“Tax, investment, institutional and social channels of economic shadowing: Challenges for macro-financial stability and good governance”

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TAX, INVESTMENT, INSTITUTIONAL AND SOCIAL CHANNELS OF ECONOMIC SHADOWING: CHALLENGES FOR MACRO-FINANCIAL STABILITY AND GOOD GOVERNANCE

Abstract

A significant size of the shadow economy is a threat to the sustainable functioning of a country's economy, its ability to finance economic and social programs. The paper studies the influence of the shadow economy on the macro-financial stability of the EU countries. The dependence between macro-financial stability and the size of the shadow economy was estimated using the quadrocentric (considering the four channels of the shadow economy) recursive (takes into account direct and inverse relationships between them) model. Dependence between indicators was analyzed using Euler's methods, Calvo's and Dixit Stiglitz's principles, Taylor's and Smets-Wouters' function. It has been proved that shadow economy channels affect the macro-financial stability almost equally (an increase in the size of the shadow economy in Slovenia by 1% leads to a decrease in macro-financial stability by 0.562% for tax, 0.56% for investment, 0.572 for institutional, and 0.444 for social channels). At the same time, the growth in the volume of shadow transactions through one channel forms an impetus for the increasing intensity of use of the remaining channels to hide income. With the help of the payment matrix, the optimal level of drivers of shadow economy by which the targeted value of the level of macro-financial stability is achieved was determined. It was concluded that ensuring good governance in the direction of preventing shadow schemes of capital withdrawal should be carried out in terms of institutional, tax, social, and investment channels of the shadow economy.

Keywords shadow economy, good governance, macro-financial stability, tax evasion, unemployment rate

JEL Classification H10, E02, E22, O17, H26

INTRODUCTION

One of the biggest triggers for destabilizing a country's economic and social development is the shadow economy. Shadow operations have a destructive effect on the most components of macroeconomic stability, restraining their growth and deepening the existing imbalances in the country. According to the World Economic Forum, in 2018, the global volume of shadow financial transactions amounted to almost a trillion US dollars, which, according to international experts, ranges from 2 to 4% of global GDP. One of the reasons is the constant expansion of income concealment schemes, the simultaneous use of several schemes in shadow activities.

In these conditions, the main task of public authorities is the formation of the prerequisites for de-shadowing of the economy, which is based on the implementation of a set of measures aimed at preventing

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the shadowing operations by economic entities and further legalization of income, ensuring a country's macro-financial stability and sustainable growth, avoiding financial imbalances and crisis phenomena in society.

1. LITERATURE REVIEW AND ANALYSIS

Despite the high size of the shadow economy in some countries and its negative influence on the economic and social development, the systematization of scientific literature proved the need to develop and implement at the state level a set of measures aimed at preventing the shadow activities of economic entities and further legalization of income.

The systematization of scientific research on the shadow economy made it possible to identify four main channels of hiding income.

Tax channel. Most scientists consider the growth of the tax burden on economic entities, the complexity of tax administration procedures, the inconsistency of the legal framework, the existence of conversion centers, etc., to be one of the biggest triggers for the growth of shadow transactions (Lyulyov et al., 2021; Vasylieva et al., 2020; Melnyk et al., 2018; Vysochyna et al., 2020a; Štreimikienė et al., 2022; Bukhtiarova et al., 2022).

Thus, Singh et al. (2012) found that an increase in an average tax rates by 1 point leads to a decrease in the size of the shadow economy by 8.7%. Achim et al. (2022) proved the asymmetric impact of the tax burden in terms of direct and indirect taxes, social contributions on the shadow economy. Based on the analysis of the dataset for the period 2005–2018 for 27 member states of the European Union, the authors confirmed the presence of a U-shaped relationship between the tax burden and the shadow economy only for direct taxes, and an inverted U-shaped relationship for indirect taxes and social contributions. In addition, the authors argued about different marginal levels of the tax burden at which the size of the shadow economy changes for new and old EU members. For example, it is 2.61 times lower for the new EU member states than for the old ones.

González Aguirre et al. (2022) analyzed the impact of tax complexity on the efficiency of tax administration. Based on the analysis of data from six countries (Bolivia, Chile, Colombia, Ecuador, Peru, and Panama) for the period from 2006 to 2017, the authors proved that countries with a lighter tax system have higher volumes of income and tax effort. Karagiorgos et al. (2022) analyzed the factors affecting the complexity of the tax system and substantiated its impact on a country's ability to expand international trade, administrative strategies and technologies. Based on the results of the study, it was concluded that the growth of tax complexity burdens citizens, businesses and tax authorities and forces them to search for alternative mechanisms to simplify tax assessment and payment procedures, including through tax evasion. The authors attribute political instability, changes in legislation, central and operational planning to the drivers of tax complexity growth.

