

## STATISTICAL MODELING OF MAIN INFLATION DRIVERS DURING THE POST-PANDEMIC PERIOD: THE CASE OF LITHUANIA


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**Abstract:** *The main inflation factors were analyzed of relatively high inflation in Lithuania after the COVID-19 pandemic in the context of European Union and euro area. The system dynamics model was developed mathematically describing the interrelations between inflation and the set of macroeconomic variables. The hypothetical reduced inflation rates were calculated modeling the different scenarios of macroeconomic changes under the inflationary environment.*

**Keywords:** *inflation, macroeconomics, statistical modeling.*

**JEL Classification:** C02, C15, C54, E27, E31

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## 1 Introduction

Many European Union countries and euro area at the beginning of the post-pandemic period faced sudden rise of inflation that was not seen for decades in these regions. The central banks applied monetary policy measures trying to ensure price stability and the purchasing power of currencies. However, the differences in inflation rates in European Union countries were significant. So, it is important to understand the main global or specific inflation drivers of a particular country. Commonly, inflation is a complex consequence of households, businesses, government behavior, market conditions, commercial banks credit policies, and central bank regulatory measures. The actual results of aggregated behavior of all participants of country's economic system are seen in macroeconomic statistics, and many non-economists consider it as uncontrolled and unavoidable phenomenon. But it is important to understand that inflation is not a self-contained phenomenon. The set of factors can be extracted from the overall macroeconomic environment that explains the main reasons for inflationary processes in the economy. Making the influence on large part of micro-elements usually is very difficult, managing and improving the macroeconomic processes, but the statistical modeling techniques allow implementing what-if analysis and analyze the possible dynamics of macroeconomic indicators by changing the parameters of economic system. As Lithuania is one of the European countries facing inflation shock after the COVID-19 pandemic, this country was selected as an object of this research.

The aim of this research is to analyze the main factors of inflation in Lithuania and to develop the statistical model which is able dynamically evaluate the dependencies between the inflation and the set of its drivers. The structure of the paper is as follows: firstly, the comparative analysis of inflation in European Union and euro area was realized; secondly, the main drivers of relatively high inflation in Lithuania during the post-pandemic period were revealed; and finally, the statistical modeling of inflation factors and outcomes was implemented. The official statistical data from EUROSTAT, World Bank, European Central Bank, Statistics Lithuania, and Bank of Lithuania was used in this research.

## 2 Theoretical framework of research relevance

Baltussen et al. (2023) generalized the assumption that periods of high inflation, deflation or stagflation are relatively uncommon in recently developed countries. In addition, Shah and Lavanya (2022) concluded that currently there has been a substantial inflation decline in developing and undeveloped countries, that was mostly caused by the growing work productivity, resource utilization efficiency, liberalization of the economies, and improved macroeconomic policies. However, the COVID-19 pandemic globally disrupted these positive inflationary trends. El-Gamal (2024), analyzing the inflation factors, has made the distinction between *baseline* inflation, which is driven by monetary policy, and short-term spikes, driven by *special* factors. Undoubtedly, the COVID-19 pandemic can be considered as a special factor with its specific dynamics, different management measures, costs, and economic consequences in different countries. Sequeira, Gil and Afonso (2021), analyzing the impact of inflation on economic development, highlighted 3 main features: firstly, it is negative, secondly, sudden inflation shocks may severely hurt economic growth, and, finally, high-inflation volatility implies high economic growth volatility. Together with increased personal insolvency, the negative consequences of inflation transfer even to mental disorders, especially of debtors and persons responsible for high bill payments. The findings of Chen, Yang and Kuper (2024) revealed that, compared with the pre-pandemic period, the number of people in contact with mental health services increased significantly with the rising inflation and living costs during the post-pandemic era.

Keeping inflation at low levels, firstly, is the direct responsibility of central banks, when their autonomous monetary policies essentially consider the balance of payments, the stock of foreign currency reserves, the interest rates set by other countries' central banks, movements in the nominal exchange rates, employment and other domestic variables (Morlin, 2023). Stabilizing the macroeconomic disbalances it is very important for the monetary and the fiscal authorities to cooperate with each other, but Stawska (2021) presented the fiscal-monetary game matrix which demonstrates that such cooperation is not easy to establish because the central bank usually aims to ensure price stability, whereas the government seeks to keep high economic growth and low unemployment and implements measures promoting inflation.

The general factors of *baseline* inflation are characterized in Minsky's Theory of Inflation, where the rate of change of consumer prices is equal to the rate

of increase of wages minus the rate of increase of labor productivity plus the rate of increase of the markup, and usually the inflation has two types: cost-push inflation, also called wage-led inflation, and demand-pull inflation, also called markup or profit inflation (Kim, 2024). The additional *special* factor of post-pandemic inflation is the public debt growth in many countries where the fiscal deficit is financed through government borrowings, what eventually produces inflationary pressures, regardless of the policies followed by the central banks. Hence, Aimola and Odhiambo (2021) accentuate that debt-financed deficits require effective coordination with the monetary authority to avoid high and unstable inflation rates that may be harmful to macroeconomic stability. Ryczkowski (2021) emphasized that the probability of an inflationary outburst especially increases when money growth is accompanied by loose credit conditions in lending institutions. Before the COVID-19 pandemic the eased monetary conditions stimulated spending and economic growth, but during the post-pandemic period the surplus money supply caused the inflation shock. Chowdhury (2024) analyzed two causes of such inflation. One is internal, happening due to the increase in human desire to consume more. The other one is external, due to distortionary policies of commercial banks, increasing the money supply. However, financial institutions have their own profit maximization desires coming from the chief executives and shareholders.

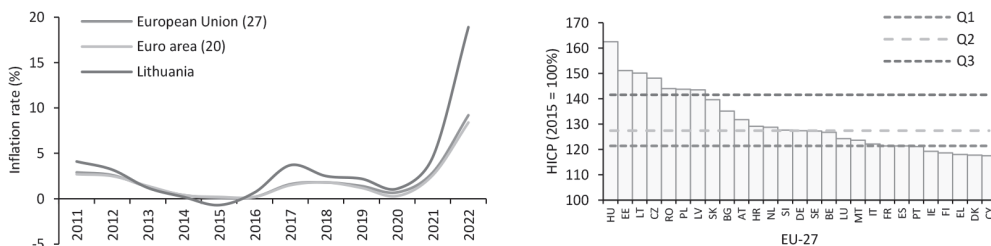
Essentially, the post-pandemic period has the main features of demand inflation. The COVID-19 with its lockdowns had thrown the world into a severe recession, artificially cutting down both supply and demand. The pandemic crisis altered the supply chains because of lockdowns, leading to supply-side shocks that further reduced demand (Mutascu and Hegerty, 2024). When the economies were reopened, the demand experienced a quick revival. The prices of goods and services rebounded, but the supply had more difficulties returning to pre-pandemic levels (Baltensperger, 2023). Craighead (2022) identified the main inflation driver as increase in labor disutility and relative demand for products and services with lower overall outputs, that were extremely large when compared to historical variations. Moreover, the supply and demand factors differ across countries within the European monetary union, so a common monetary policy can hardly avoid the risk of divergences. Pasimeni (2022) stated that the effectiveness of monetary policy reducing inflation is directly proportional to the relative importance of demand factors in driving price pressure. Knicker, et al. (2024) in addition emphasized

