Bogužas, Žygimantas; Imbrasas, Darius; Jouvanceau, Valentin et al.

Book

Anatomy of inflationary shock in Lithuania : causes, effects and implications

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Žygimantas Bogužas

Darius Imbrasas

Valentin Jouvanceau

Rokas Kaminskas

Laura Mociūnaitė

Tomas Reichenbachas

Vaidotas Tuzikas

Kasparas Vasiliauskas

Eidas Virketis

Justina Zajankauskaitė

Gedimino pr. 6, LT-01103 Vilnius

www.lb.lt

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SUMMARY

After a decade of muted consumer price growth, inflation has picked up again, with the price increase of many goods and services spiking in 2022. Two extraordinary events – the COVID-19 pandemic and the Russian aggression against Ukraine – played a leading role in the jump in inflation. The high risk of deep recession in 2020-2021 forced governments and central banks to implement various supportive measures. As the economies adapted to the pandemic, recoveries followed unexpectedly quickly with the help of expansive monetary and fiscal policies. Nevertheless, pandemic-induced supply-chain disruptions have resulted in delivery delays and increased production and transportation costs across the globe. Thus, recovering demand faced a still-constrained supply. In 2022, recovering economies were hit by another shock – the Russian war against Ukraine. The war contributed to a rise in energy prices (notably, that of natural gas, which Europe was especially dependent on). All these factors – expansionary fiscal and monetary policies, rapidly recovering economies, residual post-pandemic disruptions in supply chains, and increases in energy prices – have led to an unexpected rise in inflation throughout the world, including Lithuania.

In this occasional paper, we analyse various topics related to inflation in Lithuania, predominantly focusing on the recent inflationary episode. The latter rise of inflation was unprecedented. In 2022, average annual inflation reached 18.9 per cent in Lithuania, a level which had not been seen for more than two decades. We analyse the nature of the recent inflation shock, duration, underlying causes, and consequences. While this study mainly deals with Lithuania, it also addresses the question of whether its inflation dynamics differs from that in the rest of the euro area, and if so, how. The study thus contributes to a more nuanced understanding of inflationary process in Lithuania. While integrated within the general topic, each of the chapters in the study can be seen as separate analytical notes focusing on distinct topics.

In Section 1.1. ("Stylized facts of consumer price dynamics") and Section 1.2 ("Dynamics of consumer, producer and input prices"), we provide an overview of the dynamics of inflation and its components in Lithuania over the past two decades. During the economic boom of 2004 to 2008, Lithuania experienced an upward pressure in consumer prices. This ended in 2009 with the global financial crisis, which triggered a significant downturn in the Lithuanian economy. Afterwards, a period of relative stability in inflation took place until the COVID-19 pandemic. At its start in 2020, consumer price inflation decelerated, but price growth picked up in 2021-2022. Since reaching its peak in 2022, the annual inflation rate has been steadily declining. Historically, energy prices in Lithuania have been characterized by especially high volatility. During periods of higher inflation, they have been one of the main drivers of inflation, while during periods of lower inflation, energy prices have been an important factor reducing it.

In Section 1.3. ("Inflation expectations of Lithuanian households") and Section 1.4. ("Inflation expectations of Lithuanian firms"), we use existing survey data on Lithuanian households' and firms' inflation expectations to better understand their evolution in the recent high inflation environment. A clear upward bias can be observed in households' and firms' inflation expectations. However, there is also a significant co-movement between actual inflation and inflation expectations. As inflation started to decline in 2023, similar trends can be observed in inflation expectations.

In Section 2.1. ("Effects of energy supply shocks on price inflation along the production chain"), we assess the impact of energy supply shocks on price inflation along the production chain in Lithuania. The energy shocks are identified in two independent monthly BVAR models (Messner and Zorner (2023)). Producer price inflation for energy and food reacts at half the rate of equivalent international inflation in the month of the shock and then continues to rise for a year or year and a half. Consumer food price inflation reacts to a similar extent as producer food price inflation, while consumer energy price inflation reacts to a lesser extent than producer energy price inflation. More importantly, these reactions occur

with a lag of about one year after the shock. Finally, the impact at the bottom of the production chain, i.e. on core consumer price inflation, is quite limited. Overall, this section shows that energy supply shocks propagate gradually through the supply chain over time and are not passed on, on a one-by-one basis, to the final consumer.

In Section 2.2. ("Wage and price responses to aggregate and labour market shocks"), we assess how global and labour market shocks affect wages and consumer prices in Lithuania, and how wage responses in turn affect prices in a quarterly BVAR. Aggregate demand, aggregate supply, labour supply and wage markup shocks are identified following Foroni et al. (2018). The impulse response functions (IRFs) show that global macroeconomic shocks have a persistently higher impact on wages (hourly earnings) and consumer prices than labour-specific shocks. Typical price and wage reactions have their maximum effects after about a year, underlining their rigidity to change. Counterfactual scenarios, in which wages do not react to shocks, reveal that such wage-price spirals can be significant after aggregate supply and demand shocks. Following a demand shock, wage reactions fuel price reactions in the medium term. Following a supply shock, wage reactions counterbalance price reactions over time.

In Section 2.3. ("Energy price inflation shocks in Lithuania and the Euro area"), we analyse how the energy price shocks affect economies in Lithuania and the Euro area. We estimate two separate BVAR models (one for Lithuania, the other for the EA), including respective time series from 2002Q1 to 2022Q4 of yoy energy, food, and core HICP inflation, as well as the unemployment rate and yoy total compensation per employee, following Corsello and Tagliabracci (2023). The IRFs show that Lithuania was more vulnerable to, and more affected by, energy price inflation shocks than the EA on average over the period. For an equivalent energy shock, the effects on HICP consumer price and wage inflation were larger and more persistent.

In Section 2.4. ("What has driven the surge in inflation in Lithuania? A production-side decomposition."), using input-output tables, we decompose the inflation into its four drivers – prices of energy, prices of other imported products, wages and gross operating surplus. In our analysis, we focus on the period from 2021Q1 to 2023Q2 and find that all these supply-side factors contributed significantly to the increase in price level. We show that wage increases accounted for 40% of the calculated increase in price level, while the remaining increase was accounted for in broadly similar proportions by higher energy costs, more expensive imports of non-energy goods and services, and an increase in non-energy sector gross operating surplus (profit). The analysis also indicates that the recent increase in production costs has not yet been fully passed on to consumer prices in 2023Q2.

In Section 2.5. ("Lithuania's nominal effective exchange rate fluctuations and domestic inflation."), we analyse whether changes in nominal effective exchange rates have played a significant role in the recent surge of inflation. A relatively large share of Lithuanian imports is denominated in foreign currency, implying that inflation can be at least partially explained by currency depreciation. To determine the exchange rate pass-through to prices, a simple VAR analysis is conducted. The results of analysis indicate that exchange rate pass-through to import prices is incomplete in Lithuania, meaning that there is no tit-for-tat increase in import prices following currency depreciation. The pass-through for producer and consumer prices is even lower. Nominal exchange rate developments explain slightly more than 10% of import price variability, yet only about 1% of producer and consumer price variability. It follows that although the depreciation of the euro contributed to increasing inflation in the most recent inflation period (2021–2022) in Lithuania, its impact on producer and consumer prices was very limited.

In Section 2.6 ("A comparison of consumption basket item weights and price levels in Lithuania and the euro area"), we analyse if the differences in the composition of consumption baskets in Lithuania and euro area can explain a significant portion of inflation differentials. While gradually converging, the structure of the Lithuanian consumption basket still differs somewhat from that in the EA average. The greatest differences exist in the weights of services and food. In countries with a higher standard of living, households tend to spend less on basic needs and more on services. The same trends are observed in the development of the Lithuanian economy; as the standard of living approaches the EU average, the price level also converges, and services become a more prominent part of the consumption basket. Different weights of various goods and services in consumption baskets lead to different item weights for inflation calculation. Our calculations show that if in Lithuania we had HICP weights equal to those in the EA, our average annual headline inflation rate would have been about 1.6 percentage points lower than the factual in 2022.

In Section 2.7. ("Can price level convergence explain longer-term differences in inflation rates across euro area countries?"), following Honohan and Lane (2003), we provide evidence that in a monetary union, remaining price level differences lead to higher inflation in countries with lower price levels. For every single percentage point (pp) deviation below the average price level, countries experience around 0.02-0.036 pp higher inflation. In 2022, the price level in Lithuania was still 26 percent below the EU average. This would imply that the annual inflation in Lithuania could be about 0.5-0.9 pp higher than EA average due to the price level convergence in 2022.

The unexpectedly high inflation has affected government finances substantially. In Section 3 ("Implications of temporary acceleration in inflation for public finances"), we analyse the implications of higher inflation on the fiscal position of the general government sector. We break down recent general government revenue growth into four explanatory factors: real economic activity, price growth, the effect of government's discretionary decisions (fiscal measures) and the unexplained component or tax residual. Our decompositions show that in 2021-2022, the observed increase in tax revenue was significantly affected by the strong growth of the macroeconomic bases and implemented fiscal measures. As regards the impact of inflation, more than half of the increase in receipts from VAT, personal income tax and social contributions can be attributed to the rise in the price component. As inflation decelerates, there will be a corresponding slowdown in the nominal GDP growth and the deceleration in goods and services inflation. This would naturally slow the growth of general government revenue.

All in all, this analysis implies that during the periods of a temporary increase in inflation fiscal policy should resist using the inflation-induced proceeds to finance permanent increases in spending. In the near future, inflation could show persistence and respond more slowly to changing trends in import and producer prices (compared to the upswing) since not all of the increased costs were fully passed through to consumer prices by the middle of 2023. In the longer term, inflation prospects in Lithuania will depend not only on economic policy but also future changes in the energy sector and climate-related developments and their impact, as well as the ability to adapt to those shifts.

Keywords: inflation, convergence, price level, supply shock

JEL: C25, E61, G18, G21, G51.

CONTENTS

1.STYLIZED FACTS

1.1. STYLIZED FACTS OF CONSUMER PRICE DYNAMICS

This section delves into the stylized features that have characterized the dynamics of inflation in Lithuania over the past two decades. The investigation focuses on two inflation metrics, specifically inflation derived from the harmonized consumer price index (HICP, or headline inflation) and HICP excluding food and energy (core inflation). Within this sub-section, an examination is conducted on the components of HICP, involving a historical decomposition of their year-on-year growth rates. The decomposition spanning from January 2003 to October 2023 (Figure 1) enables an assessment of the extent to which each element contributed to annual inflation, thereby identifying their origins and dynamics. This analysis reveals the presence of six distinct periods within the specified timeframe:

- **Economic boom (2004-2008)**
- **Financial crisis (2009)**
- **Economic recovery (2010-2015)**
- **Relatively moderate inflation (2016-2019)**
- **Covid-19 (2020)**
- **Post-Covid-19 (2021-2023)**

Economic boom (2004-2008)

During the economic boom of 2004 to 2008, Lithuania experienced an upward trend in consumer prices, marking a shift from the deflationary phase of 2003. The average annual inflation in 2004 was 1.2%. The increase in Lithuania's inflation rate can largely be attributed to the food and energy components. The average annual inflation continued to climb in the subsequent years, peaking at 11.1% in 2008. The strongest contributor to the inflation increase was a growth of prices of food products. In 2008, higher prices of food, beverages and tobacco accounted for almost half of the average annual inflation; price developments of industrial goods, excluding energy, and services made up almost one-third; and changes of administered prices comprised approximately one-fifth of the average annual inflation.

Financial crisis (2009)

In 2009, the global financial crisis triggered a significant downturn in the Lithuanian economy with a reduction in consumer prices. This phase represented a sharp turnaround from the inflationary pressures observed during the economic boom. Compared with 2008, the average annual inflation was more than halved in 2009; it shrank by 6.9 percentage points to 4.2%. Approximately half of this contraction was attributed to a decrease in annual growth of prices for food, beverages, and tobacco.

Economic recovery (2010-2015)

During the years 2010 to 2015, Lithuania underwent a period of gradual economic recovery. The year 2010 marked the beginning of this recovery phase, with an average annual inflation of 1.2%. In the context of persisting weak domestic consumption and internal devaluation resulting in unit labour costs decreasing in 2009 and 2010 followed by only gradual recovery, the prices related to its development (prices of industrial goods, excluding energy, and market services) were lower than a year ago and remained subdued throughout the period. By contrast, throughout the year 2010, prices related to the movements in global food and energy markets (i.e. prices of food, fuels and administered prices) surpassed the level of a year ago. In the subsequent years, prices associated with external factors, particularly food and energy, continued to be significant contributors to the inflation. For example, in 2011, approximately one-half of inflation was determined by food prices, while two-fifths of inflation were determined by fuel and administered prices. However, the contribution of increased food prices to inflation significantly declined in the second half of 2011 as the global food commodity prices grew at an increasingly slower rate and eventually started to fall (Figure 5). In May, annual inflation reached 5.0% (the highest in approximately the previous two years) and afterwards, it was mainly decelerating. In the following four years, inflation was very low, much lower than the long-term average: in 2013 it was 1.2%, and in 2014, 0.2%. Low inflation in those few years was related to consumer-favourable developments in commodity, import and producer prices (Figure 3). This downward trend culminated in a deflationary phase when consumer prices fell markedly: average annual inflation stood at -0.7 per cent in 2015. This HICP dip can be mainly attributed to the significant decreases in the prices of energy goods, especially fuel. This spell of negative inflation was predominantly driven by one particular component, i.e. the slide in global oil prices in 2014-2015.

Relatively moderate inflation (2016-2019)

From 2016 to 2019, inflation remained moderate but was higher than in the preceding years. Starting in 2016, the HICP exhibited a consistent upward trend, reaching its peak in 2017 with an average annual inflation rate of 3.7%, mainly due to rising prices of food and services. Administered prices, which had been putting downward pressure on inflation for quite some time, started to pick up in 2017 due to tax changes, notably the increased VAT on heat energy and accelerating energy commodity prices. Core inflation, excluding the most volatile prices (energy and food), also saw a significant upturn, reaching 2.6%. Rising tensions in the labour market and the previously increased minimum wage contributed to a significant increase in labour costs. These developments contributed to a sharp rise in services prices (annual change of services prices was 5.5%). Following an increase in consumer prices in 2017, annual headline inflation subsequently moderated, standing at 2.5% in 2018 and 2.2% in 2019. Weaker growth was mainly affected by food and energy components.

Covid-19 (2020)

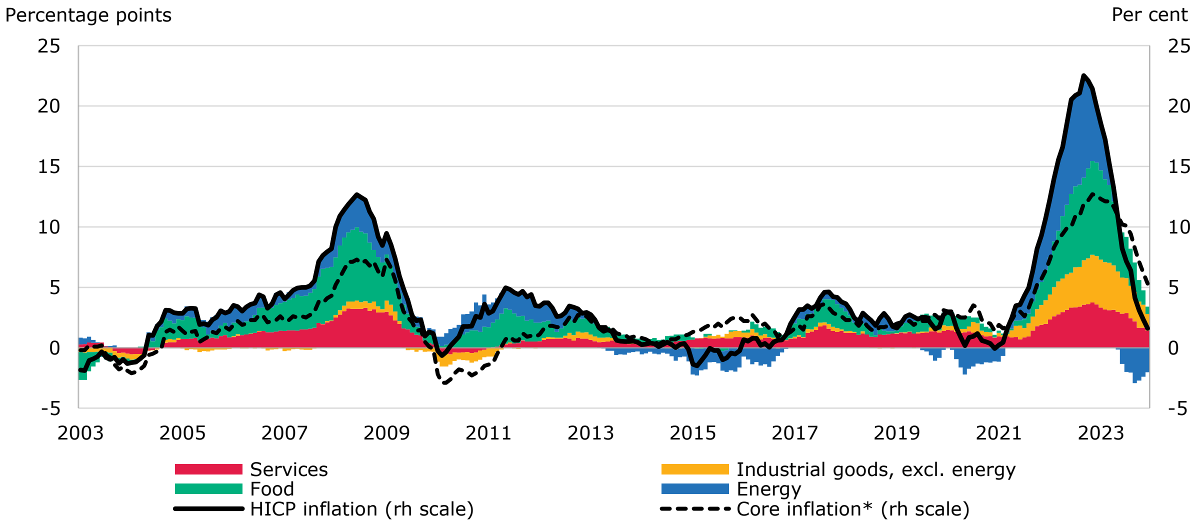
The impact of the COVID-19 pandemic did not spare price developments in Lithuania. Consumer price inflation decelerated to 1.1% in 2020 and was half the rate recorded in 2019. A decrease in Lithuania’s inflation rate can largely be attributed to the energy component. The slump in crude oil prices in 2020 led to a significant fall in prices for oil-intensive products. As a result, in Lithuania, prices for fuels and lubricants decreased by 9.1 per cent on average compared to 2019. Also, administered prices had a dampening effect on inflation and fell by approximately 2%. Food inflation, including alcoholic beverages and tobacco, decelerated in the period under review.

Post-Covid-19 (2021-2023)

In the context of Lithuania's economic recovery, along with the global economic resurgence, the average annual inflation in Lithuania reached 4.6% in 2021. Price growth picked up strongly in 2021, with annual inflation standing at 0.2% in January and rising at an annual rate of as much as 10.7% in December. Increasing prices of energy was the key upward element of inflation and contributed 1.7 percentage points to the overall inflation. The surge in global energy (Figure 5) and other commodity prices contributed to an elevation in fuel and administered prices (electricity, gas and heat). For instance, the notable increase in fuel and lubricant prices amounted to 18.2%. In the subsequent year, the energy component persisted as a principal contributor to headline inflation and accounted for 6.5 percentage points of 18.9% average annual inflation. Annual inflation developments in Lithuania in 2022 can be divided into two parts: a consistent increase up to peak inflation in September (22.5%), and a consistent decline in the following months. Rising energy prices were the main contributor to the increase in annual inflation, while the moderation of energy price growth was the main element in the decline in annual inflation towards the end of the year. In the fourth quarter, food prices became the main item of inflation in the context of declining annual growth in energy prices. The average annual rate of increase in food prices stood at 22%, contributing significantly (6.0 percentage points) to the overall inflation. In 2022, core inflation stood at 10.4%, marking the highest rate observed over two decades. In the case of services, one of the items of core inflation, the notable surge in wages and salaries (13.4%), which comprise a substantial share of the overall service costs, contributed to an escalation in service prices. Price developments of industrial goods, another component of core inflation, were significantly shaped not only by domestic factors but also by external ones, such as higher prices of various metals and other industrial commodities (Figure 5). Moreover, these developments were also affected by supply bottlenecks, which were gradually easing, with the price of freight carriage by shipping containers falling by approximately one-fifth in December 2022, compared to January of that year (Figure 5).