At the same time, a decrease in tax revenues to the budget due to the shadow operations, in turn, leads to economic imbalances in a country, structural deformations in the economy, and a decrease in the level of material well-being of the population. In the conditions of a permanent economic and political crisis, a decrease in tax revenues to the budget can have a destructive effect on a country's economic security and macro-financial stability. Ozili (2020) argued that tax evasion, on the one hand, leads to a decrease in the tax revenue used by governments to manage the economy and stabilize the financial system, and, on the other hand, contributes to increasing the financial stability of taxpayers who evade taxation.

Investment channel. Recently, illegal withdrawal of capital and their subsequent legalization in the form of direct and portfolio foreign investments has become a common practice in the context of income shadowing. The most profitable for economic entities are operations with the withdrawal of funds on the territory of offshore countries with their subsequent return to the territory of the country in the form of officially received income. This leads to the constant improvement of mechanisms for controlling the movement of funds in

the territory of offshore countries, financial operations implemented with the participation of representatives of offshore jurisdictions, the regulatory and legislative framework of which facilitates the implementation of income shadowing operations (Kozmenko & Vasyl'yeva 2008; Moskalenko et al., 2022a, 2022b; Pakhnenko et al., 2022; Kuznyetsova et al., 2017; Vysochyna et al., 2020b; Serpeninova et al., 2020).

Based on a panel analysis of OECD countries' data, Ali and Bohara (2017) proved that the difference in the size of the shadow economy in the host country and the donor country plays a key role in the decision to make foreign direct investments. Nikopour et al. (2009) investigated the link between the shadow economy and FDI for 145 countries of the world using a panel Granger causality test. Empirical calculations confirmed the hypothesis that higher FDI causes a lower size of the shadow economy, and a larger size of the shadow economy causes higher FDI.

Directing potential investments to other goals negatively affects the processes of simple and extended reproduction in the economy, innovative development, financial security of business, etc.

In particular, Marcel (2019), Agnihotri and Arora (2019), Benson and Kong (2022), and Matha et al. (2022) proved a positive effect of foreign investments on the GDP in the long term. Sineviciene et al. (2018) argued that a favorable investment climate is one of the decisive factors for ensuring a country's macro-financial stability. Based on empirical calculations, Zolkover and Georgiev (2020) proved that shadow investment activities reduce the potential of a country to attract financial resources for expanded reproduction.

Unlike the previously discussed channels, the *institutional channel* of income shadowing is considered as affecting not only the implementation of income shadowing operations, but also measures aimed at their prevention. Central government bodies are direct participants in the policy of countering shadowing of the economy and ensuring a country's macro-financial stability. The effectiveness of measures to combat shadow operations depends on the effectiveness of their work, compliance with the principles of impartiality in their actions, consistency, and the rule of law (Salman et al., 2022; Bouchetara et al., 2020; Mikhnevych et al., 2020; Bozhenko, 2022).

According to Medina and Schneider (2018), corruption in public authorities is a key factor in the transition of certain types of activities to the shadow economy. Dreher and Schneider (2010) argue that in high-income economies, corruption and the shadow economy are substitutes, while in low-income economies they can be seen as complementary economic phenomena. Similar conclusions were made by Borlea et al. (2017), who, based on the EU countries data for 2005–2014, proved a positive link between corruption and the shadow economy – a higher level of corruption leads to a larger size of the shadow economy. Shahab et al. (2015) claimed that the link between the shadow economy and corruption depends on the size of corruption. An increase in the level of corruption leads to strengthening its positive connection with the shadow economy. Daniel et al. (2021), using the example of the Czech Republic, proved that the increase in the level of perception of corruption contributes to the increase in the size of the shadow economy. At the same time, the authors concluded about the ambiguous influence of corruption on the number of workers in the official sector of economy and confirmed the hypothesis that even in its presence, this negative or positive effect disappears rather quickly. The reason for this is the desire to compensate for lost public spending caused by corruption.

In turn, this threatens the loss of the international image of a country, the trust of international investors and partners, the inflow of foreign investments, etc. (Yoshimori, 2022; Yiu et al., 2020; Alsmadi et al., 2022).

The social channel is closely related to the tax channel of income shadowing, since its use is carried out at the expense of operations for concealing income for work (Tenytska & Palienko, 2021; Orlov et al., 2021; Melnyk et al., 2021). Thus, the high tax burden on citizens, the low effectiveness of financial monitoring procedures and control over the reliability of the display by economic entities of the number of employed workers lead to a constant increase in the share of unofficial employment in the country, an increase in the gap be-

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tween the actually received and officially declared wages, etc. According to the International Labor Organization, on average almost 20% of the employed population aged 15 to 70 in the world is informally employed.