that without appropriate fiscal policy, the shocked economy can take years to recover, or it can even tip over into a deep recession, and the success of monetary policy reducing inflation depends not only on the direct economic impact of interest rate hikes, but also on customers' expectation anchoring. Szabó and Jančovič (2022) also supplemented the set of main inflation drivers arguing that inflation expectations determine inflation dynamics strongly and statistically significantly. According to Kocoglu (2023), the forecasting of inflation plays an important role in monetary policy, expectation management and communication. This idea was supported by Kliber et al. (2023), maintaining that inflation forecasts are crucial for all economic agents: households, companies and policymakers such as governments and central banks. If inflation forecasts are moderate and error free, economic decisions, including price setting, wage negotiations, consumption and investment decisions, made by economic agents could translate into better economic outcomes. Studies like Solarin et al. (2024) have proven that better economic outputs can be obtained when the inflation rate is in the range of targeted values. In this case, policymakers should look for monetary policies that are characterized by a relatively aggressive response to the evolution of inflation.

### **3 Inflation in Lithuania compared to EU-27 and euro area**

For Lithuanian economy, relatively higher inflation rates were typical compared to European Union (EU-27) and euro area (20 countries) since 2011. During the 10 years period of 2011 – 2020 the average inflation in EU-27 was 1.3%, in euro area it was 1.22%, while the average Lithuanian inflation rate was 1.82%. All these values matched the European Central Bank (ECB) targeted inflation of 0 – 2%. However, from 2021 the prices were dramatically destabilized. In 2022 the European Union faced inflation growth up to 9.2%, euro area's inflation rate reached 8.4%. Compared to these regions Lithuanian inflation was more than twice higher reaching 18.9%. The beginning of 2023 was also inflationary. Lithuanian harmonized index of consumer prices (HICP) in 2023M09 was 150.17% compared to 2015 year's datum-level of 100% and it was the third highest index in European Union. The higher indices were observed only in Hungary (162.49%) and Estonia (151.17%). The HICP values were above the third quartile (Q3 = 141.55%) also in Czechia, Romania, Poland, and Latvia. The EU-27 2023M09 HICP median (Q2) was 127.4%. The least HICP values positioning below first quartile (Q1 = 121.39%) were in Cyprus, Denmark, Greece, Finland, Ireland, Portugal, and Spain (Figure 1).

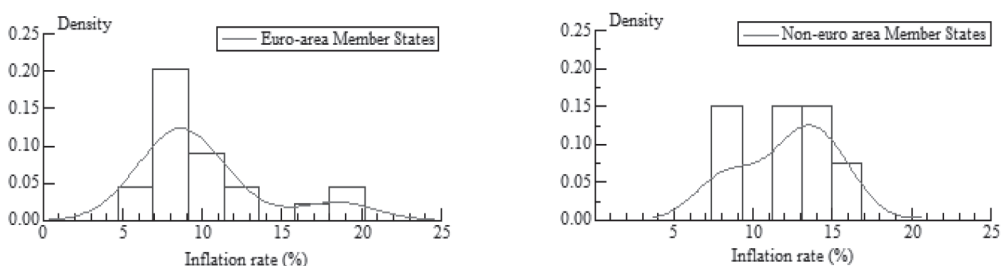
**Figure 1:** Inflation rates in 2011 – 2022 (left); 2023M09 HICP individual values and quartiles in EU-27 (right)



**Source:** processed by the author (based on EUROSTAT data)

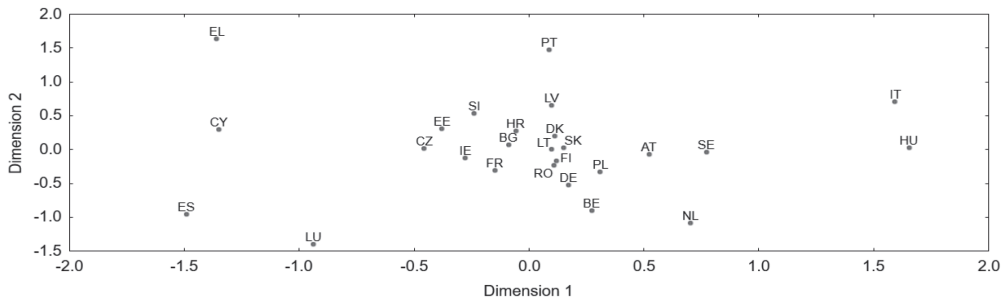
At the end of 2022, inflation was above 10% in 44.4% European Union countries. The euro area’s proportion was lower, involving 35.0% of countries. The most inflationary countries in this group were Estonia, Lithuania, and Latvia with 17.2 – 19.4% of inflation. The average value of the other 17 countries in the euro area was significantly lower – 8.8%. The higher inflation rates were more typical in non-euro area Member States. In 2022, 74.4% of these EU countries had more than 10% inflation. The exceptions were Sweden and Denmark with values of 8.1 – 8.5% (Figure 2).

**Figure 2:** Histograms and estimated density of EU-27 inflation rates in 2022



**Source:** processed by the author (based on EUROSTAT data)

The Guttman-Lingoes analysis was performed to estimate the most similar inflation direction changing patterns of EU-27 countries (Figure 3). This multidimensional scaling method in its results offered a similarity and dissimilarity graph in two dimensions. The coordinates for a set of points (EU-27 countries) in the space were computed so that the distances between pairs of these points fit as closely as possible to measure the similarities between them. The diagram allows to look for clusters of objects or regular patterns among the objects, such as circles, curved manifolds, and other structures.

**Figure 3:** Guttman-Lingoes 2020M01 – 2022M12 HICP analysis results

**Source:** processed by the author

Malta was excluded from Guttman-Lingoes analysis as an outlier having relatively low inflation in 2020 – 2022. Other countries were positioned in the two-dimensional space considering the monthly HICP changes. The most similar monthly price change directions and intensity to Lithuania occurred in Slovakia, Romania, Finland, and Denmark.

Table 1 represents the detailed 2023M10 HICP statistics of different products and services in European Union (EU), euro area (EA) and Lithuania (LT). The prices in Lithuania grew significantly more than the averages in EU-27 and euro area. Most similarities were observed in energy together with clothing and footwear price indices. The highest price growth in Lithuanian economy was observed in hotels and restaurants, food and non-alcoholic beverages, housing, services, alcohol and tobacco, energy, and education where prices grew by 52.43 – 80.91% compared to year 2015. Prices also increased in communication services while in EU-27 and euro area deflation is visible. The greatest differences between Lithuanian and EU-27 together with euro area price growth indices were in hotels and restaurants, services, and education, where HICP values differ from 38.8% to 50.76%. Health and housing prices for Lithuanian inhabitants also grew significantly more than in the compared regions. These differences were in the range of 30.95 – 36.69%. Transport, household equipment, recreation and culture, and non-energy industrial goods had the HICP differences of 12.14 – 19.72%.