Since reaching its peak in 2022, the annual inflation rate in Lithuania has been steadily declining. According to the latest available data, annual inflation stood at 1.6% in December 2023. A fall in energy prices continued to dampen inflation. Nevertheless, average annual food price growth remains the key contributor putting upward pressure on HICP inflation. Against the backdrop of falling headline inflation, core inflation is also going down, but at a slower pace.

Figure 1. HICP inflation and its main components



Sources: State Data Agency and Bank of Lithuania calculations.
* Change in HICP excl. energy, food, alcohol and tobacco.

1.2. DYNAMICS OF CONSUMER, PRODUCER AND INPUT PRICES

The changes in overall price level do not consist of homogeneous price changes in all main inflation components[1]. This suggests that shifts in sectoral relative prices exist. The information about relative[2] price levels enable us to determine the degree of alignment of each category with overall price level dynamics. Price level developments of different subcomponents relative to the overall HICP price level in Lithuania reveal that there are categories with both systematic (positive and negative) trends and persistent fluctuations (Figure 2).

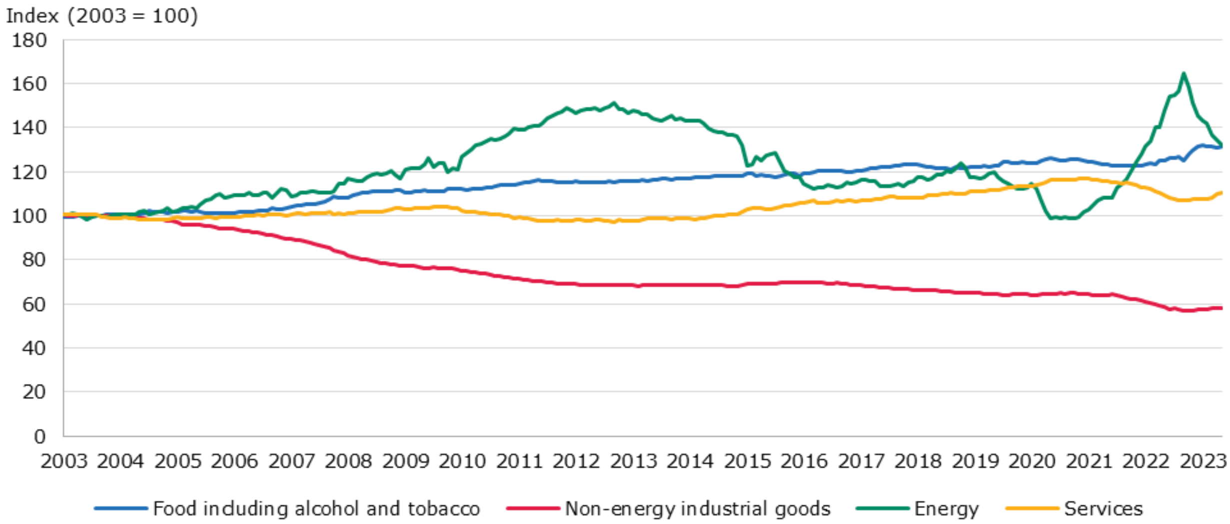
[1] This can be seen from Figure 1. Since the effect of changes in basket weights over time is relatively small and the weights within a year are fixed, the magnitude of subcomponent contributions is mainly defined by the price changes of those components.
[2] This is the ratio between the index of the HICP subcomponent and overall HICP index.

We can see that the relative price of energy significantly fluctuates. There are two periods of significant cumulative increase in the relative price of energy over the analysed period, i.e., 2010-2012 and 2021-2022. During these periods, the energy component was one of the main contributors to inflation (Figure 1). In general, the trend of relative prices of energy is in line with the changes in energy resources prices[3].

The relative prices of food, including alcohol and tobacco, and the relative prices of services, show systematic positive trends. The positive trend in relative prices of food can be attributed to the increase in prices of food commodities and excise duties on alcohol and tobacco while the upward trend in the prices of services is significantly related to the rapid growth of wages. It can be seen from Figure 2 that the cumulative difference between the services price level and the overall price level is quite small compared to the other categories. This is in line with the results of the euro area and proves that the trend in the prices of services is a good proxy of the overall price trend (Lane, 2022).

The trend in the relative prices of non-energy industrial goods (NEIG) exists and is negative. This is related to: (1) technological progress leading to cheaper production and increased productivity and (2) the impact of competition in the tradable sector.

Figure 2. Price developments relative to HICP for main inflation aggregates



Sources: Eurostat and Bank of Lithuania calculations.
*Seasonally adjusted data

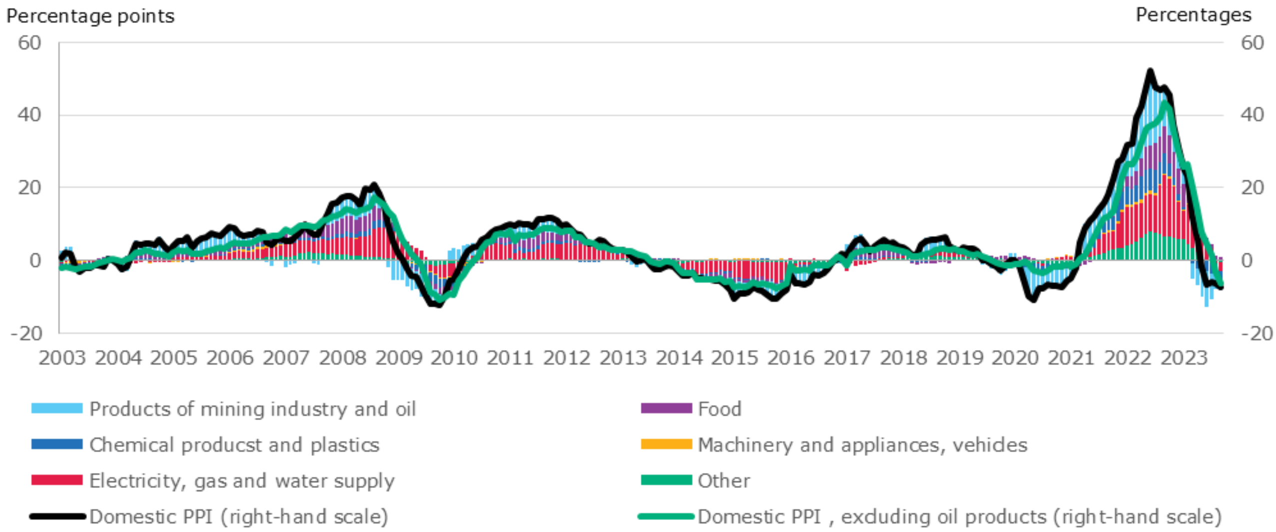
Producer prices are important indicators in the pricing chain as they capture prices at the production stage while consumer prices include additional factors such as taxes or costs and markups of the distribution and retail sectors (ECB 2017, 2023). Therefore, the dynamics of consumer and producer price inflation reflects common trends (see Figure 1 and 3). Domestic producer prices increased at an elevated pace during 2007-2008, 2011 and 2021-2022 periods. These are the periods when prices for consumers also grew the fastest. The periods of decrease in producer prices are also in line with the periods of lower consumer price inflation (2009-2010, 2013-2016, 2020). However, it should be noted that the amplitude of producer price fluctuations is greater than that of consumer prices.

As we saw from Figure 1, inflation trends were mainly shaped by the food and energy components. Energy prices are characterized by especially high volatility. Accordingly, during periods of higher

[3] For the development of energy raw material prices, see Figures 4 and 5.

inflation, energy prices were one of the main contributors to inflation, while during periods of lower inflation, energy prices were a factor reducing inflation. The same insight about energy applies to producer prices (Figure 3). The energy sector in Figure 3 is mainly represented by the mining industry and oil and electricity, gas and water supply activities. We can see that the output prices of these activities contributed to the heights of domestic producer price inflation the most. The most recent domestic producer price jump in 2021-2022 is no exception: the domestic producer prices of products of mining industry and oil, electricity, gas and water supply accounted for about two-thirds of total domestic producer price inflation during this period. In 2023, when domestic producer prices decreased, the prices of mining industry products and oil contributed negatively to this change.

Figure 3. Producer price inflation and its contributions (by economic activity, domestic market)

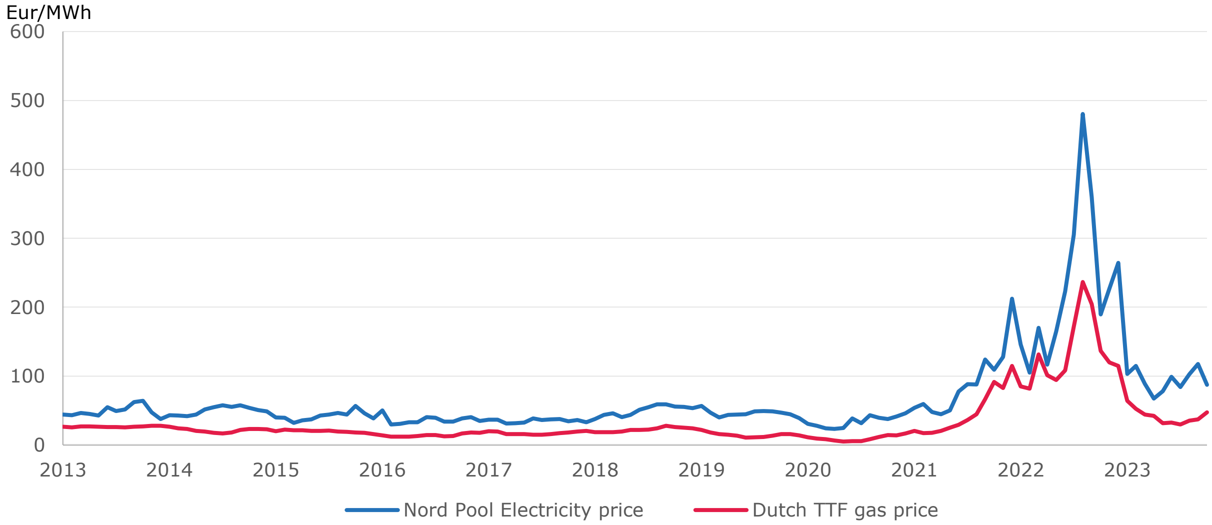


Sources: State Data Agency and Bank of Lithuania calculations.

The evolution of producer prices was accompanied by the respective trends in the prices of energy raw materials and other commodities. There are three periods of exceptional price growth in the case of raw material prices, the same as in the case of consumer and producer prices (Figure 5). The recent spike in the prices of raw materials in 2021-2022 is particularly exceptional.

The prices of energy raw materials in the EA fluctuate more than the prices of other commodities (Figure 5). Prices of energy raw materials are affected by the balance of supply and demand, economic and geopolitical uncertainty, and geopolitical tensions. All these factors were important for the spike in the prices of energy resources in 2021-2022. However, the most important factor was Russia's war against Ukraine. It significantly affected gas, electricity and to a lesser extent oil prices. In 2022, market prices for gas were almost 3 times higher than in the previous year. The peak of gas prices in Europe was reached in August 2022 - it averaged around €236/MWh and was more than five times higher year on year (Figure 4). The use of gas as a feedstock for electricity generation also contributed substantially to the rise in electricity prices on the market: electricity prices on the Nord Pool exchange in August 2022 (the peak) were more than five times higher than in August a year before. Overall, prices of energy resources in 2022 in EA were about four times higher than in 2020 and about three times higher compared to 2019 (Figure 5). The effect of the prices of energy raw materials on consumer prices in Lithuania is further analysed in Sub-sections 2.1 and 2.3-2.4.

Figure 4. The dynamics of electricity and gas prices



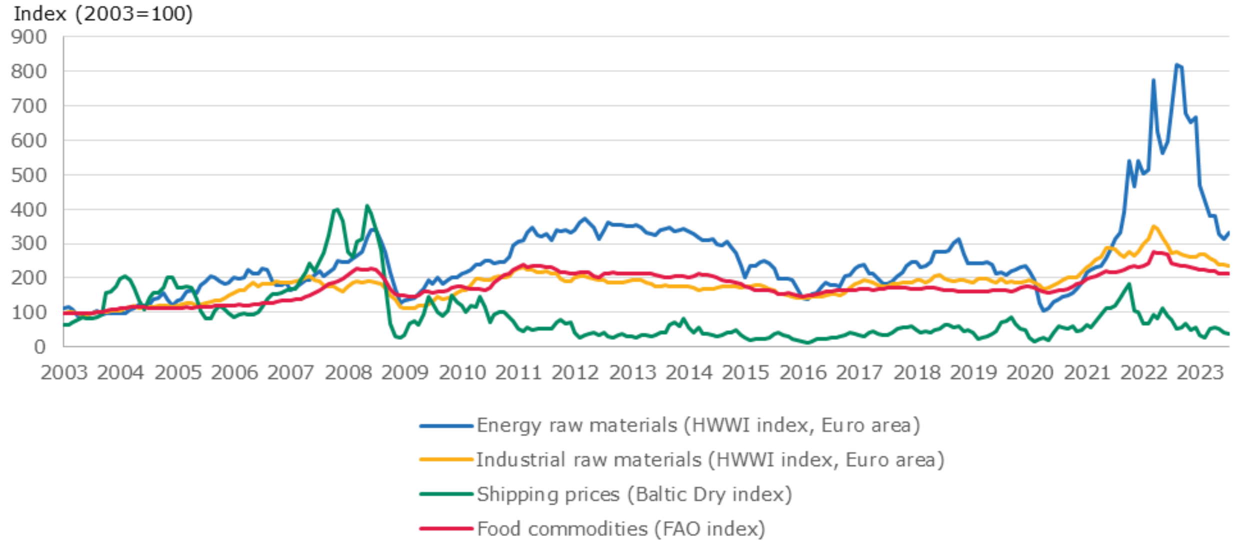
Sources: Refinitiv and Nord Pool.

During the analysed period, the prices of industrial raw materials were characterized by smaller fluctuations than the prices of energy raw materials (Figure 5). However, in 2022, the prices of industrial raw materials increased by half compared to 2020 and by the same amount compared to 2019, driven by a sequence of factors. Restrictions on the consumption of services led to a shift of consumption towards goods. The sharp rebound in global manufacturing activity also caused a rebound in new orders for inputs of production (ECB, 2021). The reaction of prices to these factors was also exacerbated by supply chain disruptions.

During 2022, food commodity prices also increased. Affected not only by the aforementioned factors, but also by Russia's war on Ukraine, the prices of food commodities increased by about half in 2022 compared to 2019.

Another notable external factor is shipping prices, represented by the Baltic Dry index (Figure 5). The trend of shipping prices was negative during the analysed period. Technological advances in transportation, infrastructure development, new communication technologies and transportation sector growth created conditions for shipping prices to fall (Daudin at al., 2022). The biggest deviations from this trend were recorded around 2007-2008 and 2021-2022. In general, the increases in shipping costs were related to increases in demand. The latest increase in demand was very specific. With the outbreak of the pandemic and the containment measures introduced to control it, the consumption of services was restricted. As consumers switched part of their spending from services to goods, companies sought to rebuild their stocks and hedge against potential supply disruptions in the future. Due to the aforementioned factors and stimulus programs, pent-up demand overwhelmed the capacity of supply chains. At the same time, shortages of containers at Asian ports due to COVID-19 restrictions increased supply bottlenecks (ECB, 2021). The result was delays in delivering goods to customers, together with a surge in the costs of goods and their delivery. Shipping costs increased over twice as much in 2021 as in 2019. This increase in shipping costs was an important contributor to inflation. The results of our analysis presented below highlight that contribution.

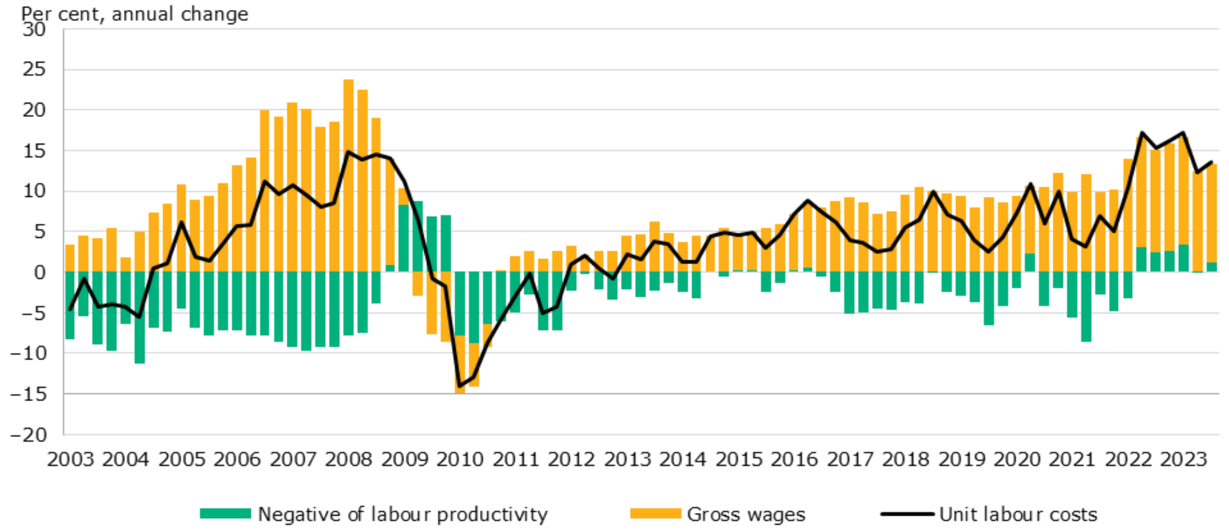
Figure 5. The dynamics of shipping costs, prices of energy raw materials and other commodities



Sources: Macrobond, FAO and Bank of Lithuania calculations.

