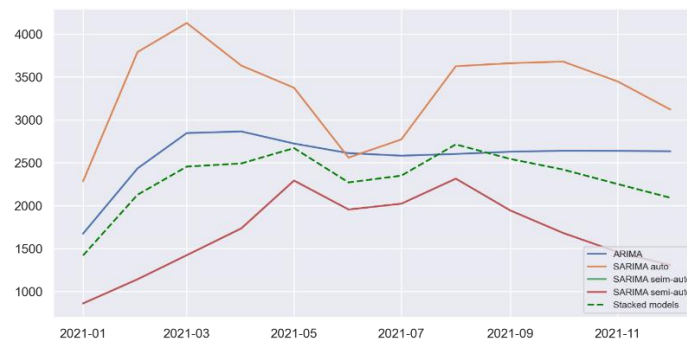


Figure A6.68 ARIMA, SARIMA, semi-auto SARIMA and stacked model comparison for AIN time series

Source: created by the author.

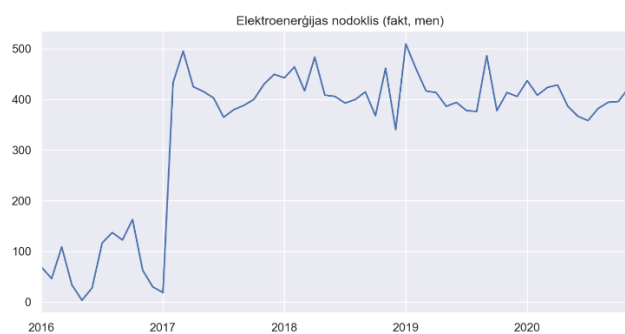


Figure A6.69 Monthly EN collections in Latvia in 2016–2020

Source: created by the author based on the SRS data.

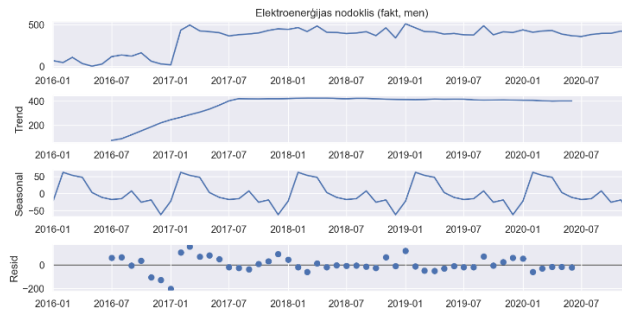


Figure A6.70 Seasonal decomposition of EN time series

Source: created by the author.

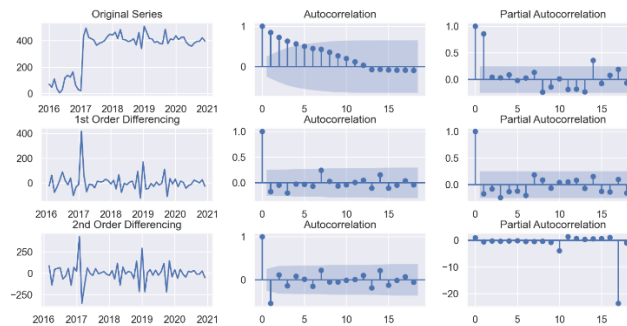


Figure A6.71 ACF and PACF plot of original and differentiated EN time series

Source: created by the author.

Table A6.5

ADF and KPSS stationarity tests for EN time series

Time series	ADF Statistic (p-value)	KPSS Statistic (p-value)	Stationarity
Original series	0.13410	0.07766	Non-stationary time series
First order differencing	1.11413e-14	0.1	Stationary time series
Second order differencing	0.00053	0.1	Stationary time series

Source: created by the author.

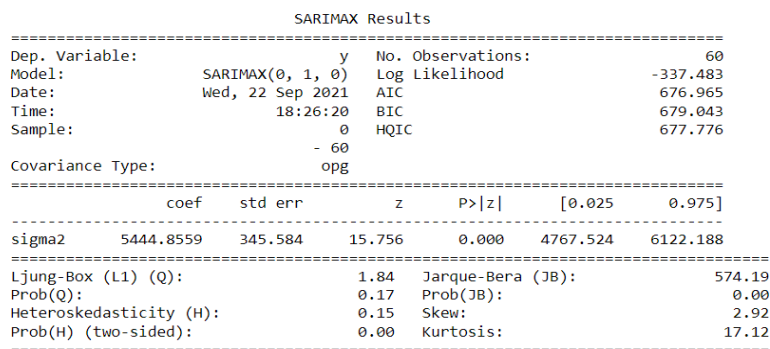


Figure A6.72 ARIMA model for EN time series

Source: created by the author.

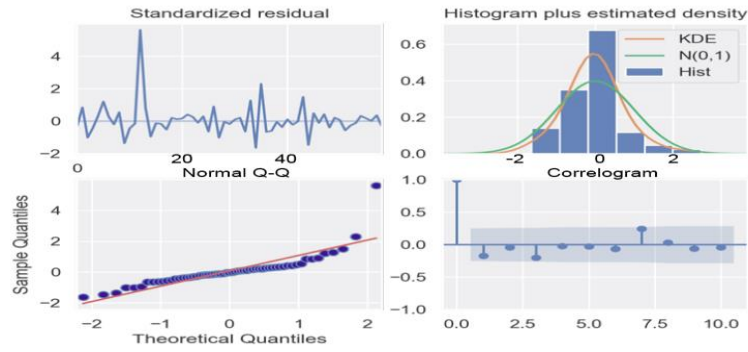


Figure A6.73 Residuals and density plots for EN time series

Source: created by the author.

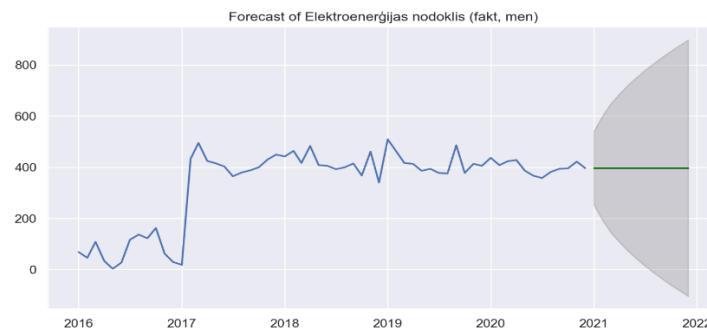


Figure A6.74 ARIMA model prediction for EN time series for next 12 months

Source: created by the author.

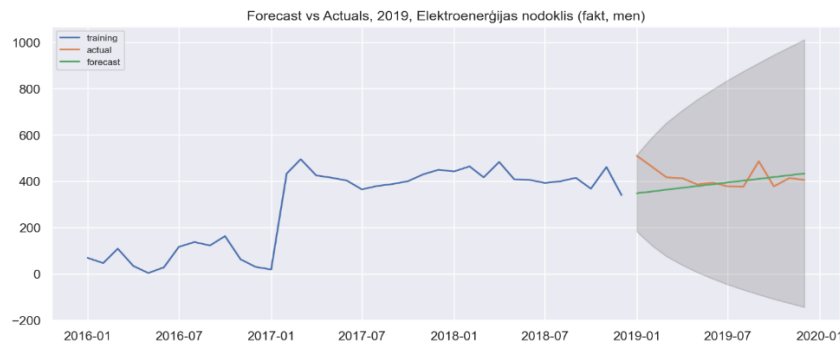


Figure A6.75 ARIMA model prediction for EN time series for 2019

Source: created by the author.

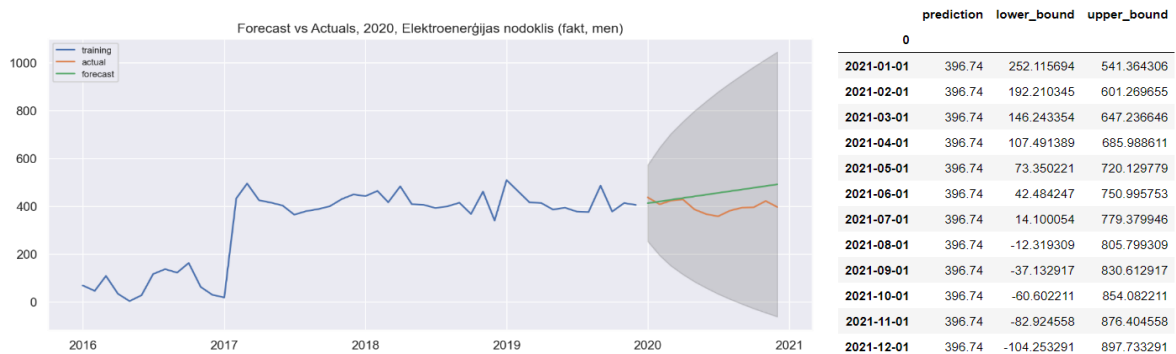


Figure A6.76 ARIMA model prediction for EN time series for 2020

Source: created by the author.

SARIMAX Results

```

=====
Dep. Variable:          y          No. Observations:      60
Model:                 SARIMAX(0, 1, 1)x(2, 1, [], 12)      Log Likelihood:       -278.853
Date:                  Wed, 22 Sep 2021                    AIC:                  565.706
Time:                  18:27:14                            BIC:                  573.107
Sample:                - 60                               HQIC:                 568.491
Covariance Type:      opg
=====
              coef      std err      z      P>|z|      [0.025      0.975]
-----
ma.L1         -0.3164      0.136     -2.326   0.020    -0.583    -0.050
ar.S.L12      -0.6578      0.104     -6.301   0.000    -0.862    -0.453
ar.S.L24      -0.3213      0.102     -3.150   0.002    -0.521    -0.121
sigma2        7331.9759    1226.827      5.976   0.000   4927.439   9736.513
=====
Ljung-Box (L1) (Q):      0.49      Jarque-Bera (JB):      43.75
Prob(Q):                0.49      Prob(JB):              0.00
Heteroskedasticity (H): 0.20      Skew:                  1.08
Prob(H) (two-sided):    0.00      Kurtosis:              7.20
=====

```

Figure A6.77 SARIMA model for EN time series

Source: created by the author.

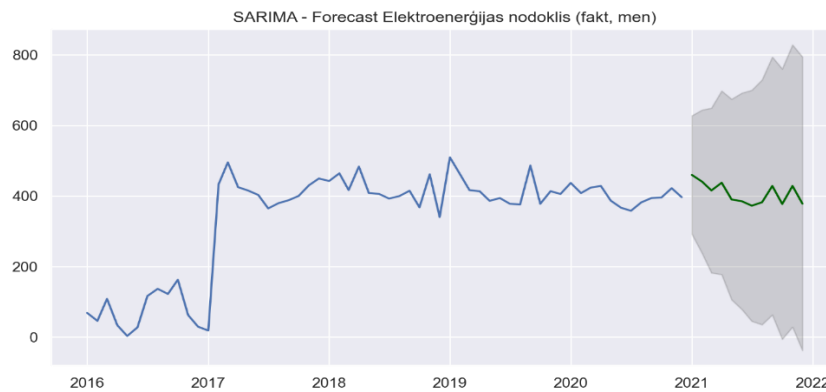


Figure A6.78 SARIMA model prediction for EN time series for next 12 months

Source: created by the author.

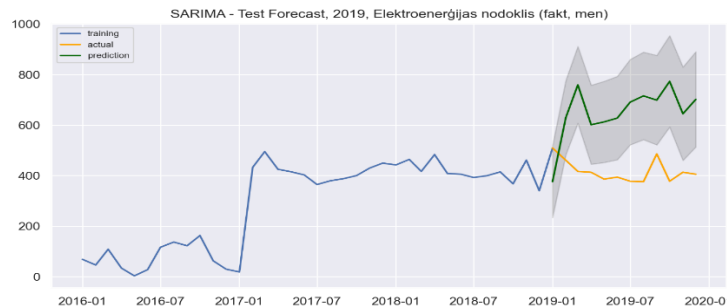


Figure A6.79 SARIMA model prediction for EN time series for 2019

Source: created by the author.

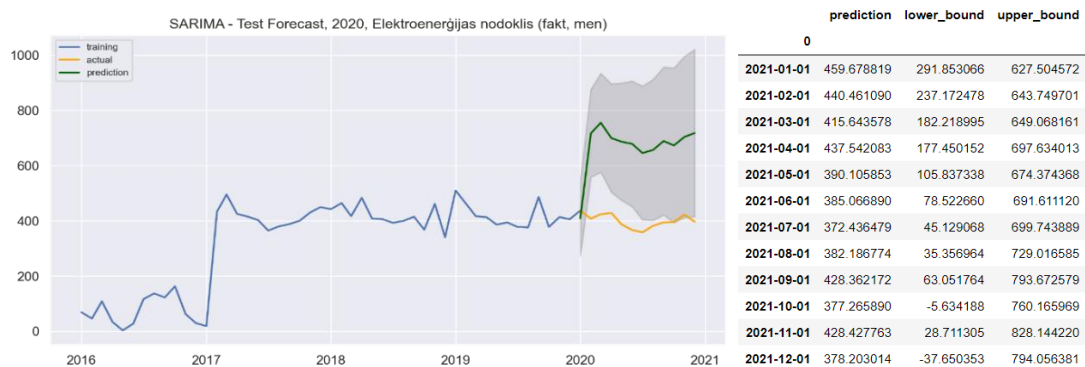


Figure A6.80 SARIMA model prediction for EN time series for 2020

Source: created by the author.

SARIMAX Results

```

=====
Dep. Variable:      Elektroenerģijas nodoklis (fakt, men)  No. observations:      60
Model:             SARIMAX(0, 1, 2)x(3, 1, 1), 12         Log Likelihood         -275.199
Date:              Wed, 22 Sep 2021                    AIC                   562.398
Time:              18:34:48                             BIC                   573.499
Sample:            01-01-2016                          HQIC                  566.576
                  - 12-01-2020
Covariance Type:  opg
=====
              coef  std err  z      P>|z|    [0.025  0.975]
-----
ma.L1         -0.2678   0.155   -1.728  0.084    -0.572   0.036
ma.L2         -0.1582   0.185   -0.854  0.393    -0.521   0.205
ar.S.L12      -0.8716   0.183   -4.762  0.000    -1.230  -0.513
ar.S.L24      -0.8375   0.194   -4.315  0.000    -1.218  -0.457
ar.S.L36      -0.7806   0.102   -7.670  0.000    -0.980  -0.581
sigma2        3042.2100  1403.638  2.167   0.030    291.131  5793.289
=====
Ljung-Box (L1) (Q):      0.24  Jarque-Bera (JB):      43.05
Prob(Q):                 0.63  Prob(JB):              0.00
Heteroskedasticity (H):  0.34  Skew:                  1.23
Prob(H) (two-sided):     0.04  Kurtosis:              7.00
=====
    
```

Figure A6.81 SARIMA model (semi-auto) for EN time series

Source: created by the author.

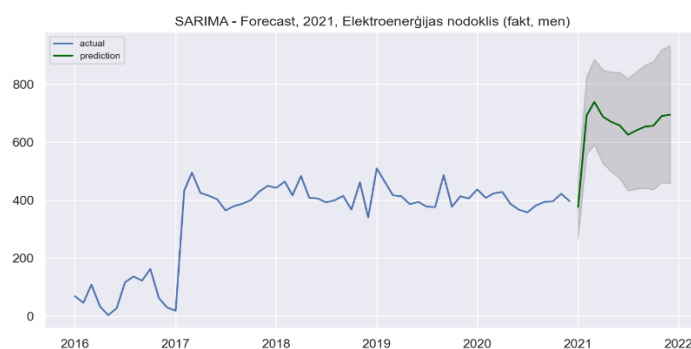


Figure A6.82 SARIMA model (semi-auto) prediction for EN time series for next 12 months

Source: created by the author.

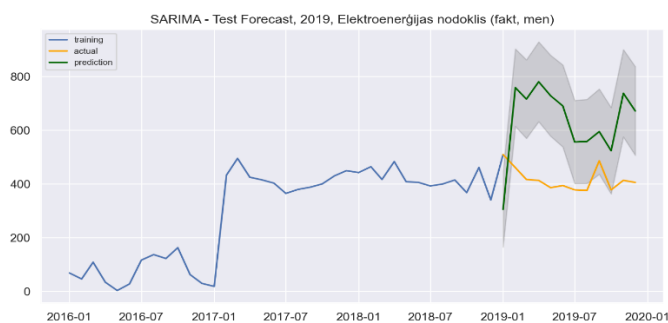


Figure A6.83 SARIMA model (semi-auto) prediction for EN time series for 2019

Source: created by the author.

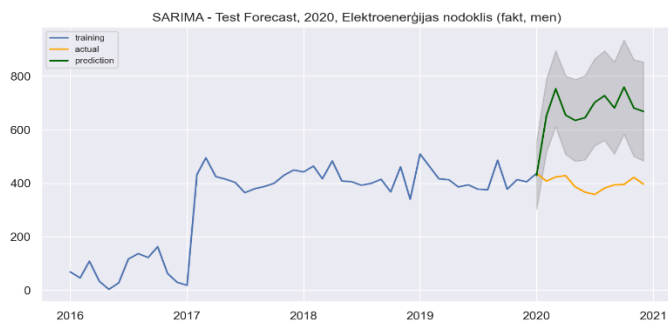


Figure A6.84 SARIMA model (semi-auto) prediction for EN time series for 2020

Source: created by the author.

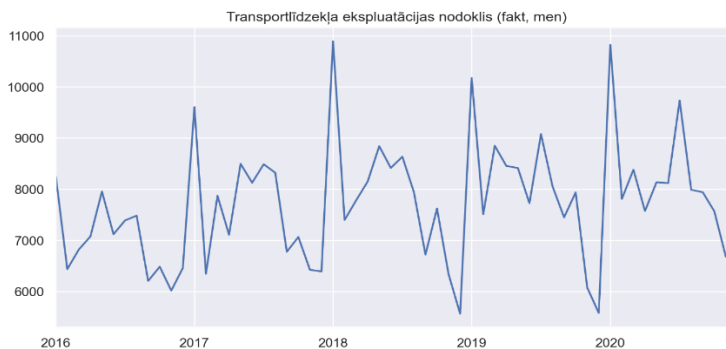


Figure A6.85 Monthly TEN collections in Latvia in 2016–2020

Source: created by the author based on the SRS data.

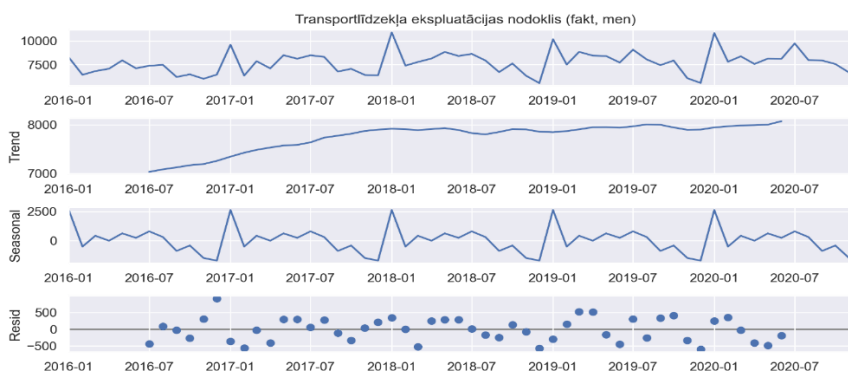


Figure A6.86 Seasonal decomposition of TEN time series

Source: created by the author.



Figure A6.87 ACF and PACF plot of original and differentiated TEN time series

Source: created by the author.

Table A6.6

ADF and KPSS stationarity tests for TEN time series

Time series	ADF Statistic (p-value)	KPSS Statistic (p-value)	Stationarity
Original series	0.03107	0.08409	Stationary time series
First order differencing	0.00113	0.1	Stationary time series
Second order differencing	5.81824e-08	0.09706	Stationary time series

Source: created by the author.

SARIMAX Results

```

=====
Dep. Variable:          y          No. Observations:      60
Model:                 SARIMAX    Log Likelihood         -507.973
Date:                  Wed, 22 Sep 2021    AIC                   1019.947
Time:                  18:48:26          BIC                   1024.135
Sample:                0              HQIC                  1021.585
Covariance Type:      opg
=====

```

	coef	std err	z	P> z	[0.025	0.975]
intercept	7696.2875	159.308	48.311	0.000	7384.049	8008.526
sigma2	1.322e+06	2.34e+05	5.657	0.000	8.64e+05	1.78e+06

```

=====
Ljung-Box (L1) (Q):      0.00    Jarque-Bera (JB):      3.76
Prob(Q):                 0.97    Prob(JB):              0.15
Heteroskedasticity (H): 1.38    Skew:                  0.57
Prob(H) (two-sided):    0.47    Kurtosis:              3.46
=====

```

Figure A6.88 ARIMA model for TEN time series

Source: created by the author.

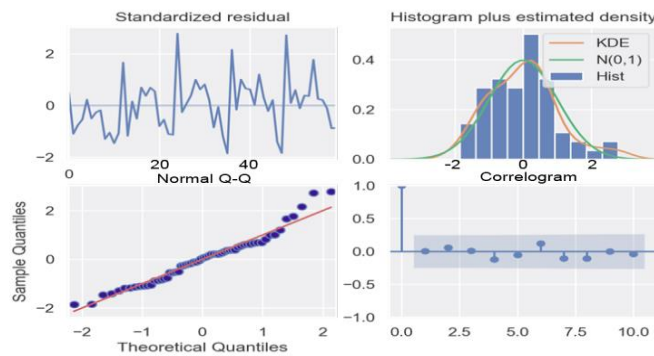


Figure A6.89 Residuals and density plots for TEN time series

Source: created by the author.

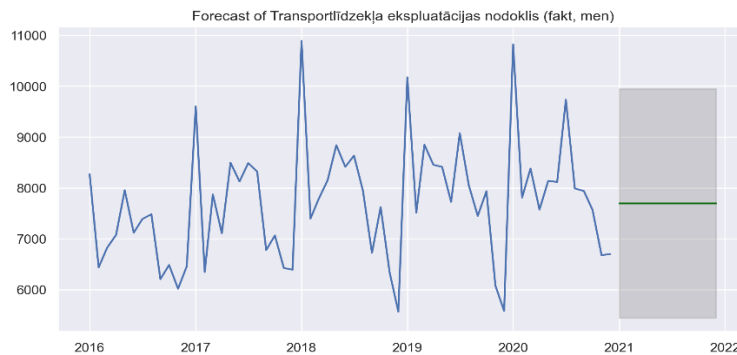


Figure A6.90 ARIMA model prediction for TEN time series for next 12 months

Source: created by the author.