**Table 1:** Detailed comparative HICP (%) statistics of 2023M10 (2015 = 100%)

	Hotels and restaurants	Food and non-alcoholic beverages	Housing	Services	Alcohol and tobacco	Energy	Education
EU-27	134.08	140.73	134.52	122.20	135.64	153.15	113.63
EA-20	130.15	135.90	130.05	118.74	132.48	152.26	107.09
LT	180.91	167.68	165.47	161.22	157.70	154.23	152.43
	Health	Transport	Household equipment	Recreation and culture	Non-energy industrial goods	Clothing and footwear	Communications
EU-27	114.62	129.05	119.60	118.24	116.48	115.17	94.94
EA-20	109.60	128.00	117.12	116.01	114.86	114.84	92.25
LT	146.29	142.27	136.84	134.30	128.62	115.48	103.51

**Source:** author's calculations

The analysis of inflation statistics has shown that on average the countries of the euro area had the lower consumer price growth than the whole European Union. However, Lithuania does not correspond to this tendency having one of the highest inflation rates. The price growth accelerated since 2021 and until 2023M09 no signs of price decline were detected. This adverse exception enhances interest in peculiarity of Lithuanian economy and the main inflation drivers.

#### 4 Drivers of relatively high post-pandemic inflation in Lithuania

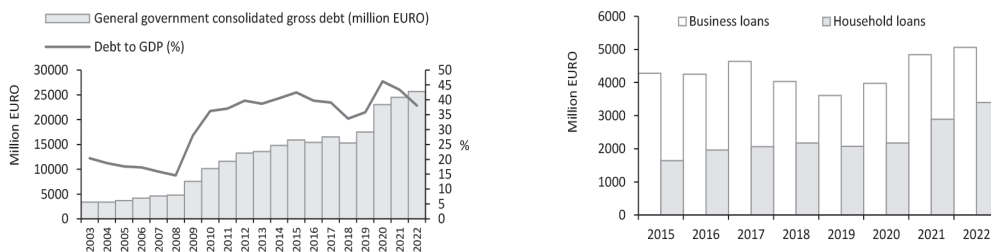
One of the most important inflation drivers is the surplus increase of money supply in economy. Managing the beginning of COVID-19 pandemic and mitigating the economic lockdown consequences in 2020 Lithuanian government increased the consolidated gross debt by 5.54 billion EURO (+31.6%) to 23.06 billion EURO. The debt to GDP ratio reached the peak-point of 46.2%. During the next two years the government's debt reached 25.67 billion EURO, however, the growing economy reduced its proportion



in GDP to 38.1%. Therefore, in 2020 – 2022 the Lithuanian government increased the money supply by 8.15 billion EURO (Figure 4).

A significant growth of new household and business loans' agreements in Lithuanian monetary financial institutions (MFIs) was observed in 2020 – 2022. During the previous low inflation period of 2015 – 2020 the average annual amount of new business loan agreements was 4.13 billion EURO with the average annual decline rate of 1.43%. In 2021 – 2022 the average annual volume of new business loans agreements increased to 4.95 billion EURO and the average annual growth rate rose to 12.79%. The new agreements of household loans in 2015 – 2020 grew on average by 5.76% yearly, having the average annual amount of 2.01 billion EURO. The optimism towards the future of households in 2021 – 2022 was considerably higher than in business, because their new loan agreements started to grow on average by 25.06% yearly, and the mean value reached 3.14 billion EURO which represents increase by 56.2%. The total amount of new business and household loans during the pandemic and post-pandemic period of 2020 – 2022 increased the money supply by 22.34 billion EURO (Figure 4).

**Figure 4:** Lithuanian general government consolidated gross debt (left) and new business and household credit agreements in Lithuanian MFIs (right)



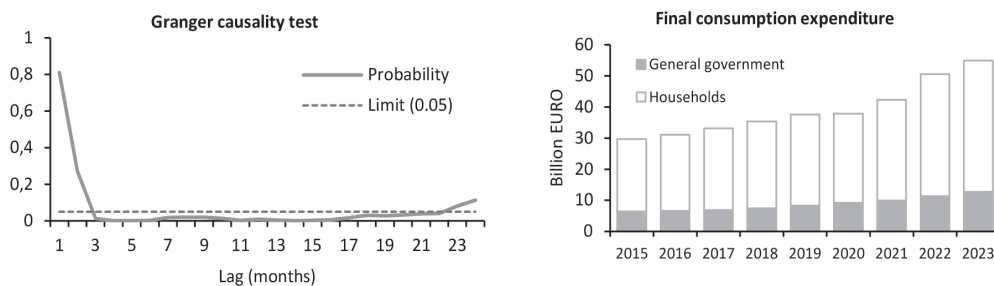
**Source:** processed by the author (based on EUROSTAT and Bank of Lithuania data)

Because one of the most important factors of money supply growth are credit institutions, the Granger causality test was used to estimate the lag in months between new business and households' loans and monthly HICP analyzing the period of 2015M01 – 2022M12. The null hypothesis (H0) is the loans do not Granger cause HICP. The lag estimation experiment includes the months from 1 to 24. The H0 hypothesis rejection limit was set to 0.05. The analysis has shown that the changes in loan amounts of credit institutions cause the

HICP to change with the lag of 3 – 22 months. The least probability (0.08%) that loans do not Granger cause HICP was in lag of 4 months, so it can be concluded, that the most significant impact of new credits on inflation is being observed after 4 months (Figure 5).

The growing private and public debts in Lithuania stimulated consumption. In 2015 – 2020 the consumption expenditure of general government on average grew by 7.53% yearly, while the period of 2020 – 2023 obtained the average 11.35% growth rate. The consumption expenditure growth of households at the same period accelerated from 4.27% to 13.85% (Figure 5). The aggregated final consumption expenditure of general government and households increased from 37.9 billion EURO in 2020 by 45.62% to 54.9 billion EURO in 2023. The real GDP growth rate was far behind the consumption expenditure increment.