In general, producer and consumer prices are affected by both external and domestic factors. We saw in the previous paragraphs that external factors such as the prices of various commodities and shipping rose significantly during the analysed period. However, not only external factors, but also domestic factors fluctuated during those years. In particular, unit labour costs that depend on developments in domestic wages and productivity increased markedly in 2008 and 2022 (Figure 6). Driven by the rapid growth of wages, unit labour costs increased by about 14% in 2008 and by about 14% in 2023. However, the impact of productivity was significantly different in both periods. While growing labour productivity helped offset the impact of higher wages in 2008, labour productivity declined in 2022, thus increasing unit labour costs. As our analysis presented below shows, wage impact on prices depends on what kind of shock (supply or demand) hits the economy. A more detailed analysis of wages on inflation is provided in sub-chapter 2.2.

Figure 6. The developments of wages, labour productivity and ULC



Sources: State Data Agency and Bank of Lithuania calculations.

References

Attinasi, M. G., Bobasu, A. and Gerinovics, R. (2021). What is driving the recent surge in shipping costs? ECB Economic Bulletin, 3/2021. Link here.

ECB Economic Bulletin (2017). What can recent developments in producer prices tell us about pipeline pressures? ECB Economic Bulletin, 3/2017. Link here.

Daudin, G., Hericourt, J., Patureau, L., (2022). Gains from trade: International transport costs still matter, especially additive ones. VoxEU column. Linke here.

Lane, Ph. R. (2022). Inflation Diagnostics. ECB Blog. Link here.

Rubene, I. (2023). Indicators for producer price pressures in consumer goods inflation. ECB Economic Bulletin, 3/2023. Link here.

1.3. INFLATION EXPECTATIONS OF LITHUANIAN HOUSEHOLDS[4]

Inflation expectations play a critical role in economic models. The primary mechanism whereby inflation expectations affect households' decisions is their perceived real interest rate, which depends not just on the nominal interest rates faced by households, but also on their expectations of future inflation. Similarly, firms' expectations of inflation should affect their pricing and wage-setting decisions and also their investment and hiring decisions because of the relationship between inflation and real economic activity.

In 2021-2023 Lithuania experienced a surge of inflation. Specifically, in 2022, inflation reached levels unseen since the early 90s. The strong increase in inflation calls for closer monitoring and understanding of the behaviour of households' and firms' inflation expectations.

The information on inflation expectations used in this sub-section is from the European Commission EU Consumer Survey. The EU Consumer survey data are collected under the framework of the Joint Harmonised EU Programme of Business and Consumer Surveys. This consumer survey covers 28 European Union member states and is conducted on a monthly basis. It includes quantitative questions on households' inflation expectations and perceptions, which are formulated as follows:

- Q51: By how many per cent do you think that consumer prices have gone up/down over the past 12 months? Consumer prices have increased by xx.xx% / decreased by xx.xx%.
- Q61: By how many per cent do you expect consumer prices to go up/down in the next 12 months? Consumer prices will increase by xx.xx% / decrease by xx.xx%.

Fig. 1 provides the data for Lithuanian inflation, average households' inflation perceptions and average households' inflation expectations over 2004-2022. We can see that households' inflation expectations and households' inflation perceptions have been systemically above the actual inflation rate (on average by 12.2 pp and 13.4 pp respectively). Nonetheless, there is significant co-movement between actual inflation and inflation expectations/perceptions. We can identify 6 distinct periods:

- Economic boom (2004-2008)
- Financial crisis (2009)
- Economic recovery (2010-2015)
- Adoption of euro (2015-2018)
- Covid-19 (2020)
- Post-Covid-19 rise in inflation (2021 - 2023)

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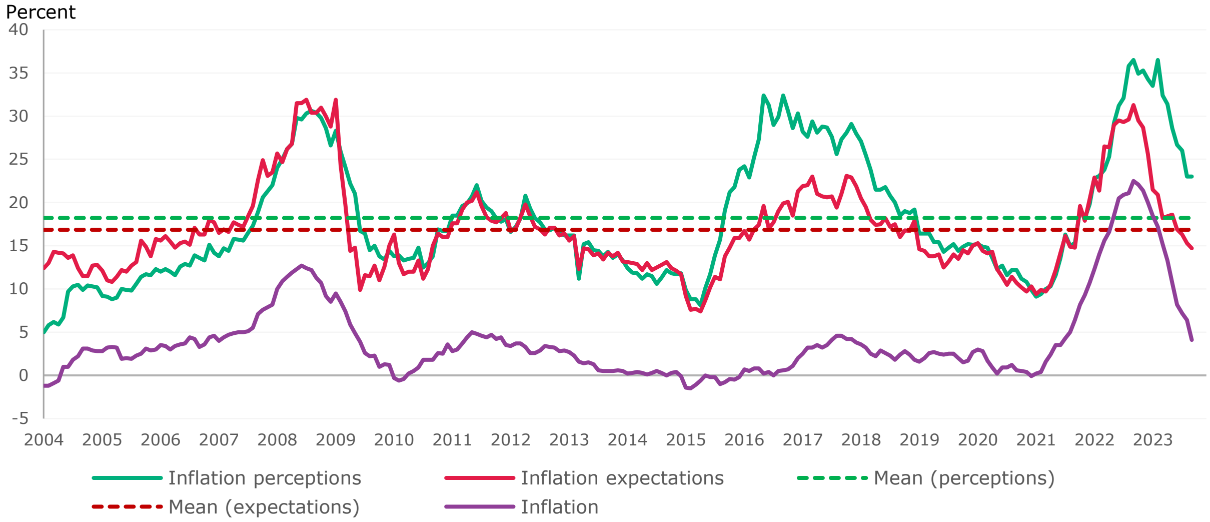
[4] For more detailed analysis of Lithuanian households' inflation expectations see Reichenbachas T. (2023)

Figure 1. Lithuanian consumers' quantitative estimation of inflation perceptions and inflation expectations



Source: Statistics Lithuania

1. Economic boom (2004-2008). From 2004 to 2008, inflation, households' inflation expectations and households' inflation perceptions were rising. Over this period, inflation increased from -1.2% (in January of 2004) to around 12% (it peaked in June of 2008 at 12.6%). Inflation expectations and inflation perceptions increased from 12.4% and 5% to 31.9% and 30.3%, respectively. There were three main factors behind rising inflation at the time. First, over this period the Lithuanian economy recorded unprecedented economic growth, which in part was a result of economic convergence. The gross domestic product (GDP) grew on average by almost 8 per cent. Second, over this period Lithuania experienced a domestic credit-fuelled housing bubble, which also added to internal demand and, thus, inflation. Third, in addition to those internal developments, this period was marked by an unprecedented rise in oil prices (especially in 2007-2008), which further contributed to inflation in Lithuania. It is interesting that over this period inflation expectations were on average 2.7 pp higher than inflation perceptions, possibly indicating that households were anticipating an acceleration in price growth.

2. Financial crisis (2009-2010). At the end of 2008, internal imbalances unravelled and Lithuania had one of the highest declines of GDP in the world. During the course of 2009, GDP contracted by 15%. This had an impact on inflation, which declined from around 10% to around 1%. Inflation expectations and inflation perceptions shrank to 13% and 13.9%, respectively. Over this period, inflation expectations were on average 1.8 pp lower than inflation perceptions.

3. Economic recovery (2011-2015). The years 2011 to 2015 constituted a period of economic recovery. Lithuania experienced limited inflationary pressures as the economy at the time was growing sustainably. Over this period, on average households' inflation expectations were close to households' inflation perceptions.

From the first three periods we have discussed, it seems that households are able to distinguish between periods of economic boom and periods of economic contraction. Over the periods of economic boom, households expect that inflation will increase while over the contractionary periods they expect the opposite.

4. Adoption of euro (2015-2018). As of 1 January 2015, Lithuania officially became the 19th member of the euro area. While at the time of the euro introduction inflation perceptions and inflation expectations were relatively low, they started increasing rapidly in the second half of 2016. In September

2016, average households' inflation perceptions had reached an all-time high of 32.4%, while inflation expectations peaked at around 20%. Over this period, on average, inflation expectations were 6pp lower than inflation perceptions (in June of 2016 it was 14.3pp lower). We thus do not see a high increase of aggregate inflation around the time of the euro introduction. Also, the euro changeover did not lead to a significant change in the overall inflation rate in Lithuania between 2015 and 2019 (for discussion, see Jouvanceau 2021). However, some inflationary effects emerge in sub-categories. One possible explanation concerns the "confirmation bias". As many households were expecting an increase in prices before the introduction of the euro, they started looking for such increases and attributed those that they found to the changeover. There is anecdotal evidence that, at the time, a great deal of media attention was focused on the price increases of specific goods (e.g., a cup of coffee). So, as those topics were discussed in the media, households started thinking that inflation was increasing, even though inflation was not significantly higher. Inflation perceptions at the time were higher than in 2008 although actual inflation was almost 6 times lower. Similar tendencies have been observed in other countries after the introduction of the euro (see Arioli 2017).

5. Covid-19 (2020). The Covid-2019 pandemic induced higher volatility in inflation. At the start of the pandemic, there was a collapse in oil prices which exerted a downward pressure on inflation and likely on inflation perceptions and inflation expectations. Over the pandemic period, inflation expectations and perceptions followed the trends of actual inflation. We do not see that inflation expectations and inflation perceptions were significantly different.

6. Post-Covid-19 rise in inflation (2021-2023). From mid-2021, there has been a global rise in aggregate demand, recovery in oil prices, and many supply bottlenecks. These factors contributed to a sharp rise in inflation which, in Lithuania, has reached levels not seen for more than two decades. This coincided with a comparable increase in inflation perceptions and inflation expectations (by 25.8 pp and 20.1 pp respectively). From mid-2022, we see that inflation perceptions were higher compared to inflation expectations. The gap widened and peaked at 15.6 pp in February 2023. One intuitive explanation for this could be that households expected that the 2022-2023 increase in inflation would be temporary. The post-euro introduction and post-financial crisis periods also featured a widening of the gap between inflation perceptions and inflation expectations, albeit to a lesser extent.

References

Arioli, R., Bates, C., Dieden, H. Ch., Duca, I., Friz, R., Gayer, Ch., Kenny, G., Meyler, A. and Pavlova, I., (2017) *EU consumers' quantitative inflation perceptions and expectations: an evaluation,* Occasional Paper Series 186, European Central Bank. Link here.

Jouvanceau V. (2021) *The Effect of the Euro Changeover on Prices: Evidence from Lithuania*, Bank of Lithuania Working Paper Series 93, Bank of Lithuania. Link here.

Reichenbachas T. (2023) *Households' inflation expectations in Lithuania: A First look and overview*, Bank of Lithuania Discussion Paper Series 31, Bank of Lithuania. Link here.

1.4. INFLATION EXPECTATIONS OF LITHUANIAN FIRMS

By using the information on firms' inflation expectations from an annual survey conducted by the Bank of Lithuania[5], we argue that the risk coming from higher inflation or wage expectations of Lithuanian firms is receding. As of 2020, an additional question has been included in the traditional questionnaire asking firms to provide their quantitative estimates of expected general price change and expected wage growth, both in Lithuania as a whole and in their firm over the next 12 months. The survey is stratified by sector of economic activity, geographic area and number of employees. There were four waves of this survey (2020, 2021, 2022, 2023).

Figure 1: Histogram of firms' inflation expectations

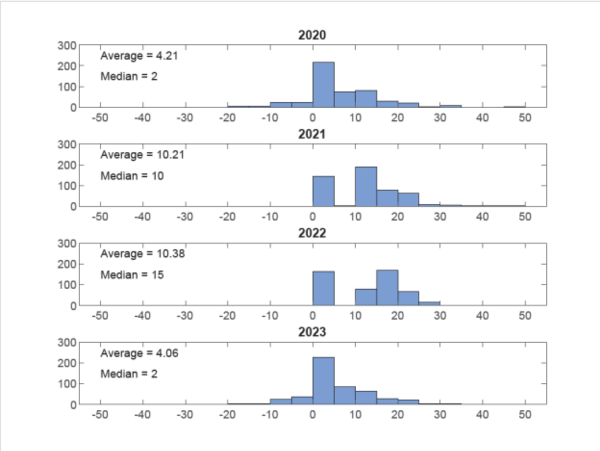
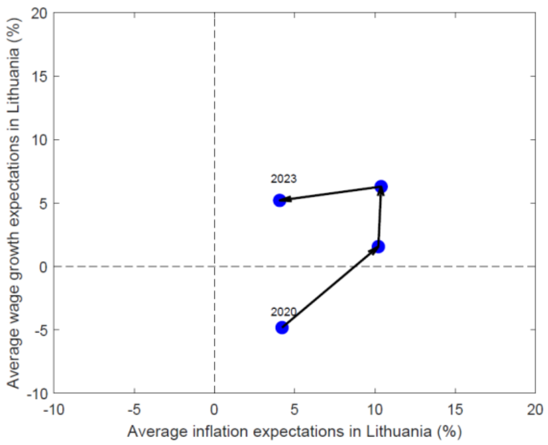


Figure 2: Evolution of inflation and wage growth expectations



After inflation rose significantly in the second half of 2021, firms' inflation expectations started to move upwards too, but to a lesser degree than households. Fig. 1 plots the data on firms' inflation expectations. In 2020, firms on average were expecting inflation of 4.2 percent (the median firm, however, was expecting 2 percent inflation). This increased significantly in 2021 and 2022, reaching more than 10 percent (inflation expectations of median firm in 2022 reached 15 percent), but average inflation expectations decreased in 2023.

Additionally, there are two questions on wages. The first focuses on wage growth expectations in the whole country over the next 12 months. The second focuses on wage growth expectations in the specific firm over the next 12 months. Figures 3 and 4 provide results.

[5] For more information see https://www.lb.lt/lt/apzvalgos-ir-leidiniai/category.40/series.197

Figure 3: Histogram of firms' wage growth expectations (country level)

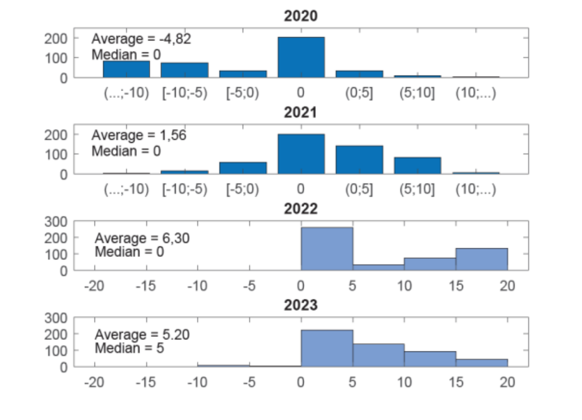


Figure 4: Histogram of firms' wage growth expectations (firm level)

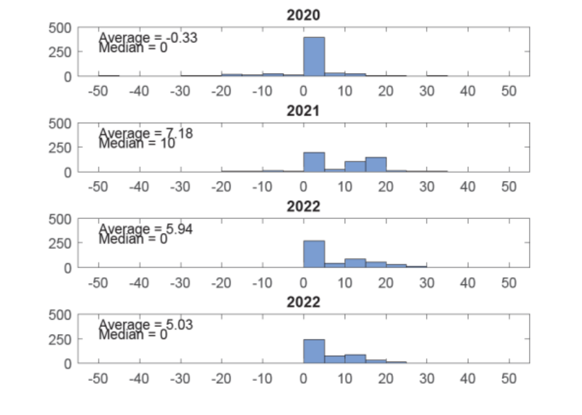


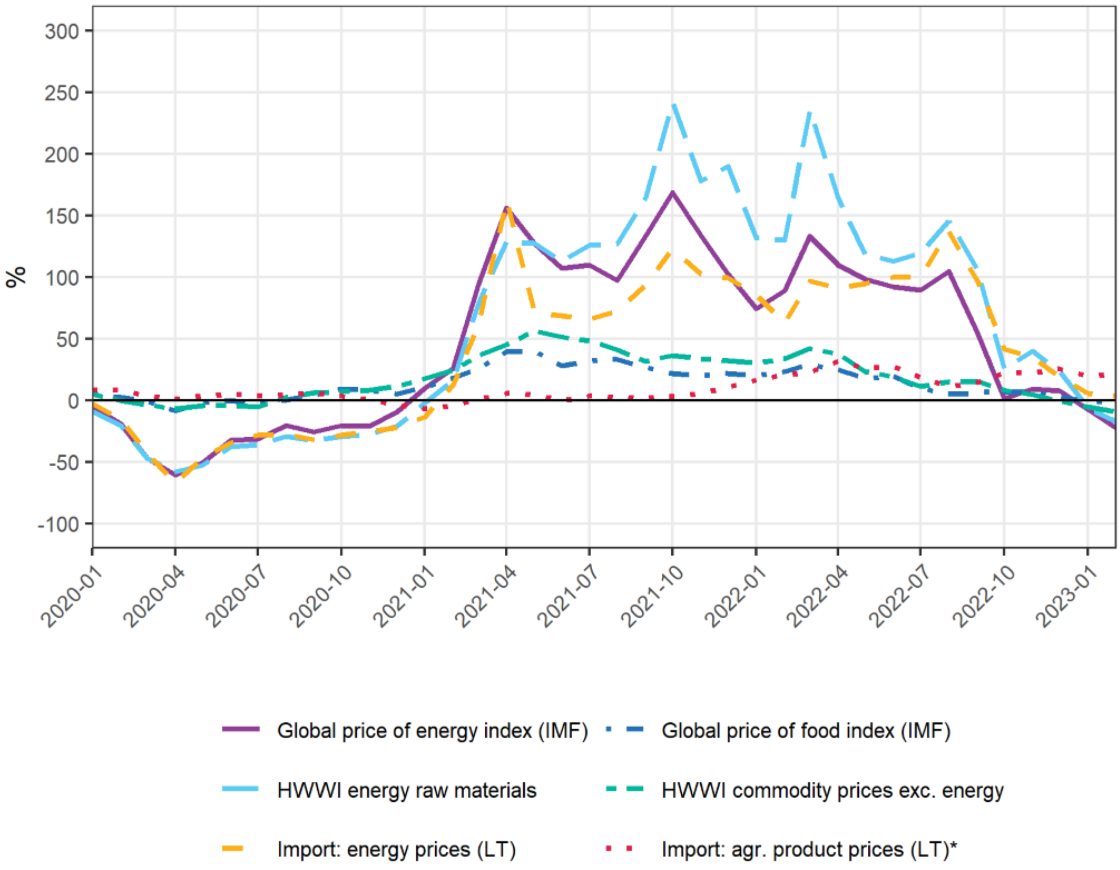
Fig. 2 links average inflation expectations and average wage expectations in Lithuania. We can see that, in mid-2020, respondents expected wage decreases in the country (on average -4.8%), while most of the firms did not expect wage decreases in their firm (Fig. 4). In 2022, firms expected a wage increase of 6.3 percent on average in Lithuania. When asked about their own firm, most respondents thought that wages would not change. However, in 2021-2022, an increasing number of firms expected a significant wage increase in their firm. In 2023, firms' inflation and wage growth expectations decreased compared to 2022.