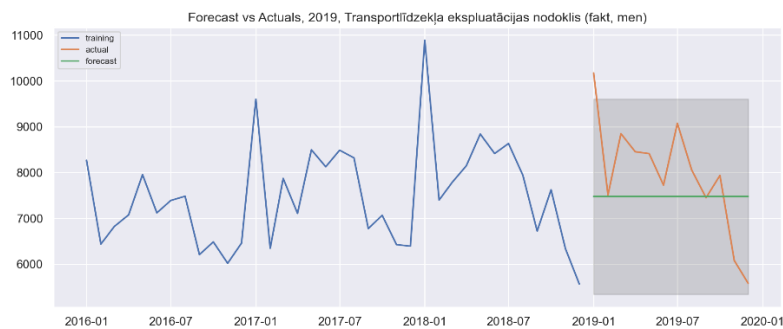


Figure A6.91 ARIMA model prediction for TEN time series for 2019

Source: created by the author.

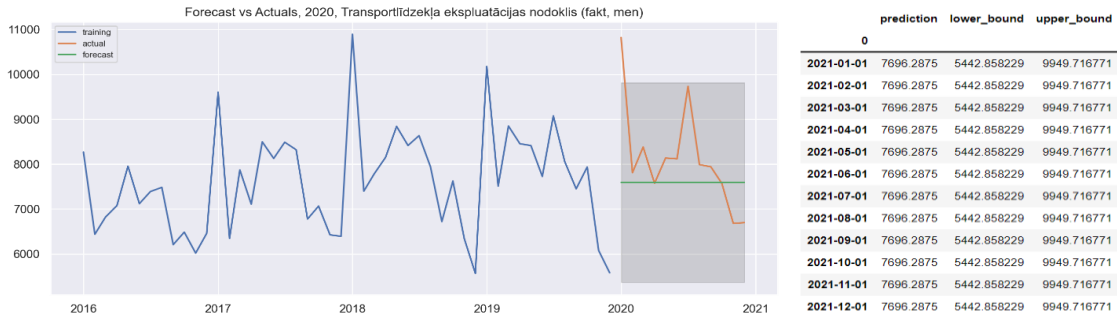


Figure A6.92 ARIMA model prediction for TEN time series for 2020

Source: created by the author.

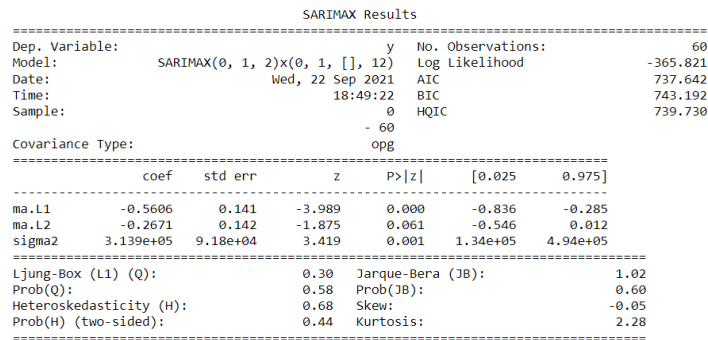


Figure A6.93 SARIMA model for TEN time series

Source: created by the author.

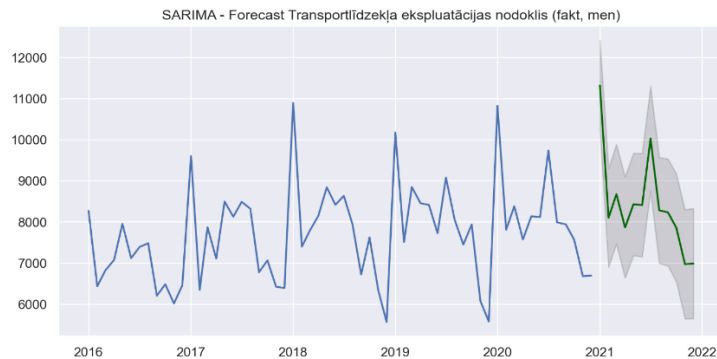


Figure A6.94 SARIMA model prediction for TEN time series for next 12 months

Source: created by the author.

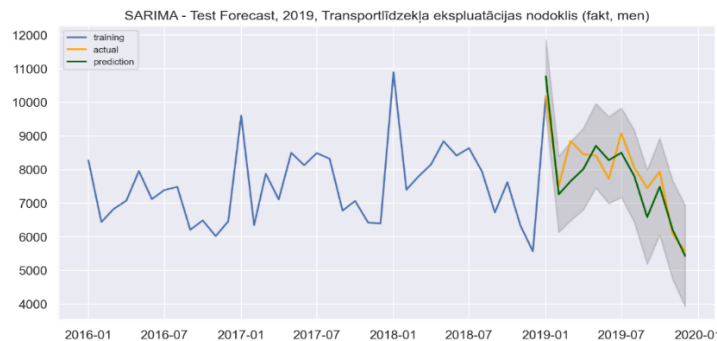


Figure A6.95 SARIMA model prediction for TEN time series for 2019

Source: created by the author.

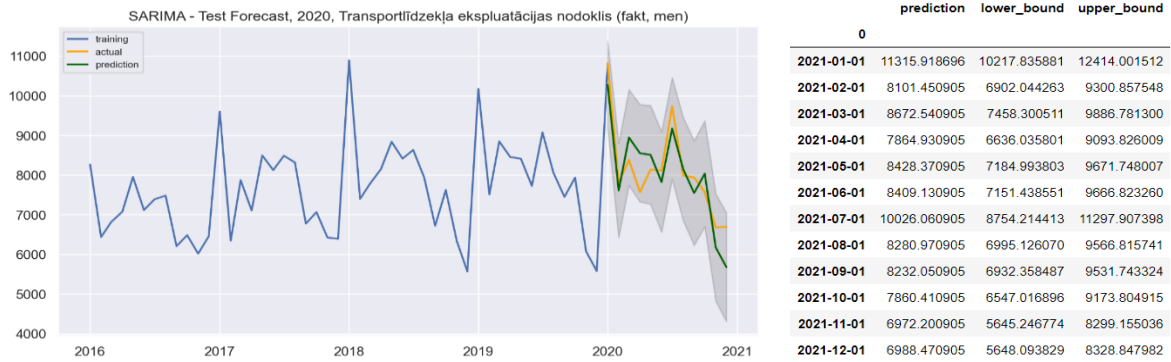


Figure A6.96 SARIMA model prediction for TEN time series for 2020

Source: created by the author.

SARIMAX Results

```

=====
Dep. Variable:   Transportlīdzekļa ekspluatācijas nodoklis (fakt, men)   No. Observations:   60
Model:          SARIMAX(2, 1, 3)x(0, 1, [], 12)                         Log Likelihood      -362.274
Date:           wed, 22 Sep 2021                                       AIC                  736.548
Time:           18:59:46                                               BIC                  747.648
Sample:         01-01-2016                                             HQIC                 740.725
Covariance Type: opg
=====
coef    std err    z    P>|z|    [0.025    0.975]
-----
ar.L1    0.6965    0.142    4.911    0.000    0.419    0.975
ar.L2   -0.9419    0.104   -9.029    0.000   -1.146   -0.737
ma.L1   -1.4026    0.225   -6.246    0.000   -1.843   -0.962
ma.L2    1.2630    0.320    3.942    0.000    0.635    1.891
ma.L3   -0.5965    0.205   -2.905    0.004   -0.999   -0.194
sigma2   2.751e+05  8.01e+04  3.436    0.001   1.18e+05  4.32e+05
=====
Ljung-Box (L1) (Q):    0.00   Jarque-Bera (JB):    0.75
Prob(Q):               0.96   Prob(JB):            0.69
Heteroskedasticity (H): 0.42   Skew:                -0.10
Prob(H) (two-sided):  0.10   Kurtosis:            2.41
=====

```

Figure A6.97 SARIMA model (semi-auto) for TEN time series

Source: created by the author.

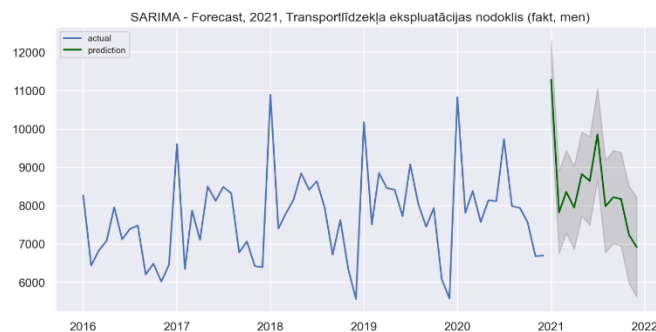


Figure A6.98 SARIMA model (semi-auto) prediction for TEN time series for next 12 months

Source: created by the author.

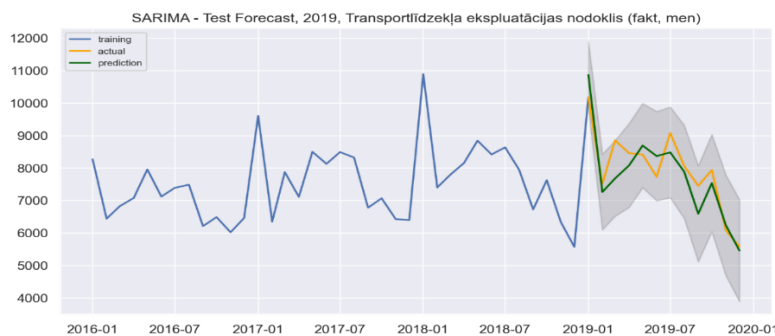


Figure A6.99 SARIMA model (semi-auto) prediction for TEN time series for 2019

Source: created by the author.

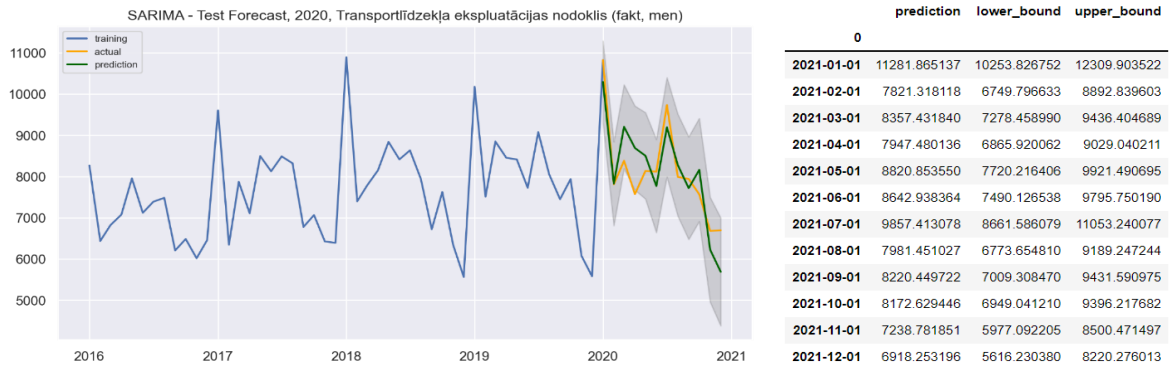


Figure A6.100 SARIMA model (semi-auto) prediction for TEN time series for 2020

Source: created by the author.

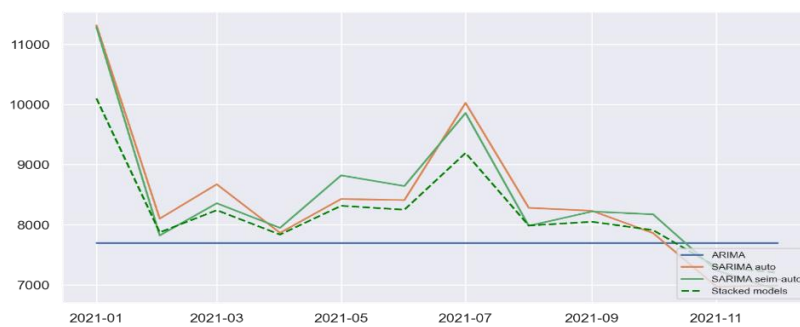


Figure A6.101 ARIMA, SARIMA, semi-auto SARIMA and stacked model comparison for TEN time series

Source: created by the author.

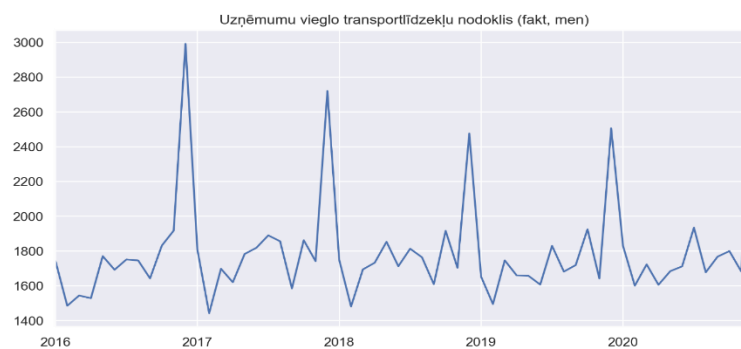


Figure A6.102 Monthly UVTN collections in Latvia in 2016–2020

Source: created by the author based on the SRS data.

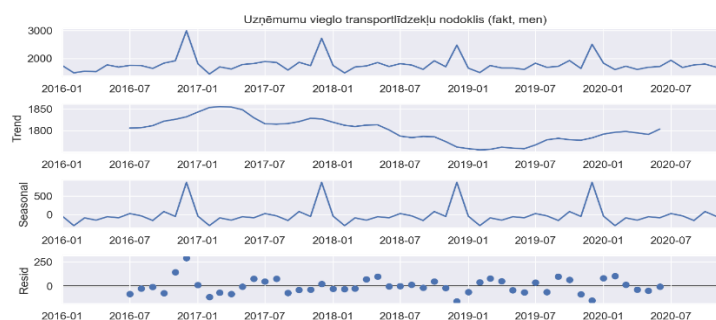


Figure A6.103 Seasonal decomposition of UVTN time series

Source: created by the author.

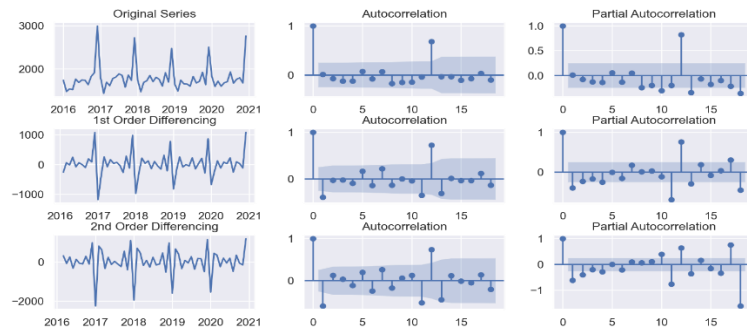


Figure A6.104 ACF and PACF plot of original and differentiated UVTN time series

Source: created by the author.

Table A6.7

ADF and KPSS stationarity tests for UVTN time series

Time series	ADF Statistic (p-value)	KPSS Statistic (p-value)	Stationarity
Original series	0.79234	0.1	Non-stationary time series
First order differencing	0.02271	0.1	Stationary time series
Second order differencing	4.32841e-15	0.1	Stationary time series

Source: created by the author.

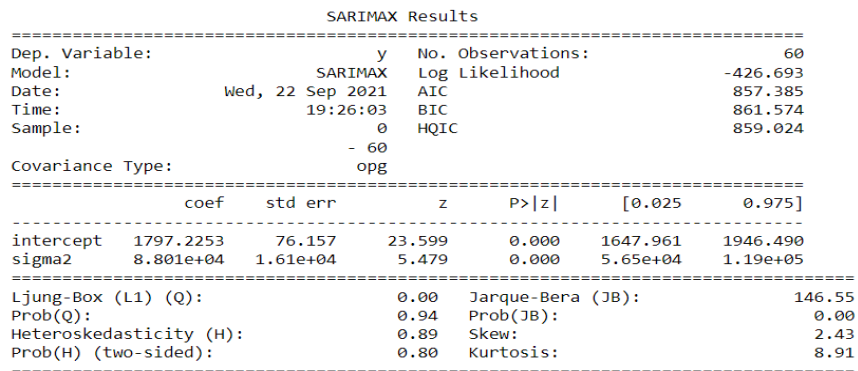


Figure A6.105 ARIMA model for UVTN time series

Source: created by the author.

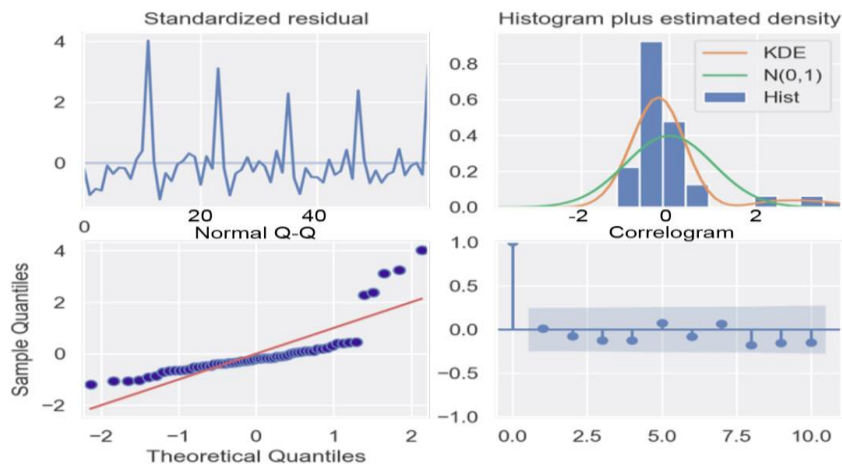


Figure A6.106 Residuals and density plots for UVTN time series

Source: created by the author.

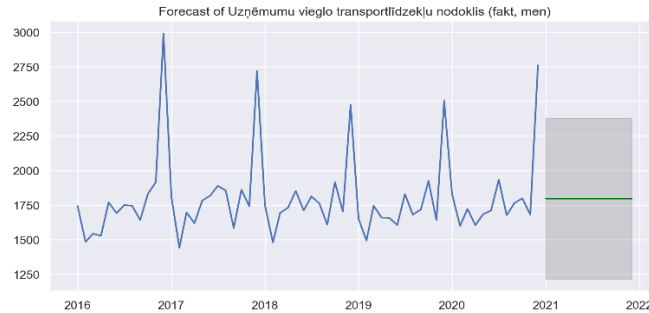


Figure A6.107 ARIMA model prediction for UVTN time series for next 12 months

Source: created by the author.

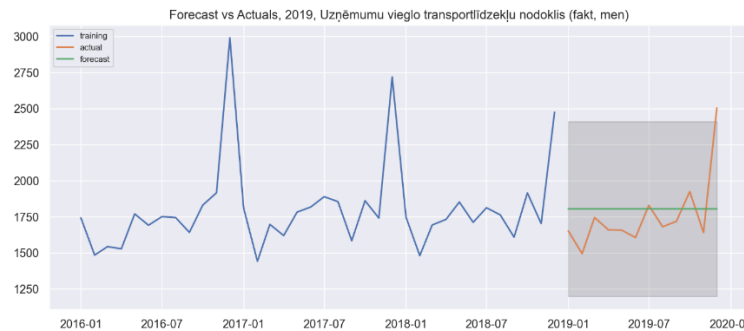


Figure A6.108 ARIMA model prediction for UVTN time series for 2019

Source: created by the author.

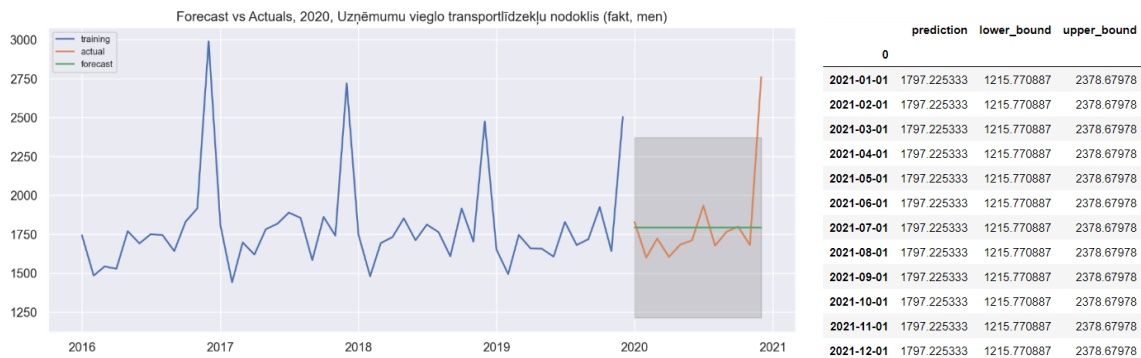


Figure A6.109 ARIMA model prediction for UVTN time series for 2020

Source: created by the author.

```

=====
SARIMAX Results
=====
Dep. Variable:          y                No. Observations:          60
Model:                 SARIMAX(0, 1, 2)x(0, 1, [], 12)    Log Likelihood             -283.693
Date:                  Wed, 22 Sep 2021                    AIC                        573.386
Time:                  19:26:50                          BIC                        578.936
Sample:                0                                HQIC                       575.475
Sample:                - 60
Covariance Type:      opg
=====
              coef    std err          z      P>|z|    [0.025    0.975]
-----
ma.L1         -0.4077      0.119      -3.427    0.001    -0.641    -0.175
ma.L2         -0.4891      0.156      -3.138    0.002    -0.795    -0.184
sigma2        9922.0842    2044.959      4.852    0.000    5914.039    1.39e+04
=====
Ljung-Box (L1) (Q):           0.04    Jarque-Bera (JB):           0.79
Prob(Q):                      0.84    Prob(JB):                   0.67
Heteroskedasticity (H):       0.98    Skew:                       -0.32
Prob(H) (two-sided):          0.97    Kurtosis:                   2.98
=====

```

Figure A6.110 SARIMA model for UVTN time series

Source: created by the author.

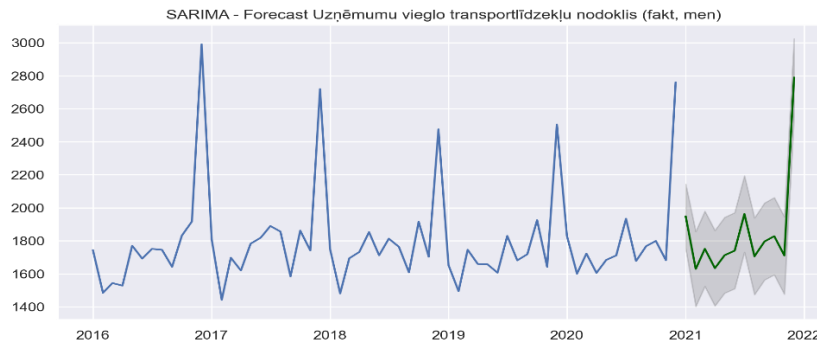


Figure A6.111 SARIMA model prediction for UVTN time series for next 12 months

Source: created by the author.

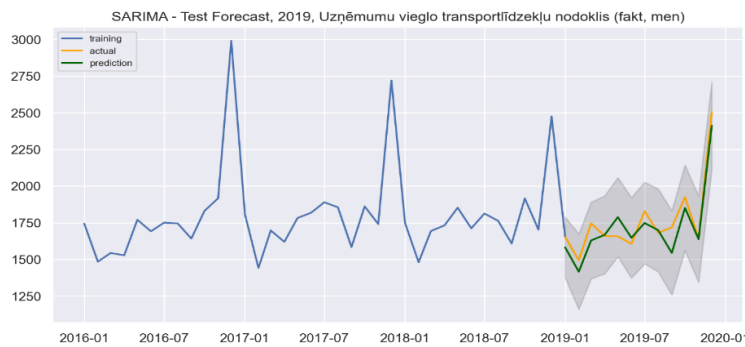


Figure A6.112 SARIMA model prediction for UVTN time series for 2019

Source: created by the author.