**Figure 5:** Granger causality test results (left) and final consumption expenditure of Lithuanian households and general government (right)



Source: processed by the author (based on EUROSTAT data)

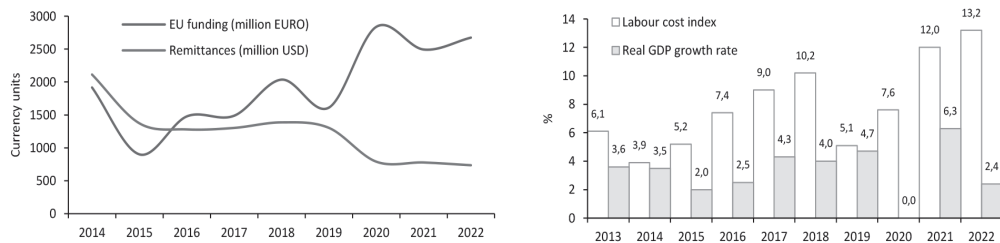
The average annual inflows of Lithuanian government, municipalities, social insurance and other funds from EU, foreign countries, and international organizations before the pandemic (2014 – 2019) was 1.572 billion EURO. In 2020 the EU financial support increased to 2.837 billion EURO and the average inflows of one year in 2020 – 2022 were 2.668 billion EURO. Compared to the pre-pandemic period this amount became higher by 69.8%, increasing the money supply in Lithuanian economy in three years by 8.004 billion EURO.

According to the World Bank's statistics, remittances from Lithuanian emigrants in 2020 – 2022 additionally increased the money supply by 2.305 billion USD. However, they tend to decline. The most significant drop-offs

were in 2015 and in 2020, when the remittances decreased by 35.0% and 39.4%. During the pre-pandemic period of 2015 – 2019, emigrants transferred on average 1.329 billion USD yearly, while the COVID-19 pandemic reduced the average value to 768 million EURO.

The COVID-19 pandemic increased the gap between the real GDP and labor cost growth rates. Before the pandemic this gap was in the range of 0.4% – 6.2%, while in 2020 the labor cost index surpassed the GDP growth by 7.6%, and in 2022 the gap reached 10.8%. This disbalance between personal income growth and value creation stimulated inflation (Figure 6).

**Figure 6:** EU funding and emigrants' remittance money flows to Lithuania (left), labor cost indices and Lithuanian real GDP growth rates (right)

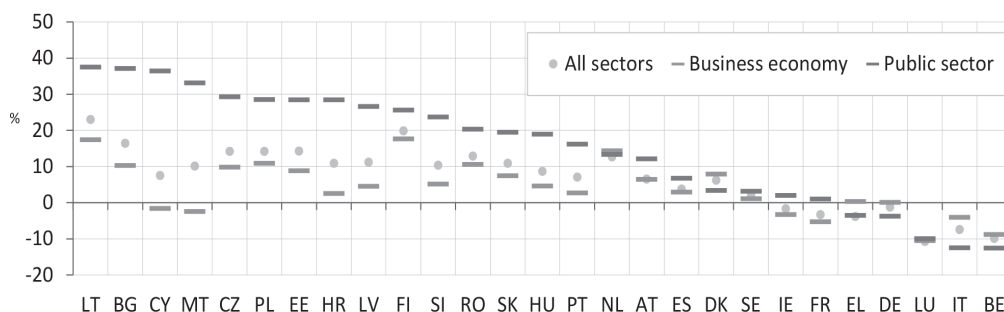


**Source:** processed by the author (based on EUROSTAT and the World Bank data)

At the beginning of COVID-19 pandemic in Lithuania the money borrowed by increasing the public debt was used not only for the management of pandemic, but also the wages of public sector's employees increased dramatically. In 2020Q1 – 2021Q3 for the persons employed in Lithuanian public sector the average salary increased by 37.6% and it was the highest growth in EU. The business employees experienced 17.5% growth in wages during the same period. The gap between public and business salaries growth was 20.1%. The average growth of wages in overall Lithuanian economy was 23.0% which undoubtedly increased inflation when the restrictive measures of pandemic were applied and reduced the production output in part of manufacturing and service activities. For comparison, in all EU-27 countries during the first 7 quarters of pandemic the average labor cost grew by 6.8%, businesses increased their salaries on average by 4.1%, while the growth of wages in public sector was 3.7 times higher and reached 15.2%. Besides Lithuania the highest boost of public sector employees' wages was also in Bulgaria

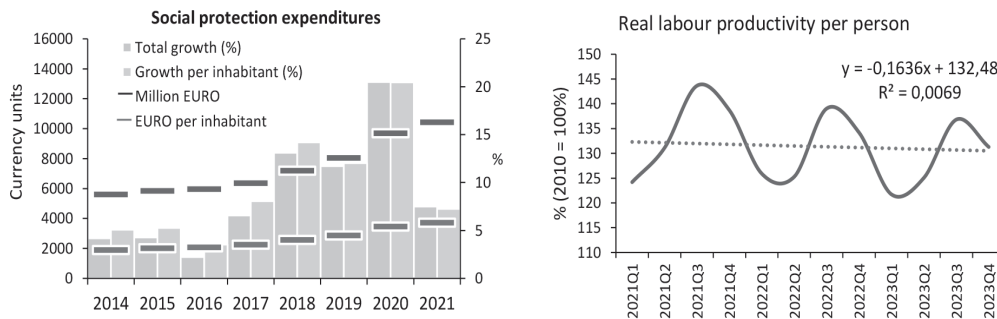
(37.2%), Cyprus (36.5%), Malta (33.2%), and Czechia (29.4%). The highest gap between public and business sectors' wages was in Cyprus (38.0%), Malta (35.6%), Bulgaria (26.8%), Croatia (25.9%), and Latvia (22.1%). The most responsible public finance management reducing the negative consequences of pandemic regarding public wages and inflation was in Belgium, Italy, Luxembourg, Germany, and Greece (Figure 7).

**Figure 7:** Labor cost growth rates in EU (2020Q1 – 2021Q3)



**Source:** processed by the author (based on EUROSTAT data)

The purchasing power of Lithuanian social care beneficiaries became significantly higher in 2020 when the social protection expenditures were increased by 20.5%. The total amount of these expenditures in one year grew from 8.1 to 9.7 billion EURO and the expenditures for one inhabitant changed from 2 882.83 to 3 472.47 EURO. At the beginning of the pandemic having the inflation rate at 1.1% level, the ability to purchase more production and services became possible not only for working persons, but also for socially supported Lithuanian inhabitants. In addition, the real labor productivity per person in Lithuania tends to decline with the linear regression slope of -0.1636% on average every quarter (Figure 8).