2. LITHUANIAN INFLATION FLUCTUATIONS AND DIFFERENTIALS

2.1. EFFECTS OF ENERGY SUPPLY SHOCKS ON PRICE INFLATION ALONG THE PRODUCTION CHAIN

The surge in global demand following the COVID-19 pandemic and the reduction in energy supplies due to Russia's invasion of Ukraine led to steep rises in global commodity and import prices in Lithuania between 2021 and 2023 (Figure 1). As a result, consumer and producer price inflation for food and energy increased significantly over the same period in Lithuania (Figure 2).

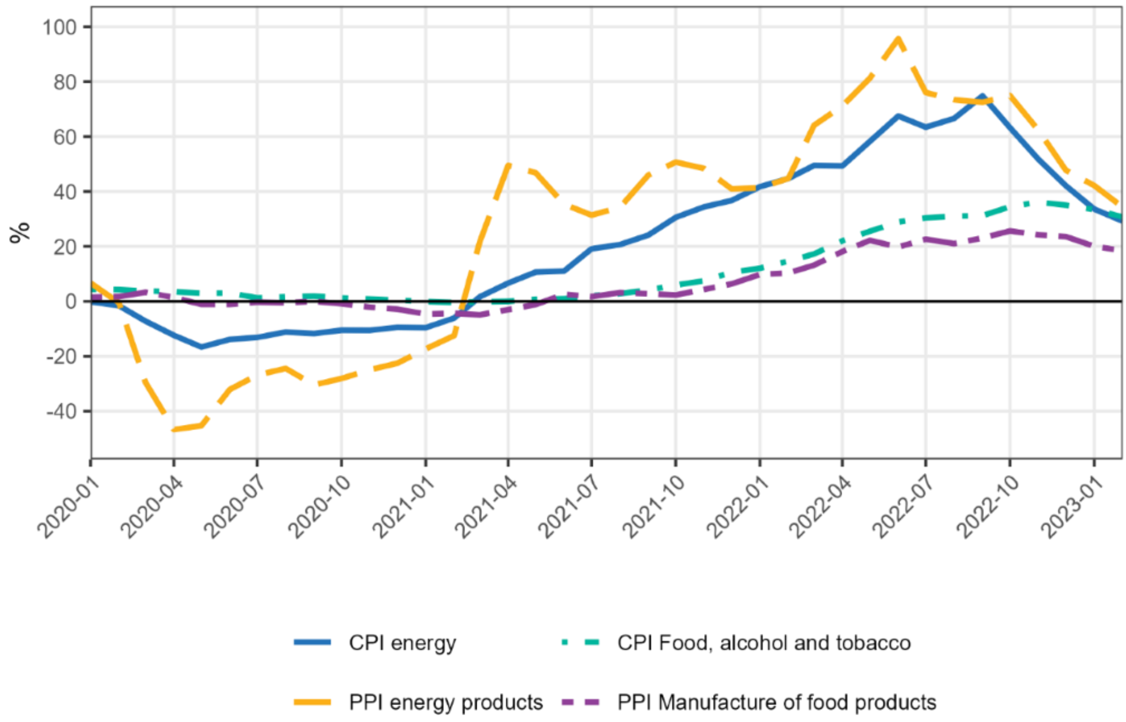
Figure 1. Inflation rates of commodity price indices in Lithuania



Notes: each series is a year-on-year inflation rate. *"Agr" represents "agriculture." "Import agr. product prices (LT)" stands for "import: products of agriculture, forestry, and fishing".

A closer look at these figures indicates that global shocks propagate on prices with different amplitudes, speeds, and persistence, depending on the sector and level of the production chain (e.g., the propagation is large and rapid for producer energy prices; moderate and persistent for consumer food prices.). To shed light on these phenomena, we examine how supply shocks caused by fluctuations in international commodity prices propagate to prices in Lithuania.

Figure 2. Inflation rates of producer and consumer prices in Lithuania



Notes: each series is a year-on-year inflation rate. CPI means consumer price index and PPI producer price index.

The main reason for examining the effects of supply shocks along the production chain rather than globally is that prices are likely to react heterogeneously at various levels of the chain. For example, a sudden change in the price of electricity should exert strong direct inflationary pressure at all levels (electricity is used by all types of agents and is not easily substitutable). By contrast, a variation in the base price of wheat is likely to have a greater impact on prices at the primary (suppliers) and intermediate (producers) levels than at the final (consumers) level. Indeed, assuming that prices vary after each transformation of wheat, such as its processing into flour and then into bread, an increase in the price of wheat caused by a supply shock may not be fully passed through to final consumption prices; the main reasons for this include factors such as the inertia of commercial contracts, the intensity of competition, the substitutability of products and the sensitivity of demand to price variations – price elasticity of demand.

In this analysis, we highlight this heterogeneity in the impact of supply shocks on inflation along the production chain in two sectors. Specifically, we adapt the methodology of Messner and Zorner (2023), involving Bayesian vector autoregression (BVAR) models that separate the consequences of supply shocks in the energy and food sectors. All our models include monthly year-on-year data, from 2001M1 to 2023M2, of a measure of international commodity (or Lithuanian import) price inflation, as well as real industrial production growth, energy (or food) producer and consumer price inflation, and core consumer price inflation in Lithuania.[6]

Broadly, a BVAR model is a system of equations in which each time series of variables (the observables) is a function of its own past values, but also those of the other variables. The model can never perfectly

[6] Models involving import price inflation in Lithuania range from 2007M1 to 2023M2 due to the lack of earlier data. Each BVAR assumes 13 lags and Minnesota priors. For more details, refer to the technical appendix.

match the data values, so a residual component remains for each equation. This residual component represents unexpected movements in the data and is therefore the source for identifying supply shocks. The technical appendix provides comprehensive information on how the shocks are estimated.

To ensure identification of negative supply shocks, we condition, based on theory, that an impulse in the residual component of global commodity price inflation (or import price inflation in Lithuania) triggers a decrease in industrial output growth in Lithuania as well as an increase in all types of price inflation in the same month.[7]

Table 1 summarizes our restrictions in the BVAR models. In this table, a "+" ("-") sign indicates that the shock considered will lead to an increase (decrease) in this variable in the same month (on impact).

Table 1. Sign restrictions in the BVAR models

	Shock	
Variable	Energy supply shock (-)	Demand shock (+)
Int. commodity inflation* or import price inflation (LT)	+	+
Real industrial production growth	-	+
PPI energy inflation or PPI food inflation	+	+
CPI energy inflation or CPI food inflation	+	+
Core CPI inflation	+	+

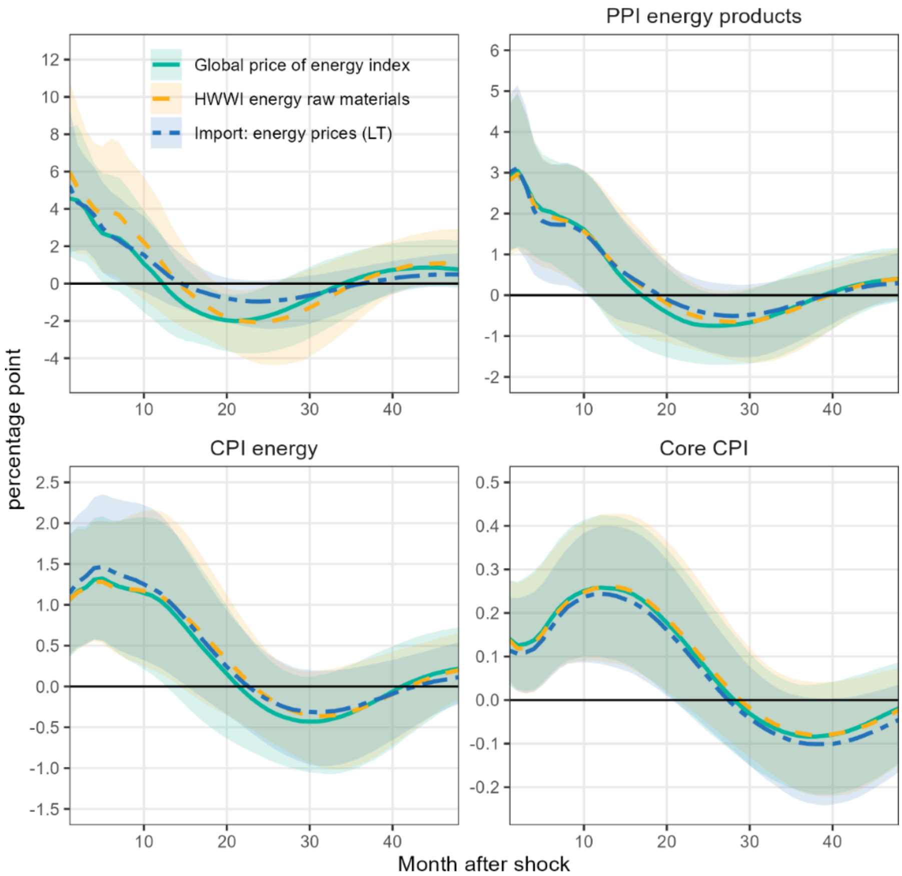
Notes: “Int.” refers to international. In total, we estimate 3 models for the energy sector and 3 for the food sector. We use 4 different time series representing international commodity price inflation. More details about the series are provided below.

Figure 3 shows how negative energy supply shocks (of one standard deviation) affect price inflation in Lithuania. These shocks are identified in three independent BVAR models using year-on-year inflation from the IMF global price of energy index, the HWWI raw energy materials index, and Lithuania’s energy import prices respectively, as indicated in the top left panel.[8] Not surprisingly, the energy commodity (and import) price inflation rises sharply when the shock occurs, before the effects wear off after around 8 months. Over the same month, energy PPI inflation in Lithuania reacts similarly, but rises half as much as energy commodity inflation (median responses of 3 percentage points vs. 6 percentage points (pp)).

[7] In parallel, demand shocks are identified to refine the estimation of the model's structural parameters.

[8] All HWWI indices used in this analysis were obtained from the Bundesbank website (url: https://www.bundesbank.de/en/statistics/economic-activity-and-prices/-/prices-651256).

Figure 3. Impulse responses after an energy supply shock



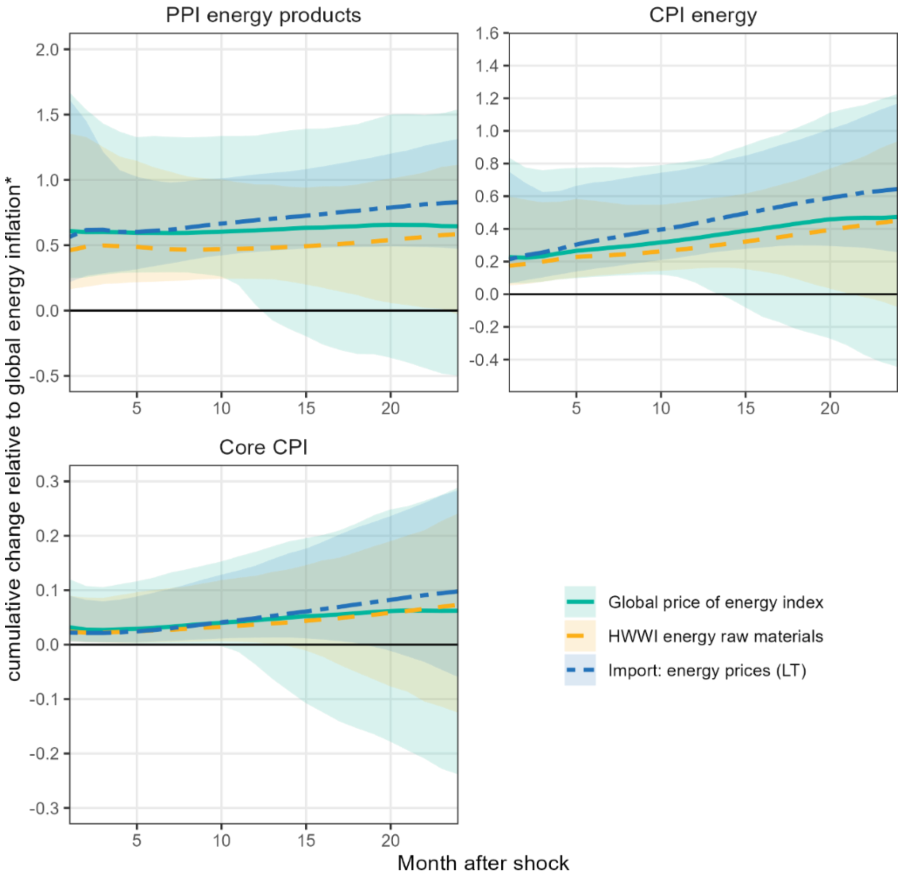
Notes: The impulse responses are estimated in three independent BVAR models. Each colored line represents (top left panel) the variable used to identify the supply shocks in each model. The other three variables are common to all three models. A line represents the median of 10,000 impulse response draws, and the shaded areas represent the 68% confidence interval.

In comparison, the reaction of the energy CPI to the shock is more gradual, with the maximum impact occurring after 3 months. The effects of the shock persist for a year, and a year and a half. At impact, energy CPI inflation reacts about 5 times less than energy commodity inflation. These results indicate a moderate pass-through of energy costs to consumer prices and rigidity to change. This rigidity is even more pronounced in the reaction of core CPI to the shock (prices of all items excluding energy and food), with the maximum effect occurring after about a year. On impact, core consumer inflation rises by around 50 times less than global energy price inflation.

To further illustrate the pass-through of the shocks, Figure 4 shows the cumulative change in producer and consumer price inflation against that of global energy inflation (or inflation in import energy prices). This graph helps to visualize how increases in international energy prices are progressively passed on to domestic prices. After two years, total cumulative energy product inflation in the PPI represents between 0.5 and 0.7 of global energy price inflation, illustrating a sizeable pass-through. This proportion is higher than that of cumulative energy CPI inflation, for which the ratio is between 0.4 and 0.6. Finally, the pass-through of the shocks to domestic core CPI inflation is barely significant.

Moving on to the next sector, Figure 5 illustrates the impact of negative food supply shocks (of one standard deviation) on price inflation in Lithuania. These shocks are identified in three independent BVAR models using, respectively, year-on-year inflation of the IMF global price of food index, the HWWI index of non-energy commodity prices, and prices of imported agricultural products from Lithuania, as shown in the top left panel.

Figure 4. Pass-through after an energy supply shock



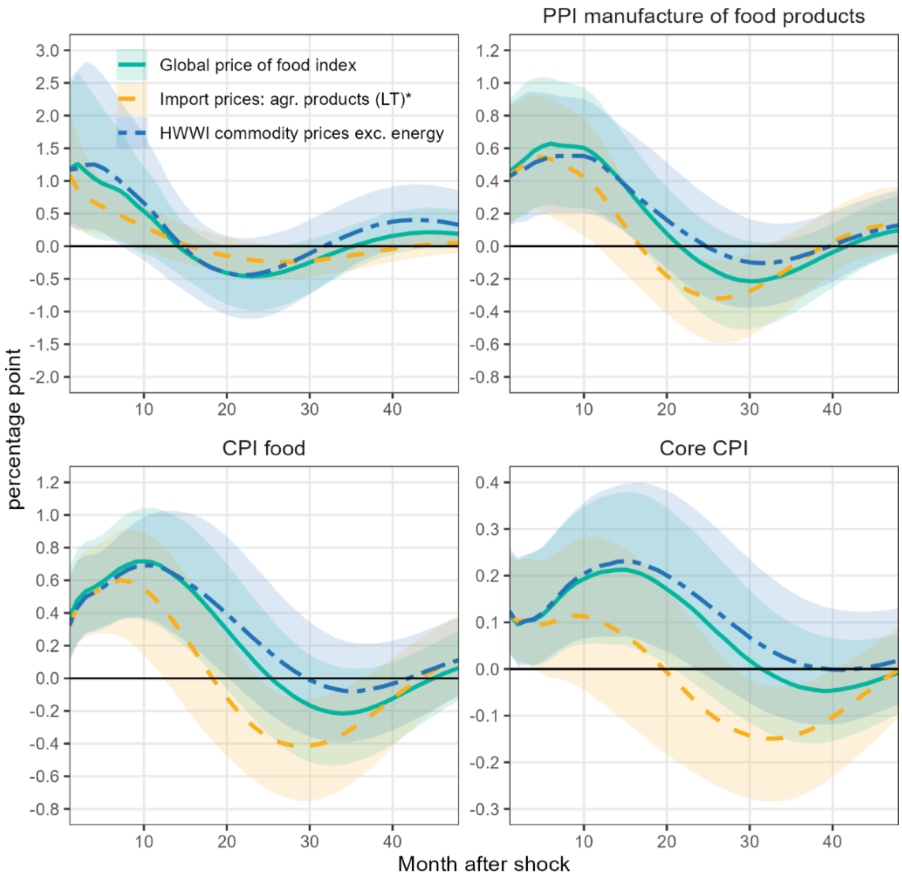
Notes: The impulse responses are estimated in three independent BVAR models. *(y-axis) Each panel represents the ratio between the cumulative changes of the impulse responses of a measure of domestic inflation and those of the variable used to identify supply shocks in each of the models (see legend for details). A line represents the median of 10,000 impulse response draws, and the shaded areas represent the 68% confidence interval.

In each model, the shock induces a sharp rise in global food inflation at impact and propagates for around 10 months. This leads to an increase in PPI food inflation of around 0.5 percentage points in the same month, which is comparatively half as large as the increase in global food inflation. The greatest impact on producer food inflation occurs after 5 months and then persists for a year.

Interestingly, the effects of the shocks on consumer food inflation are broadly similar to those on producer food inflation. The difference is that the maximum impact is higher (0.7 pp vs. 0.6 pp), occurs later (after 10 months vs. 5 months) and the effects persist longer (up to 2 years vs. 1.5 years). Finally, consumer core inflation is the most sluggish to react to food supply shocks, peaking after a year. On impact, the latter reacts about 10 times less than global food inflation.