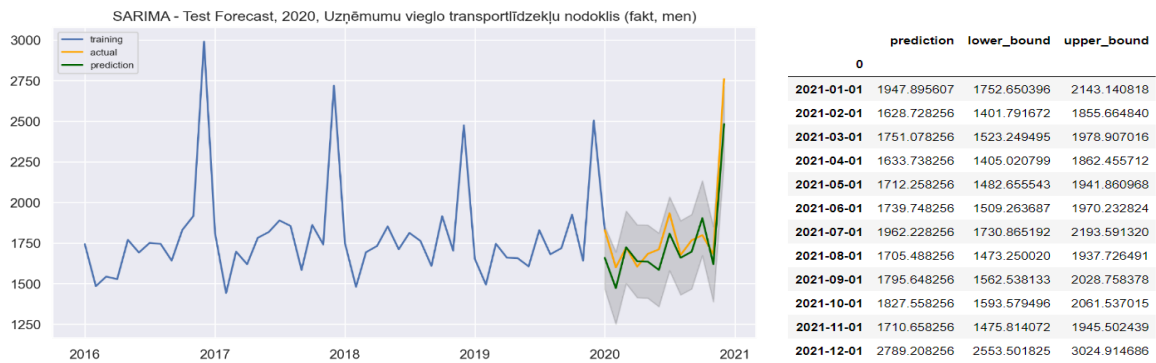


Figure A6.113 SARIMA model prediction for UVTN time series for 2020

Source: created by the author.

```

SARIMAX Results
-----
Dep. Variable:   Uzņēmumu vieglo transportlīdzekļu nodoklis (fakt, men)   No. Observations:   60
Model:          SARIMAX(0, 1, 2)x(3, 1, [], 12)   Log Likelihood      -279.293
Date:           Wed, 22 Sep 2021   AIC                  570.587
Time:           19:50:32   BIC                  581.688
Sample:         01-01-2016   HQIC                 574.764
                - 12-01-2020

Covariance Type: opg
-----
                coef    std err          z      P>|z|      [0.025     0.975]
-----
ma.L1          -0.3843    0.137       -2.805    0.005    -0.653    -0.116
ma.L2          -0.5172    0.201       -2.569    0.010    -0.912    -0.123
ar.S.L12       -0.0499    0.282       -0.177    0.860    -0.603    0.503
ar.S.L14       -0.3406    0.218       -1.562    0.118    -0.768    0.087
ar.S.L16       -0.4697    0.409       -1.149    0.250    -1.270    0.331
sigma2         6312.7281    3018.426     2.091    0.036    396.721    1.22e+04

Ljung-Box (L1) (Q):      0.29   Jarque-Bera (JB):      0.87
Prob(Q):                 0.59   Prob(JB):              0.65
Heteroskedasticity (H): 0.75   Skew:                  -0.32
Prob(H) (two-sided):     0.58   Kurtosis:              2.79
    
```

Figure A6.114 SARIMA model (semi-auto) for UVTN time series

Source: created by the author.

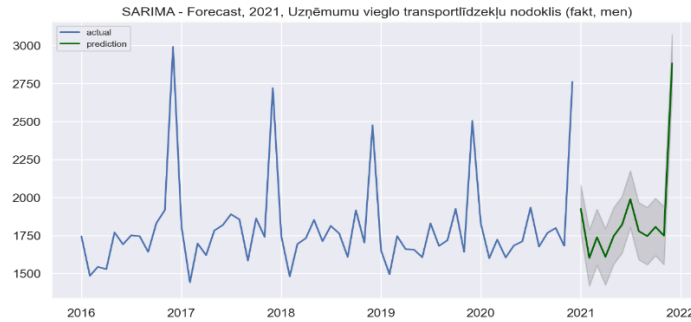


Figure A6.115 SARIMA model (semi-auto) prediction for UVTN time series for next 12 months

Source: created by the author.

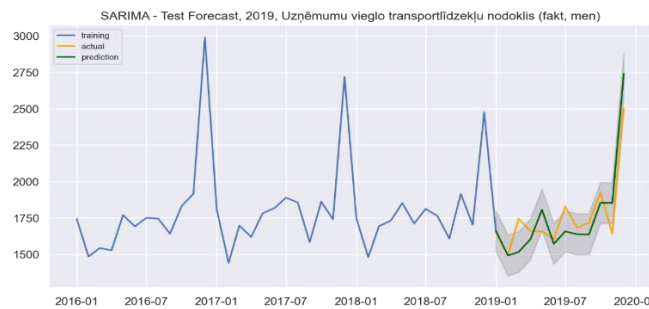


Figure A6.116 SARIMA model (semi-auto) prediction for UVTN time series for 2019

Source: created by the author.

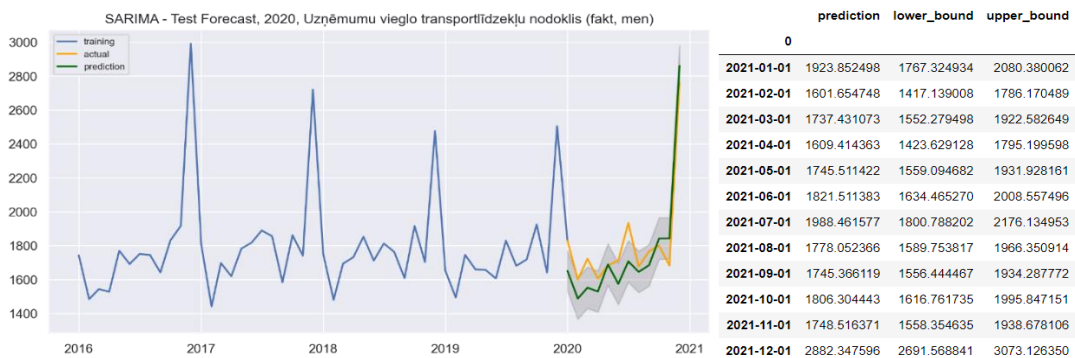


Figure A6.117 SARIMA model (semi-auto) prediction for UVTN time series for 2020

Source: created by the author.

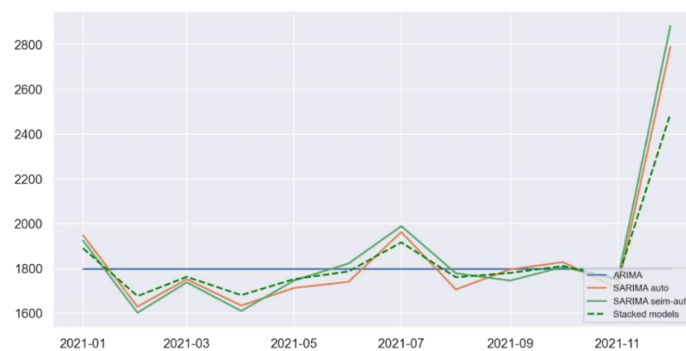


Figure A6.118 ARIMA, SARIMA, semi-auto SARIMA and stacked model comparison for UVTN time series

Source: created by the author.

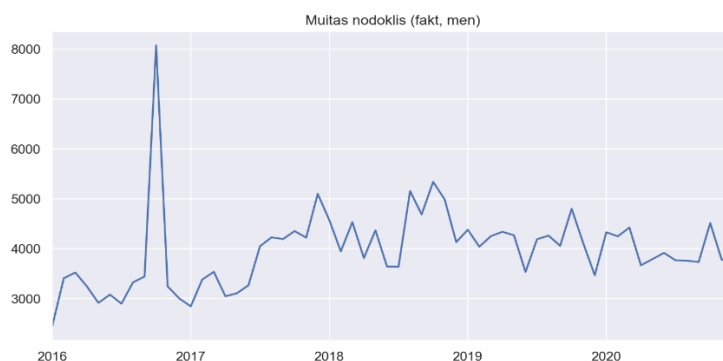


Figure A6.119 Monthly MN collections in Latvia in 2016–2020

Source: created by the author based on the SRS data.

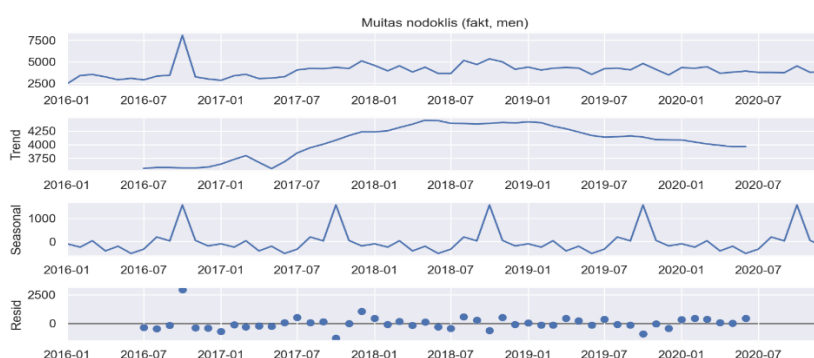


Figure A6.120 Seasonal decomposition of MN time series

Source: created by the author.

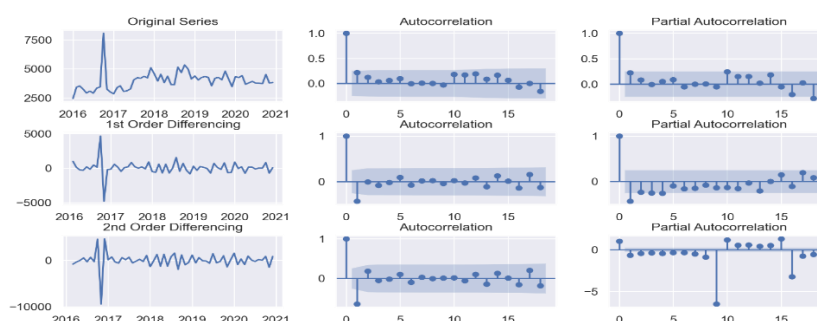


Figure A6.121 ACF and PACF plot of original and differentiated MN time series

Source: created by the author.

Table A6.8

ADF and KPSS stationarity tests for MN time series

Time series	ADF Statistic (p-value)	KPSS Statistic (p-value)	Stationarity
Original series	4.49229e-08	0.1	Stationary time series
First order differencing	2.48430e-12	0.1	Stationary time series
Second order differencing	2.36793e-12	0.1	Stationary time series

Source: created by the author.

SARIMAX Results

```

=====
Dep. Variable:          y          No. Observations:          60
Model:                 SARIMAX(0, 1, 1)      Log Likelihood:          -480.786
Date:                 Thu, 23 Sep 2021      AIC:                    965.573
Time:                 17:45:13             BIC:                    969.728
Sample:               0                   HQIC:                   967.195
Covariance Type:     opg
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
ma.L1         -0.8182         0.101      -8.081      0.000      -1.017      -0.620
sigma2        6.63e+05      3.91e+04     16.951      0.000      5.86e+05      7.4e+05
=====
Ljung-Box (L1) (Q):           0.53      Jarque-Bera (JB):           868.25
Prob(Q):                     0.47      Prob(JB):                   0.00
Heteroskedasticity (H):       0.09      Skew:                       3.40
Prob(H) (two-sided):          0.00      Kurtosis:                   20.52
    
```

Figure A6.122 ARIMA model for MN time series

Source: created by the author.

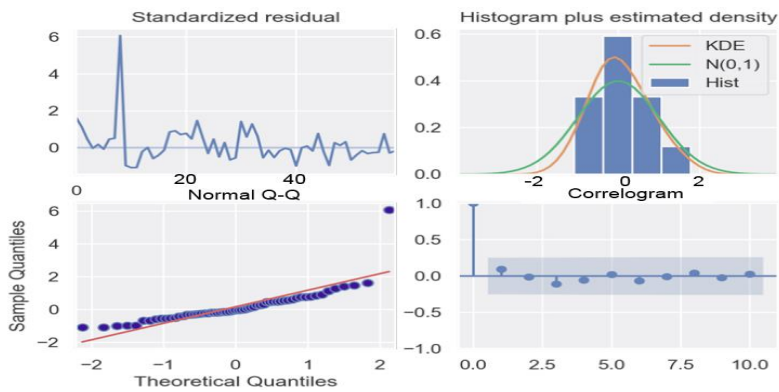


Figure A6.123 Residuals and density plots for MN time series

Source: created by the author.

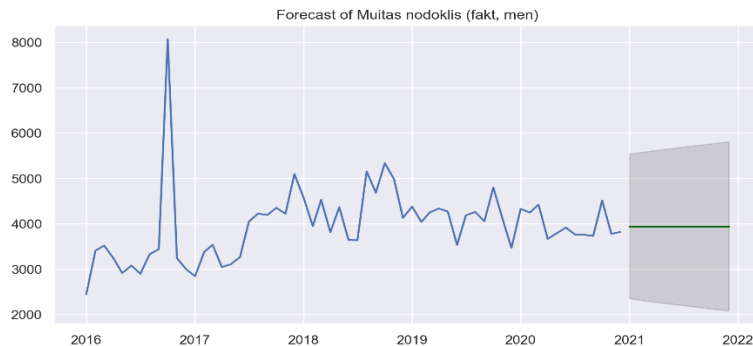


Figure A6.124 ARIMA model prediction for MN time series for next 12 months

Source: created by the author.

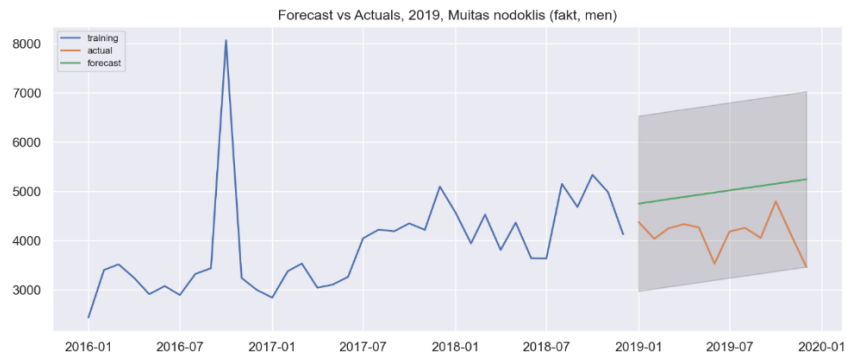


Figure A6.125 ARIMA model prediction for MN time series for 2019

Source: created by the author.

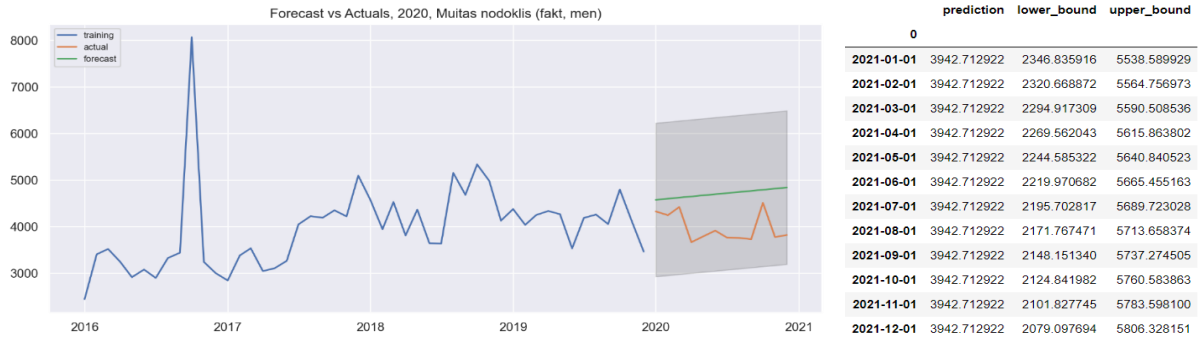


Figure A6.126 ARIMA model prediction for MN time series for 2020

Source: created by the author.

SARIMAX Results

```

-----
Dep. Variable:          y                No. Observations:   60
Model:                SARIMAX(1, 0, 1)x(0, 1, 1, 12)    Log Likelihood      -384.979
Date:                 Thu, 23 Sep 2021                AIC                 779.957
Time:                 17:46:04                       BIC                 789.313
Sample:               0                             HQIC                783.493
Covariance Type:     opg
-----
coef    std err    z    P>|z|    [0.025    0.975]
-----
intercept  -9.9837    34.525   -0.289   0.772   -77.651    57.684
ar.L1      0.9923     0.073   13.511   0.000    0.848     1.136
ma.L1     -0.8689     0.115   -7.565   0.000   -1.094    -0.644
ma.S.L12  -0.5990     0.242   -2.479   0.013   -1.072    -0.125
sigma2     6.688e+05  1.77e+05  3.774   0.000   3.21e+05  1.02e+06
-----
Ljung-Box (L1) (Q):    0.07   Jarque-Bera (JB):    23.38
Prob(Q):              0.79   Prob(JB):            0.00
Heteroskedasticity (H): 0.19   Skew:                -0.33
Prob(H) (two-sided):  0.00   Kurtosis:            6.35
-----

```

Figure A6.127 SARIMA model for MN time series

Source: created by the author.

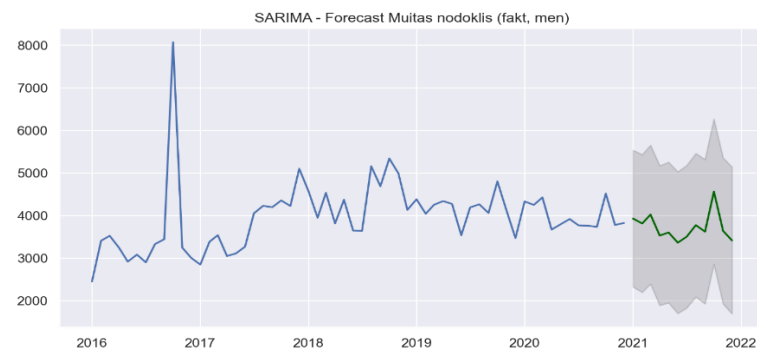


Figure A6.128 SARIMA model prediction for MN time series for next 12 months

Source: created by the author.

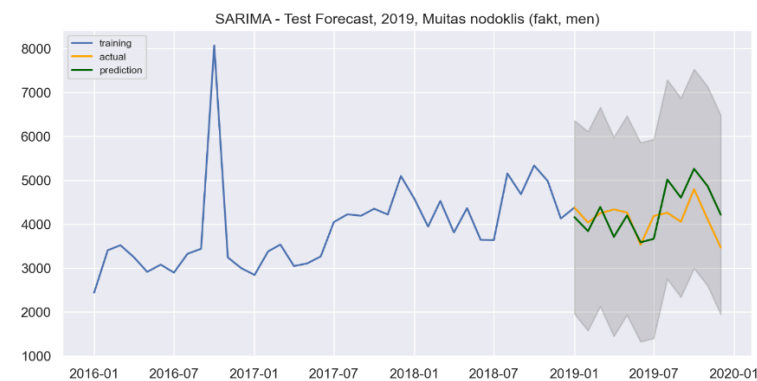


Figure A6.129 SARIMA model prediction for MN time series for 2019

Source: created by the author.

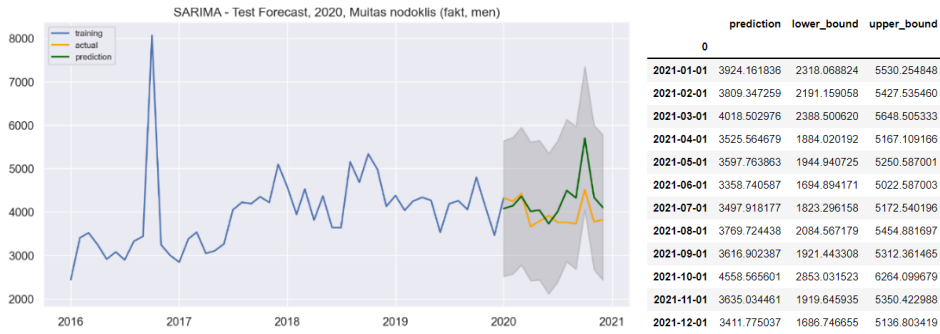


Figure A6.130 SARIMA model prediction for MN time series for 2020

Source: created by the author.

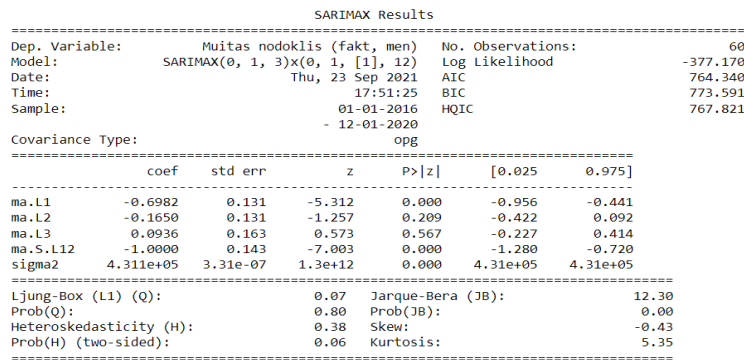


Figure A6.131 SARIMA model (semi-auto) for MN time series

Source: created by the author.

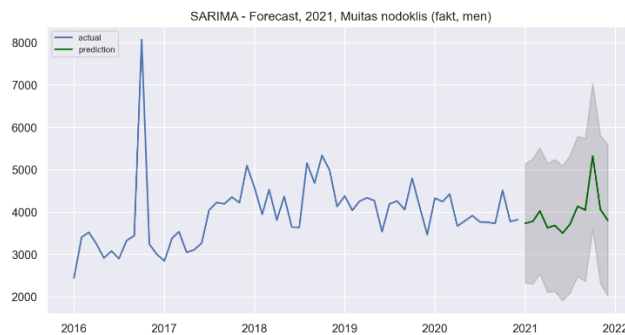


Figure A6.132 SARIMA model (semi-auto) prediction for MN time series for next 12 months

Source: created by the author.

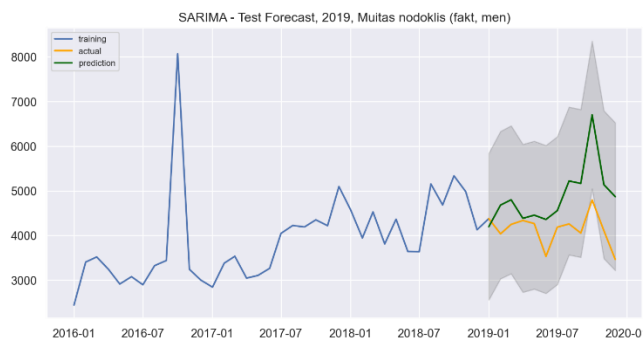


Figure A6.133 SARIMA model (semi-auto) prediction for MN time series for 2019

Source: created by the author.