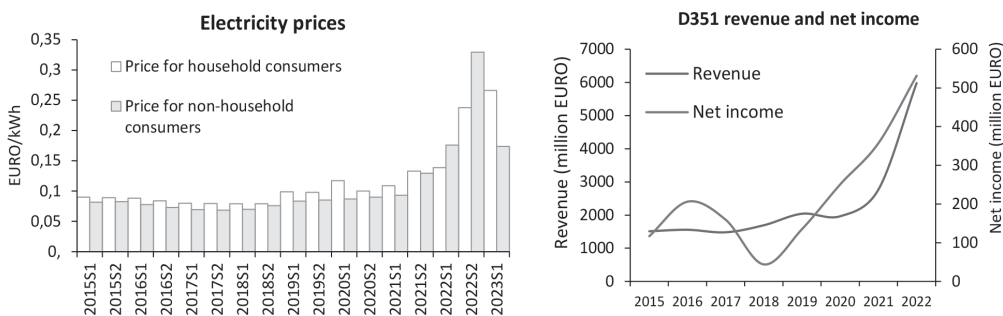
**Figure 8:** Lithuanian social protection expenditures and real labor productivity

**Source:** processed by the author (based on EUROSTAT data)

When the liberalization of Lithuanian electricity market started in 2010 the aim was declared to create the free energy market and competition of private suppliers which should have the positive impact on energy prices for consumers. However, since 2021 when the liberalization process approached the end and the last groups of household consumers became able to select the private energy suppliers, the electricity prices changed to the opposite direction. During the period of 2021S1 – 2023S1 the electricity prices for households on average increased by 127.4%, the prices for non-household consumers in 2021S1 – 2022S2 grew by 278.2%. Consequently, the revenue of Lithuanian electricity production, transmission, and distribution sector's (D351) business enterprises in 2021 – 2022 increased by 116.0%. The net income constantly grew since 2018 (from 43.9 to 531.3 million EURO in 2022), and the growth of this period was 1 110.9% (Figure 9).

Such a situation occurred when the government's regulation was reduced to about 50% of electricity price (infrastructure costs) and the other 50% is being determined by competition and free market. The growth of energy costs significantly increased the expenditures in other businesses: manufacturing, trade, and services. That caused the growth of inflation, increasing the surplus profits of energy suppliers, additionally ensuring the positive money flows from the established government's partial energy expenses compensation mechanism for businesses and households. It can be concluded that the declared aspect of Lithuanian energy suppliers' social responsibility raises lots of questions.

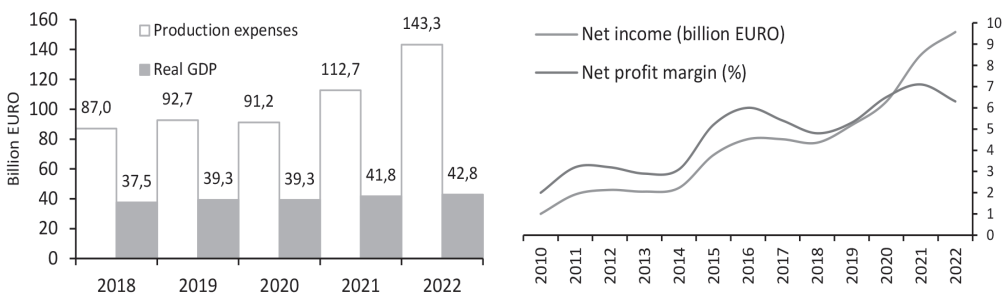
**Figure 9:** Electricity prices in Lithuania (semi-annual data 2015S1 – 2023S1) and Lithuanian electricity production, transmission, and distribution sector’s (D351) revenue and net income



**Source:** processed by the author (based on EUROSTAT and Statistics Lithuania data)

The sudden increment of production expenses in Lithuanian business enterprises occurred in 2021 and it continued until 2022. These expenses include raw materials, resold products, energy, purchased services, salaries for employees, depreciation and amortization of assets, and taxes. In 2020 – 2022 the production expenses grew by 57.1%, while the real GDP growth (at comparative prices of 2010) was only 8.9% (Figure 10).

**Figure 10:** Aggregated production expenses, real GDP of Lithuania, net income, and net profit margin of Lithuanian business enterprises

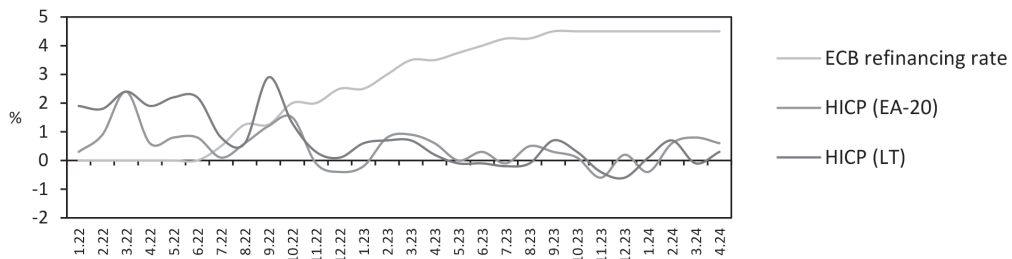


**Source:** processed by the, author (based on Statistics Lithuania data)

The Lithuanian business enterprises’ net income increased its growth rate when the COVID-19 pandemic began in 2020, and the public debt together with public sector’s wages and social protection expenditures raised. In 2010 – 2019 the average annual growth rate of net income was 20.1%, while the

period of 2019 – 2022 ensured the average growth of 22.7% yearly. The highest average net profit margin of businesses in Lithuania occurred also during the pandemic and post-pandemic period (6.6%). For comparison, in 2010 – 2019 the average value of this indicator was 4.1%. However, the continuous growth of production costs in 2022 reduced the net profit margin from 7.1% to 6.3%, compared to the most profitable year 2021 (Figure 10). The growth of net profitability by more than 10% in 2021 was observed in oil and gas, forestry, timber and paper industries, and accommodation, mass media, immovable property operations, consulting and other services.

**Figure 11:** ECB refinancing rate and HICP monthly rate of change of Lithuania and euro area in 2022-01 – 2024-04



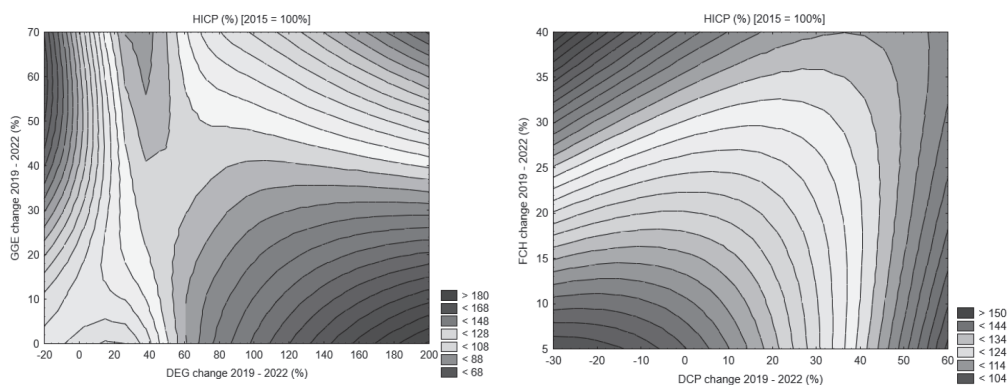
**Source:** processed by the author (based on EUROSTAT and ECB data)

Figure 11 indicates the impact of ECB refinancing rate increment on the inflation in Lithuania and euro area. The rate started its growth (from 0.5%) since July 2022, but the significant impact on HICP monthly rate of change was observed at the beginning of 2023 when the rate reached 2.5%. The average Lithuanian HICP monthly rate of change in 2022 was 1.53%, while in 2023M01 – 2024M04 it declined to 0.17%. The values of the euro area (EA-20) in these periods were 0.73% and 0.28% respectively. The growth of central bank interest rates significantly increased the interest rates and interest payments of business and household credits in commercial banks. The average 2022M01 interest rate of credit remainders in Lithuanian commercial banks was 2.69%, but in 2024M04 it reached 6.38% which indicates increased burden of debt related payments for businesses and households. The further analysis and statistical modeling aim to estimate the hypothetical positive outcomes of more responsible borrowing, reduced surplus consumption, and improved attitude towards sustainability, related to production-consumption disbalances and inflation.