Figure 6 shows the cumulative change in domestic inflation in relation to global food inflation measures. After two years, the shock's impact on PPI and CPI food inflation is substantial, with respective ratios of 0.5 to 0.7 and 0.6 to 1. Its impact on core CPI inflation is much smaller, accounting for between 20% and 35% of the increase in global food inflation after 24 months.

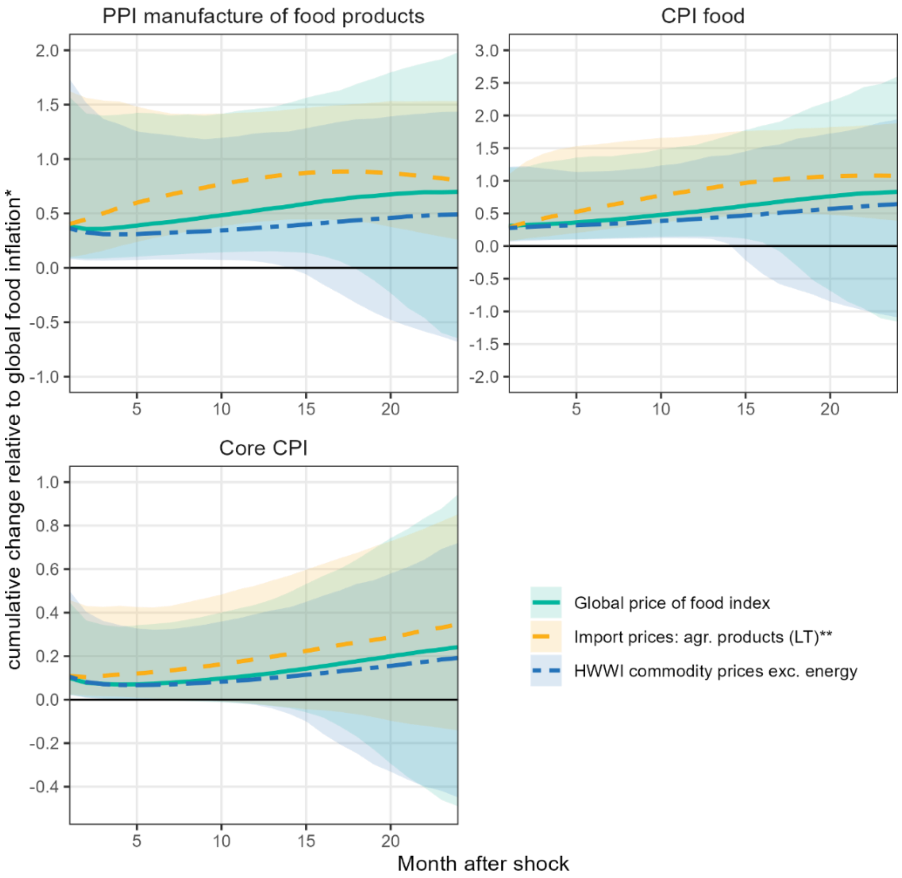
Figure 5. Impulse responses after a food supply shock



Notes: The impulse responses are estimated in three independent BVAR models. Each colored line represents (top left panel) the variable used to identify the supply shocks in each model. The other three variables are common to all three models. A line represents the median of 10,000 impulse response draws, and the shaded areas represent the 68% confidence interval. *"Agr" represents "agriculture." "Import agr. product prices (LT)" stands for "import: products of agriculture, forestry, and fishing".

This analysis provides estimates of how negative commodity supply shocks affect domestic producer and consumer price inflation in the food and energy sectors and the core consumer inflation rate in Lithuania. First, we find, unsurprisingly, that these shocks lead to a sharp rise in global commodity price inflation, and rapidly spread to domestic production prices in the corresponding sectors. Producer price inflation for energy and food reacts at half the rate of equivalent international inflation in the month of the shock, then continues to rise for a year or a year and a half. Consumer food price inflation responds to a similar extent to producer food price inflation, and to a lesser extent in the energy sector; more importantly, these reactions occur with a lag of around a year after the shock. Finally, the impact at the bottom of the production chain, i.e., core consumer price inflation, is extremely limited. The response of inflation at this level is 10 (food shocks) to 50 times (energy shocks) lower than that of global commodity price inflation in the month the shock occurs, and 4 to 10 times after 2 years. Overall, this study shows that energy supply shocks propagate gradually through the supply chain over time and are not passed on one-by-one to the final consumer.

Figure 6. Pass-through after a food supply shock



Notes: The impulse responses are estimated in three independent BVAR models. *Each panel represents the ratio between the cumulative changes of the impulse responses of a measure of domestic inflation and those of the variable used to identify supply shocks in each of the models (see legend for details). **"Agr" represents "agriculture." "Import agr. product prices (LT)" stands for "import: products of agriculture, forestry, and fishing.". A line represents the median of 10,000 impulse response draws, and the shaded areas represent the 68% confidence interval. Headers indicate the type of shock.

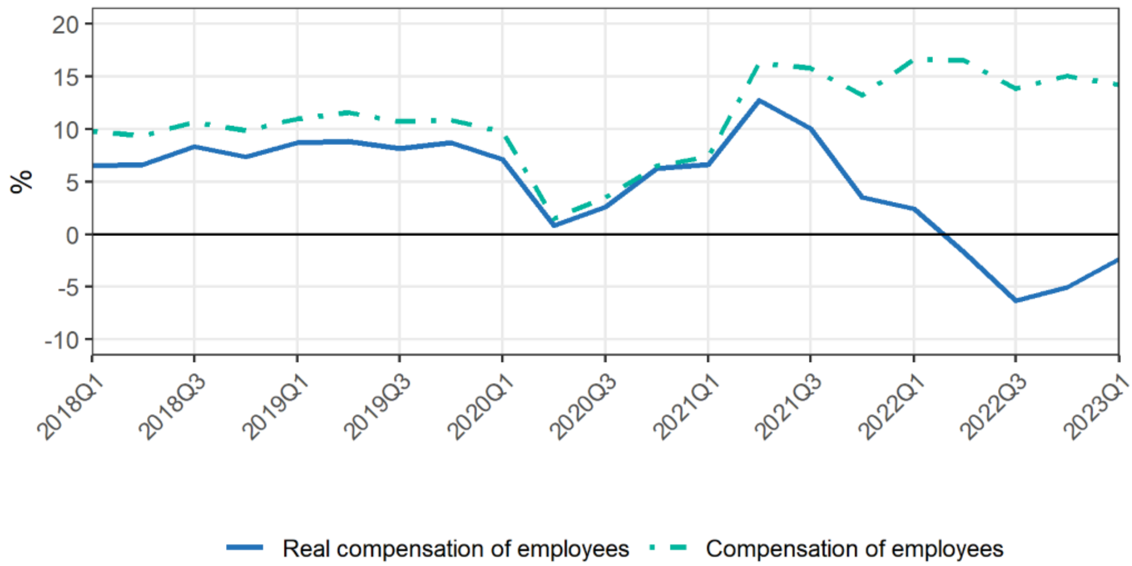
Reference

Messner, T. and Zörner, T., (2023). "Aggregate price pressures along the supply chain: a euro area perspective", Monetary Policy and the Economy Q4/22–Q1/23, Oesterreichische Nationalbank.

2.2. WAGE AND PRICE RESPONSES TO AGGREGATE AND LABOR MARKET SHOCKS

From 2021 onwards, soaring prices severely affected the purchasing power of Lithuanian workers, as evidenced by the year-on-year growth in real compensation of employees shown in Figure 1. Under such circumstances, workers can be expected to negotiate higher wages to compensate losses. If they succeed, this can lead to further price rises, and so on -- a phenomenon termed a wage-price spiral.

Figure 1. Real versus nominal compensation of employees



In macroeconomic theory, this adjustment process depends not only on the characteristics of goods and labor markets, but also on the nature of aggregate shocks.[9] Assume that, in an economy, workers and firms have some monopoly power, that prices and wages are, to a certain extent, rigid to change, and that their changes are staggered.[10] In this context, if a positive aggregate demand shock occurs, production and labor demand will increase. On the other hand, workers (firms) will seek higher real wages (price markups), leading to higher nominal wages and prices. However, these increases will only be gradual and staggered, so that wage and price changes will feed into each other until a pre-shock equilibrium is reached. The strength of this wage-price spiral will depend on the degree of price and wage inertia (and their staggered structures), as well as on market powers (Blanchard (1986)).[11]

In this analysis, we illustrate how global and labor market shocks influence wages and consumer prices in Lithuania, and how wage responses in turn affect prices. To extract the shocks, we adapt the methodology of Conti and Nobili (2019) to the Lithuanian economy. It consists of a BVAR model and quarterly aggregate data.[12] The latter include time series from 2002Q1 to 2022Q4 of real GDP, the overall HICP index excluding energy prices, total nominal compensation per hour (henceforth wages), real labor productivity (real GDP divided by the total number of employees) and the unemployment rate. All these variables are transformed into natural logarithms, except for the unemployment rate.

[9] More precisely, in the New Keynesian theory.

[10] This means that goods prices and wages are adjusted at long discrete time intervals (half-yearly or yearly). For evidence of price rigidity in Lithuania, see Jouvanceau (2022).

[11] In an extreme case of perfect competition, continuous price and wage setting and rational expectations, the spiral will be zero, as the adjustment of prices and wages will be synchronized and instantaneous.

[12] Each BVAR assumes 5 lags and Minnesota priors. For more details, see the technical appendix.

We identify shocks by imposing sign restrictions on the BVAR impulse responses based on the theoretical foundations of Foroni et al. (2018). We consider the following four shocks. First*, positive demand shocks* lead to an increase in aggregate demand, and consequently a rise in GDP, prices, and wages. In response, unemployment falls, and real labor productivity rises (if the change in real GDP exceeds the change in employment). This type of shock reflects the impact of expansionary monetary policy or increased public spending, among others. Second, *positive aggregate supply shocks* boost GDP, driving prices and unemployment down. These shocks include both technological advances and commodity supply floods. Third, *negative labor supply shocks* result in fewer jobseekers, whether employed or unemployed, and then lead to a fall in GDP. With fewer workers on the market, wages rise, as do prices. Changes in the desire to work and migratory flows are examples of this kind of shock. Fourth *negative wage markup shocks* reflect increases in workers' bargaining power, boosting their wages. This entails higher unemployment, rising prices and lower GDP. These shocks reflect increased unionization, higher minimum wages, and other labor market changes/reforms.[13]

Table 1 summarizes our restrictions in the BVAR model. In this table, a "+" ("-") sign indicates that the shock considered will lead to an increase (decrease) in this variable during the same month (on impact).[14]

Table 1. Sign restrictions in the BVAR model

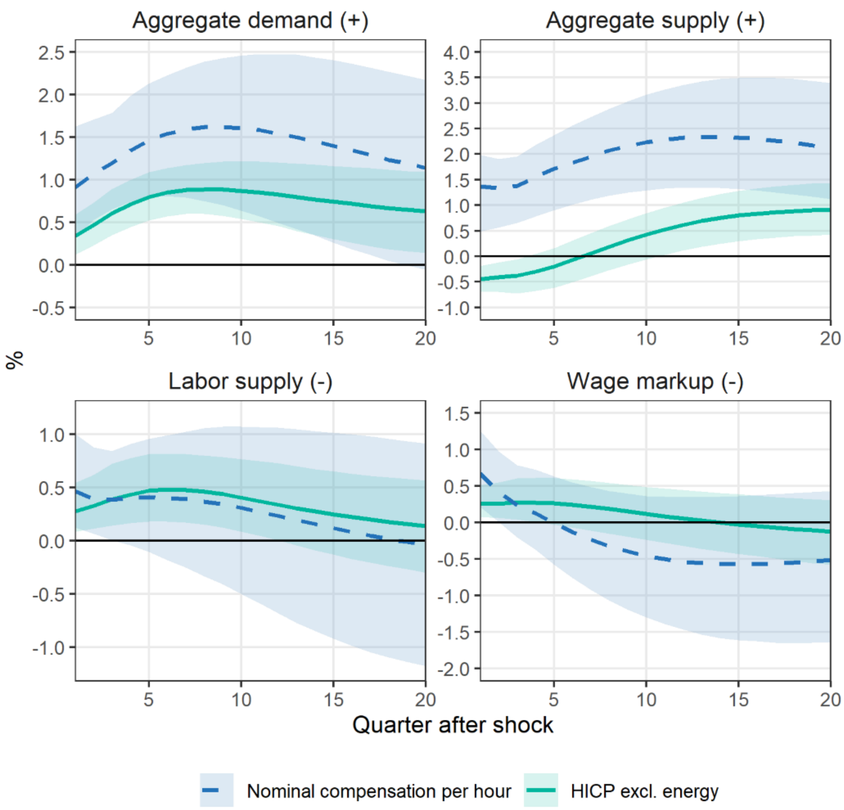
	Shock			
Variable	Demand	Supply	Labor supply	Wage markup
Real GDP	+	+	-	-
HICP excluding energy	+	-	+	+
Nominal compensation per hour	+		+	+
Real labor productivity	+	+		
Unemployment rate	-	-	-	+

Figure 2 shows the reactions of nominal wages (compensation per hour) and consumer prices to each type of shock (one standard deviation shocks). A typical positive aggregate demand shock leads to a diffuse rise in wages for at least five years, with a turning point after a year and a half. Prices follow a similar trend but vary less than wages. For a clearer picture of this difference, Figure 3 shows the ratio of the cumulative impact of these shocks on prices to that on wages. The median ratio stabilizes at around 0.5 over the entire duration of the shock's impact.

[13] Note that it is not necessary to identify negative demand or supply shocks, nor positive labor supply and wage markup shocks, as identification is symmetrical in BVAR models.

[14] We do not take a position on how nominal wages react to a positive aggregate supply shock, even though in typical New Keynesian models, real wages increase following such a shock. Adding this restriction to the model does not change the qualitative results and does little to alter the quantitative results. These results are available on request.

Figure 2. Impulse responses after each shock



Notes: A line represents the median of 10,000 impulse response draws, and the shaded areas represent the 68% confidence interval. Headers indicate the type of shock.

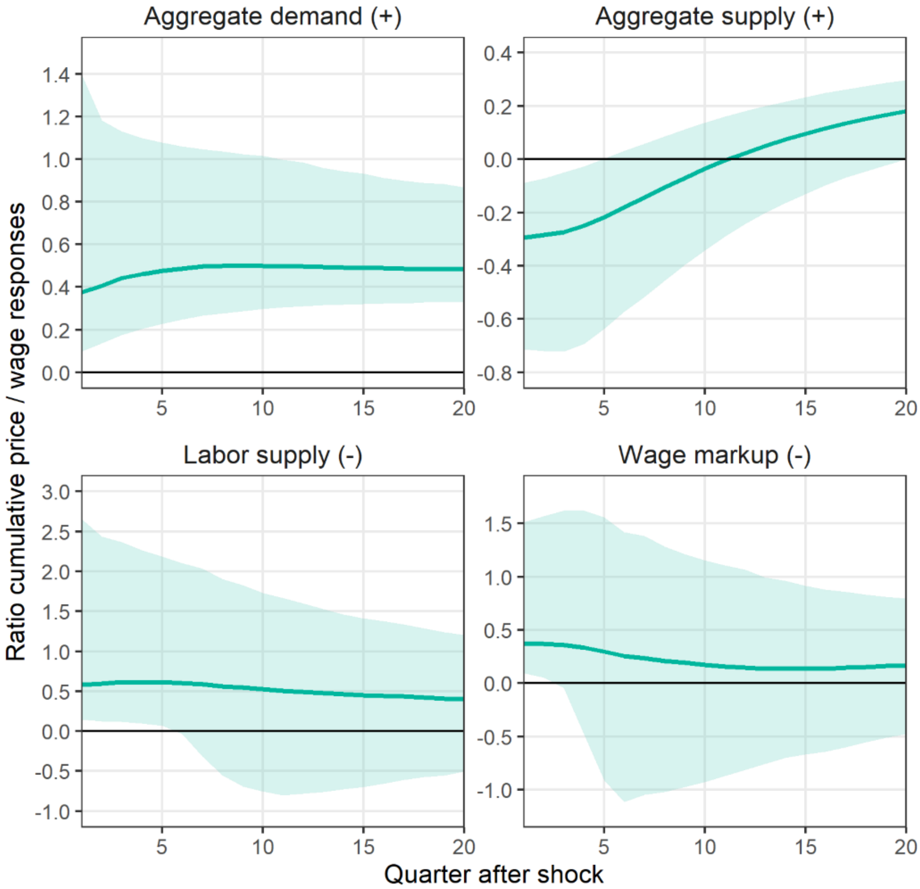
Interestingly, a positive aggregate supply shock leads to a persistent increase in wages, even if the model was not restricted to this effect (see Table 1, and Figure 2 top right panel). In comparison, consumer prices fall for around a year, then appear to follow wage dynamics. As with demand shocks, prices react much less than wages to supply shocks (see Figure 3).

In contrast, a labor supply shock significantly increases wages and prices in a synchronized fashion, but only over a period of approximately one year. On impact, wages react about twice as strongly as prices (see Figure 3). This is also the case for a typical wage markup shock, where in response to the shock, wages rise more than prices. For this type of shock, the effects are only transitory, lasting only about half a year.

We shall now explore the wage-price spirals for each type of shock. To do this, we compare the price impulse responses in a model where all variables respond to shocks with those in a model where wage impulse responses are zero at all horizons (i.e., a counterfactual scenario).[15] Their differences will tell us to what extent the shock is passed on to prices through wage changes. The counterfactual impulse responses are computed as in Bobeica et al. (2019).

[15] In all cases, we construct the counterfactuals under the assumption that all shocks contribute equally to offsetting endogenous wage responses. For more details, see Appendix N of Bobeica et al. (2019).