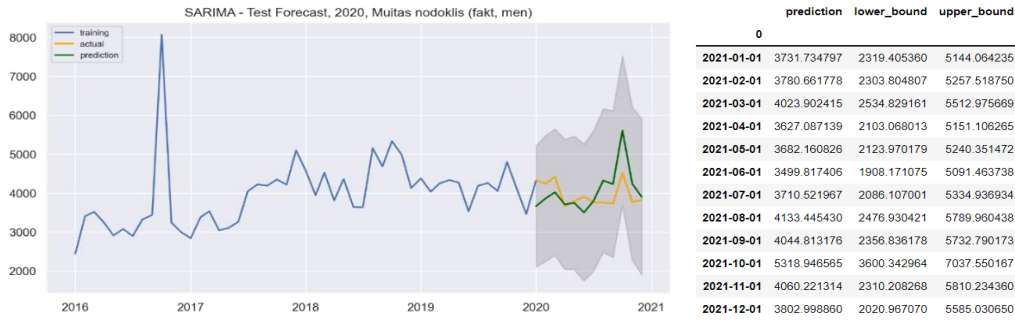


Figure A6.134 SARIMA model (semi-auto) prediction for MN time series for 2020

Source: created by the author.

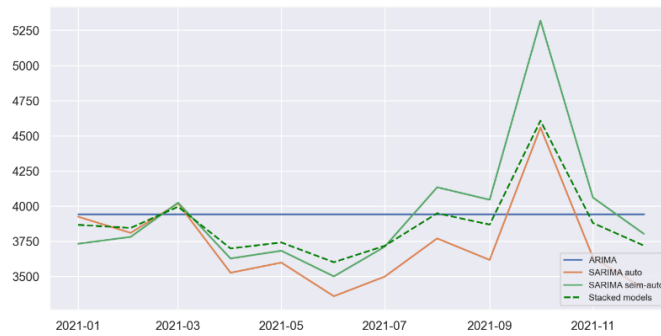


Figure A6.135 ARIMA, SARIMA, semi-auto SARIMA and stacked model comparison for MN time series

Source: created by the author.



Figure A6.136 Monthly VSAOI collections in Latvia in 2016–2020

Source: created by the author based on the SRS data.

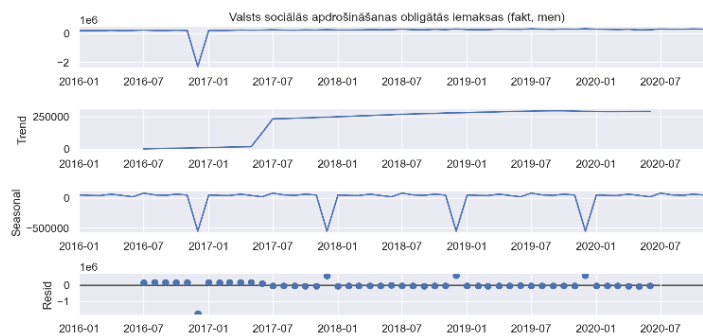


Figure A6.137 Seasonal decomposition of VSAOI time series

Source: created by the author.

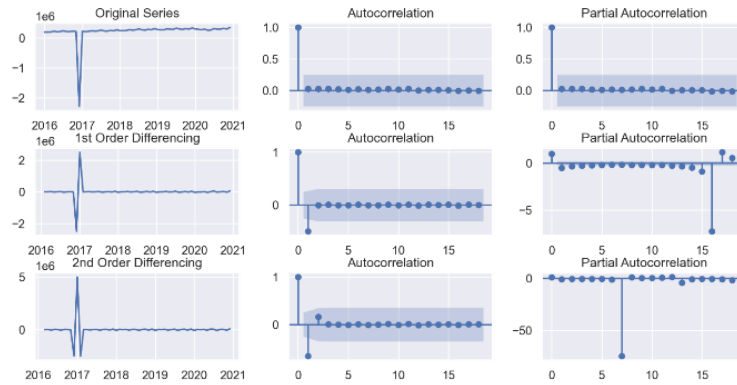


Figure A6.138 ACF and PACF plot of original and differentiated VSAOI time series

Source: created by the author.

Table A6.9

ADF and KPSS stationarity tests for VSAOI time series

Time series	ADF Statistic (p-value)	KPSS Statistic (p-value)	Stationarity
Original series	0.48696	0.1	Stationary time series
First order differencing	3.52107e-24	0.1	Stationary time series
Second order differencing	3.77249e-08	0.1	Stationary time series

Source: created by the author.

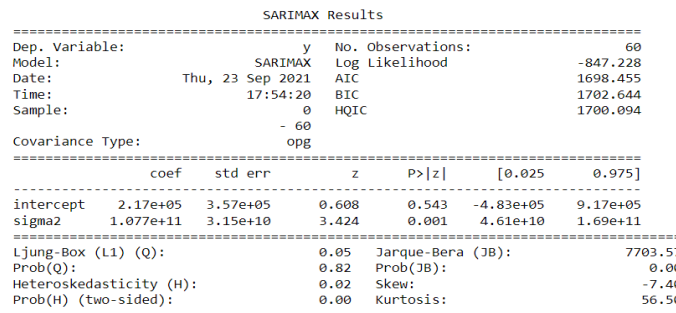


Figure A6.139 ARIMA model for VSAOI time series

Source: created by the author.

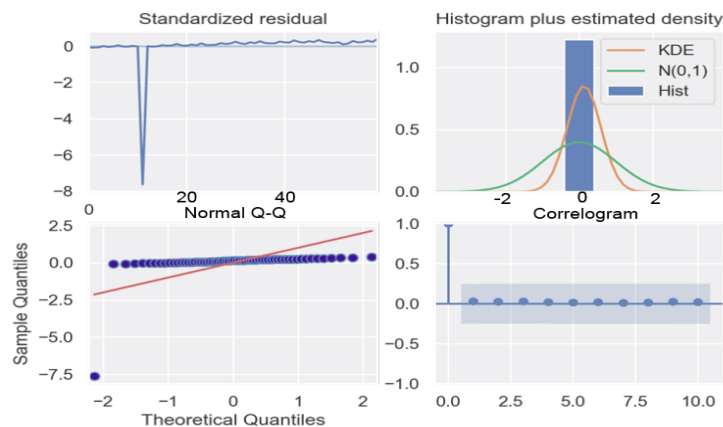


Figure A6.140 Residuals and density plots for VSAOI time series

Source: created by the author.



Figure A6.141 ARIMA model prediction for VSAOI time series for next 12 months

Source: created by the author.

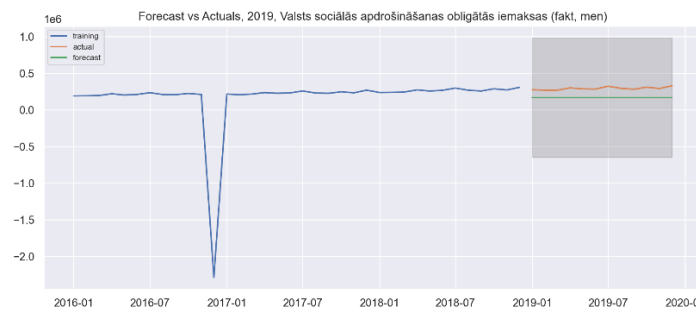


Figure A6.142 ARIMA model prediction for VSAOI time series for 2019

Source: created by the author.

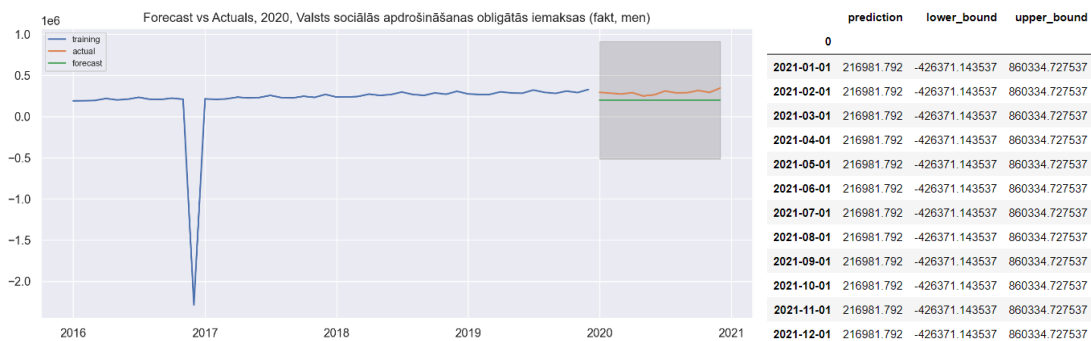


Figure A6.143 ARIMA model prediction for VSAOI time series for 2020

Source: created by the author.

```

=====
SARIMAX Results
=====
Dep. Variable:          y          No. Observations:          60
Model:                 SARIMAX(0, 1, [1], 12)  Log Likelihood            -670.199
Date:                  Thu, 23 Sep 2021        AIC                       1346.398
Time:                  17:55:12              BIC                       1352.012
Sample:                0                    HQIC                      1348.520
Covariance Type:      opg

=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
intercept    7.275e+04    5.85e+04     1.243    0.214    -4.2e+04    1.87e+05
ma.S.L12     -0.5957             0.096    -6.212    0.000    -0.784    -0.408
sigma2       1.315e+11         0.094    1.4e+12    0.000    1.32e+11    1.32e+11
=====
Ljung-Box (L1) (Q):          0.00    Jarque-Bera (JB):          953.55
Prob(Q):                    0.98    Prob(JB):                  0.00
Heteroskedasticity (H):     0.18    Skew:                      4.36
Prob(H) (two-sided):        0.00    Kurtosis:                  23.02
=====

```

Figure A6.144 SARIMA model for VSAOI time series

Source: created by the author.

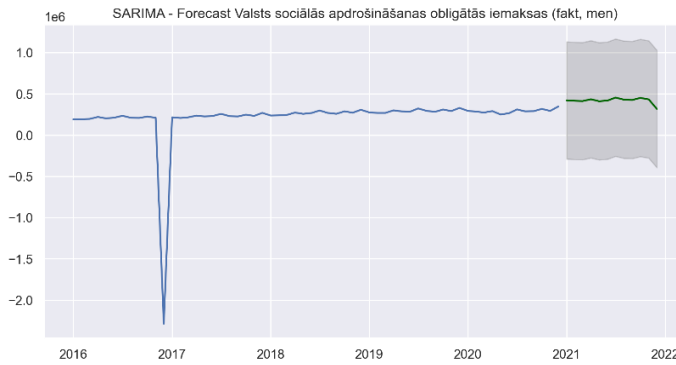


Figure A6.145 SARIMA model prediction for VSAOI time series for next 12 months

Source: created by the author.



Figure A6.146 SARIMA model prediction for VSAOI time series for 2019

Source: created by the author.



	prediction	lower_bound	upper_bound
0			
2021-01-01	420584.048124	-290648.271894	1.131816e+06
2021-02-01	414675.422209	-296556.897809	1.125908e+06
2021-03-01	412018.185564	-299214.134454	1.123251e+06
2021-04-01	434387.754080	-276844.565938	1.145620e+06
2021-05-01	410302.359071	-300929.960946	1.121535e+06
2021-06-01	417962.915358	-293269.404660	1.129195e+06
2021-07-01	454626.078249	-256606.241769	1.165858e+06
2021-08-01	429733.955938	-281498.364080	1.140966e+06
2021-09-01	425966.602897	-285265.717121	1.137199e+06
2021-10-01	450845.371464	-260386.948554	1.162078e+06
2021-11-01	432410.244807	-278822.075211	1.143643e+06
2021-12-01	317175.957701	-394056.362316	1.028408e+06

Figure A6.147 SARIMA model prediction for VSAOI time series for 2020

Source: created by the author.

```

=====
SARIMAX Results
=====
Dep. Variable:   Valsts sociālās apdrošināšanas obligātās iemaksas (fakt, men)   No. Observations:   60
Model:          SARIMAX(0, 1, 3)x(0, 1, [1], 12)                               Log Likelihood      -650.375
Date:           Thu, 23 Sep 2021                                                AIC                  1310.749
Time:           17:58:19                                                         BIC                  1320.000
Sample:         01-01-2016                                                       HQIC                 1314.231
               - 12-01-2020
Covariance Type: opg

=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
ma.L1         -0.9552    277.117        -0.003    0.997    -544.094    542.183
ma.L2         -0.9805     12.484        -0.006    0.995     -24.548     24.387
ma.L3          0.9356      9.847         0.004    0.997     -19.265     19.336
ma.S.L12      -1.0000     277.138        -0.004    0.997     -544.181    542.181
sigma2        1.914e+10    1.39e-08    1.38e+18    0.000    1.91e+10    1.91e+10
=====
Ljung-Box (L1) (Q):           0.23   Jarque-Bera (JB):           129.58
Prob(Q):                      0.63   Prob(JB):                   0.00
Heteroskedasticity (H):       0.46   Skew:                        2.42
Prob(H) (two-sided):          0.13   Kurtosis:                    9.54
=====
    
```

Figure A6.148 SARIMA model (semi-auto) for VSAOI time series

Source: created by the author.

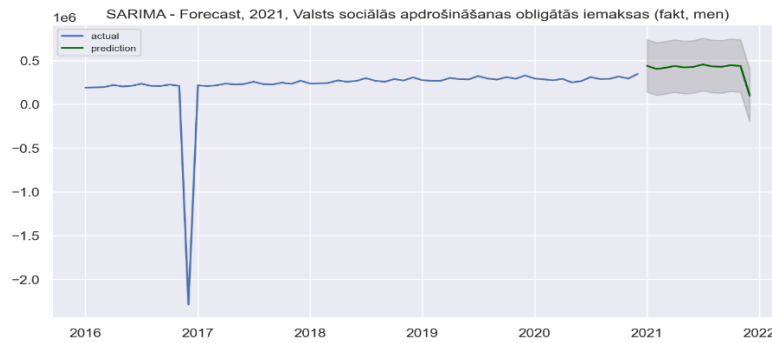


Figure A6.149 SARIMA model (semi-auto) prediction for VSAOI time series for next 12 months

Source: created by the author.



Figure A6.150 SARIMA model (semi-auto) prediction for VSAOI time series for 2019

Source: created by the author.

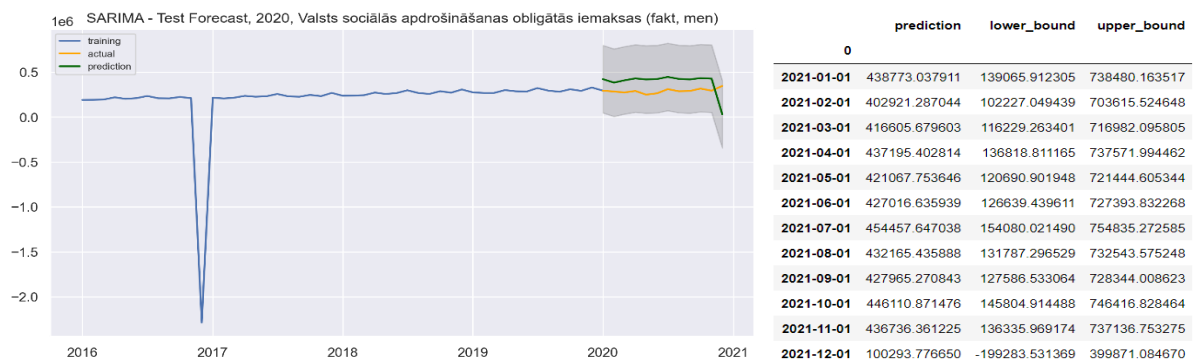


Figure A6.151 SARIMA model (semi-auto) prediction for VSAOI time series for 2020

Source: created by the author.

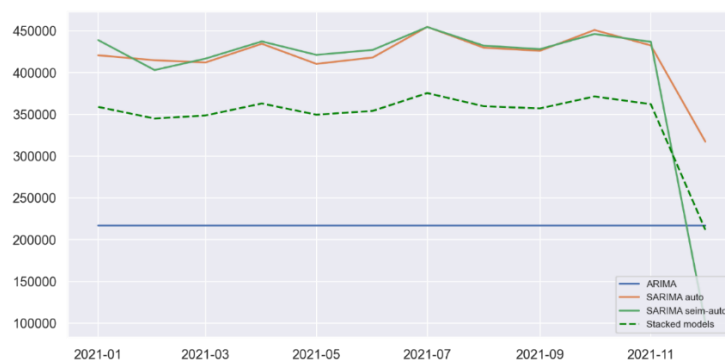


Figure A6.152 ARIMA, SARIMA, semi-auto SARIMA and stacked model comparison for VSAOI time series

Source: created by the author.

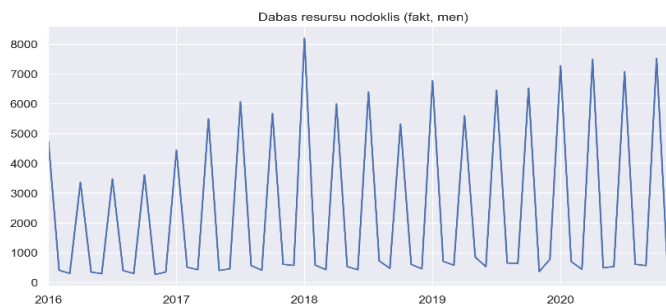


Figure A6.153 Monthly DRN collections in Latvia in 2016–2020

Source: created by the author based on the SRS data.

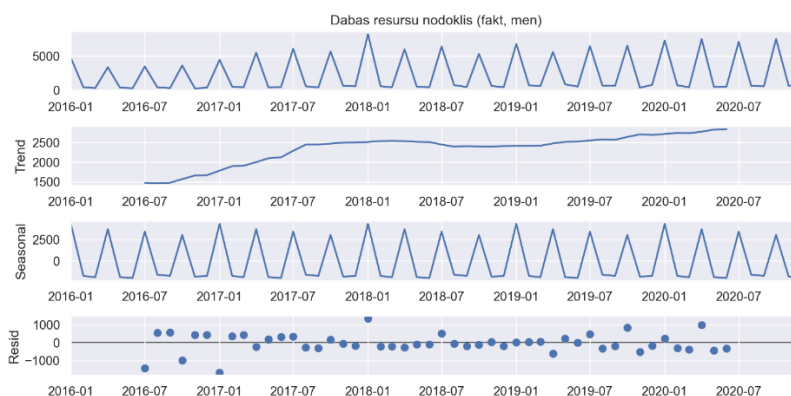


Figure A6.154 Seasonal decomposition of DRN time series

Source: created by the author.

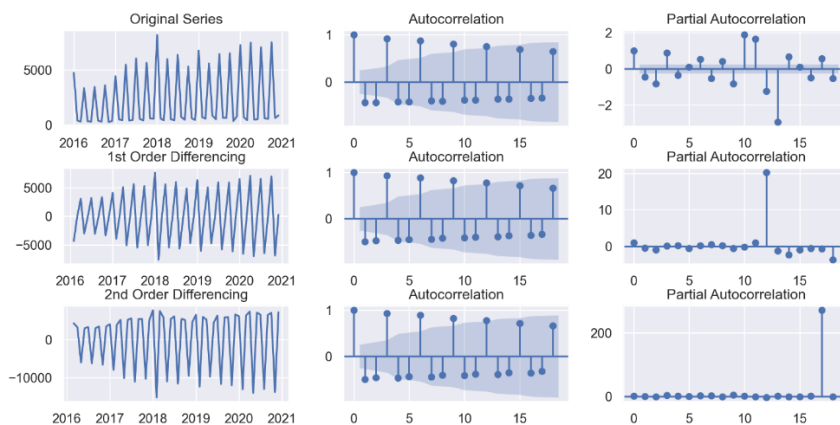


Figure A6.155 ACF and PACF plot of original and differentiated DRN time series

Source: created by the author.

Table A6.10

ADF and KPSS stationarity tests for DRN time series

Time series	ADF Statistic (p-value)	KPSS Statistic (p-value)	Stationarity
Original series	0.66087	0.07615	Stationary time series
First order differencing	3.26235e-11	0.1	Stationary time series
Second order differencing	1.61297e-07	0.06916	Stationary time series

Source: created by the author.

SARIMAX Results						
Dep. Variable:	y	No. Observations:	60			
Model:	SARIMAX(5, 1, 1)	Log Likelihood:	-457.614			
Date:	Thu, 23 Sep 2021	AIC:	929.227			
Time:	18:00:45	BIC:	943.770			
Sample:	0	HQIC:	934.904			
	- 60					
Covariance Type:	opg					
	coef	std err	z	P> z	[0.025	0.975]
ar.L1	-1.0077	0.741	-1.360	0.174	-2.460	0.445
ar.L2	-0.9928	0.846	-1.174	0.240	-2.650	0.665
ar.L3	-0.5166	0.858	-0.602	0.547	-2.198	1.165
ar.L4	-0.5077	0.412	-1.232	0.218	-1.315	0.300
ar.L5	-0.5180	0.076	-6.776	0.000	-0.668	-0.368
ma.L1	0.0542	0.816	0.066	0.947	-1.544	1.653
sigma2	2.692e+05	3.33e+04	8.092	0.000	2.04e+05	3.34e+05
Ljung-Box (L1) (Q):	0.07		Jarque-Bera (JB):	87.21		
Prob(Q):	0.78		Prob(JB):	0.00		
Heteroskedasticity (H):	0.34		Skew:	1.50		
Prob(H) (two-sided):	0.02		Kurtosis:	8.15		

Figure A6.156 ARIMA model for DRN time series

Source: created by the author.

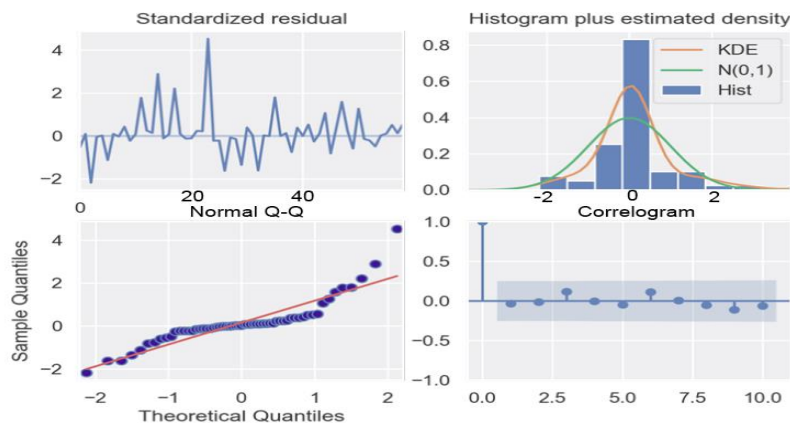


Figure A6.157 Residuals and density plots for DRN time series

Source: created by the author.

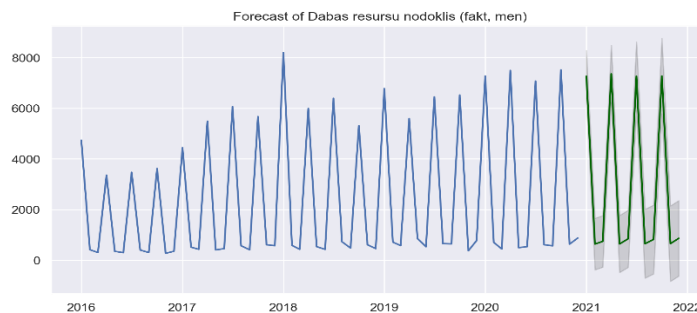


Figure A6.158 ARIMA model prediction for DRN time series for 2020

Source: created by the author.