Given that this group of tax revenues is one of the main sources of financing the social development programs, high levels of informal employment significantly reduce the country's potential to fulfill its social function and implement social protection programs for the population (Petrushenko et al., 2022; Eddassi, 2020; Sadigov, 2020; Kuzior et al., 2022).

According to the obtained results, macro-financial stability significantly depends on individual determinants of tax, investment, institutional, and social channels of shadowing the economy. Thus, the implementation of measures aimed at identifying the key drivers of the shadow economy and their further optimizing, should serve as one of the priority measures in the implementation of the policy of countering the shadow economy and ensuring its macro-financial stability.

Thus, the purpose of the study is to analyze the influence of shadow economy drivers within tax, investment, institutional and social channels on the macro-financial stability of the country and to optimize their values in view of maintaining the targeted level of macro-financial stability.

2. METHODOLOGY

This study is based on the construction of a quadrocentric (which takes into account the influence of four channels of income shadowing – tax, investment, institutional and social) recursive (takes into account the logical sequence, complementarity of these channels, probable direct and inverse relationships between them) model, which formalizes the dependence of macro-financial stability from the most relevant determinants of shadowing of the economy within each of the channels. The model provides for the formalization of the nature and strength of the connection between the analyzed indicators based on the estimation of the parameters of the structural equations, which take into account the entire set of endogenous and exogenous variables.

The basis of the construction of the model, which formalizes the dependence of the macro-financial stability of a country on the determinants of investment, tax, institutional and social channels of shadowing of the economy, is the consideration of not only direct connections between indicators, but also their mutual influence on each other.

The information base of the study is the data of the World Bank and the Organization for Economic Cooperation and Development. The research object is the interrelationships between the determinants of investment, tax, institutional, social channels of shadowing of the economy and macro-financial stability on the example of eight EU countries (Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia, Hungary, the Czech Republic). All calculations are carried out using Statista software packages.

At the first stage of the study, an array of data characterizing the macro-financial stability of the country and the drivers of shadowing of the economy within investment, tax, institutional, and social channels will be formed.

To characterize the volume of shadow operations, an indicator of the size of the shadow economy calculated according to the Schneider method will be chosen.

The level of a country's macroeconomic stability will be assessed using the indicators proposed by the European Commission, reflecting the presence of financial and economic imbalances in the country (Eurostat, 2022). This technique is based on the assessment of 14 indicators of macroeconomic imbalances:

1. Current account balance;
2. Net international investment position;
3. Real effective exchange rate;
4. Export market shares;
5. Nominal unit labor cost;
6. House price index – deflated;
7. Private sector credit flow, consolidated;
8. Private sector debt, consolidated;
9. General government gross debt (EDP concept), consolidated;
10. Unemployment rate;
11. Total financial sector liabilities, non-consolidated;

12. Activity rate, % of total population aged 15-64;
13. Long-term unemployment rate, % of active population aged 15-74;
14. Youth unemployment rate, % of active population aged 15-24.

The determination of the integral level of a country's macro-financial stability will be carried out on the basis of Erlang's formula, which takes into account both the priority of the indicators and their impact on the integral indicator:

$$MFS_t = \left(1 + \frac{\tilde{\lambda}_{1t}}{1!} + \frac{\left(\tilde{\lambda}_{2t}\right)^2}{2!} + \frac{\left(\tilde{\lambda}_{3t}\right)^3}{3!} + \ldots + \frac{\left(\tilde{\lambda}_{it}\right)^i}{i!}\right)^{-1}, \quad (1)$$

where MFS_t is an integral indicator of macro-financial stability of a country in period t; $\tilde{\lambda}_{it}$ is the normalized value of the i-th ranking indicator of macro-financial stability in period t; $i!$ – i factorial.

The normalization of indicators of macro-financial stability in each period will be carried out based on constructing the Pareto diagram.

Based on the results of assessing the most influential drivers of the shadow economy within the tax channel, the following parameters were selected: time spent on preparing tax returns (TC_1), the level of the tax burden of income and capital taxes, % (TC_2), the level of the tax burden of labor taxes and social contributions (TC_3).

The study of the relationship between a country's macro-financial stability and institutional channel of the shadow economy will be conducted based on the following indices: government efficiency ($I_{NS}C_1$); corruption perception index ($I_{NS}C_2$); rule of law index ($I_{NS}C_3$).

The dependence of the level of macro-financial stability on the most relevant determinants of the investment channel of the shadow economy will be assessed using the following indicators: the ratio of the volume of inflow and outflow of direct foreign investment to the volume of the country's GDP (IC_1), the volume of net investment in non-financial assets (IC_2); volumes of portfolio investments (IC_3).

The most relevant determinants of the social channel of shadowing of the economy, which influence the level of the country's macro-financial stability, include: unemployment rate ($SC1$), Gini index ($SC2$), the ratio of the average income of the richest 10% to the poorest 10% (SC_3).