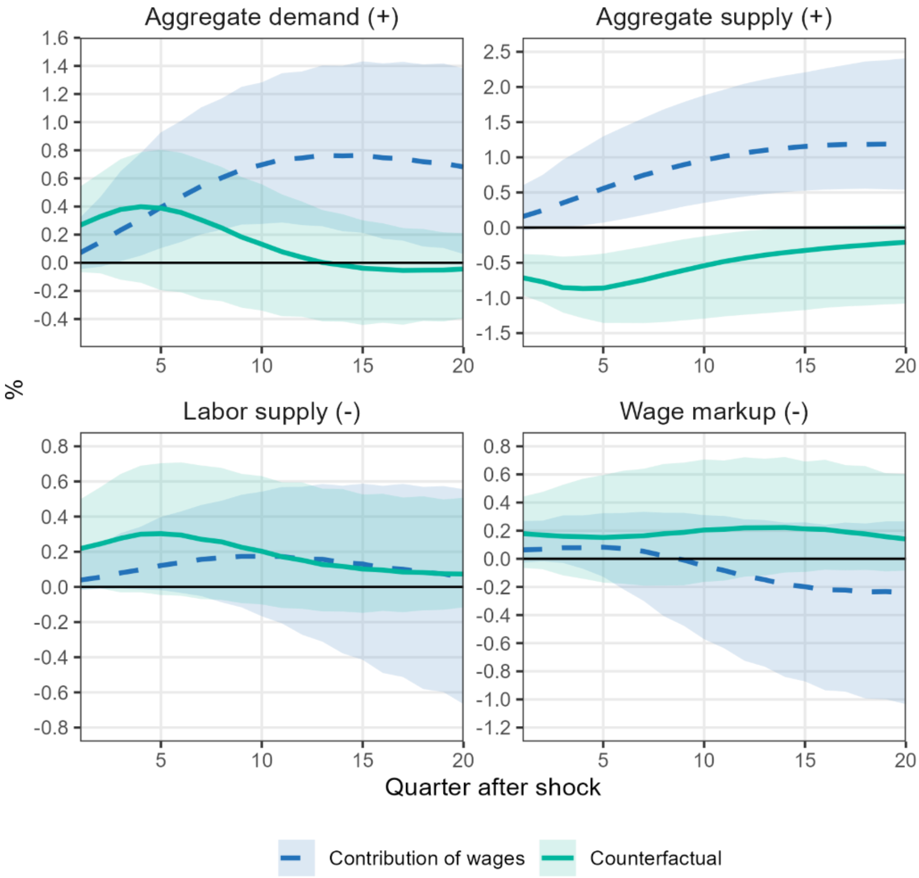
Figure 3. Cumulative response of prices to wages after each shock



Notes: Each panel represents the ratio of the cumulative changes of the impulse responses of HICP excluding energy to nominal compensation per hour. A line represents the median of 10,000 impulse response draws, and the shaded areas represent the 68% confidence interval. Headers indicate the type of shock.

Figure 4 shows the counterfactual impulse responses and the contribution of wages to the price response. The contribution of wages to price inflation is small on impact and then insignificant over time for both labor market shocks. In the event of a positive aggregate demand shock, wage contribution is minimal on impact, then increases over time, demonstrating a substantial wage-price spiral. The contribution pattern is similar for a positive aggregate supply shock. The counterfactual price responses show a larger persistent decline (Figure 3) compared to the reference scenario (Figure 2). This reveals that wages have an inflationary contribution in this case. The model therefore predicts that a negative supply shock, such as the one following Russia's invasion of Ukraine, should lead to a persistent decline in nominal wages and, subsequently, consumer prices over the quarters (prices excluding energy goods and services). The inflationary contribution of wages is small and non-significant over time for the two negative labor market shocks.

Figure 4. Counterfactual impulse responses of prices after each shock



Notes: A line represents the median of 10,000 impulse response draws, and the shaded areas represent the 68% confidence interval. Headers indicate the type of shock. The term "counterfactual" in the legend means that consumer price responses to a specific shock were obtained by forcing wage responses to be zero over the 20 periods. "Contribution of wages" indicates the difference in impulse responses between the reference price effects shown in green in Figure 2 and the counterfactual effects in this graph.

This analysis shows, using a BVAR model, that over the past 20 years, global macroeconomic shocks have had a more persistent and greater impact on wages (hourly earnings) and consumer prices than labor-specific shocks in Lithuania. Typical price and wage reactions have their maximum effects after about a year, underlining their rigidity to change. According to macroeconomic theory, this persistence and nominal rigidity may imply second-round effects, i.e., price-wage spirals. Our counterfactual scenarios, in which wages do not react to shocks, reveal that such spirals can be significant for aggregate supply and demand shocks. For the latter, wage reactions fuel price reactions in the medium term. Conversely, after supply shocks, wage reactions counterbalance price reactions over time. This underlines the importance of correctly identifying shocks before tackling potential wage-price spirals.

References

Blanchard, O. J., (1986). "The Wage Price Spiral." *The Quarterly Journal of Economics* 101, no. 3 543–65. https://doi.org/10.2307/1885696.

Bobeica, E., Ciccarelli, M. and Vansteenkiste, I., (2019). "The link between labor cost and price inflation in the euro area," Working Paper Series 2235, European Central Bank.

Conti, A. M. and Nobili, A., (2019). "Wages and prices in the euro area: exploring the nexus," Questioni di Economia e Finanza (Occasional Papers) 518, Bank of Italy, Economic Research and International Relations Area.

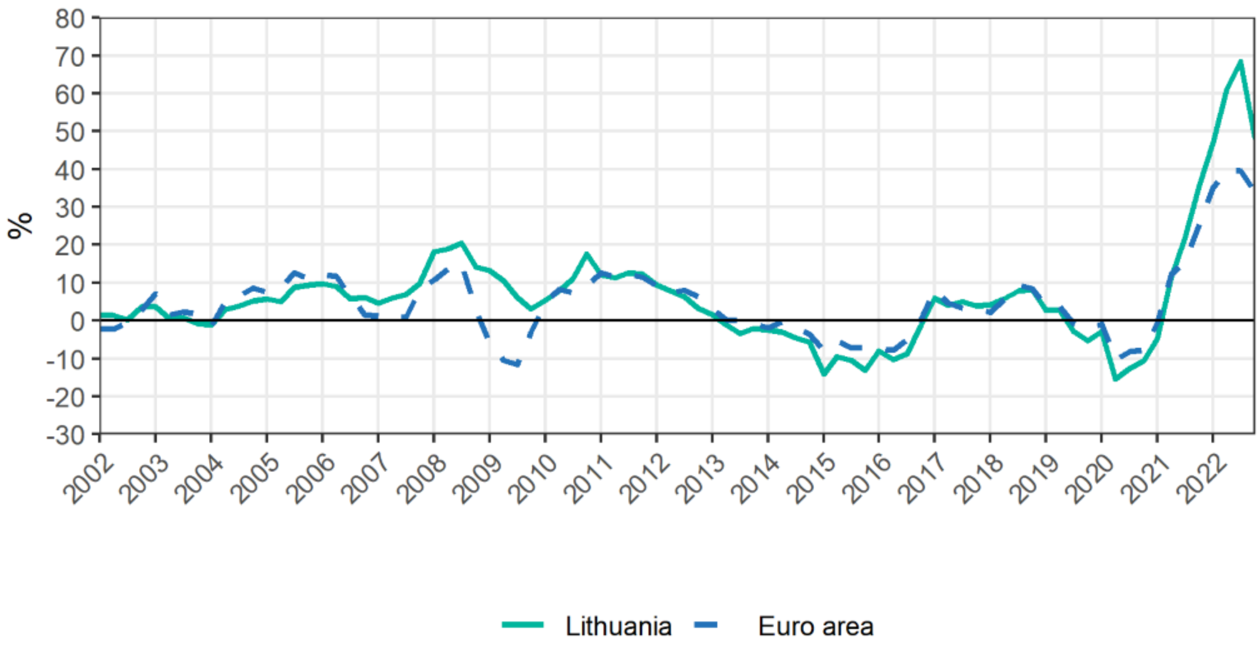
Foroni, C., Furlanetto, F., and Lepetit, A., (2018). Labor supply factors and economic fluctuations. *International Economic Review*, 59(3), 1491–1510. http://www.jstor.org/stable/45018798

Jouvanceau V., (2022). "Producer and consumer price rigidity: the case of Lithuania," Bank of Lithuania Discussion Paper Series 27, Bank of Lithuania.

2.3. ENERGY PRICE INFLATION SHOCKS, LITHUANIA AGAINST EURO AREA

As illustrated above, the COVID-19 pandemic and Russia's invasion of Ukraine led to a surge in international commodity prices, which was rapidly passed on to consumer prices in Europe. Nevertheless, HICP energy price inflation has not responded identically in all euro area (EA) countries. Figure 1 illustrates that in Lithuania, year-on-year (yoy) HICP energy price inflation peaked at around 70% in 2022Q3, compared with around 40% in the EA. These differences are mainly due to contrasting anti-shock policies (e.g., level of electricity subsidies), the degree of dependence on Russian gas and dissimilar domestic energy demand and supply.

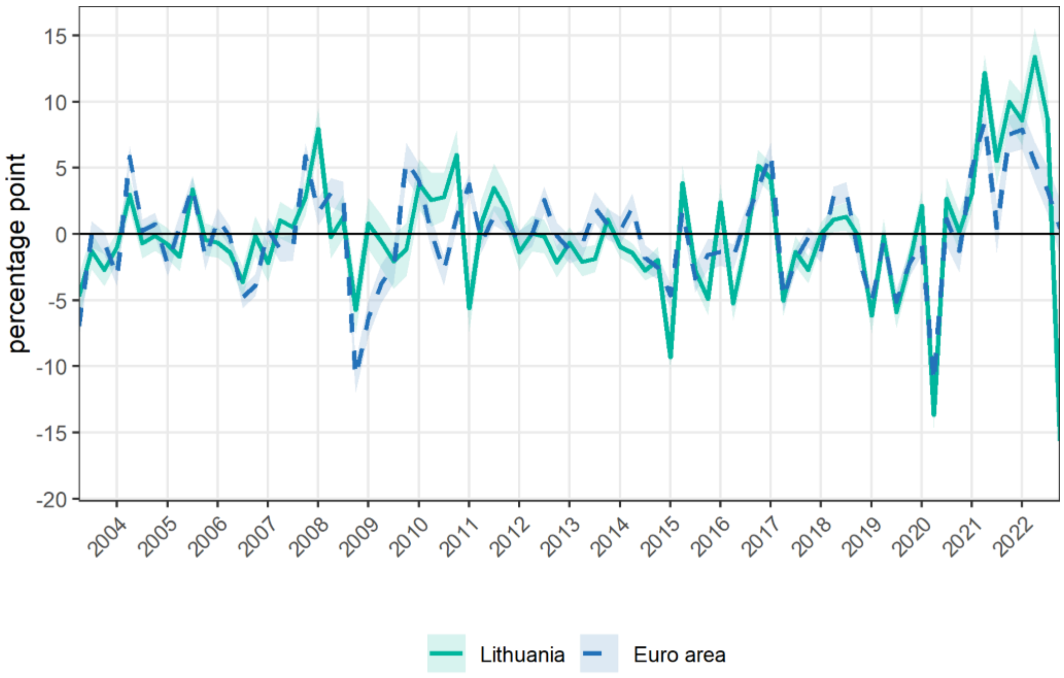
Figure 1. HICP energy prices inflation



Source: FRED economic data, St. Louis Fed.

This raises the question of whether a typical energy price shock affects consumer prices differently in Lithuania than in the EA. To address this issue, we adapt the methodology of Corsello and Tagliabracci (2023) and estimate two separate BVAR models (one for Lithuania, the other for the EA) including respective time series from 2002Q1 to 2022Q4 of yoy energy, food, and core HICP inflation, as well as the unemployment rate and yoy total compensation per employee.[16] Like these authors, we identify energy price inflation shocks by specifying recursive BVAR models, i.e. energy price inflation can only be affected contemporaneously by energy shocks.[17] The BVAR models utilizing Lithuanian and EA data possess consistent model structure and shock identification. We can consequently highlight divergences in their respective energy shocks over the period due to differences in variable correlations, the occurrence and magnitude of the shocks, or all three.

Figure 2. Energy price inflation shocks: Lithuania against euro area

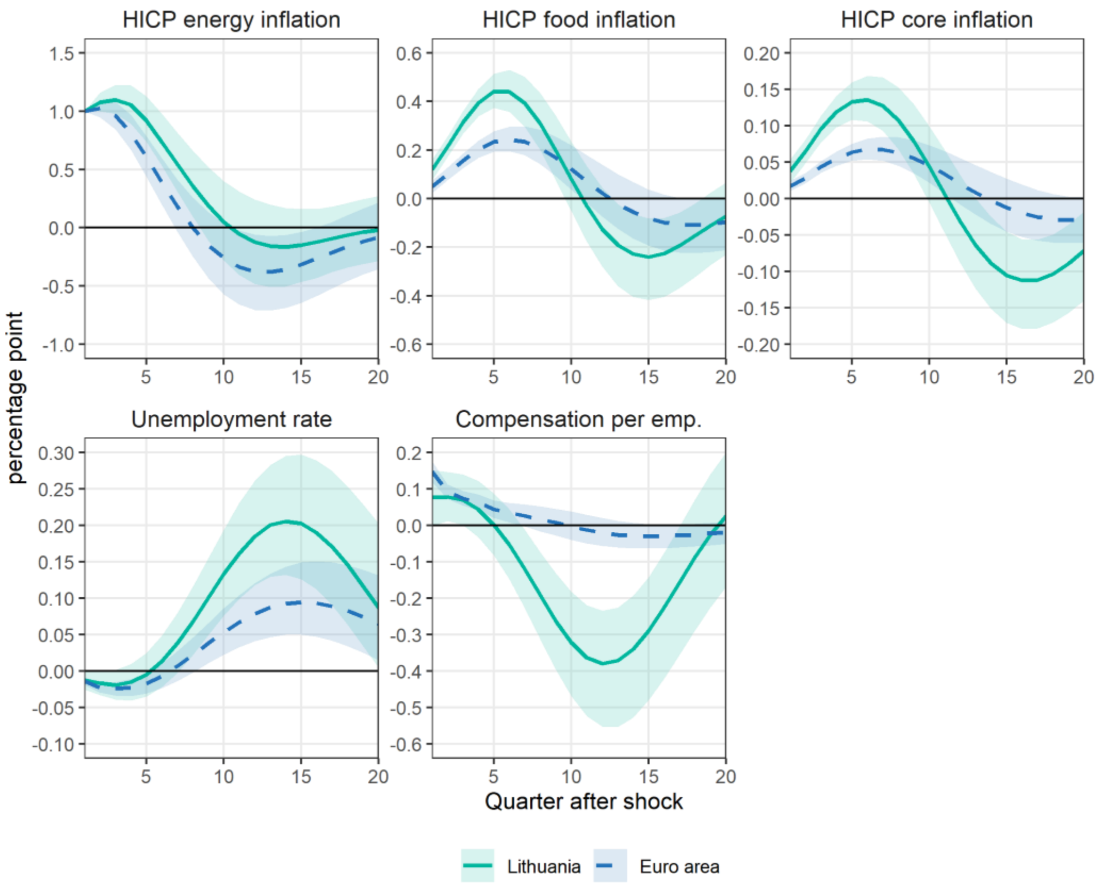


Notes: A line represents the median of 10,000 structural shock draws, and the shaded areas represent the 68% confidence interval.

While the dynamics of energy shock were largely similar, Lithuania's variance was twice that of the EA. Notably, since 2021, Lithuania has been experiencing larger and more persistent positive energy shocks than its peers.

[16] The unemployment rate and total compensation growth per employee serve to control endogenous labor market responses triggered by energy shocks.
[17] In other words, this assumes that energy price inflation is exogenous to the other types of short-term disturbance in the model.

Figure 3. Impulse responses after an energy price inflation shock



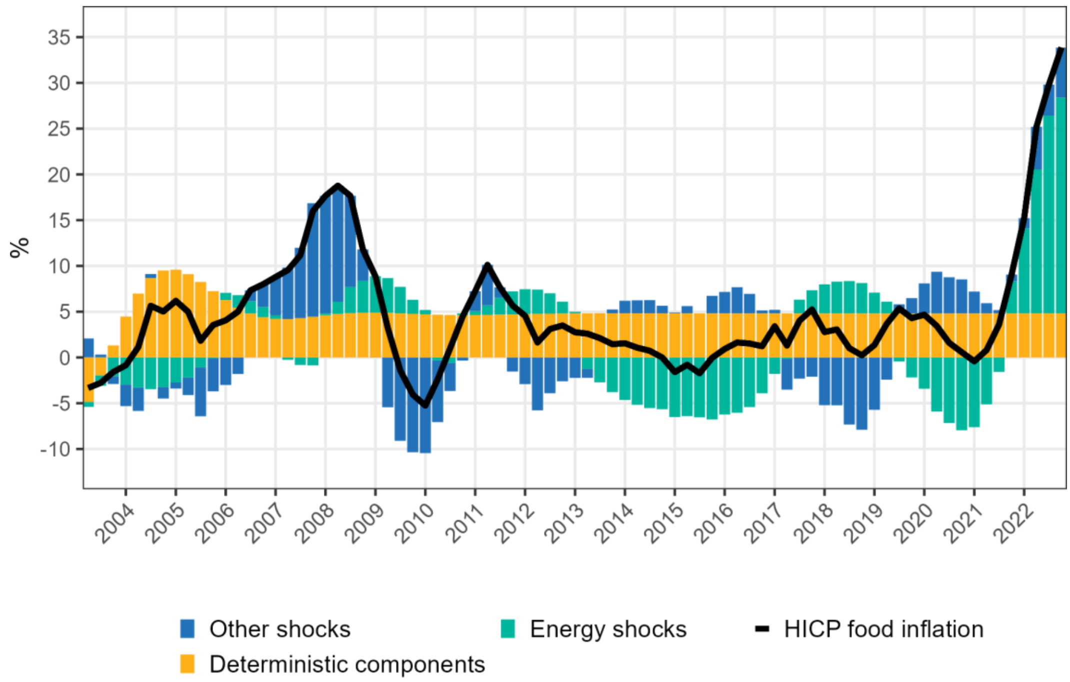
Notes: A line represents the median of 10000 impulse response draws, and the shaded areas represent the 68% confidence interval. In each model, the shock is calibrated to produce a one percentage point change in yoy HICP energy inflation on impact (top left panel). "emp." refers to employee.

Further on, Figure 3 illustrates the typical responses of model variables to an energy shock creating a one percentage point response of HICP energy inflation on impact. Such a shock generally has larger and longer-lasting effects on HICP energy inflation in Lithuania than in the EA.