## 5 Statistical modeling of inflation factors and outcomes

The contour charts were drawn analyzing the statistical interrelations of HICP average index and rate of change, government consolidated gross debt (DEG), general government expenditure (GGE), domestic credit to private sector (DCP), and final consumption expenditure of households (FCH) in EU-27 countries (Figure 12).

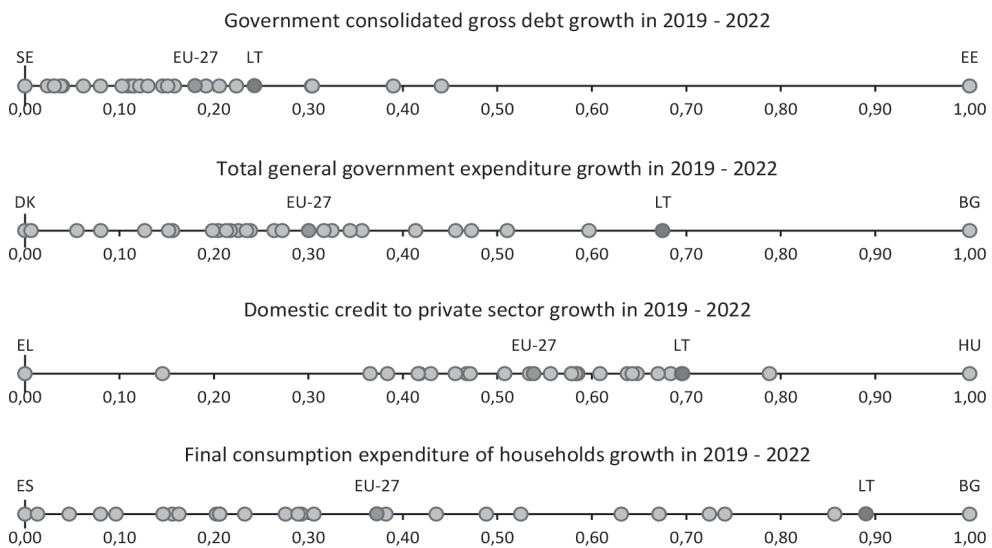
**Figure 12:** Statistical interrelations between government consolidated gross debt, total general government expenditure, and HICP (left); domestic credit to private sector, final consumption expenditure of households, and HICP (right)



**Source:** processed by the author (based on EUROSTAT and the World Bank data)

The dynamics of 2019 – 2022 period has shown that the highest consumer price growth was typical of EU-27 countries with the most intense public borrowing. The countries that significantly increased the general government expenditure during the COVID-19 pandemic met the problem of high inflation. However, the countries that increased the government expenditure due to the growth of the real economy and not increasing the public debt dramatically, did not suffer the consequences of high inflation. The growth of domestic credit to the private sector also was a very important factor in inflation in EU-countries, and the growing final consumption of households stimulated inflation irrespective of private indebtedness growth rate.



**Figure 13:** Dimension indices of EU-27 macroeconomic changes

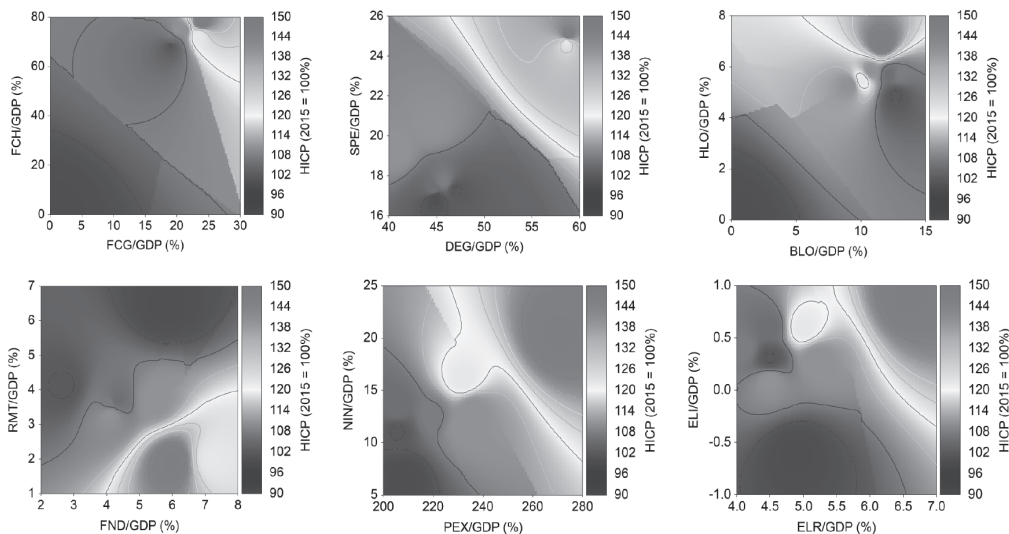
**Source:** processed by the author (based on EUROSTAT and World Bank data)

The relative distances of EU-27 macroeconomic indicators' changes in 2019 – 2022 were measured by dimension indices ( $D_i$ ):

$$D_i = \frac{\text{Actual value} - \text{Minimum value}}{\text{Maximum value} - \text{Minimum value}} \quad (1)$$

Figure 13 indicates the analyzed 4 macroeconomic indicators in relative distance scale [0; 1]. The relative position of Lithuania is shown together with EU-27 average, and countries that obtained minimal (0) and maximal (1) values. According to all analyzed indicators, Lithuania is far above EU-27 averages and is one of the leading countries having relatively high values of inflation factors. Only in Bulgaria, Romania, Czechia, and Estonia, the government indebtedness grew more than in Lithuania. The general government expenditure growth was higher only in Bulgaria, domestic credit to private sector increased more only in Romania and Hungary, and the growth of final consumption expenditure of households was higher only in Bulgaria. Experiencing such high values of inflation factors, Lithuania could not avoid the inflation shock in 2022. So, the following analysis aims to estimate how the decrease of inflation drivers (closer to EU-27 averages) could reduce inflation in this country.