SARIMAX Results						
Dep. Variable:	y	No. Observations:	60			
Model:	SARIMAX(0, 1, 2)x(0, 1, [], 12)	Log Likelihood:	-383.265			
Date:	Thu, 23 Sep 2021	AIC:	772.530			
Time:	18:08:04	BIC:	778.081			
Sample:	0	HQIC:	774.619			
	- 60					
Covariance Type:	opg					
	coef	std err	z	P> z	[0.025	0.975]
ma.L1	-1.2105	0.152	-7.980	0.000	-1.508	-0.913
ma.L2	0.4712	0.152	3.102	0.002	0.173	0.769
sigma2	7.028e+05	1.21e+05	5.805	0.000	4.66e+05	9.4e+05
Ljung-Box (L1) (Q):	0.32		Jarque-Bera (JB):	12.00		
Prob(Q):	0.57		Prob(JB):	0.00		
Heteroskedasticity (H):	0.22		Skew:	0.98		
Prob(H) (two-sided):	0.00		Kurtosis:	4.52		

Figure A6.159 SARIMA model for DRN time series

Source: created by the author.

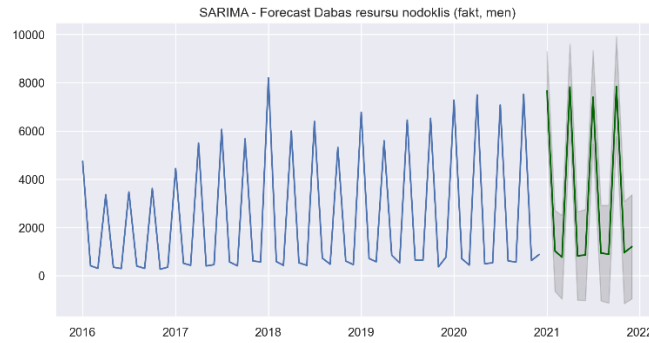


Figure A6.160 SARIMA model prediction for DRN time series for next 12 months

Source: created by the author.

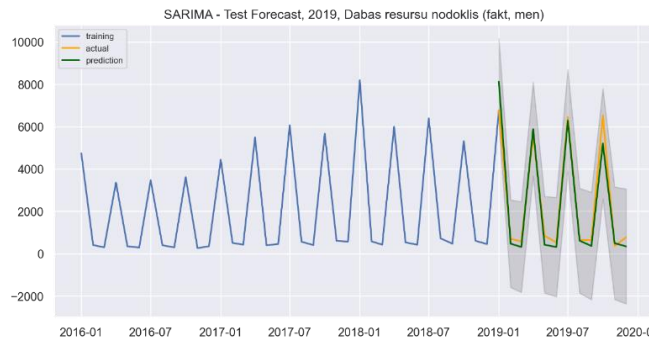


Figure A6.161 SARIMA model prediction for DRN time series for 2019

Source: created by the author.

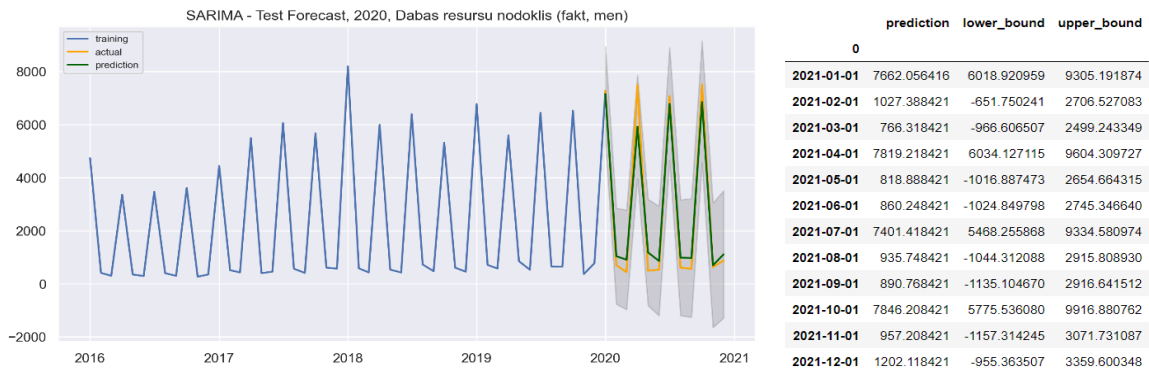


Figure A6.162 SARIMA model prediction for DRN time series for 2020

Source: created by the author.

```

=====
SARIMAX Results
=====
Dep. Variable:    Dabas resursu nodoklis (fakt, men)    No. Observations:    60
Model:           SARIMAX(2, 1, 0)x(2, 1, [1], 12)    Log Likelihood       -364.104
Date:            Thu, 23 Sep 2021                    AIC                  740.208
Time:            18:12:40                            BIC                  751.309
Sample:          01-01-2016                          HQIC                 744.385
Covariance Type: opg
=====
              coef    std err          z      P>|z|    [0.025    0.975]
-----
ar.L1         -1.0926        0.051    -19.469    0.000    -1.184    -0.992
ar.L2         -0.9995        0.003   -286.209    0.000    -1.006    -0.993
ar.S.L12      -0.6451        0.229    -2.814    0.005    -1.094    -0.196
ar.S.L24      -0.4117        0.222    -1.858    0.063    -0.846    0.023
ma.S.L12      -0.9064        0.331    -2.737    0.006    -1.556    -0.257
sigma2        1.647e+05    2.31e-06    7.12e+10    0.000    1.65e+05    1.65e+05
=====
Ljung-Box (L1) (Q):           0.52    Jarque-Bera (JB):           13.32
Prob(Q):                      0.47    Prob(JB):                   0.00
Heteroskedasticity (H):       0.48    Skew:                        0.39
Prob(H) (two-sided):          0.16    Kurtosis:                    5.49
=====

```

Figure A6.163 SARIMA model (semi-auto) for DRN time series

Source: created by the author.

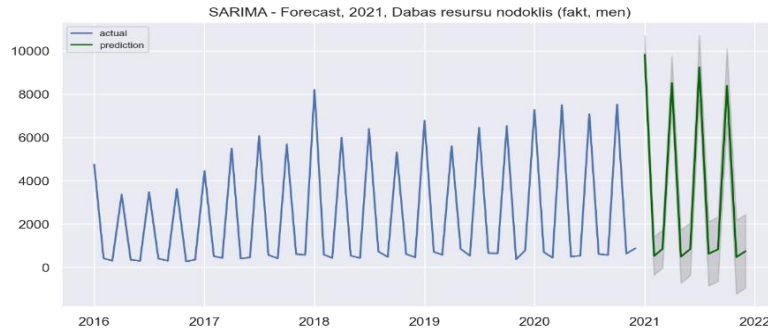


Figure A6.164 SARIMA model (semi-auto) prediction for DRN time series for next 12 months

Source: created by the author.

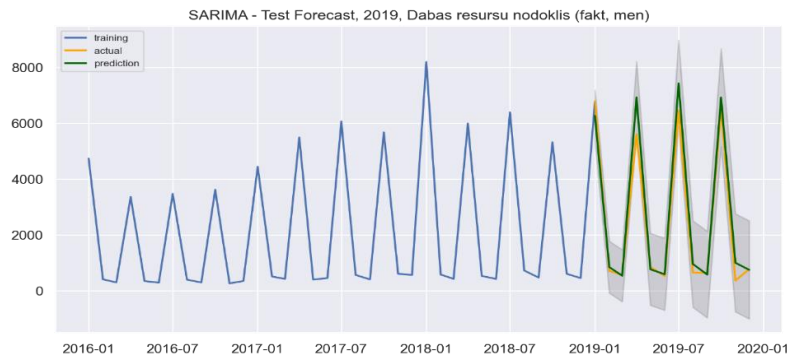


Figure A6.165 SARIMA model (semi-auto) prediction for DRN time series for 2019

Source: created by the author.

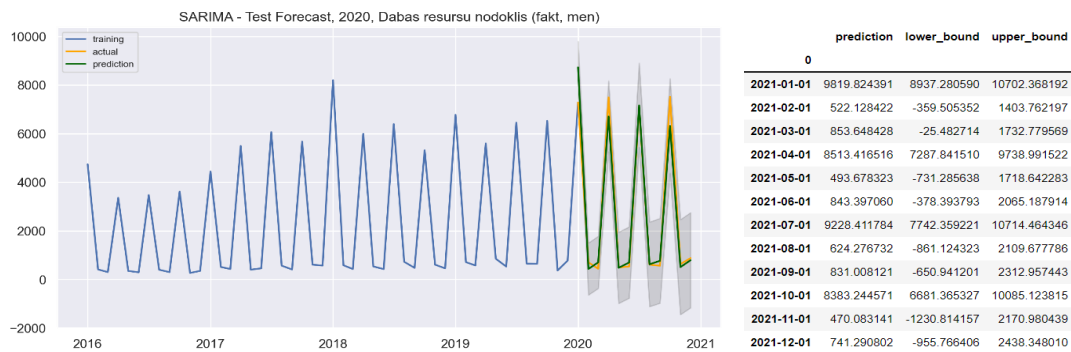


Figure A6.166 SARIMA model (semi-auto) prediction for DRN time series for 2020

Source: created by the author.

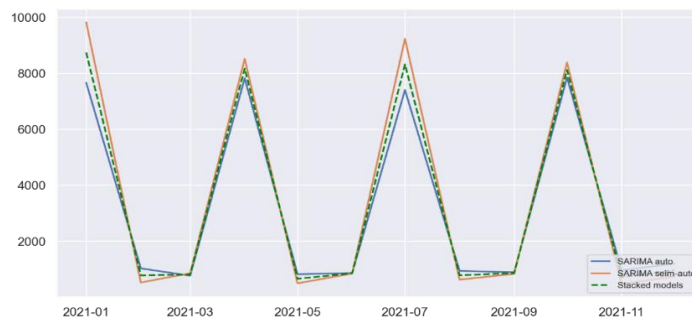


Figure A6.167 ARIMA, SARIMA, semi-auto SARIMA and stacked model comparison for DRN time series

Source: created by the author.

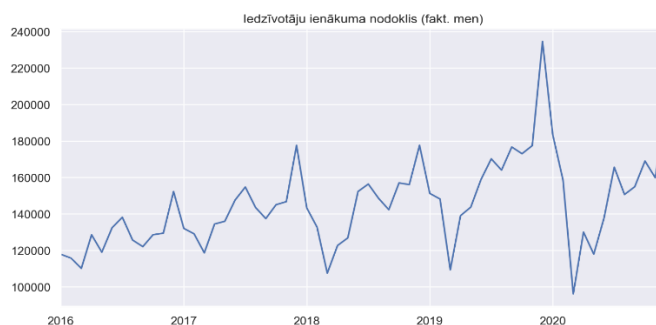


Figure A6.168 Monthly IIN collections in Latvia in 2016–2020

Source: created by the author based on the SRS data.

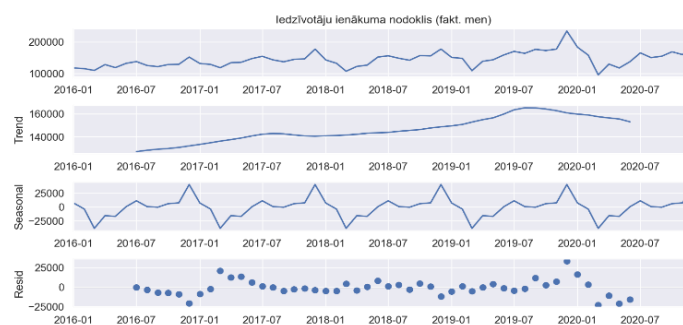


Figure A6.169 Seasonal decomposition of IIN time series

Source: created by the author.

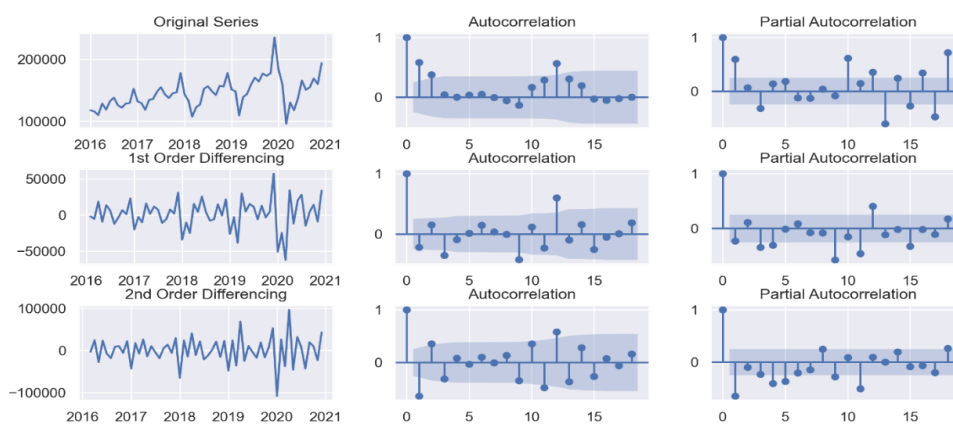


Figure A6.170 ACF and PACF plot of original and differentiated IIN time series

Source: created by the author.

Table A6.11

ADF and KPSS stationarity tests for IIN time series

Time series	ADF Statistic (p-value)	KPSS Statistic (p-value)	Stationarity
Original series	0.52757	0.02482	Non-stationary time series
First order differencing	0.77018	0.1	Stationary time series
Second order differencing	7.47167e-15	0.1	Stationary time series

Source: created by the author.

SARIMAX Results

```

=====
Dep. Variable:          y          No. Observations:      60
Model:                SARIMAX(2, 0, 1)  Log Likelihood:       -679.275
Date:                 Thu, 23 Sep 2021  AIC:                   1366.549
Time:                 18:19:09         BIC:                   1374.927
Sample:                0             HQIC:                  1369.826
Covariance Type:      opg
=====

```

	coef	std err	z	P> z	[0.025	0.975]
ar.L1	-0.0072	0.024	-0.306	0.759	-0.053	0.039
ar.L2	0.9909	0.020	49.585	0.000	0.952	1.030
ma.L1	0.9812	0.136	7.196	0.000	0.714	1.248
sigma2	4.181e+08	1.57e-10	2.66e+18	0.000	4.18e+08	4.18e+08

```

=====
Ljung-Box (L1) (Q):      0.31  Jarque-Bera (JB):      3.53
Prob(Q):                 0.58  Prob(JB):              0.17
Heteroskedasticity (H): 5.51  Skew:                  -0.44
Prob(H) (two-sided):    0.00  Kurtosis:              3.80
=====

```

Figure A6.171 ARIMA model for IIN time series

Source: created by the author.

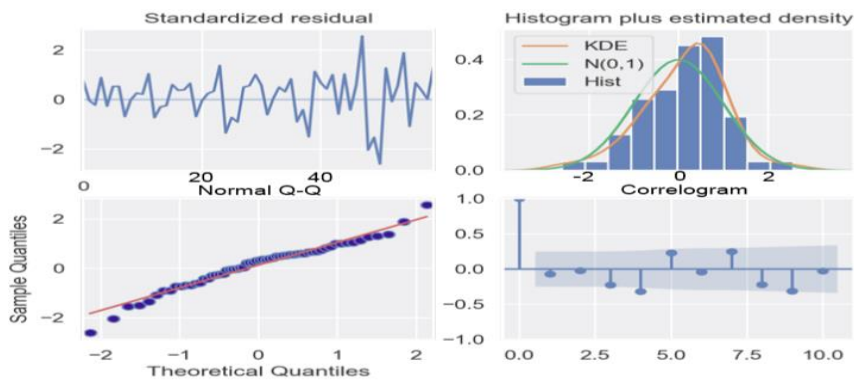


Figure A6.172 Residuals and density plots for IIN time series

Source: created by the author.

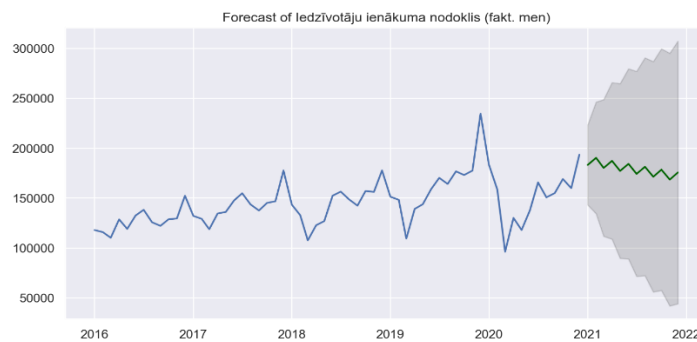


Figure A6.173 ARIMA model prediction for IIN time series for next 12 months

Source: created by the author.

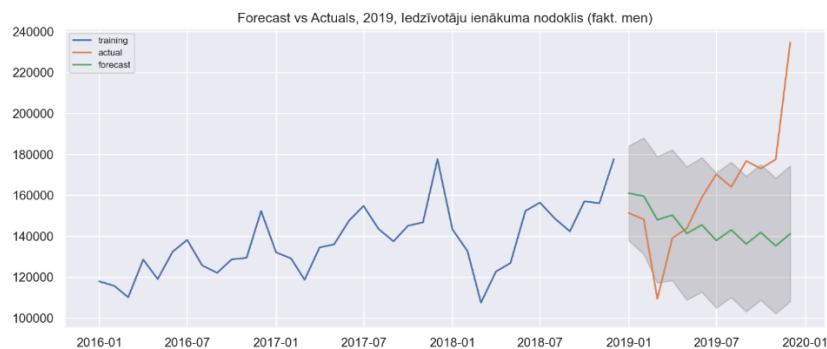


Figure A6.174 ARIMA model prediction for IIN time series for 2019

Source: created by the author.

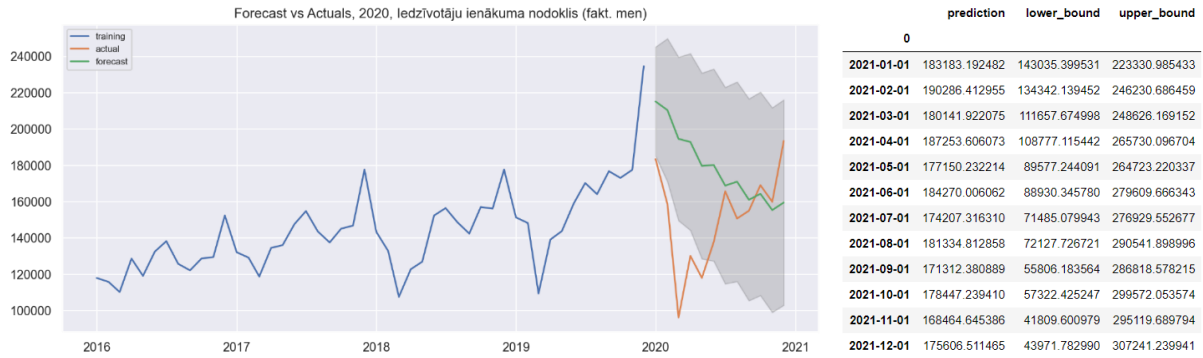


Figure A6.175 ARIMA model prediction for IIN time series for 2020

Source: created by the author.

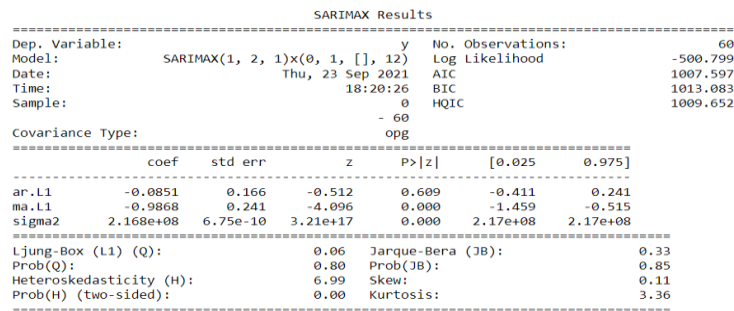


Figure A6.176 SARIMA model for IIN time series

Source: created by the author.

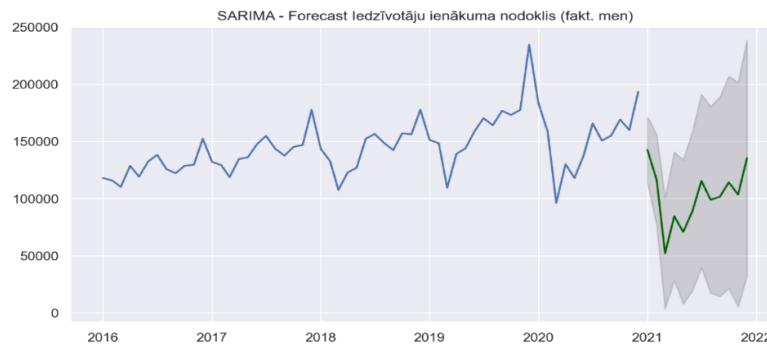


Figure A6.177 SARIMA model prediction for IIN time series for next 12 months

Source: created by the author.

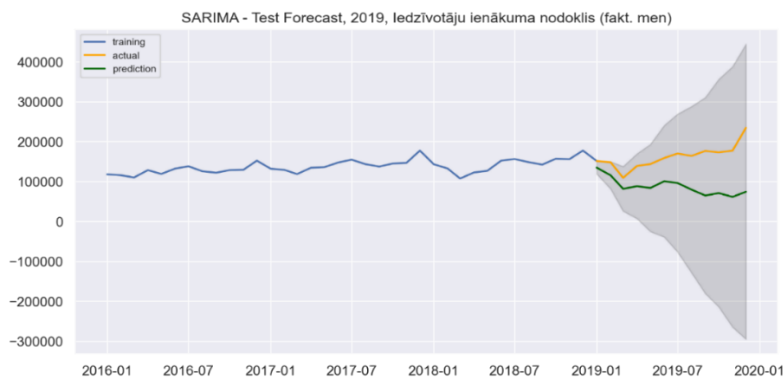


Figure A6.178 SARIMA model prediction for IIN time series for 2019

Source: created by the author.