Formalization of the influence of shadow economy channels on macro-financial stability will be carried out on the basis of constructing structural equation models that take into account not only the influence of shadow economy channels on a country's macro-financial stability, but also their interrelationships.

At the next stage, based on the calculation of the Stinger-Lind, MacDonald, Gamma index and adjusted gamma index, the non-centrality parameter of the distribution, the adequacy of the constructed system of equations and the reliability of the obtained results will be checked.

At the last stage, the sensitivity of the quadrocentric recursive model will be evaluated, and the value of the main determinants of the shadow economy to achieve the planned level of macro-financial stability will be optimized. For this purpose, a matrix to check the model's sensitivity to changes in the factor indicator will be built. The criterion of the sensitivity of the analyzed model is the closeness of the placement of data relative to each other.

Optimization of the values of the main determinants of the shadow economy in view of maintaining the targeted level of macro-financial stability will be carried out using simulation modeling (the iterative Brown-Robinson method and game theory). Within this stage, the minimum values of all the analyzed determinants of changes in the intensity of using shadowing channels of the economy, which ensure the maintenance of the targeted level of macro-financial stability, will be determined.

The Brown-Robinson method is based on the hypothesis that the implementation of a certain strategy is carried out by means of a certain number of iterations. In the process of these integrations, game participants make decisions about the expediency or impracticality of implementing certain actions, thereby gaining experience in implementing strategies. The formalization of the decision-making process during the game is shown in Table 1.

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Table 1. Payment matrix

A\B	B_1	...	B_k	...	B_p	...	B_q
A_1	A_{11}	...	A_{1k}	...	A_{1p}	...	A_{1q}
...	...	...	...	...	...	...	...
A_m	A_{m1}	...	A_{mk}	...	A_{mp}	...	A_{mq}
...	...	...	...	...	...	...	...
A_n	A_{n1}	...	A_{nk}	...	A_{np}	...	A_{nq}
...	...	...	...	...	...	...	...
A_l	A_{l1}	...	A_{lk}	...	A_{lp}	...	A_{lq}

3. RESULTS

The obtained results (Table 2) show that, on average, most EU countries have a sufficiently high level of macro-financial stability. At the same time, Hungary, Slovakia and Romania have the lowest values of macro-financial stability.

The next stage in the development of the quadrocentric recursive model is estimating the parameters of the structural equations of the dependence of macro-financial stability on the shadow economy channels. Structural modeling results made it possible to build a system of structural equations that formalize the dependence of macro-financial

$$\begin{cases} I_{NS}C_1 = -1.658 \cdot I_{NS}C \\ I_{NS}C_2 = -0.0534 \cdot I_{NS}C + 0.006 \\ I_{NS}C_3 = -0.0834 \cdot I_{NS}C \\ MFS_1 = MFC + 0.512 \\ \tilde{N}_1 = TC + 1{,}526.658 \\ TC_2 = 0.171 \cdot TC + 0.544 \\ TC_3 = 0.1145 \cdot TC + 0.01874 \\ IC_1 = IC + 0.0012 \\ IC_2 = -1.598 \cdot IC + 5.234 \\ IC_3 = 2.517 \cdot IC + 41.325 \\ SC_1 = SC + 0.0014 \\ SC_2 = -9.0214 \cdot SC + 7054.654 \\ SC_3 = 0.726 \cdot SC + 15.365 \\ MFS = -3.981 \cdot TC - 8.567 \cdot IC - 2.231 \cdot I_{NS}C - 12.165 \cdot SC \\ IC = 8.431 \cdot TC + 4.417 \cdot I_{NS}C \\ SC = 7.625 \cdot TC + 7.729 \cdot IC + 5.18 \cdot I_{NS}C \\ TC = 0.236 \cdot I_{NS}C \end{cases} . \quad (2)$$

Table 2. Dynamics of the integral indicator of macro-financial stability in EU countries

Countries	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Latvia	0.59	0.71	0.65	0.65	0.67	0.86	0.80	0.86	0.86	0.86	0.86	0.86	0.86	0.89
Lithuania	0.47	0.44	0.66	0.86	0.65	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.87
Poland	0.38	0.46	0.49	0.52	0.52	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.87	0.87
Czech Republic	0.86	0.86	0.86	0.66	0.65	0.79	0.79	0.86	0.86	0.86	0.86	0.86	0.86	0.88
Hungary	0.45	0.27	0.86	0.79	0.78	0.78	0.84	0.84	0.86	0.57	0.46	0.54	0.56	0.56
Slovakia	0.73	0.65	0.41	0.31	0.35	0.42	0.69	0.69	0.66	0.65	0.65	0.66	0.65	0.67
Romania	0.69	0.65	0.64	0.65	0.65	0.66	0.68	0.69	0.71	0.73	0.76	0.77	0.76	0.77
Slovenia	0.66	0.86	0.86	0.86	0.84	0.84	0.84	0.86	0.86	0.80	0.80	0.86	0.88	0.88

stability (fragment for Latvia) on selected determinants of the shadow economy in terms of tax, investment, institutional and social channels.