**Figure 14:** Statistical interrelations between Lithuanian inflation drivers and HICP



**Source:** processed by the author (based on EUROSTAT and World Bank data)

The contour charts of main Lithuanian inflation drivers analyzed in Chapter 4 are shown in Figure 14, where the relative ratios of years 2015 – 2022 to the real GDP (the basis is year 2010) were calculated: the final consumption expenditure of households (FCH) and general government (FCG), government’s consolidated gross debt (DEG), social protection expenditure (SPE), business (BLO) and household (HLO) loans, remittances of emigrants (RMT), EU funding (FND), production expenses (PEX) and net income (NIN) of business enterprises, revenue (ELR) and net income (ELI) of electricity suppliers. The 2019 – 2022 change indices and Pearson correlation coefficients ( $r$ ) were calculated of the same variables to HICP (2015 = 100%) indicator (period of 2019 – 2022) in Table 2.

The visualization of three variable dependencies in Figure 14 indicates that inflation in Lithuania during the post-pandemic period rose as an overall result of all analyzed factors except remittances of emigrants that were declining in recent years. The correlation coefficients confirmed strong direct interdependencies ( $0.76 \leq r \leq 0.98$ ) of all factors, except EU fundings that recently fluctuated. The growing significant disbalances between money supply and real production output are visible, comparing the relative indicators

of pre-pandemic (2019) and post-pandemic (2022) periods (Table 2). The business-related factors, such as production expenditure and net income of business enterprises, also differ significantly. The financial wealth of electricity suppliers (sudden growth of revenue and net income) took precedence over the other participants of the economy and their social responsibility declarations.

**Table 2:** Comparison of Lithuanian inflation drivers in 2019 and 2022

<b>Ratio to GDP</b>	<b>DEG</b>	<b>BLO</b>	<b>HLO</b>	<b>FCG</b>	<b>FCH</b>	<b>FND</b>
2019 (%)	40.8	10.7	5.8	19.8	74.3	5.4
2022 (%)	58.8	11.6	6.9	23.8	77.6	6.0
Index (2022/2019)	1.44	1.08	1.19	1.20	1.04	1.10
r	0.80	0.76	0.91	0.82	0.76	0.43
<b>Ratio to GDP</b>	<b>RMT</b>	<b>SPE</b>	<b>PEX</b>	<b>NIN</b>	<b>ELR</b>	<b>ELI</b>
2019 (%)	3.7	19.2	231.7	11.6	4.5	0.1
2022 (%)	1.9	25.0	270.0	20.3	6.6	0.9
Index (2022/2019)	0.50	1.30	1.17	1.75	1.47	7.30
r	-0.84	0.82	0.93	0.98	0.92	0.90

**Source:** author's calculations

As the demand inflation was the most typical for Lithuania during the post-pandemic period, multiple linear regression models were developed to estimate the statistical dependency of final consumption expenditure of general government (FCG) and households (FCH) on macroeconomic inflation drivers:

$$FCG = 0.3645 \times REG + 0.0978 \times DEG + 165.4348 \quad (2)$$

where REG is total general government revenue and DEG is government consolidated gross debt (million EURO) of Lithuania in 2014 – 2023 ( $R^2 = 0.9974$ , MAPE = 2.76%).

$$FCH = 0.565 \times COE + 3.671 \times HLO + 8\,036.362 \quad (3)$$

where COE is compensation of employees and HLO is new household loan agreements (million EURO) of Lithuania in 2015 – 2022 ( $R^2 = 0.9724$ , MAPE = 2.21%). The numbers in the equations are the slopes and intercepts of the multiple linear regression models.

In Lithuanian economy the aggregated final consumption expenditure mainly

consisted of final consumption expenditure of households (75.4% – 77.8%) and final consumption expenditure of general government (22.0 – 24.3%). The proportion of other participants of the economy in 2019 – 2022 was only 0.2% – 0.3% and was not included in this research.

The percentage growth rates were calculated for the final consumption expenditure of households, general government, and total in 2019 – 2022. Further, the elasticity coefficients ( $E_i$ ) were calculated to estimate, how sensitive the total consumption expenditure is to the changes of households' and general government's consumption changes:

$$E_i = \frac{\Delta C(\%)}{\Delta i(\%)} \quad (4)$$

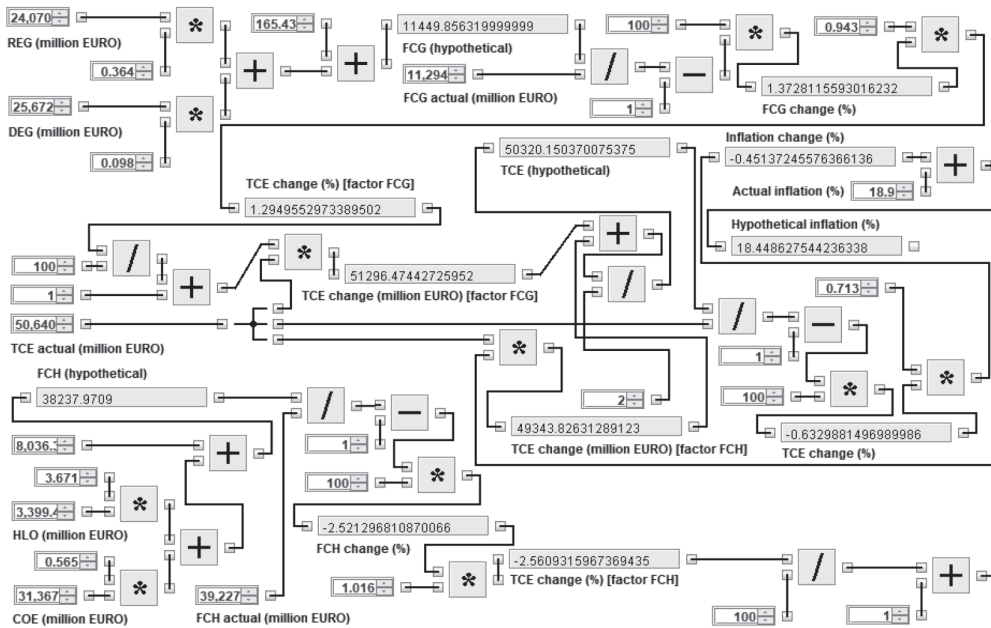
where  $\Delta C(\%)$  is the percentage growth rate of result variable (total consumption expenditure (TCE)), and  $\Delta i(\%)$  is the percentage growth rate of factor variable (final consumption expenditure of households (FCH) or general government (FCG)) in 2019 – 2022.

The elasticity coefficients are  $EFCH = 1.015720$  and  $EFCG = 0.943287$ , which means that the growth of final consumption expenditure of households by 1% increases the total consumption expenditures in Lithuanian economy by 1.015720%, and the growth of final consumption expenditure of general government by 1% increases the total consumption expenditures by 0.943287%. These coefficients allowed to separate the effects of households and government consumption changes on the overall aggregated consumption in the economy.