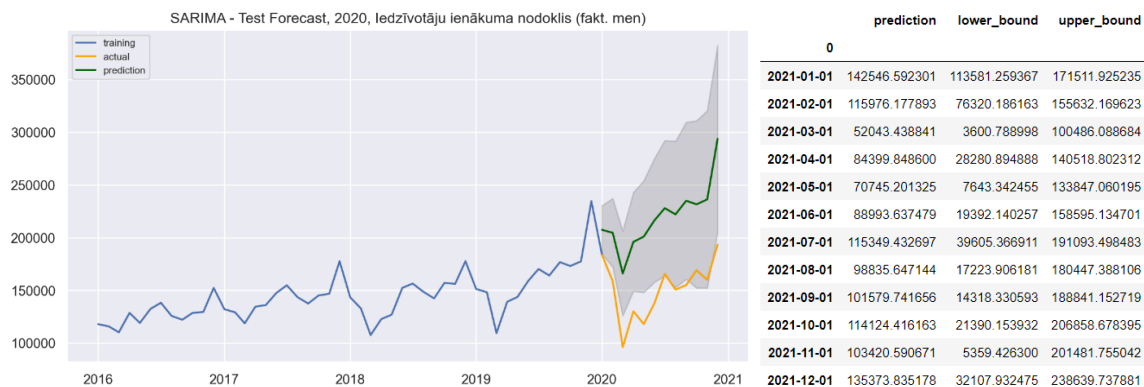


Figure A6.179 SARIMA model prediction for IIN time series for 2020

Source: created by the author.

SARIMAX Results

```

=====
Dep. Variable:   Iedzīvotāju ienākuma nodoklis (fakt. men)   No. Observations:   60
Model:          SARIMAX(0, 1, 0)x(0, 1, 0, 12)             Log Likelihood      -509.570
Date:           Thu, 23 Sep 2021                          AIC                 1021.141
Time:           18:24:20                                    BIC                 1022.991
Sample:         01-01-2016                                 HQIC                1021.837
               - 12-01-2020
Covariance Type: opg
=====
              coef      std err      z      P>|z|      [0.025      0.975]
-----
sigma2        1.462e+08    2.69e+07    5.439    0.000    9.35e+07    1.99e+08
=====
Ljung-Box (L1) (Q):           0.49   Jarque-Bera (JB):           0.68
Prob(Q):                      0.48   Prob(JB):                   0.71
Heteroskedasticity (H):       7.62   Skew:                        0.22
Prob(H) (two-sided):          0.00   Kurtosis:                    3.39
=====
    
```

Figure A6.180 SARIMA model (semi-auto) for IIN time series

Source: created by the author.

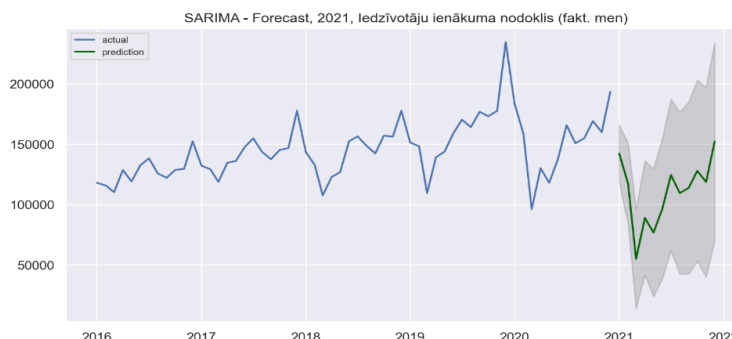


Figure A6.181 SARIMA model (semi-auto) prediction for IIN time series for next 12 months

Source: created by the author.

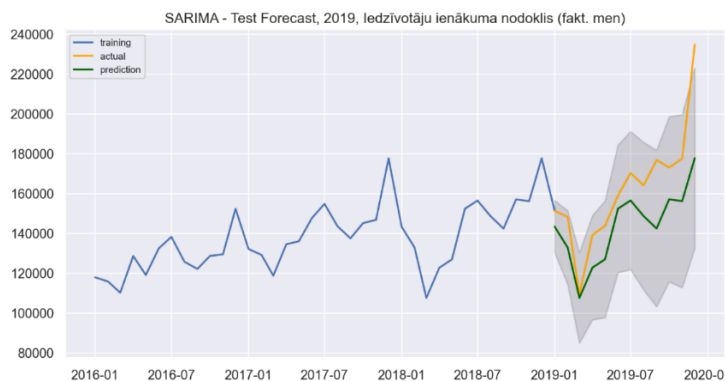


Figure A6.182 SARIMA model (semi-auto) prediction for IIN time series for 2019

Source: created by the author.

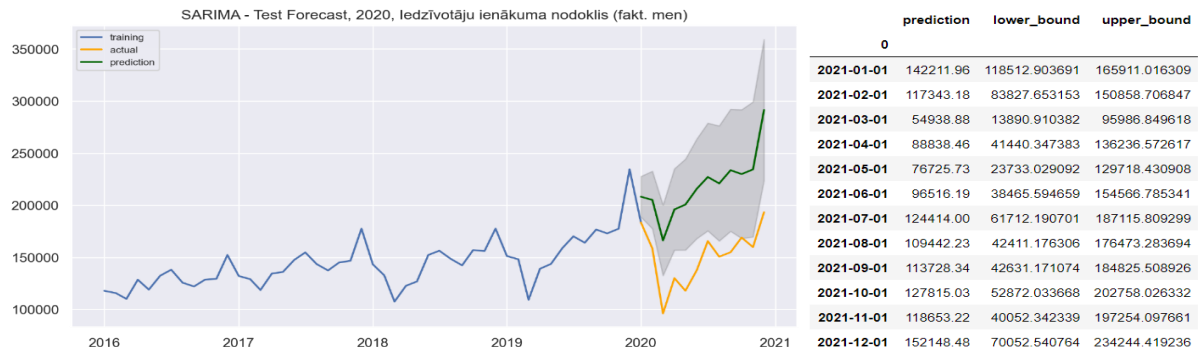


Figure A6.183 SARIMA model (semi-auto) prediction for IIN time series for 2020

Source: created by the author.

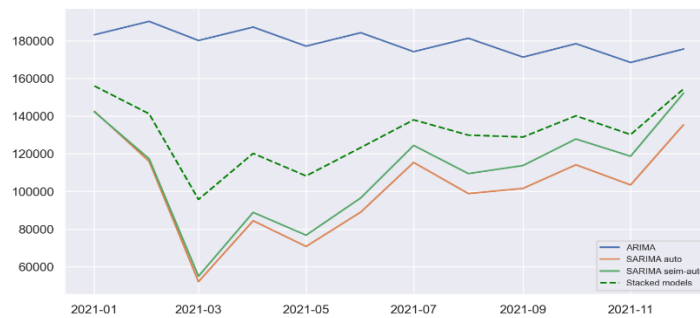


Figure A6.184 ARIMA, SARIMA, semi-auto SARIMA and stacked model comparison for IIN time series

Source: created by the author.

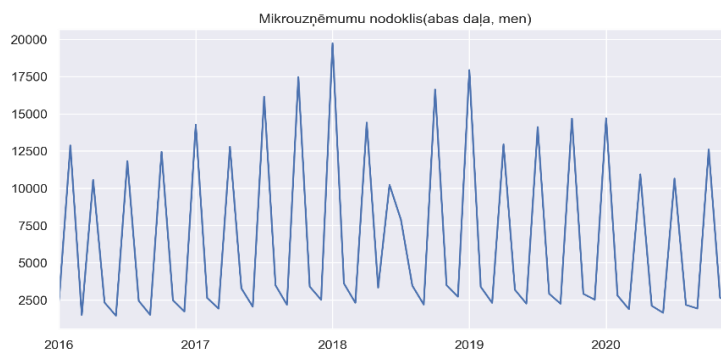


Figure A6.185 Monthly MUN collections in Latvia in 2016–2020

Source: created by the author based on the SRS data.

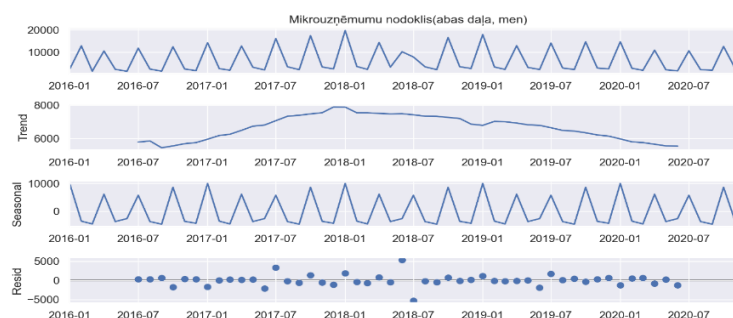


Figure A6.186 Seasonal decomposition of MUN time series

Source: created by the author.

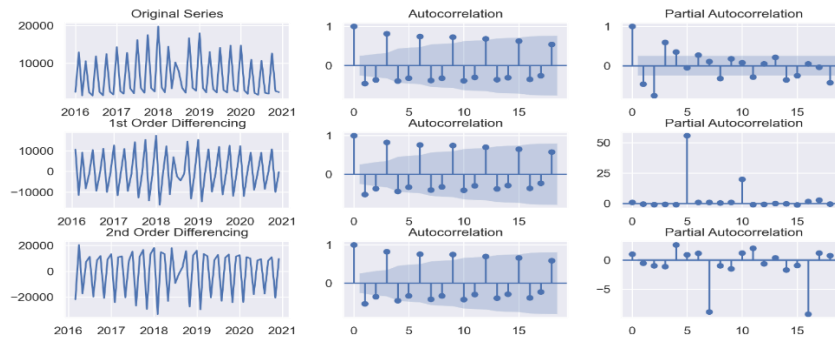


Figure A6.187 ACF and PACF plot of original and differentiated MUN time series

Source: created by the author.

Table A6.12

ADF and KPSS stationarity tests for MUN time series

Time series	ADF Statistic (p-value)	KPSS Statistic (p-value)	Stationarity
Original series	0.00888	0.1	Stationary time series
First order differencing	0.00276	0.07020	Stationary time series
Second order differencing	9.61478e-05	0.09549	Stationary time series

Source: created by the author.

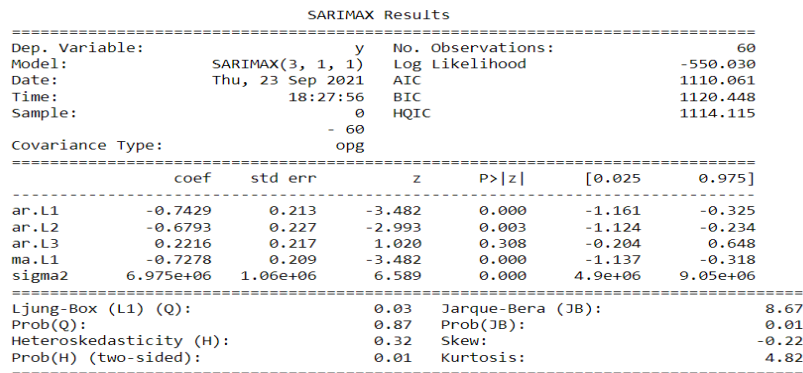


Figure A6.188 ARIMA model for MUN time series

Source: created by the author.

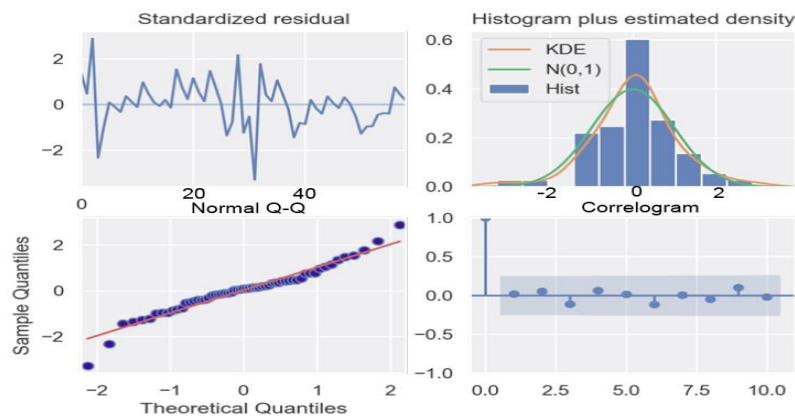


Figure A6.189 Residuals and density plots for MUN time series

Source: created by the author.

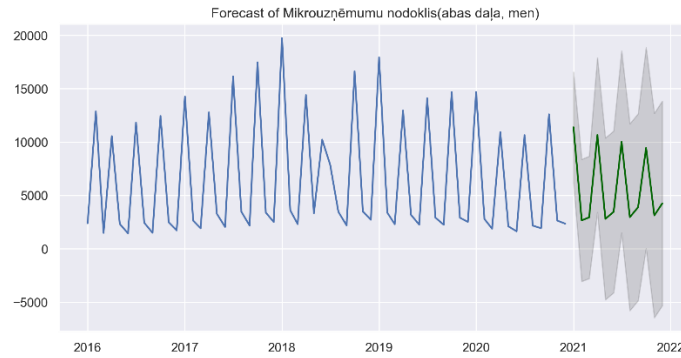


Figure A6.190 ARIMA model prediction for MUN time series for next 12 months

Source: created by the author.

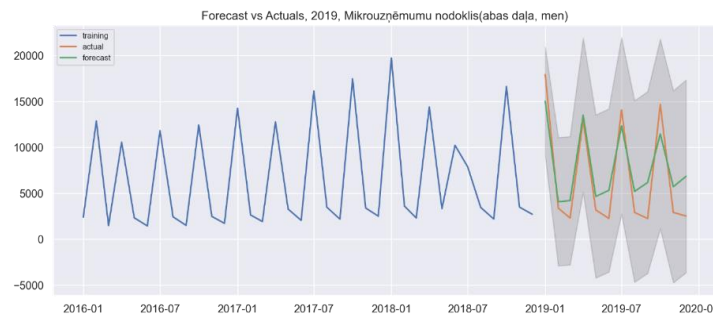


Figure A6.191 ARIMA model prediction for MUN time series for 2019

Source: created by the author.

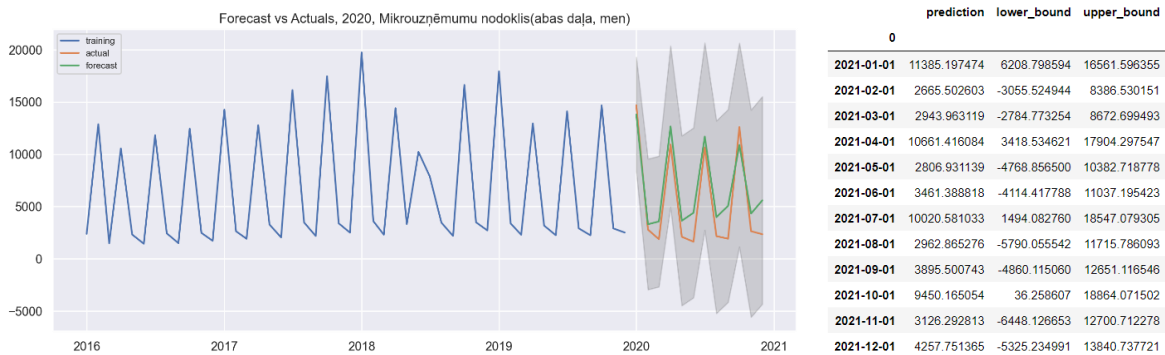


Figure A6.192 ARIMA model prediction for MUN time series for 2020

Source: created by the author.

```

=====
SARIMAX Results
=====
Dep. Variable:          y          No. Observations:          60
Model:                 SARIMAX(3, 0, 1)x(0, 1, 1, 12)      Log Likelihood             -450.784
Date:                  Thu, 23 Sep 2021                    AIC                       913.568
Time:                  18:29:00                            BIC                       924.795
Sample:                0                                  HQIC                      917.811
Sample frequency:      - 60
Covariance Type:      opg
=====
              coef      std err      z      P>|z|      [0.025      0.975]
-----
ar.L1          0.2267      0.129      1.762      0.078      -0.025      0.479
ar.L2          0.1899      0.099      1.917      0.055      -0.004      0.384
ar.L3          0.4606      0.107      4.306      0.000      0.251      0.670
ma.L1         -0.6601      0.120     -5.504      0.000     -0.895     -0.425
ma.S.L12      -0.4840      0.138     -3.502      0.000     -0.755     -0.213
sigma2        7.292e+06      5e-09      1.46e+15      0.000      7.29e+06      7.29e+06
=====
Ljung-Box (L1) (Q):          0.39      Jarque-Bera (JB):          2.75
Prob(Q):                    0.53      Prob(JB):                  0.25
Heteroskedasticity (H):     0.11      Skew:                      0.56
Prob(H) (two-sided):        0.00      Kurtosis:                  3.31
=====
    
```

Figure A6.193 SARIMA model for MUN time series

Source: created by the author.

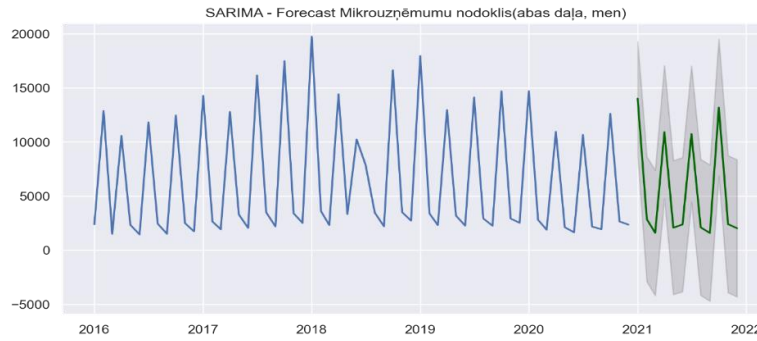


Figure A6.194 SARIMA model prediction for MUN time series for next 12 months

Source: created by the author.

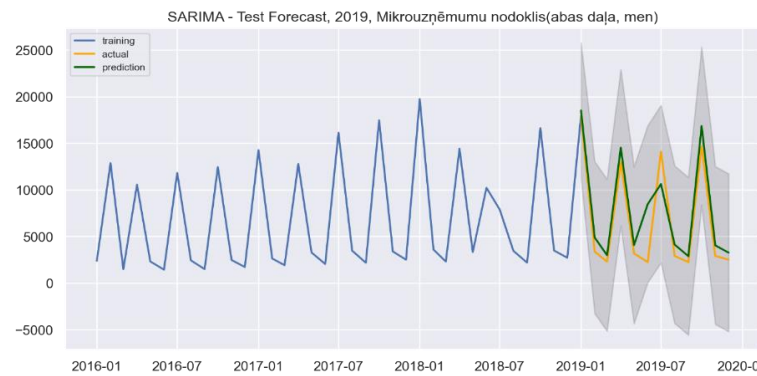


Figure A6.195 SARIMA model prediction for MUN time series for 2019

Source: created by the author.

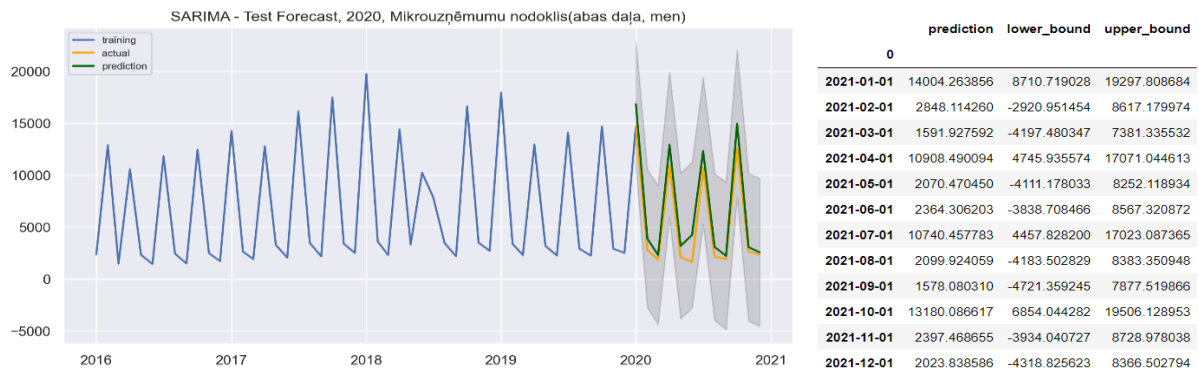


Figure A6.196 SARIMA model prediction for MUN time series for 2020

Source: created by the author.

```

SARIMAX Results
=====
Dep. Variable:   Mikrouzņēmumu nodoklis(abas daļa, men)   No. Observations:   60
Model:          SARIMAX(2, 1, 1)x(0, 1, 1, 12)           LOG Likelihood      -442.422
Date:           Thu, 23 Sep 2021                          AIC                 894.843
Time:           18:37:00                                   BIC                 904.094
Sample:         01-01-2016                                HQIC                898.324
                - 12-01-2020
Covariance Type: opg
=====
                coef    std err          z      P>|z|      [0.025    0.975]
-----
ar.L1            -0.7091     0.133      -5.334     0.000     -0.970     -0.449
ar.L2            -0.4330     0.130      -3.318     0.001     -0.689     -0.177
ma.L1            -0.6324     0.161      -3.929     0.000     -0.948     -0.317
ma.S.L12         -0.4306     0.119      -3.625     0.000     -0.663     -0.198
sigma2           7.523e+06    8.99e-09    8.37e+14    0.000    7.52e+06    7.52e+06
=====
Ljung-Box (L1) (Q):           0.80   Jarque-Bera (JB):           2.52
Prob(Q):                      0.37   Prob(JB):                   0.28
Heteroskedasticity (H):       0.09   Skew:                        -0.30
Prob(H) (two-sided):          0.00   Kurtosis:                    3.96
=====

```

Figure A6.197 SARIMA model (semi-auto) for MUN time series

Source: created by the author.

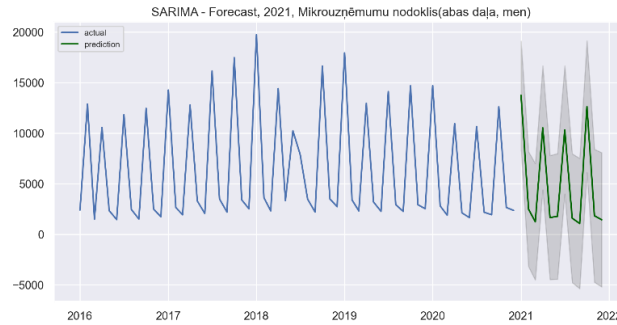


Figure A6.198 SARIMA model (semi-auto) prediction for MUN time series for next 12 months

Source: created by the author.

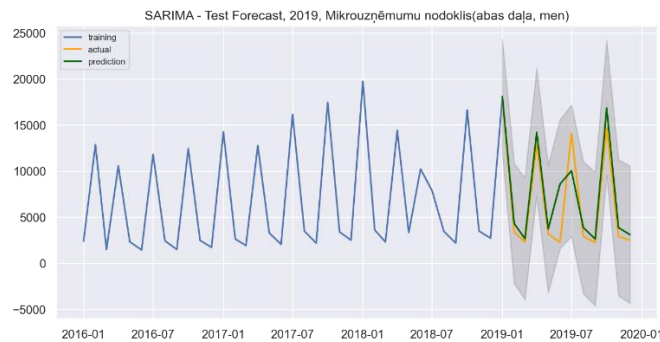


Figure A6.199 SARIMA model (semi-auto) prediction for MUN time series for 2019

Source: created by the author.