According to the results of systematizing the parameters of the quadrocentric recursive model for the analyzed countries (Table 3), it is possible to conclude about the validity of the proposed hypothesis regarding the negative impact of the shadow economy in terms of its tax, institutional and social channels on the level of macro-financial stability of the analyzed countries with a level of statistical significance of more than 95%.

Thus, an increase in the size of the shadow economy of Slovenia by 1% is accompanied by a decrease in the macro-financial stability by 0.562% within the tax, 0.56% – investment, 0.572 – institutional and 0.444 – social channels. Thus, it is possible to conclude that these channels have almost the same level of influence on the stability of the national economy.

The results of the study of the degree of interchannel diffusion in the section of the four analyzed channels indicate their direct dependence. Thus, a 1% increase in the volume of implementing shadow transactions through tax channels in Slovenia forms an impetus for an increase in the intensity of the use of the investment channel by 0.109%, social by 0.522%. A 1% increase in the volume of shadow transactions through the institutional channel is accompanied by a 0.531% increase in the intensity of investment, 0.309% – social, and 0.493% – tax channels.

In addition, the obtained results make it possible to analyze the influence of explicit endogenous parameters of the model on its latent components. The obtained results prove a significant positive

Table 3. Parameters of the model of influence of shadow economy relevant determinants on macro-financial stability and their diffusion

Influence	Slovenia	Slovakia	Czech Republic	Latvia	Lithuania	Poland	Hungary	Romania
$I_{NS}C_1 \leftarrow I_{NS}C$	–0.562	–3.787	–4.541	–1.658	–1.935	–4.460	–3.410	–2.800
$I_{NS}C_2 \leftarrow I_{NS}C$	–0.377	–0.047	–0.049	–0.053	–0.058	–0.060	–0.040	–0.080
$I_{NS}C_3 \leftarrow I_{NS}C$	0.383	–0.016	–0.084	–0.083	–0.110	–0.020	–0.060	–0.160
$MFS_1 \leftarrow MFS$	1	1	1	1	1	1	1	1
$TC_1 \leftarrow TC$	1	1	1	1	1	1	1	1
$TC_2 \leftarrow TC$	0.535	1.036	4.994	0.171	1.183	1.220	3.760	0.456
$TC_3 \leftarrow TC$	0.518	1.098	5.764	0.114	1.214	1.120	4.340	0.460
$IC_1 \leftarrow IC$	1	1	1	1	1	1	1	1
$IC_2 \leftarrow IC$	–1.671	–9.103	–4.664	–1.598	–1.819	–10.730	–3.510	–2.630
$IC_3 \leftarrow IC$	0.334	2.469	2.139	2.517	2.854	2.910	1.610	4.130
$SC_1 \leftarrow SC$	1	1	1	1	1	1	1	1
$SC_2 \leftarrow SC$	–1.167	–6.044	–5.533	–9.021	–10.456	–7.130	–4.160	–15.120
$SC_3 \leftarrow SC$	0.616	0.963	0.232	0.726	0.811	1.130	0.170	1.170
$MFS \leftarrow TC$	–0.562	–0.262	–5.132	–3.981	–4.524	–0.310	–3.860	–6.540
$MFS \leftarrow IC$	–0.560	–0.218	–0.732	–8.567	–9.691	–0.260	–0.550	–14.010
$MFS \leftarrow I_{NS}C$	–0.572	–2.148	–3.082	–2.231	–2.593	–2.530	–2.320	–3.750
$MFS \leftarrow SC$	–0.444	–0.640	–0.636	–13.165	–13.305	–0.750	–0.480	–19.240
$IC \leftarrow TC$	0.109	2.902	4.134	8.431	9.583	3.420	3.110	13.850
$IC \leftarrow I_{NS}C$	0.531	1.457	0.435	4.417	4.926	1.720	0.330	7.120
$SC \leftarrow TC$	0.522	7.171	7.322	7.625	8.672	8.450	5.510	12.540
$SC \leftarrow IC$	0.310	1.057	5.931	7.729	8.698	1.250	4.460	12.570
$SC \leftarrow I_{NS}C$	0.309	0.094	2.586	5.180	5.700	0.110	1.950	8.240
$TC \leftarrow I_{NS}C$	0.493	0.580	0.116	0.236	0.262	0.680	0.090	0.380

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Table 4. The results of the calculation of non-centrality indices

Indicator	Slovenia	Slovakia	Czech Republic	Latvia	Lithuania	Poland	Hungary	Romania
The non-centrali`ty parameter of the distribution	0.15	0.25	0.325	0.47	0.314	0.658	0.478	0.365
Stinger-Lind index	0.109	0.094	0.070	0.063	0.11	0.05	0.09	0.03
MacDonald's non-centrality index	0.617	0.721	0.880	0.674	0.85	0.66	0.97	0.37
Gamma index	0.848	0.905	1.355	1.252	1.07	1.02	1.81	0.58
Adjusted gamma index	0.109	0.094	0.070	0.063	0.11	0.05	0.09	0.03

influence of the indices of government efficiency ($I_{NS}C_1$) and perception of corruption ($_{INS}C_2$) on the volume of shadow transactions in all analyzed countries.