Moreover, beyond deterministic terms, energy shocks explain on average ~ 80% of food inflation movements in 2022. This compares with an average contribution of only ~ 55% for the EA in the same year. In turn, the shock causes food and core inflation to rise for around two years in both zones, but the response of this inflation is approximately twice as strong in Lithuania as in the EA. Interestingly, core and food inflation then decline after around three years by almost the same amount as the previous increase, indicating that this type of shock typically has short-term inflationary effects. Finally, the shock also triggers wage inflation for a few quarters in both regions, followed by a deep and prolonged decline in Lithuania. This is due to rising unemployment (bottom left panel) and, more generally, to the low downward rigidity of wages in the country.[18]

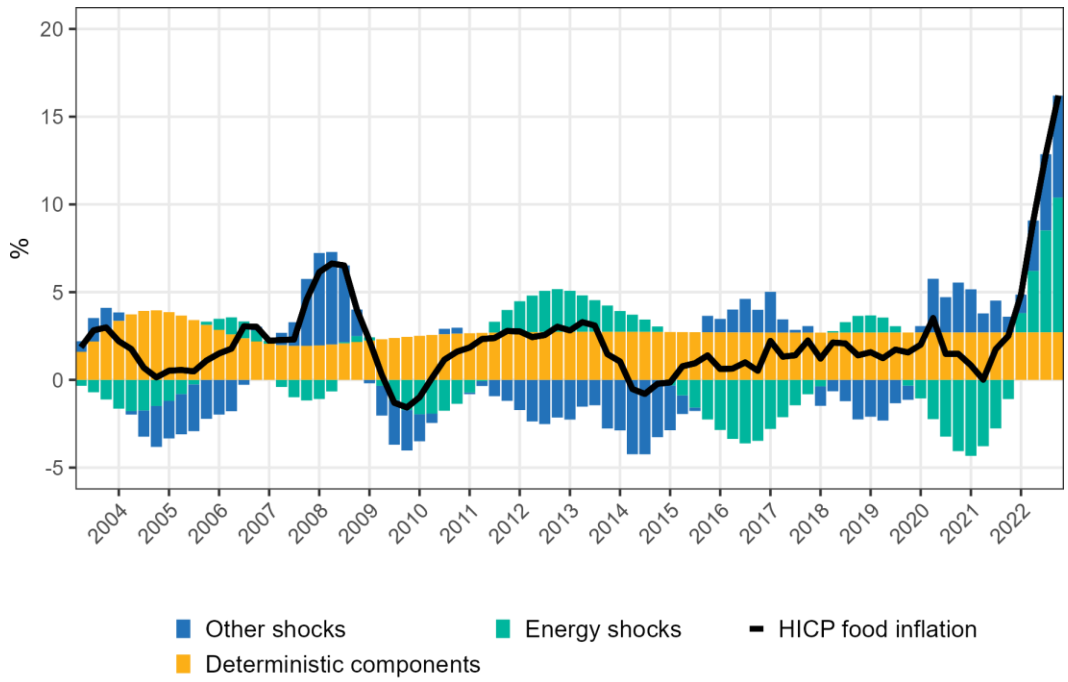
[18] As exemplified by the internal devaluation during the Great Recession. Further evidence in Pesliakaitė and Šiaudvytis (2015).

Figure 4. Historical decomposition of year-over-year HICP food inflation in Lithuania



Notes: The black line indicates year-on-year food inflation. The stacked bars show the average contribution of the model's various shocks and deterministic components to the evolution of food inflation growth.

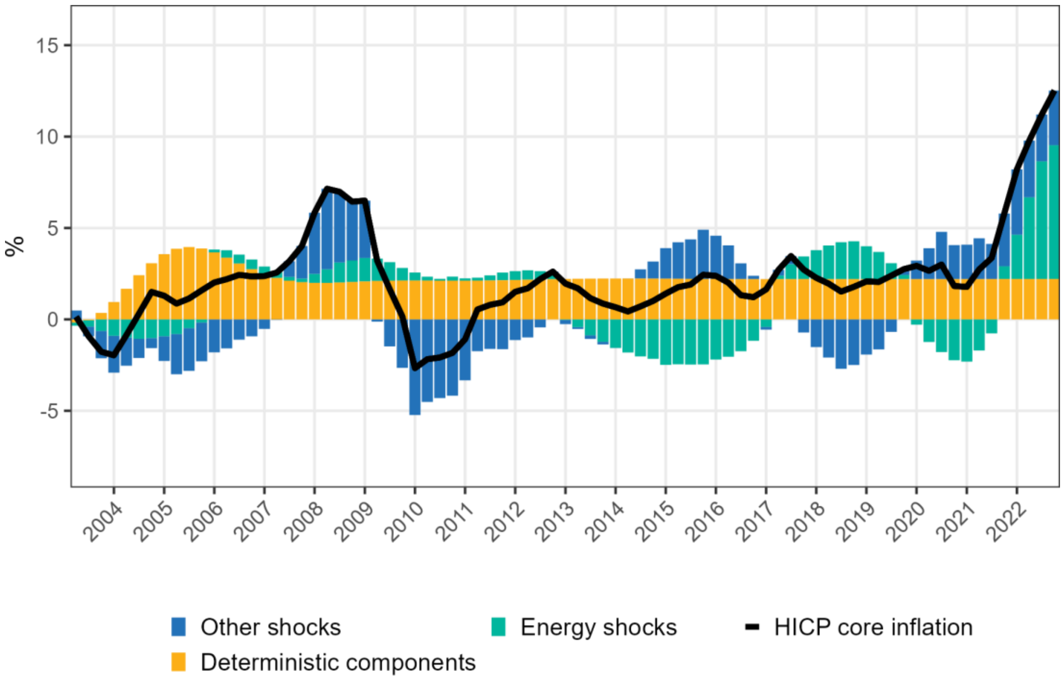
Figure 5. Historical decomposition of year-over-year HICP food inflation in the euro area



Notes: The black line indicates year-on-year food inflation. The stacked bars show the average contribution of the model's various shocks and deterministic components to the evolution of food inflation growth.

The consequences of these energy shocks are also depicted in Figures 4 and 5, which show the historical decomposition of food inflation in Lithuania and the EA, respectively. The model suggests that most of the variations in food inflation in Lithuania since 2020 are due to energy shocks rather than any other type of shock.[19]

Figure 6. Historical decomposition of year-over-year HICP core inflation in Lithuania

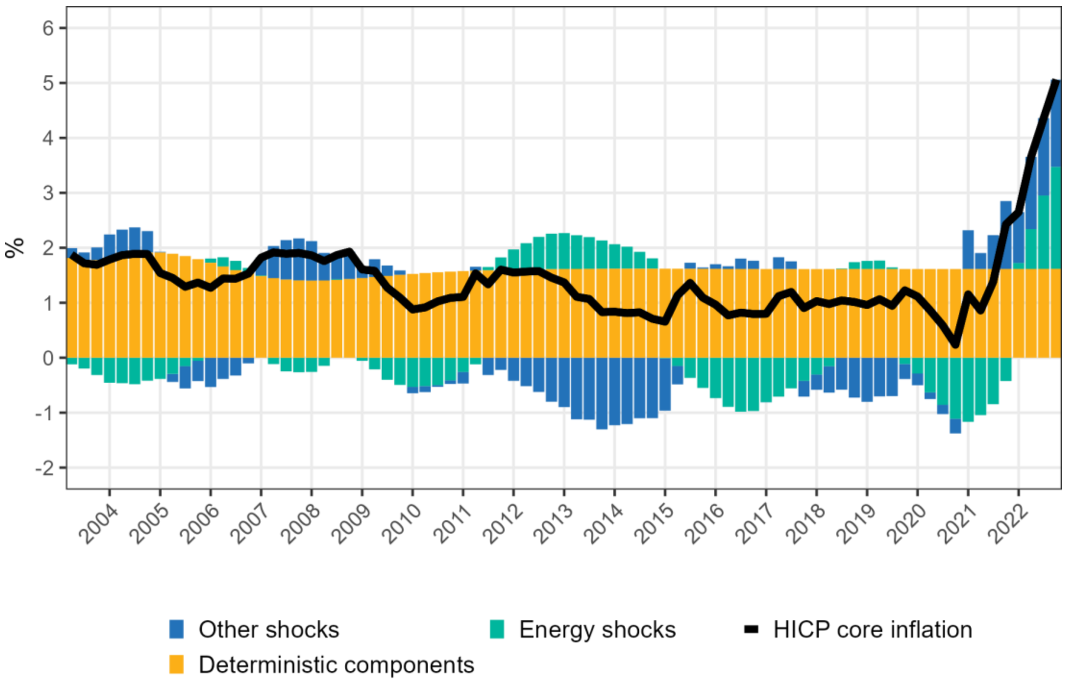


Notes: The black line indicates year-on-year core inflation. The stacked bars show the average contribution of the model's various shocks and deterministic components to the evolution of core inflation growth.

Figures 6 and 7 show the historical distribution of core inflation in Lithuania and the EA respectively. Although significant, the contribution of energy shocks to core inflation is lower than that to food inflation, averaging around 60% in 2022. This reflects a reduced impact of this type of shock on the prices of consumer goods and services that are less energy-intensive. For the EA, the average contribution in 2022 is about 35%.

[19] In this model, energy shocks probably encompass a wide range of aggregate supply shocks, since these would produce qualitatively similar responses. These results therefore highlight that food inflation (see Figure 4) has been driven mainly by supply shocks rather than demand shocks in recent years in Lithuania. In fact, the "other shocks" refer to the four other shocks not identified in the model. They mainly capture demand-side disturbances, as reflected in their impulse responses. These are available on request.

Figure 7. Historical decomposition of year-over-year HICP core inflation in the euro area



Notes: The black line indicates year-on-year core inflation. The stacked bars show the average contribution of the model's various shocks and deterministic components to the evolution of core inflation growth.

This study shows that Lithuania was more affected by and vulnerable to energy price inflation shocks than other EA countries between 2002Q1 and 2022Q4. For an equivalent energy shock, the effects were greater and more persistent on HICP consumer price and wage inflation. This explains why the model estimates that, in 2022, most of Lithuania's food and core inflation was due to energy shocks, while their contribution was smaller for the EA.

References

Corsello, F. and Tagliabracci, A., (2023) "Assessing the pass-through of energy prices to inflation in the euro area". Bank of Italy Occasional Paper No. 745. http://dx.doi.org/10.2139/ssrn.4350522

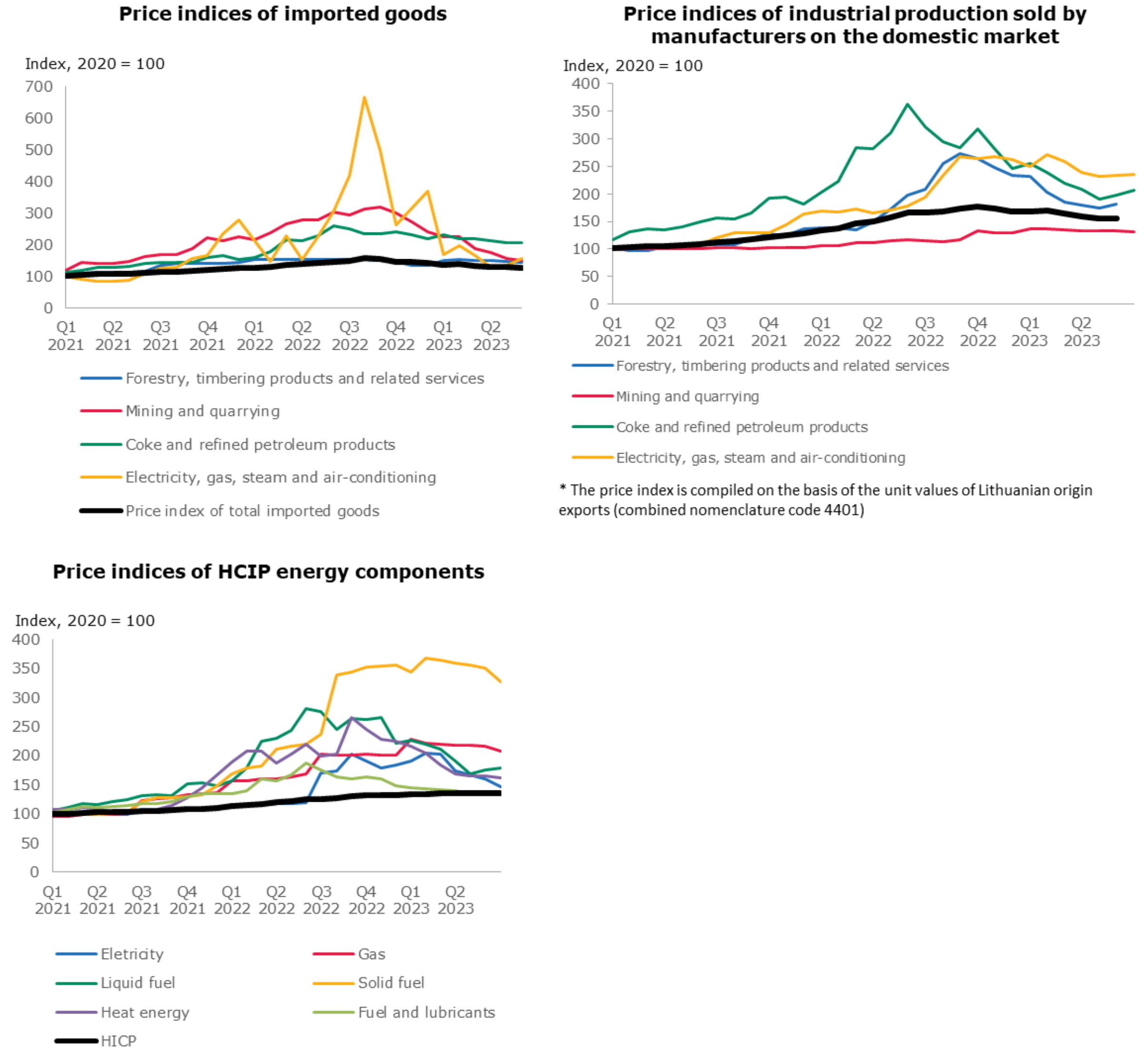
Pesliakaitė J. and Šiaudvytis, T., (2015) "Wage and price setting behaviour of Lithuanian firms: survey–based evidence for 2008–2009 and 2010–2013". Bank of Lithuania Occasional Paper Series No. 8.

2.4. WHAT HAS DRIVEN THE SURGE IN INFLATION IN LITHUANIA? A PRODUCTION-SIDE DECOMPOSITION

In this sub-section, we analyse the impact of supply-side factors on the evolution of the household consumption deflator in 2021Q1-2023Q3. Using input-output tables, we examine the impact of assessed increase in production costs on the final prices of household consumption goods and services. The estimates are based on the methodology used in Schneider (2023).

Global economy has experienced a very strong price surge since the start of 2021 that resulted from several factors. In the euro area rising energy commodity prices were among the strongest drivers of surging inflation (Lane, 2022). As shown in Section 1.1, the energy price spike was also particularly strong in Lithuania. To better understand how the rising energy commodity prices and the decisions of energy sector companies may have influenced price developments in Lithuania, this sub-section differentiates between the energy sector and the rest of the economy. Regarding the former, the analysis covers output and price developments of four economic activities: forestry and logging (NACE[20] code A.02); mining and quarrying (B); manufacture of coke and refined petroleum products (C.19); and supply of electricity, gas, steam and air conditioning (D.35). As can be seen from Figure 1, the prices of both the products produced in these activities and the products imported from other countries increased very rapidly during the period under analysis. For many products, prices in mid-2022 were 2-3 times higher than their average levels in 2021, while, for example, the price index for imported electricity, gas, steam and air conditioning in August 2022 was almost 5 times higher than its average value in 2021. The increase in the prices of these imported products and those produced domestically for the Lithuanian market has made energy products more expensive for consumers. For many energy products, prices in mid-2022 were 2-3 times higher than their average level in 2021 (Figure 1, bottom panel).

Figure 1. Evolution of various energy product prices in Lithuania



Sources: State Data Agency and author's calculations.

[20] Statistical classification of economic activities in the European Community.

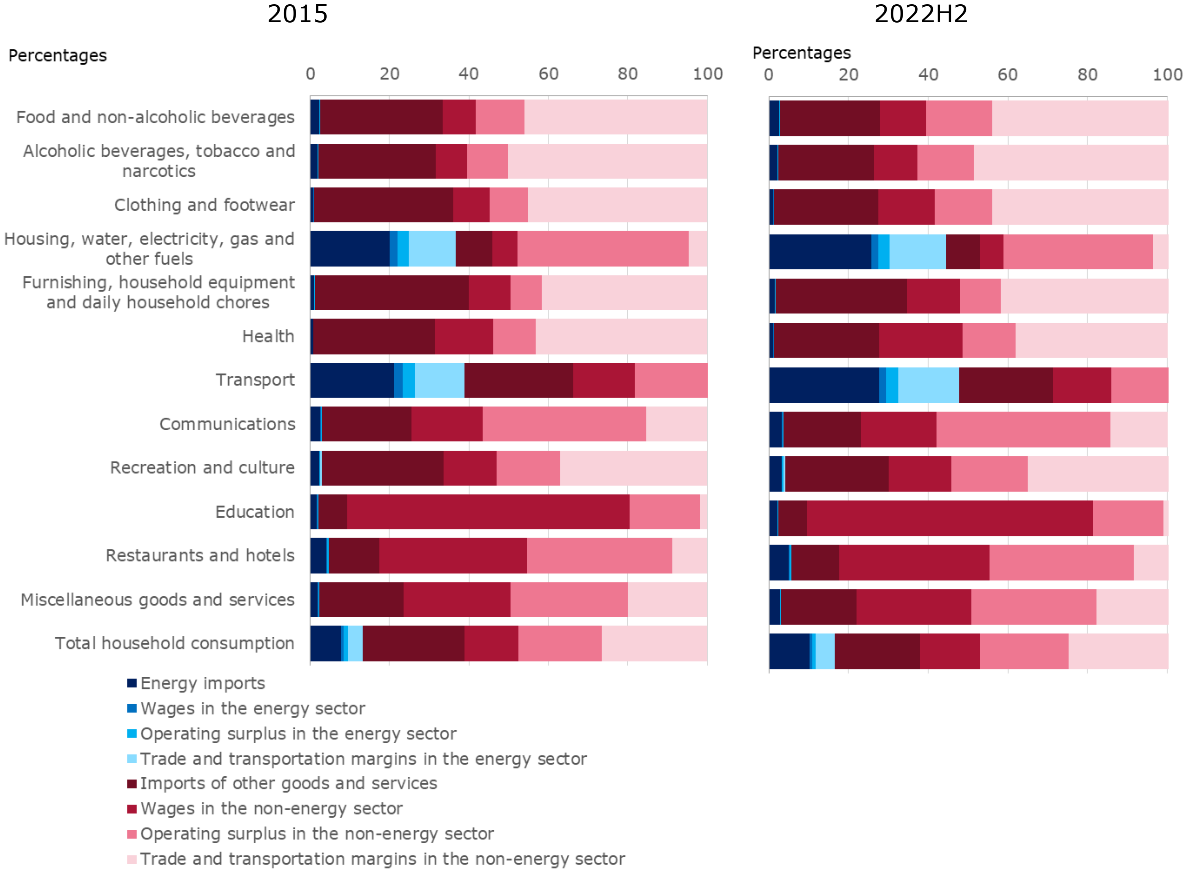
An analysis of the production cost structure of the household consumption basket shows that, before the energy price spike, in only a few groups of goods and services energy-related expenditure accounted for a more significant share of the price, as shown by the bars coloured in shades of blue (Figure 2). Based on the 2015 input-output tables, a supply-side breakdown[21] (Schneider (2023)) of the twelve main groups of household consumption goods and services[22] shows that only the housing, water, electricity, gas and other fuel goods and services, and the transportation goods and services energy-related expenditures constituted a noticeable share of the total value of goods and services sold to households. In these cases, in 2015 the energy-related component accounted for 36.7% and 38.8% respectively, but only 13.2% of the cost of the household consumption basket as a whole. However, the significant increase in energy prices in the second half of 2022 led to a very pronounced change in these indicators. Based on the 2015 input-output tables and various price and cost indices (for example, the price index for imported goods, the price index for industrial output sold by producers, deflators of economic activities, wage developments, etc.), supply-side modelling of the evolution of the prices of goods and services[23] suggests that the share of energy-related expenditure in the total household consumption would have increased to 16.5% in the second half of 2022 (for 2021 the share would be 12.6%), while for housing, water, electricity, gas and other fuel goods and services and transportation goods and services it would have increased to 44.6% and 47.7%, respectively (36.4% and 38.8% in 2021).