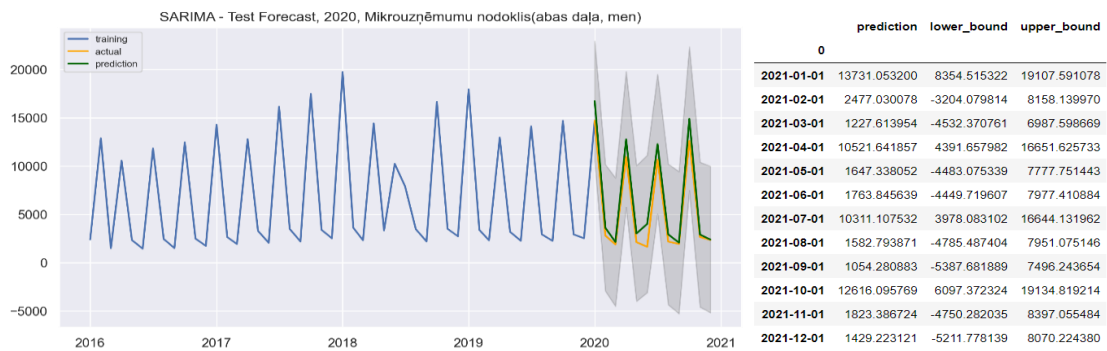


Figure A6.200 SARIMA model (semi-auto) prediction for MUN time series for 2020

Source: created by the author.

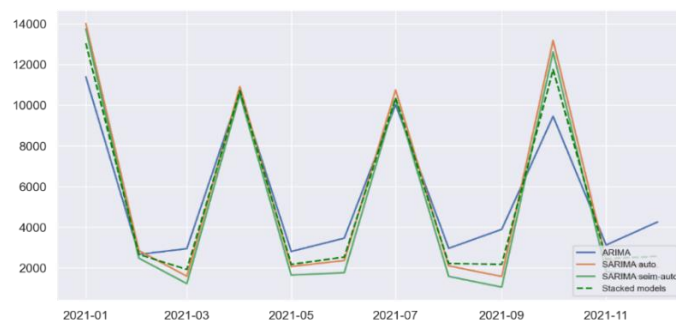


Figure A6.201 ARIMA, SARIMA, semi-auto SARIMA and stacked model comparison for MUN time series

Source: created by the author.

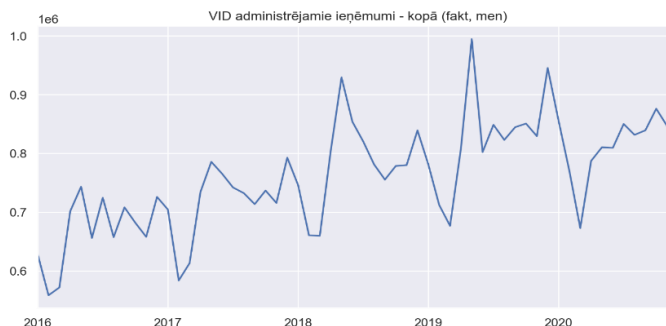


Figure A6.202 Monthly VID AI (total SRS administrated income) collections in Latvia in 2016–2020

Source: created by the author based on the SRS data.

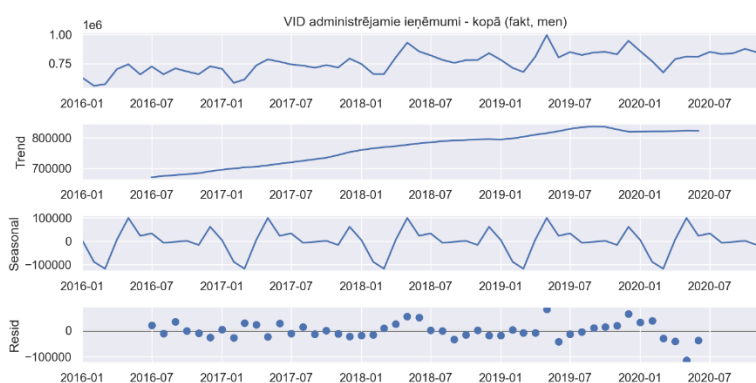


Figure A6.203 Seasonal decomposition of VID AI time series

Source: created by the author.

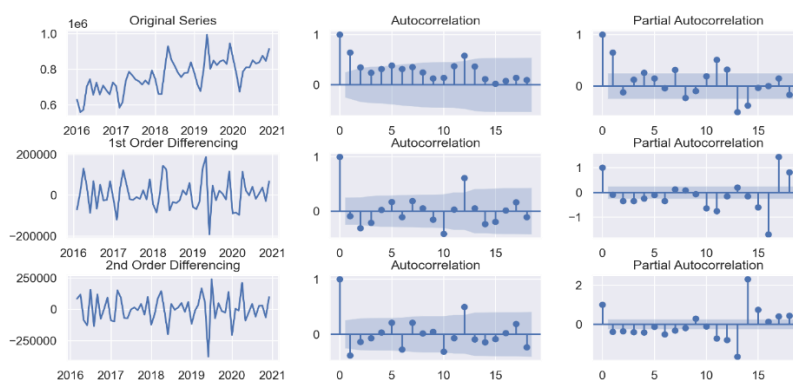


Figure A6.204 ACF and PACF plot of original and differentiated VID AI time series

Source: created by the author.

Table A6.13

ADF and KPSS stationarity tests for VID AI time series

Time series	ADF Statistic (p-value)	KPSS Statistic (p-value)	Stationarity
Original series	0.28742	0.02082	Non-stationary time series
First order differencing	1.08322e-09	0.1	Stationary time series
Second order differencing	3.14422e-08	0.1	Stationary time series

Source: created by the author.

SARIMAX Results

```

=====
Dep. Variable:          y          No. Observations:          60
Model:                 SARIMAX(1, 0, 2)  Log Likelihood             -751.701
Date:                  Thu, 23 Sep 2021  AIC                          1511.401
Time:                  19:11:35        BIC                          1519.779
Sample:                0              HQIC                         1514.678
Covariance Type:      opg
=====

```

	coef	std err	z	P> z	[0.025	0.975]
ar.L1	0.9998	0.001	772.988	0.000	0.997	1.002
ma.L1	-0.3497	0.134	-2.603	0.009	-0.613	-0.086
ma.L2	-0.4103	0.128	-3.202	0.001	-0.661	-0.159
sigma2	4.219e+09	1.29e-11	3.27e+20	0.000	4.22e+09	4.22e+09

```

=====
Ljung-Box (L1) (Q):          0.28  Jarque-Bera (JB):          0.52
Prob(Q):                     0.60  Prob(JB):                  0.77
Heteroskedasticity (H):      1.64  Skew:                      0.22
Prob(H) (two-sided):         0.28  Kurtosis:                  3.15
=====

```

Figure A6.205 ARIMA model for VID AI time series

Source: created by the author.

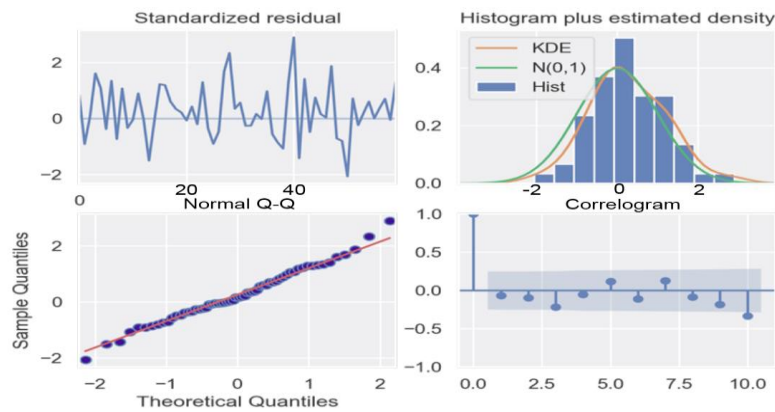


Figure A6.206 Residuals and density plots for VID AI time series

Source: created by the author.

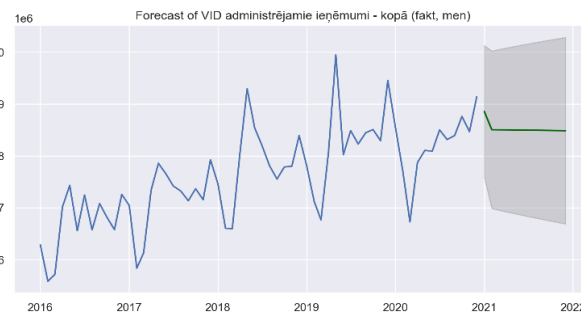


Figure A6.207 ARIMA model prediction for VID AI time series for next 12 months

Source: created by the author.

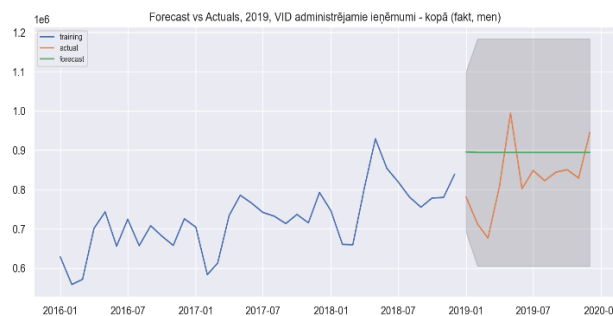


Figure A6.208 ARIMA model prediction for VID AI time series for 2019

Source: created by the author.

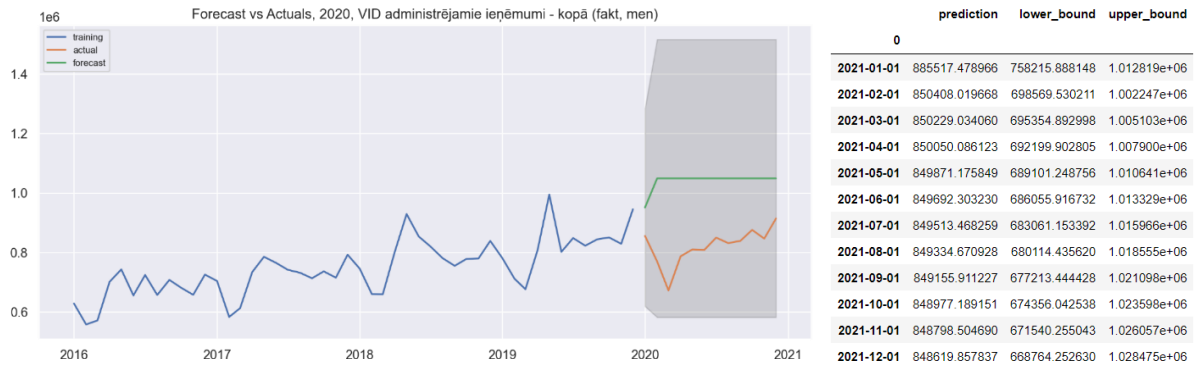


Figure A6.209 ARIMA model prediction for VID AI time series for 2020

Source: created by the author.

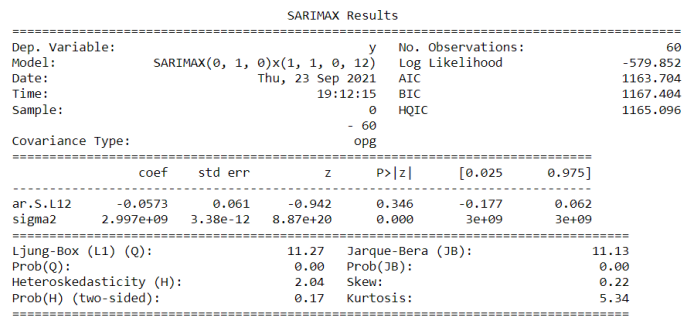


Figure A6.210 SARIMA model for VID AI time series

Source: created by the author.

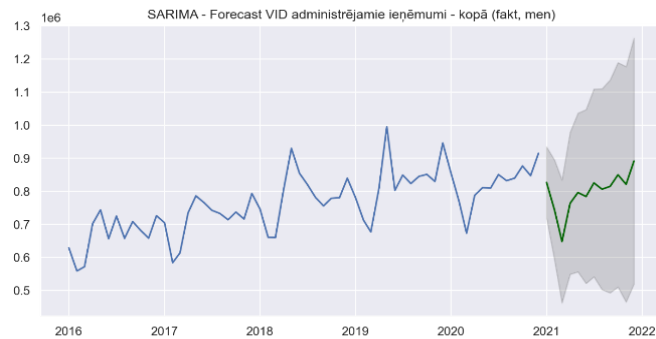


Figure A6.211 SARIMA model prediction for VID AI time series for next 12 months

Source: created by the author.

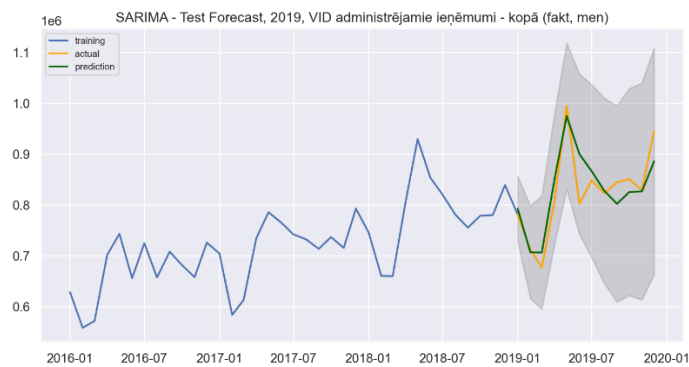


Figure A6.212 SARIMA model prediction for VID AI time series for 2019

Source: created by the author.

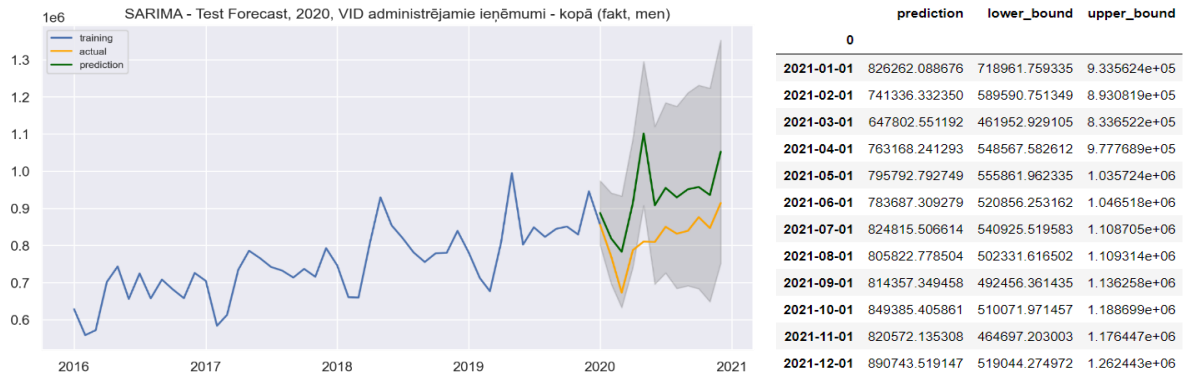


Figure A6.213 SARIMA model prediction for VID AI time series for 2020

Source: created by the author.

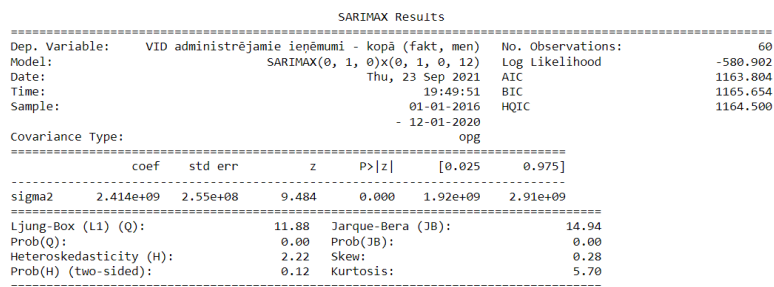


Figure A6.214 SARIMA model (semi-auto) for VID AI time series

Source: created by the author.

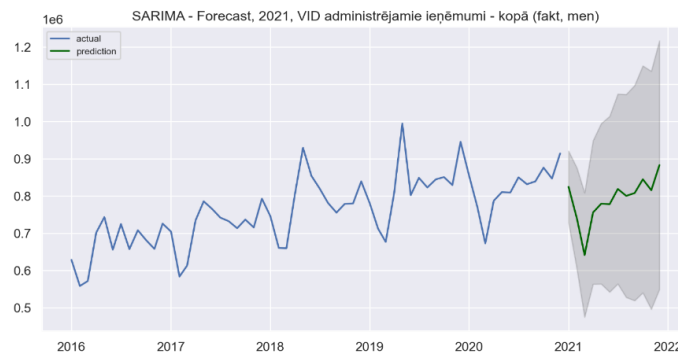


Figure A6.215 SARIMA model (semi-auto) prediction for VID AI time series for next 12 months

Source: created by the author.

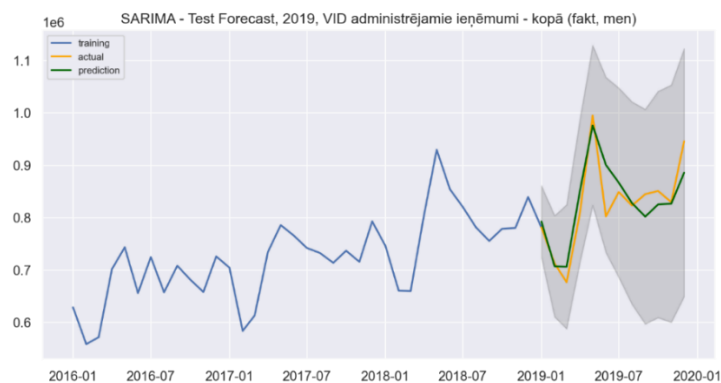


Figure A6.216 SARIMA model (semi-auto) prediction for VID AI time series for 2019

Source: created by the author.

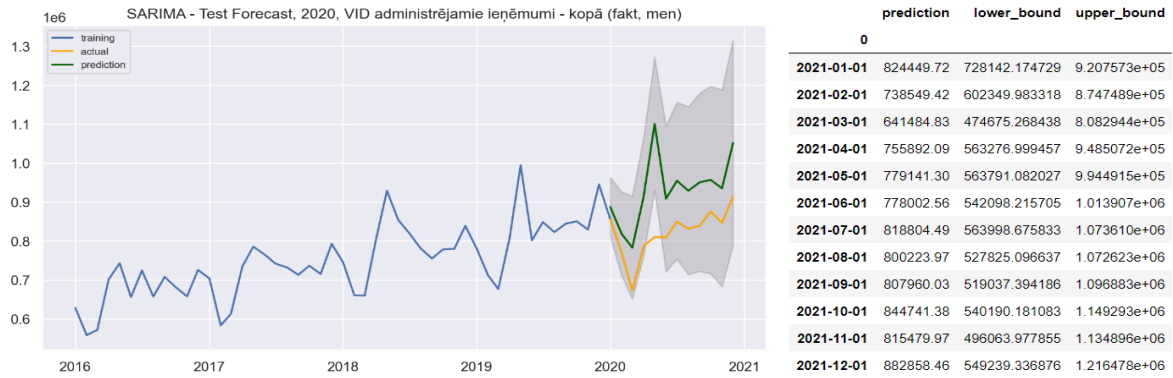


Figure A6.217 SARIMA model (semi-auto) prediction for VID AI time series for 2020

Source: created by the author.



Figure A6.218 ARIMA, SARIMA, semi-auto SARIMA and stacked model comparison for VID AI time series

Source: created by the author.

Tax prism states and interpretation

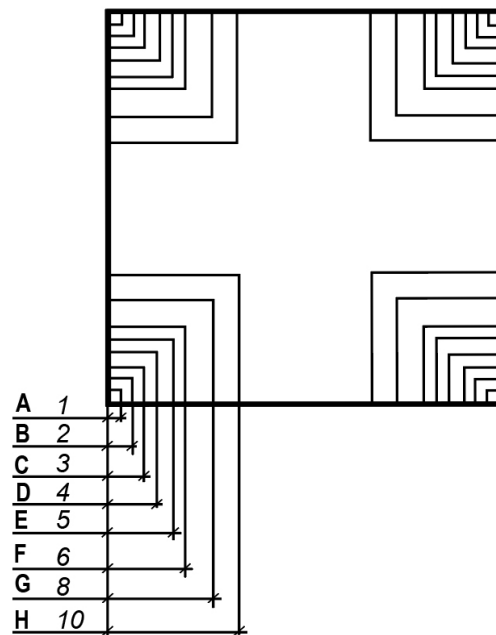


Figure A7.1 Geometric interpretation of the total volume of tax payments

Source: created by the author.

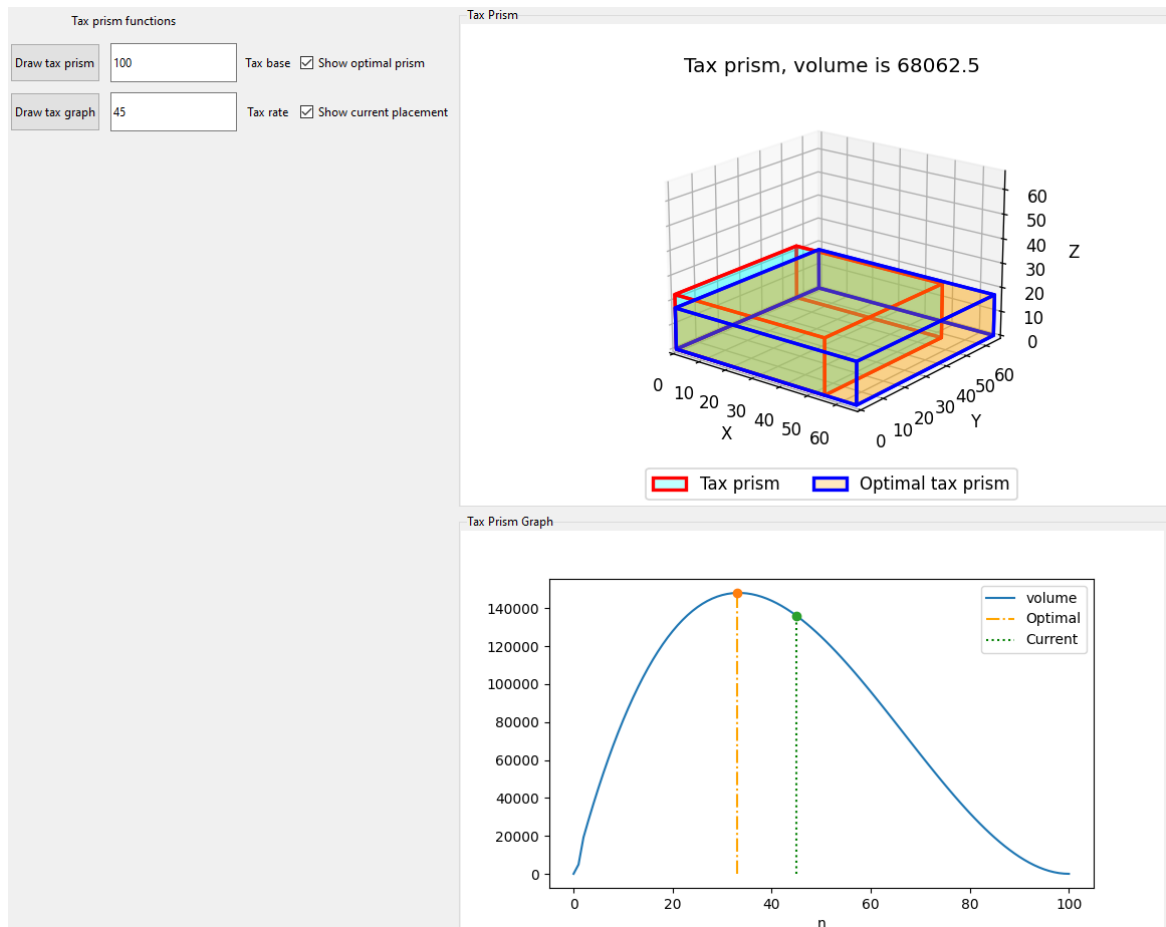


Figure A7.2 Tax prism – high tax burden

Source: created by the author.