Thus, a 1% increase in the indices of business confidence and the quality of regulatory policy is accompanied by a decrease in the intensity of the use of the institutional channel by 0.562% and 0.377% in Slovenia, 3.78% and 0.047% in Slovakia, 4.541% and 0.049% in the Czech Republic, and 1.935% and 0.058% in Lithuania, respectively. At the same time, the growth in the Rule of Law Index has a positive effect on the intensity of implementation of shadow transactions through the institutional channel. Thus, it can be said that the improvement of regulatory mechanisms in a country does not allow obtaining the desired effect in the direction of countering the shadowing of the economy. One of the prerequisites of this situation is the imperfection of the system of regulatory and legal support for countering shadowing of the economy, shortcomings in the functioning of a country's judicial system, and the low efficiency of the work of most institutions that regulate these issues. This leads to the active use of corruption schemes for concealing income, involving officials of various levels, lobbying for the interests of individuals, etc.

Within the tax channel, all identified indicators have a direct statistically significant relationship with the level of macro-financial stability. Thus, for example, with an increase in the level of the tax burden in a country by 1%, the intensity of the use of tax tools for income shadowing increases on average by 0.5% in Slovenia, 1% in Slovakia, 5% in the Czech Republic, 0.1% in Latvia, etc.

Within the social channel, the greatest influence on the volume of implementation of shadow operations is exerted by the unemployment of the population, even a slight decrease of which serves as a catalyst for the activation of the use of shadow schemes for concealing income in order to increase the level of one's purchasing power.

Among the determinants of the investment channel of the shadow economy, the ratio of the inflow and outflow of direct foreign investment to a country's GDP and the volume of net investment in non-financial assets exert the greatest influence on the volume of shadow transactions.

Table 4 shows the results of checking the reliability of the obtained results based on the calculation of the Stinger-Lind, MacDonald, Gamma index and adjusted gamma index non-centrality indices, estimates of the distribution non-centrality parameter indicate the adequacy of the constructed structural equation models for all countries. The values of the non-centrality parameter of the distribution and the Stinger-Lind Index indicate a high level of compliance of the obtained model with the realities of economic development at the level of statistical significance of 5%. For each of the built models, the values of adequacy indicators are within 0.05-0.7, which allows us to conclude about their sufficient quality and reliability of the obtained results. The values of MacDonald's non-centrality index, gamma index and adjusted gamma index range from 0.5 to 0.7, which does not exceed their critical value (0.95).

In general, the values of the disagreement function confirm the previous results regarding the satisfactory quality of the constructed models. The next stage in the process of minimizing the values of the constructed function and checking the adequacy of the quadrocentric model is the construction of graphs of the normalized residuals of the model.

The values of the matrix given in Table 6 are characterized by a high degree of fluctuation relative to each other, which allows us to draw a conclusion

Table 5. Results of the optimal solution search (a fragment for Slovenia)

ITN	DISC	RCOS	LAMBDA	MAXCON	NRP	NRC	NAIC
0	39.556	0.840	1.000	0.000	0	0	4
1	36.924	0.780	1.000	0.000	2	0	1
2	33.634	0.304	1.000	0.000	2	0	1
3	27.093	0.243	1.000	0.000	2	0	2
4	26.941	0.253	1.000	0.000	2	0	2
5	25.382	0.243	1.000	0.000	2	0	3
6	24.441	0.253	1.000	0.000	2	0	4
7	24.420	0.253	1.000	0.000	2	0	4
8	24.410	0.253	1.000	0.000	3	0	5
9	24.238	0.263	1.000	0.000	3	0	6
10	24.187	0.253	1.000	0.000	2	0	6

Table 6. Matrix for testing the sensitivity of the quadrocentric model to a change in the factor indicator (a fragment for Slovenia)