Using the elasticity coefficient, the next step was to evaluate, how sensitive Lithuanian inflation of a year (numerator  $\Delta INF(\%)$ ) is to the changes in total final consumption expenditure (denominator  $\Delta C(\%)$ ). When dividing these changes of 2019 – 2022, the result has shown that the growth of total final consumption expenditure by 1% increases the year's inflation by 0.713082%.

The system dynamics model with fixed variables was developed to analyze the hypothetical inflation in Lithuania based on changes of estimated inflation drivers (Figure 15).

**Figure 15:** System dynamics model for inflation prediction and model's test results



Source: developed by the author

The data flow is visible in Figure 15 through the connections between constants, variables, mathematical operators, calculated intermediate values and results. The inputs of model (million EURO) are the total general government revenue (REG), the government consolidated gross debt (DEG), the compensation of employees (COE), the new household loan agreements (HLO), the final consumption expenditure of general government (FCG actual), households (FCH actual), and total final consumption expenditure in the whole economy (TCE actual), as well as actual inflation of a year. The data processing algorithm consists of 8 stages: (1) the hypothetical final consumption expenditure of general government (FCG) and households (FCH) are calculated according to multiple linear regression models; (2) the percentage differences between hypothetical and actual final consumption expenditures of general government and households are calculated; (3) multiplying these differences by elasticity coefficients, the total consumption expenditure percentage changes influenced by FCG and FCH factors are calculated; (4) these percentage changes are recalculated into the total consumption expenditure (TCE) changes in million EURO influenced by FCG and FCH factors; (5) the hypothetical

total consumption expenditure is calculated combining the effects of FCG and FCH; (6) the percentage difference between hypothetical and actual TCE is calculated; (7) multiplying this difference by elasticity coefficient, the percentage inflation change is calculated; (8) adding this change to the actual inflation of a year, the hypothetical inflation is calculated considering the changes of inflation drivers modeled in different scenarios.

The model was tested by using the actual data of 2022 year’s Lithuanian economy (Figure 15 and Table 3). The prediction error is -0.4514%.

**Table 3:** Model’s test results

Year	Predicted inflation (%)	Actual inflation (%)	Prediction error (%)
2022	18.4486	18.9	-0.4514

Source: author’s calculations

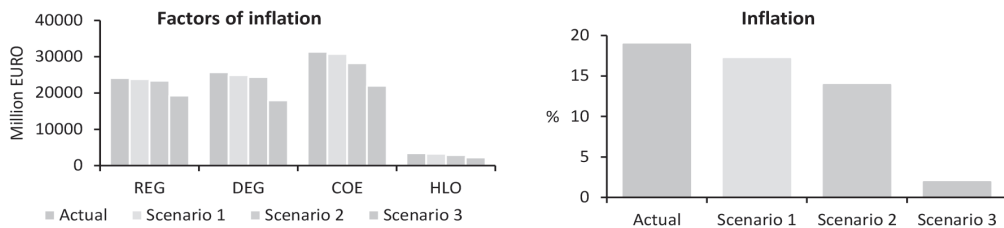
The user of the model can evaluate the expected inflation under the different scenarios. Three scenarios were analyzed modeling the hypothetical changes of 2022 year’s Lithuanian economy. In first two scenarios the total general government revenue ( $\Delta$ REG), the government consolidated gross debt ( $\Delta$ DEG), the compensation of employees ( $\Delta$ COE), and the new household loan agreements ( $\Delta$ HLO), were realistically reduced by 1% – 15%. The third scenario is drastic which aims hypothetically to estimate the possible decline of inflation drivers to keep the inflation not exceeding the targeted value of 2% (Table 4).

**Table 4:** Hypothetical scenarios of Lithuanian economy in 2022

	$\Delta$ REG (%)	$\Delta$ DEG (%)	$\Delta$ COE (%)	$\Delta$ HLO (%)	INF (%)
Scenario 1	-1	-3	-2	-5	17.1
Scenario 2	-3	-5	-10	-15	13.9
Scenario 3	-20	-30	-30	-36	1.9

Source: author’s calculations

Using the developed system dynamics model, the hypothetical inflation (INF) of Lithuania in 2022 was estimated. The comparison of macroeconomic indicators is shown in Figure 16.

**Figure 16: Lithuanian inflation (2022) modeling results**

**Source:** processed by the author

The statistical modeling results have shown that the 1st scenario of Lithuanian economy could reduce the 2022 year's inflation from 18.9% to 17.1%, the 2nd scenario allowed to expect the inflation decline of 13.9%, and the 3rd scenario could reduce the inflation to 1.9%. The developed system dynamics model allows us to analyze the additional different scenarios aiming to estimate the impact of changed values of macroeconomic factors on inflation.

## 6 Conclusions

At the end of the pandemic and during the post-pandemic period in Lithuania, the price growth of goods and especially services was significantly higher compared to EU-27 and euro area average growth rates. That was mainly influenced by sudden increase of public debt which was directed towards the easing of negative economic consequences of pandemic, and more intensively growing household debt, accelerating the money supply when the output of real sector was growing tenuously, and the labor productivity trend was slightly declining. One of the highest in EU-27 increase of Lithuanian public sector's wages and salaries stimulated the demand in product and service markets with the limited real growth of value added. In the inflationary environment solving the problems of social care system, the significant growth of social protection expenditures also increased the money supply, as well as the numerous EU funding instruments, that have important inflationary effect in the part of public highly funded activities that often can be considered of doubtful social and economic importance. Businesses were also pressured to increase labor costs, competing in shrinking Lithuanian labor market due to the three-decade continuing emigration and negative population increment rates. The growth of business costs was largely determined by the shock of electricity prices, when

electricity producers and suppliers increased their revenue and net income several times. The average profitability of business enterprises also increased, which indicates, that the price growth in most cases was determined not only by the increase of business costs, but also by raising profit margins due to low demand elasticity and surplus consumption based on money supply increment.

The ECB restrictive monetary policy measures had positive impact on inflation reduction in Lithuania, however, it is more important for economic system participants to understand the inflation drivers and make timely, reasonable borrowing and surplus consumption restricting decisions, avoiding a threatful price spiral effect in country's economy. The developed model in this research allows estimating the hypothetical inflation levels under the selected macroeconomic scenarios and understand the magnitude of disbalances between the changes of money supply and real production outputs. The limitation of the research is the natural complexity of inflation because of the behavior of many participants in the economy, having specific motives when making the pricing, borrowing, consumption and finance management decisions. Further research implies the development of a more complex inflation model including a higher number of variables and their statistical interrelations. Nevertheless, it is necessary to lead a scientific discussion on the obvious signs of overconsumption in consumer societies, over-indebtedness, insufficient abilities of real value creation striving only to consume more, when a sustainable development of the economy is desirable, avoiding debt spirals, crises of over-indebtedness, and irrational resource utilization. Profit maximization as the only real objective of businesses under cover of ostensible social responsibility and greedflation is not the way that modern economies should follow.

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