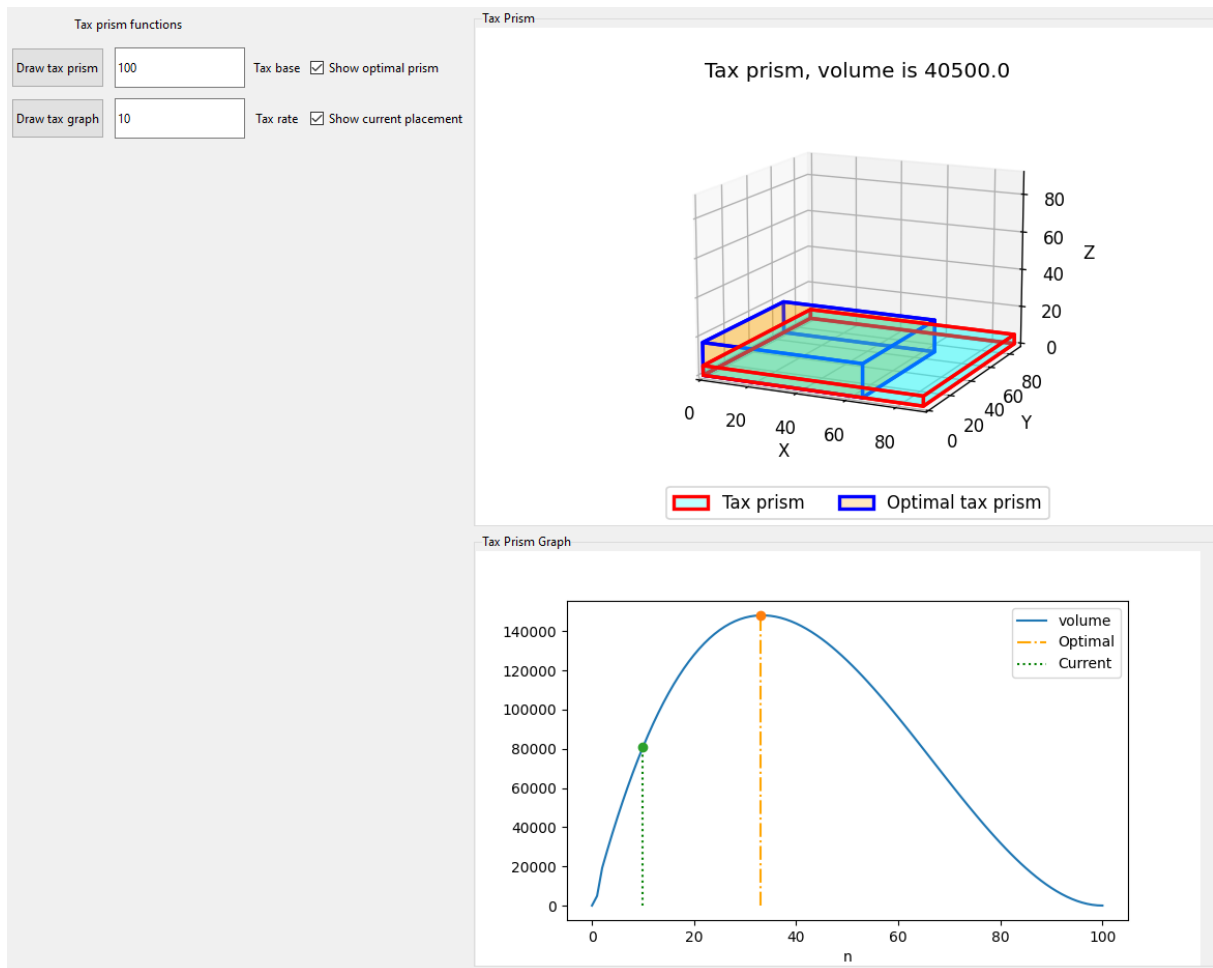


Figure A7.3 Tax prism – low tax burden

Source: created by the author.

Expert survey results processing

Table A8.1

Summary sheet of expert survey for tax ranking

No. of expert	Tax ranking based on the significance criterion													
	Value Added Tax	Personal Income Tax	Lottery and Gambling Tax	Customs Duty	Corporate Income Tax	Mandatory State Social Insurance Contributions	Microenterprise Tax	Solidarity Tax	Electricity Tax	Immovable Property Tax	Vehicle Operation Tax	Company Car Tax	Excise Duties	Natural Resources Tax
1	1	6	13	8	5	3	11	14	12	4	10	9	2	7
2	3	1	11	7	2	6	10	14	13	8	9	12	5	4
3	2	4	12	8	3	5	14	9	13	6	11	10	1	7
4	7	6	14	5	1	2	10	13	12	4	9	11	3	8
5	3	9	12	6	2	5	11	14	13	10	7	8	1	4
6	1	7	13	6	3	4	12	14	11	5	9	10	2	8
7	1	5	12	7	3	4	11	13	14	6	10	9	2	8
8	3	4	11	9	2	6	14	12	13	5	7	8	1	10
9	3	2	12	7	1	8	11	14	13	4	9	10	5	6
10	2	4	13	8	3	5	10	14	12	6	9	11	1	7
11	3	5	10	7	1	4	11	14	13	6	9	12	2	8
12	2	4	11	7	5	1	13	12	8	9	10	14	3	6
13	3	1	12	6	2	4	11	13	14	7	8	9	5	10
14	1	4	13	8	3	5	12	10	14	6	9	11	2	7
15	2	3	13	6	4	7	11	14	12	8	9	10	1	5
16	5	4	14	8	2	3	11	12	13	6	10	9	1	7
17	1	4	13	11	3	5	9	14	12	6	7	8	2	10
18	4	3	8	5	1	9	12	13	14	11	6	7	2	10
19	2	6	11	7	5	1	14	13	9	4	10	12	3	8
20	1	3	11	8	9	2	12	14	13	4	6	10	5	7
21	1	4	10	7	2	6	13	12	14	5	9	11	3	8
22	3	5	11	8	1	4	12	14	13	6	7	10	2	9
23	1	4	12	9	2	3	10	13	14	8	7	11	5	6
24	1	7	13	9	2	8	14	11	12	4	6	10	3	5
25	2	6	12	7	3	5	13	10	14	4	8	11	1	9

Table A8.1 continuation

No. of expert	Tax ranking based on the significance criterion													
	Value Added Tax	Personal Income Tax	Lottery and Gambling Tax	Customs Duty	Corporate Income Tax	Mandatory State Social Insurance Contributions	Microenterprise Tax	Solidarity Tax	Electricity Tax	Immovable Property Tax	Vehicle Operation Tax	Company Car Tax	Excise Duties	Natural Resources Tax
23	1	4	12	9	2	3	10	13	14	8	7	11	5	6
24	1	7	13	9	2	8	14	11	12	4	6	10	3	5
25	2	6	12	7	3	5	13	10	14	4	8	11	1	9
26	1	3	10	4	2	7	12	14	13	8	9	11	5	6
x^j	59	114	307	188	72	122	304	334	328	160	220	264	68	190
$x^j - \bar{x}$	-136	-81	112	-7	-123	-73	109	139	133	-35	25	69	-127	-5
$(x^j - \bar{x})^2$	18496	6561	12544	49	15129	5329	11881	19321	17689	1225	625	4761	16129	25

Source: created by the author.

Table A8.2

Distribution of taxes by importance according to the opinion of experts

Rank	Type of tax
1	Value-Added Tax
2	Excise Duties
3	Corporate Income Tax
4	Personal Income Tax
5	Mandatory State Social Insurance Contributions
6	Immovable Property Tax
7	Customs Duty
8	Natural Resources Tax
9	Vehicle Operation Tax
10	Company Car Tax
11	Microenterprise Tax
12	Lottery and Gambling Tax
13	Electricity Tax
14	Solidarity Tax

Source: created by the author.

Summary sheet of the expert group survey for ranking taxation criteria

No. of expert	Tax criteria ranking based on the significance				
	The criterion of equity	The criterion of certainty and accuracy of taxes	The criterion of ease of collection of taxes for taxpayers	The criterion of efficiency	The criterion of obligation
1	4	1	5	3	2
2	1	4	5	3	2
3	3	2	5	4	1
4	3	2	5	1	4
5	3	1	5	2	4
6	3	2	4	1	5
7	3	1	5	2	4
8	1	2	5	4	3
9	3	1	4	5	2
10	1	3	5	4	2
11	4	3	5	2	1
12	3	2	5	1	4
13	3	1	4	2	5
14	3	2	5	4	1
15	1	2	5	4	3
16	5	1	3	2	4
17	4	2	5	1	3
18	2	3	4	5	1
19	5	2	4	1	3
20	2	4	5	3	1
21	5	3	4	1	2
22	4	2	5	1	3
23	3	1	4	5	2
24	3	2	5	1	4
25	4	1	5	3	2
26	3	1	4	2	5
x^j	79	51	120	67	73
$x^j - \bar{x}$	1	-27	42	-11	-5
$(x^j - \bar{x})^2$	1	729	1764	121	25

Source: created by the author.

Table A8.4

Summary sheet of the survey of the first subgroup of experts to rank the criteria of taxation

No. of expert	Tax criteria ranking based on the significance				
	The criterion of equity	The criterion of certainty and accuracy of taxes	The criterion of ease of collection of taxes for taxpayers	The criterion of efficiency	The criterion of obligation
1	4	1	5	3	2
2	3	2	5	4	1
3	1	2	5	4	3
4	3	1	4	5	2
5	1	3	5	4	2
6	4	3	5	2	1
7	3	2	5	4	1
8	1	2	5	4	3
9	2	3	4	5	1
10	2	4	5	3	1
11	3	1	4	5	2
12	4	1	5	3	2
x^j	31	25	57	46	21
$x^j - \bar{x}$	-5	-11	21	10	-15
$(x^j - \bar{x})^2$	25	121	441	100	225

Source: created by the author.

Table A8.5

Distribution of taxation criteria by importance according to the results of processing the opinions of the first subgroup of experts

Rank	Criteria of taxation
1	The criterion of obligation
2	The criterion of certainty and accuracy of taxes
3	The criterion of equity
4	The criterion of efficiency
5	The criterion of ease of collection of taxes for taxpayers

Source: created by the author.

Table A8.6

Summary sheet of the survey of the second subgroup of experts to rank the criteria of taxation

No. of expert	Tax criteria ranking based on the significance				
	The criterion of equity	The criterion of certainty and accuracy of taxes	The criterion of ease of collection of taxes for taxpayers	The criterion of efficiency	The criterion of obligation
1	1	4	5	3	2
2	3	2	5	1	4
3	3	1	5	2	4
4	3	2	4	1	5
5	3	1	5	2	4
6	3	2	5	1	4
7	3	1	4	2	5
8	5	1	3	2	4
9	4	2	5	1	3
10	5	2	4	1	3
11	5	3	4	1	2
12	4	2	5	1	3
13	3	2	5	1	4
14	3	1	4	2	5
x^j	48	26	63	21	52
$x^j - \bar{x}$	6	-16	21	-21	10
$(x^j - \bar{x})^2$	36	256	441	441	100

Source: created by the author.


Table A8.7

Distribution of taxation criteria by importance according to the results of processing the opinions of the second subgroup of experts

Rank	Criteria of taxation
1	The criterion of efficiency
2	The criterion of certainty and accuracy of taxes
3	The criterion of equity
4	The criterion of obligation
5	The criterion of ease of collection of taxes for taxpayers

Source: created by the author.

Taxation survey questionnaire



LATVIJAS UNIVERSITĀTE

Taxation Survey

The survey is conducted with the assistance of the University of Latvia specialists, and is related to the Latvian taxes and tax system.

Please, fill in the questionnaire (the estimated time to fill the questionnaire is 10-15 minutes).

Participation in this study is voluntary. If you feel uncomfortable answering any questions, you can withdraw from the survey at any point.

All answers will be confidential, and the information obtained from the questionnaire will be used only in aggregated form, excluding the possibility to identify the study participants.

Thank you very much for your time and support!

Please start the survey by clicking on the "Start" button below.

1

* Please, rate all 14 current taxes of the tax system of Latvia based on their importance to the government, using a scale from 1 to 9, where 1 is the least important and 9 is the most important (if you're not sure, what is the tax - you can click on it and read the description).

	Least important									Most important								
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
Company car tax	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Customs duty	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Electricity tax	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Enterprise income tax	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Excise duty	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Immovable property tax	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lotteries and gambling tax	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Micro-enterprise tax	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Natural resources tax	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Personal income tax	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Solidarity tax	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
State compulsory social security contributions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Value added tax	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vehicle operation tax	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

* Is current general VAT (PVN) rate of 21% being optimal for you?

Yes

No

I don't know

2

* What VAT (PVN) rate would be optimal for you, considering that VAT (PVN) is having the most share in the government revenues (numeric input between 0-100)?

* Do you think that Enterprise Income Tax (UIN) should favour companies or the government budget?

Companies

Government budget

I don't know

Other

* Do you think that the current Enterprise Income Tax (UIN) is optimal (pre-reform, in 2017 its share in GDP was 1.6%, nowadays it declined to 0.2%)?

Yes, it is optimal


No, tax rates for the companies are still too high

No, tax rates for the companies are too low

I don't know

Other

3

Taxation Survey 

* The microenterprise tax must be removed, and microenterprises have to be taxed as ordinary enterprises. Do you agree with this statement?

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

* Do you think that excise duties (akcizes) on fuel should be changed?

Yes, excise duties should be lowered

Yes, excise duties should be raised

No, current excise duties are optimal

I don't know

Other

* Do you think that the compulsory state social security contributions (VSAOI) are being burdensome for the individuals?

Yes, and they should be lowered


No, they and they could be raised, as providing social security

They are optimal, as they are now

I don't know

Other

4

Taxation Survey 

• Please rank (1-5) the following basic taxation principles for the optimal tax system (from the most important to the least important):

Drag your choices here to rank them

Most important ↑

Least important ↓

- The principle of certainty and accuracy of taxes
- The principle of ease of collection of taxes for taxpayers
- The principle of efficiency
- The principle of equity (fairness)
- The principle of obligation

• The tax administration process is costly for Latvia. Do you agree with this statement?

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

5

Taxation Survey QuestionPro

• Which of the following principles of taxation are more applicable to nowadays tax system of Latvia?

The principle of efficiency

The principle of equity (fairness)

I don't know

• The shadow economy sector (tax evasion) is high in Latvia. Do you agree with this statement?

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

• I know what taxes I am paying and how they are calculated. Do you agree with this statement?

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

6

Taxation Survey QuestionPro

• Is the current proportion of tax revenues that is left for self-governances (pašvaldības) is sufficient for their sustainable growth (i.e. 25% of personal income tax, Lottery and Gambling tax, as well as Immovable Property tax is left for the corresponding self-governance, the rest is transferred to the state budget)?

Yes, the current share is optimal

No, self-governances should have more funds at their disposal

No, self-governances should have less funds at their disposal

I don't know

Other

• The tax evasion should be severely punished and persecuted by the state authorities. Do you agree with this statement?

Strongly disagree (e.g. because tax evasion still yields government revenues via consumption and indirect taxes)

Disagree

Neutral

Agree

Strongly agree (e.g. because tax evasion harms the government budget revenues)

• The tax system of Latvia is optimal. Do you agree with this statement?

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

7

Taxation Survey QuestionPro

• Do you think that the tax system of Latvia is more favourable to the taxpayer or the state?

The tax system of Latvia is more favourable to the taxpayer

The tax system of Latvia is more favourable to the state

There is a perfect balance between the parties

I don't know

• Do you have any benefits and rebates (nodokļu atvieglojumi un atlaides) from paying taxes?

Yes, and I'm using them

Yes, but I'm not using them

No, I don't have any benefits

None that I'm aware of

• The tax reform of 2018, as well as later changes, were also aimed to reduce socio-economical stratification in society. Eventually, this goal was achieved. Do you agree with this statement?

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

8

Taxation Survey QuestionPro


• International Tax Competitiveness Index 2021 shows, that overall Latvian tax system has 2nd place (runner-up) in the competitiveness of the tax system. Do you think that the Latvian tax system is really second-best among OECD countries?

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

• Were the changes in the Enterprise income tax (UIN) of 2018 and later worth it?

- Yes, Latvia is very attractive for the business and as a tax shelter
- No, new business is developing slowly and now unable to fill the gap in budget revenues
- Nothing is really changed since pre-reform times
- I don't know
- Other

9

Taxation Survey 

• Considering current taxes and economic situation, what is the amount of income (in EUR) that will allow for one person to have:

Poor standard of living

Insufficient standard of living

Average standard of living

Good standard of living

Excellent standard of living

10

Taxation Survey 

• Are you using EDS (Elektroniskās deklarācijas sistēma)?

- Yes
- No
- I don't know what it is


• Is the usage of EDS (Elektroniskās deklarācijas sistēma) clear to you?

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

• What is your gender?

- Male
- Female
- Other


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Taxation Survey 

• What is your age?


- Under 18
- 18
- 19
- 20
- 21
- 22
- 23
- 24
- 25
- 26
- 27
- 28
- 29
- 30
- 31
- 32
- 33
- 34
- 35
- 36
- 37
- 38

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Taxation Survey 

39
 40
 41
 42
 43
 44
 45
 46
 47
 48
 49
 50
 51
 52
 53
 54
 55
 56
 57
 58
 59
 60
 61
...

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Taxation Survey 

62
 63
 64
 Above 64


• What is your highest educational level?

Undergraduate
 Bachelor's degree
 Master's degree
 PhD degree
 Other

• What is your occupation (Select all that apply)?

Unemployed
 Self-employed
 Employed in the business sector
 Employed in government structures
 Employed in educational structures
 Other


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Taxation Survey 

• Where are you from?

Rīga
 Kurzeme
 Latgale
 Vidzeme
 Zemgale
 Other

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Taxation Survey 

Reviews from the companies



*SIA TRADE HUB PRODUCTIONS
Dzirnavu iela 60a-24, LV 1050, Rīga
Reģ. Nr. 40103709004
PVN Reģ. Nr. LV40103709004
AS SWEDBANK, konts: LV77HABA0551044527548*

2022.gada 04.februārī

ATSAUKSME

par Baltijas Starptautiskās Akadēmijas doktoranta A. Ļeontjeva zinātniskā darba rezultātu izmantošanu

Aleksejs Ļeontjevs (Alexey Leontyev, p.k. 150298-14676) veica SIA „Trade Hub Productions” finanšu darbības pētījumu, sākot no 2019. gada.

A. Ļeontjevs veica SIA „Trade Hub Productions” finanšu darbību, sniedza uzņēmuma finansiālā stāvokļa novērtējumu un ekonomisko efektivitāti. Ar viņa izstrādāto instrumentu palīdzību, ieskaitot „nodokļu prizmas” metodi, veikta uzņēmuma nodokļu stāvokļa novērtēšana.

Zinātnisko pētījumu ietvaros mūsu uzņēmumam viņš veica vairāku veidu nodokļu aplikšanas optimizāciju, sniedza rekomendācijas pasākumiem, kas ļauj samazināt nodokļu slogu, gan īstermiņa, gan arī ilgtermiņa periodos.

A. Ļeontjeva piedāvātā nodokļu prizmas metode iekļauta mūsu ekonomikas apakšnodeaļas darbībā. Tā ir novatoriska un ļauj vizualizēt uzņēmuma darbības procesus dažādos periodos, ieskaitot prognozes, kā arī modelēt iespējamās nodokļu sloga konkrētas optimizācijas varianta sekas.

Dotā metode, realizēta datorprogrammas veidā, ļauj mūsu speciālistiem operatīvi novērtēt uzņēmuma tekošo finansiālo stāvokli un izskatīt iespējamo scenāriju izvēloties daudz piemērotāku nodokļu aplikšanas formu Latvijas Republikas likumdošanas ietvaros. Īpaši aktuāla patreizējai ekonomiskai situācijai mūsu uzņēmumam ir iespēja novērst neparedzētus apstākļus, ko viņš realizēja statistikas un dinamikas nodokļu prizmas veidā.

SIA „Trade Hub Productions” atzīmē pozitīvu efektu izmantojot A. Ļeontjeva piedāvāto metodi un instrumentus, kas ļāva uzlabot mūsu uzņēmuma ekonomikas apakšnodeaļas darbu un rekomendē tos izmantot citās uzņēmumu ekonomikas apakšnodeaļās.

Valdes loceklis

Inesa Mihasjonoka



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Review

The enterprise was partly involved in the carried out research of Mr. Alexey Leontyev. For research purposes, we provided to Mr. Alexey Leontyev all necessary information and data.

Conducted calculations showed several weaknesses in Leon News Agency spol. s r.o. financial conditions, which would be improved according to received suggestions.

The tax prism method developed by Mr. Alexey Leontyev has been applied during the process of tax analysis of the enterprise Leon News Agency spol. s r.o., and allowed to visualize enterprise activities in specific periods, properly analyze and model tax flows, and to model consequences of the specific ways of tax planning.

The tax prism method should be implemented in a wide range of enterprises throughout the world. Herein mentioned approach is unique and does not have substitutes yet.

We are grateful to Mr. Alexey Leontyev for a full-fledged analysis of Leon News Agency spol. s r.o. activity and provided recommendations and suggestions.

Finance director
Leon News Agency spol. s r.o.
Tomaš Kotrch



18-01-2022

Quantum programming certificates



DIPLOMA

presented to

Alexey Leontyev

for successfully completing the online workshop
Quantum Computing and Programming
using QWorld's introductory tutorial Bronze

Maksims Dimitrijevs

(Dr. Maksims Dimitrijevs, QLatvia)

October 19-24, 2020

QWORLDCHALLENGE
autumn edition



DIPLOMA

presented to

Alexey Leontyev

for successfully completing the online
Global Quantum Programming Workshop QSilver
focusing on complex numbers and Shor's algorithm,
using QWorld's intermediate level tutorial Silver.

Özlem Salehi

Özlem Salehi
QWorld & QTurkey

Abdullah Khalid

Abdullah Khalid
QPakistan

Workshop leaders: Özlem Salehi, Maksims Dimitrijevs, Jibran Rashid, Abdullah Khalid, Aurél Gábris

Diploma Number: QSilver2-12

QWORLD

MAY
2021