Indicator	TC_1	TC_2	TC_3	IC_1	IC_2	IC_3	$I_{NS}C_1$	$I_{NS}C_2$	$I_{NS}C_3$	SC_1	SC_2	SC_3
TC_1	0.00	–0.01	0.00	0.00	0.01	–0.01	0.00	0.00	0.00	0.21	–0.03	0.00
TC_2	–48.53	0.00	0.00	–0.01	0.74	–0.55	0.03	0.07	–0.03	17.85	–1.17	0.15
TC_3	–2.90	0.53	0.00	0.05	–0.34	–0.18	0.05	0.01	0.10	22.92	1.06	–0.02
IC_1	53.89	–0.34	10.70	0.00	1.94	2.49	–1.26	–1.18	–1.01	–91.13	20.34	–1.67
IC_2	35.99	0.63	0.35	0.00	0.00	0.53	–0.05	–0.07	0.06	–64.15	1.90	–0.14
IC_3	–32.11	–0.32	–0.36	0.00	0.30	0.00	0.05	0.03	0.01	–43.25	0.36	0.10
$I_{NS}C_1$	5.21	0.03	0.08	0.00	–0.05	0.15	1.11	–0.01	0.00	4.14	0.00	–0.02
$I_{NS}C_2$	17.63	3.41	5.24	–0.33	–2.27	4.79	–0.71	0.00	0.00	–18.53	19.09	–1.47
$I_{NS}C_3$	–15.05	–2.63	4.21	–0.37	5.33	1.65	–0.41	0.00	0.00	33.05	–12.76	0.21
SC_1	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SC_2	–11.01	–0.12	0.09	0.00	0.14	–0.05	0.01	0.03	–0.03	0.48	0.00	0.06
SC_3	9.65	0.17	0.00	0.00	–0.08	0.27	–0.01	–0.01	0.00	11.30	0.00	1.09

about the high level of sensitivity of the model to changes in factor indicators.

Thus, the developed methodology allows assessing the dependence of macro-financial stability on the most relevant determinants of investment, tax, institutional and social channels of the shadow economy, to assess the consequences of their cross-channel diffusion, and to identify, on this basis, the most priority directions for countering illegal income shadowing schemes as drivers for increasing a country's macro-financial stability.

Implementation of each of the selected vectors of economic development is possible at the expense of 20 decision-making strategies (10 for each), the characteristics of which are given in Table 7.

For the level of macro-financial stability, indices of government efficiency, the rule of law, the amount of net investment in non-financial assets; volumes of portfolio investments, the optimal interval is defined as the interval from the maximum for the period from 2010 to 2021 to their theoretically possible value. A fragment of the matrix for determining the optimal values of the determinants of changes in the intensification of the use of economic shadowing channels that achieve the targeted level of macro-financial stability (rows A_1-A_{10}) and the minimum values of disincentive indicators/maximum values of stimulator indicators (rows B_1-B_{10}) is given in Table 8.

Strategies will be developed for disincentive indicators (the size of the shadow economy, the time spent on preparing tax returns, the corruption perception index, the unemployment rate), which consists in the uniform distribution of the interval of values from the value of their root mean square deviation to the estimated minimum val-

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Table 7. Statistical analysis of the most influential determinants of tax, investment, institutional, social channels of the shadow economy and the level of macro-financial stability of Slovenia

Indicator	min_i	max_i	σ_i	$\bar{x}$	$\bar{x}-\sigma_i$	$min_i-\sigma_i$
MFC	0.240	0.848	0.231	0.624	0.393	0.009
TC_1	0.271	0.954	0.261	0.703	0.442	0.010
TC_2	0.304	1.075	0.293	0.791	0.498	0.011
TC_3	0.342	1.209	0.329	0.890	0.561	0.013
$I_{NS}C_1$	0.386	1.361	0.371	1.001	0.630	0.014
$I_{NS}C_2$	0.434	1.532	0.417	1.127	0.709	0.016
$I_{NS}C_3$	0.489	1.724	0.470	1.269	0.798	0.018
IC_1	0.549	1.940	0.529	1.427	0.899	0.021
IC_2	0.619	2.184	0.595	1.607	1.011	0.023
IC_3	0.696	2.457	0.670	1.808	1.138	0.026
SC_1	0.784	2.765	0.753	2.035	1.281	0.029
SC_2	0.882	3.113	0.848	2.290	1.441	0.033
SC_3	0.993	3.503	0.954	2.578	1.622	0.037

ue of these indicators, calculated as the difference between the actual minimum value and the root mean square deviation).

Based on the constructed quadrocentric recursive model of the dependence of macro-financial stability on the determinants of changes in the intensity of using shadow economy channels, this study will determine the optimal values of individual parameters of the model by substituting those obtained in rows A_1-A_{10}; B_1-B_{10} parameter values. Based on this, a payment matrix was created that allows us to determine the optimal value of the parameter depending on the selected development strategy. For example, for strategy A_6 (0.93) and B_5 (16.44%), the unemployment rate takes the value of 15.64%.

Based on the defined strategies for increasing the level of macro-financial stability of a country and reducing the size of the shadow economy, and taking into account the values of individual elements of the matrix, the next stage will determine the optimal (minimum possible for which the targeted value of the level of macro-financial stability is achieved) level of drivers of changes in the intensity of the use of the shadow economy channel.

Table 8. Matrix for determining the optimal value of the unemployment rate, which ensures the achievement of the targeted level of a country's macro-financial stability and the minimization of the size of the shadow economy

Strategy		B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}
		2.80	6.21	9.62	13.03	16.44	19.86	23.27	26.68	30.09	33.50
A_1	0.84	41.05	36.07	24.65	21.77	17.44	11.65	9.41	5.70	4.56	2.97
A_2	0.86	40.71	35.73	24.31	21.42	17.09	11.31	9.07	5.37	4.23	2.64
A_3	0.88	40.35	35.39	23.96	21.07	16.74	10.95	8.71	5.02	3.88	2.27
A_4	0.89	40.00	35.02	23.59	20.72	16.38	10.59	8.35	4.66	3.51	1.92
A_5	0.91	39.62	34.65	23.22	20.33	16.00	10.22	7.98	4.28	3.14	1.53
A_6	0.93	39.23	34.26	22.84	19.95	15.61	9.83	7.59	3.90	2.76	1.15
A_7	0.95	38.84	33.86	22.44	19.56	15.21	9.44	7.20	3.49	2.35	0.76
A_8	0.96	38.42	33.46	22.02	19.14	14.81	9.02	6.78	3.09	1.95	0.34
A_9	0.98	38.00	33.02	21.60	18.72	14.39	8.60	6.36	2.67	1.52	−0.07
A_{10}	1.00	37.58	32.60	21.17	18.29	13.95	8.17	5.93	2.24	1.09	−0.51

4. DISCUSSION

The study results confirmed the hypothesis that a country's macro-financial stability is sensitive to changes in the size of the shadow economy in terms of tax, investment, institutional and social channels. The obtained results correlate with the results of previous studies on the relationship between macro-financial stability and shadow economy drivers (Achim et al., 2022; Ali & Bohara 2017; Borlea et al., 2017; Marcel, 2019).

At the same time, this study does not support the results of Salé et al. (2021), Zolkover and Renkas (2020), and Fast (2021), who consider that tax channels are the most influential factor in reducing the level of macro-financial stability of a country. According to the study, tax, investment, institutional and social channels of the shadow economy exert almost the same influence on the macro-financial stability of a country. Thus, the policy of countering the shadowing of the economy should be aimed simultaneously at various components of the state's development, taking into account their influence on the resulting indicator, cross-channel diffusion, and taking into account the maintenance of the targeted level of macro-financial stability.

At the same time, this paper has some limitations that can be considered in further research. This is due to the impossibility of assessing dependence for individual countries with medium and low levels of economic growth due to the lack of data on individual indicators. Secondly, there are currently no unified global approaches to assessing the size of the shadow economy.

CONCLUSION

This study focuses on the link between the drivers of the shadow economy in terms of tax, investment, institutional and social channels and a country's macro-financial stability. With the help of dynamic stochastic modeling using Euler's methods, the principles of Calvo and Dixit Stiglitz, the function of Taylor and Smets-Wouters, a quadrocentric recursive model was built that formalizes the dependence of the level of macro-financial stability on the most relevant determinants of investment, tax, institutional and social channels of the shadow economy, as well as their diffusion. It has been proven that the growth in the volume of shadow transactions has a negative effect on macro-financial stability. Thus, with an increase in the size of the shadow economy of Slovenia by tax, investment, institutional and social channels by 1%, the level of macro-financial stability will decrease by 0.562%, 0.56%, 0.572% and 0.444%, respectively. On the basis of the simulation modeling toolkit, the optimal levels of the main determinants of combating the shadow economy are determined in order to maintain the targeted level of macro-financial stability.

According to the results of the study, the tools for preventing shadow operations can be identified in terms of institutional, tax, social, and investment channels of shadowing the economy.

Measures to prevent shady schemes for concealing income through the tax channel should include: reducing corruption in public sector; cooperation between business, population and state institutions; improved tax calculation and payment procedures, strengthened responsibility for tax evasion, etc.

Reducing the intensity of the use of the institutional channel is possible due to the expansion of sectors of the economy in which electronic government services are actively being introduced; reducing the bureaucracy in the state administration system, etc.

The implementation of measures within the investment channel of income shadowing involves: increasing the transparency of information about economic entities that carry out operations in the territory of offshore zones, movement of investment resources from these territories; improvement of procedures of financial monitoring and control over the movement of funds.

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Within the framework of the social channel, the measures include: the introduction of programs to increase the financial literacy of the population, its tax morale, the formation of society's understanding of the importance of fulfilling one's tax obligations in full, increasing transparency in the use of tax resources, etc.

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