[21] In this breakdown, first household consumption at purchaser's prices is decomposed to trade and transportation margins and household consumption at basic prices (basic prices are used in input-output tables). Then household consumption at basic prices is decomposed to domestically produced household consumption at basic prices and direct imports for household consumption at basic prices. Additionally, using input-output table transformation domestically produced household consumption is decomposed to wages, operating surplus and imports used in production of domestically produced household consumption for both energy and non-energy sectors.

[22] Follows classification of individual consumption according to purpose (COICOP).

[23] The following assumptions were made: a) the structure of the production cost of goods and services remains unchanged; b) the ratio between imported household consumption goods and services and those produced in Lithuania remains unchanged; c) the share of compensation of employees in value-added remains unchanged; and d) the trade and transportation margins remain constant.

Figure 2. Estimated cost structure of private consumption goods



Sources: Eurostat, State Data Agency and author's calculations.

Although the increase of energy prices was particularly pronounced and had a noticeable impact on price developments in Lithuania, the cost structure of various groups of goods and services reveals that other factors could have played an important role as well. In those household consumption items, where goods have traditionally had a more significant share, trade and transport margins and the value of imported goods and services other than energy (e.g. food and non-alcoholic beverages, alcoholic beverages, tobacco and drugs, clothing and footwear) account for a particularly large share of the cost structure, while for those household consumption items where services account for a more significant share (e.g. education, restaurants and hotels, communications) - compensation of employees and gross operating surplus[24]. Changes in the cost of these components have therefore also had a significant impact on the evolution of consumption deflator in recent years.

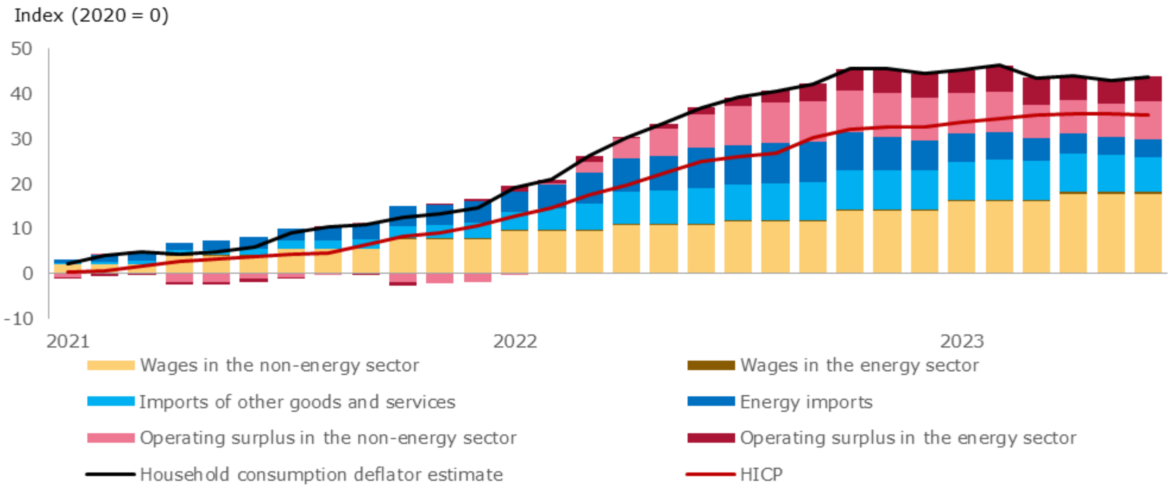
Decomposition of the evolution of household consumption deflator shows that during the period from 2021Q1 to 2023Q2 increases in domestic production costs, imported product prices and wages could account for a rise in the price level of modelled household consumption expenditure of almost 44% (see Figure 3). Wage increases in the non-energy sector accounted for 40% of this cost increase, while the remaining 60% was driven in broadly similar proportions by higher energy costs (including the impact of

[24] Gross operating surplus is used as an abbreviation for the sum of the following indicators: gross operating surplus, gross mixed income, production and import taxes, subsidies (–).

imports and domestic intermediate consumption), more expensive imports of non-energy goods and services, and a rise in gross operating surplus.

It is important to note that the level of household consumption deflator, as measured by this method, has risen by more than the HICP - by 43.8% and 35.5%, respectively. This suggests that the rise in production costs that has taken place in recent years has not yet been fully passed on to the prices of goods and services to consumers. At the same time, it needs to be acknowledged that due to the methodology used to estimate these factors, it is likely that the development of gross operating surplus is an overestimated factor[25], i.e. the impact of the gross operating surplus on the increase in the level of prices has been lower.

Figure 3. Estimated contributions to household consumption deflator level developments since January 2021

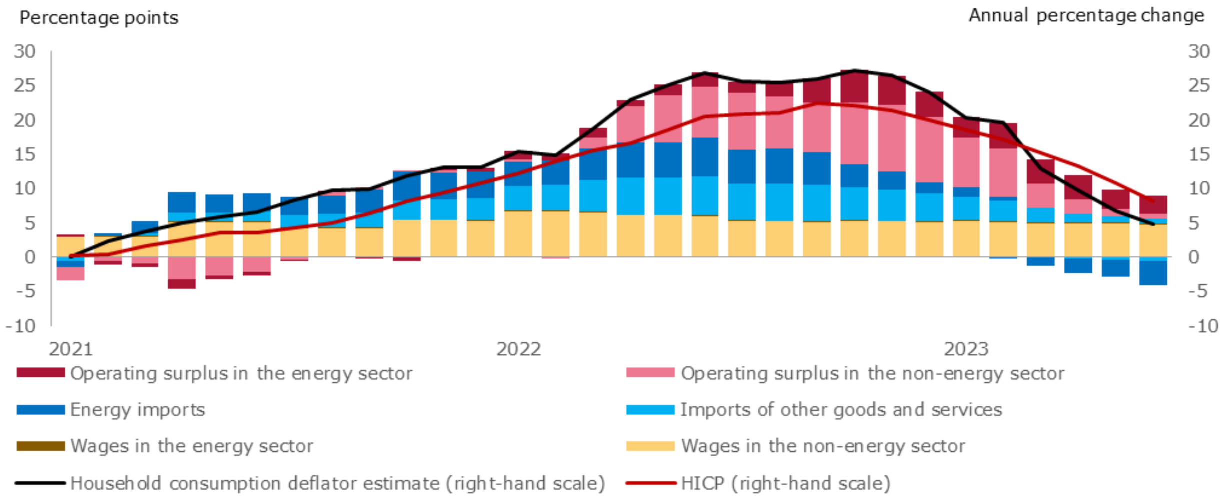


Sources: Eurostat, State Data Agency and author's calculations.

As price pressures from supply-side factors started to ease, the annual growth rate of the HICP outpaced that of the input-output table-based estimated measure of household consumption deflator (Figure 4). This pattern has been observed since April 2023 and continued for four consecutive months. The main contributors to the relatively faster slowdown in the rate of expansion of household consumption deflator based on estimation using the input-output tables are the price decreases of energy products and their imports (prices of domestically produced energy products in Lithuania were 17.2% lower in June 2023 than in the second half of 2022, while those of imported energy products were 49% lower), as well as the less rapid increase in gross operating surplus. It is also important to note that the upward pressure on annual price inflation stemming from wage growth has remained relatively stable over the whole period under review, currently standing at around 5 percentage points. Given that the approach used suggests that the rise in production costs in recent years has not yet been fully passed on to consumer prices, it is likely that in the short term, the annual growth rate of HICP will exceed the rate of growth of household consumption deflator estimated using the input-output tables.

[25] The impact of gross operating surplus on price developments is calculated as the residual value of the overall changes in production costs minus the impact of other analysed factors.

Figure 4. Estimated contributions to household consumption deflator growth developments since January 2021



Sources: Eurostat, State Data Agency and author's calculations.

To summarise, the decomposition of the evolution of household consumption deflator based on the input-output tables shows that under certain assumptions the dynamics of its components could explain an increase in the price level of almost 44% over the period from 2021Q1 to 2023Q2. The approach reveals that all main supply-side factors analysed in this study - higher prices of energy and other imported products, higher wages and increased gross operating surplus - contributed significantly to the increase in the price level. Wage increases accounted for 40% of the calculated increase in the price level, while the remaining increase was accounted for in roughly similar proportions by higher energy costs (including the impact of imports and domestic intermediate consumption), more expensive imports of non-energy goods and services, and the increase in non-energy sector gross operating surplus. The analysis also indicates that the increase in production costs in recent years has not yet been fully passed on to consumer prices. Therefore, it is likely that the evolution of HICP indicator in the short-term could be more pronounced than the changes in the prices of imported goods and services or in the prices of goods and services produced domestically for the Lithuanian market would imply.

References

Lane, P. (2022). Inflation Diagnostics. The ECB blog. Internet source here.

Schneider, M. (2023). What is the effect of energy prices on consumer prices in Austria? A production-side decomposition. Oesterreichische Nationalbank Monetary Policy and the Economy Q4/22-Q1/23. Internet source here.

2.5. LITHUANIA'S NOMINAL EFFECTIVE EXCHANGE RATE FLUCTUATIONS AND DOMESTIC INFLATION

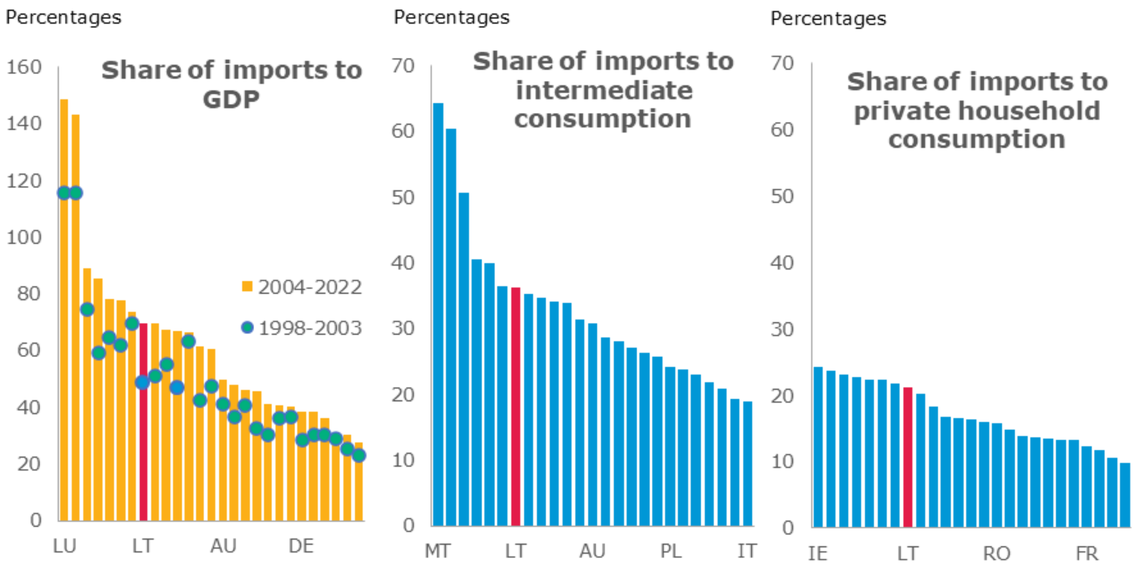
This sub-section explores the extent to which inflation in Lithuania is the result of Lithuania's exchange rate fluctuations. As such, this section will focus mostly on nominal exchange rate pass-through (ERPT) to prices.

ERPT refers to the degree to which changes in the exchange rate of a country's currency affect the prices of imported goods and subsequently influence domestic inflation through pricing chain. When exchange rate pass-through is high, a change in currency value leads to noticeable price changes in imported products. Conversely, when a pass-through is low, currency fluctuations have limited effect on prices, and inflation remains relatively unaffected. Thus nominal exchange rate appreciation could provide a buffer against rising prices of imports. In this instance, if currency appreciation is relatively high and exchange rate pass-through is also high, at least part of increases in import prices would be absorbed by appreciation of exchange rate. Depreciation, in contrast, could exacerbate the increases in the prices of imports.

One factor that affects the degree of ERPT to prices is a country's openness to trade and share of imported products in intermediate consumption and final consumption. The general idea here is that the more open a country is to imports, the higher ERPT will most likely be to import and other prices. Enlargement of the EU, technological advances and lower transportation costs have increased cross-border trade flows (Figure 1, left panel). Openness, as measured by the share of external trade in GDP, varies substantially across economies, with smaller countries generally being more open to trade. Compared to 1998-2003, imports to Lithuania accounted for a higher share of GDP in 2004-2022[26]. As for the share of imports in intermediate and final consumption, Lithuania is also ranked as one of the top countries within the EU (Figure 1, center panel). This indicates that *ceteris paribus* Lithuania's import and other prices are more likely to be exposed to currency fluctuations than in other EU countries.

[26] Share of imports to GDP accounted for 49% in 1998–2003, while in 2004–2022 for roughly 70%.

Figure 1[27]. Imports of goods and services as share of GDP in the EU economies, share of imported products in intermediate consumption and final consumption of households in 2010-2022.

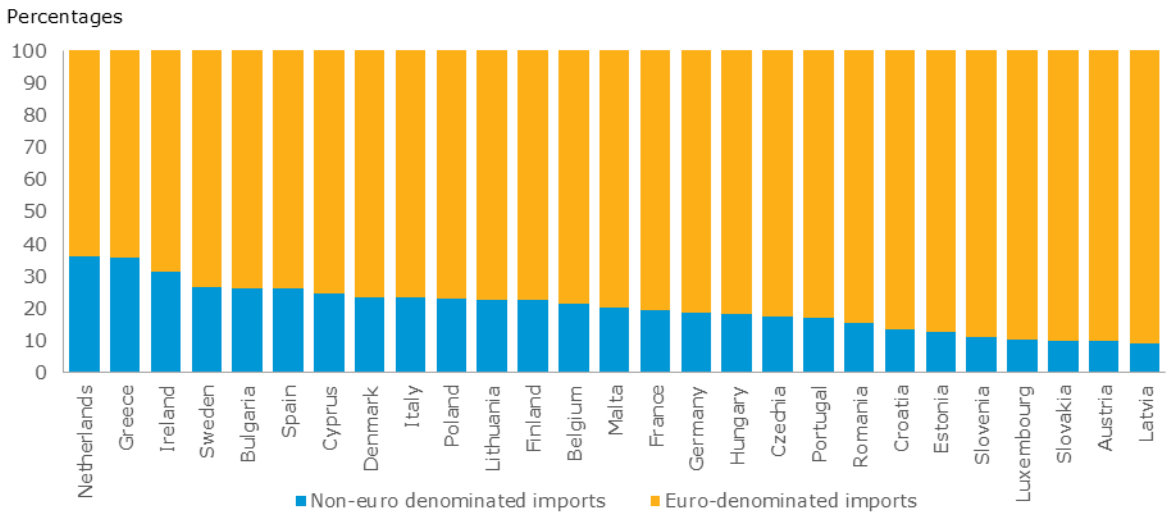


Sources: Eurostat and Bank of Lithuania calculations. Sources: OECD and Bank of Lithuania calculations. Sources: OECD and Bank of Lithuania calculations.

One factor that could limit the magnitude of ERPT despite a high share of imports is invoicing in domestic currency. If exports are invoiced in exporter's currency, the so-called producer currency pricing, export prices will be more sensitive to exporter's own costs and less to importer's (domestic) conditions (Ortega, Osbat and Rubene, 2020). This will most likely increase ERPT to the import and other prices. By contrast, invoicing in the destination's currency, the so-called local currency pricing, will most likely reduce the ERPT. As shown in Figure 2, historically (2010–2022) more than 20% of Lithuania's imports were denominated in non-euro currencies – a slightly higher share than in most EU countries. One reason for high invoicing in foreign currency is Lithuania's dependency on imports of mineral products, which are usually denominated in dollars.

[27] Share of imports to GDP was calculated by dividing nominal imports of goods and services for each year by nominal GDP for the same year. Then the shares of each year were averaged for specified periods (i.e. 1998-2003 and 2004-2022). Share of imports to intermediate consumption and share of imports to private household consumption were calculated by averaging annual values of both indicators in OECD database for the period 2010-2022.

Figure 2. Invoice currency for imports of goods in EU 2010-2022

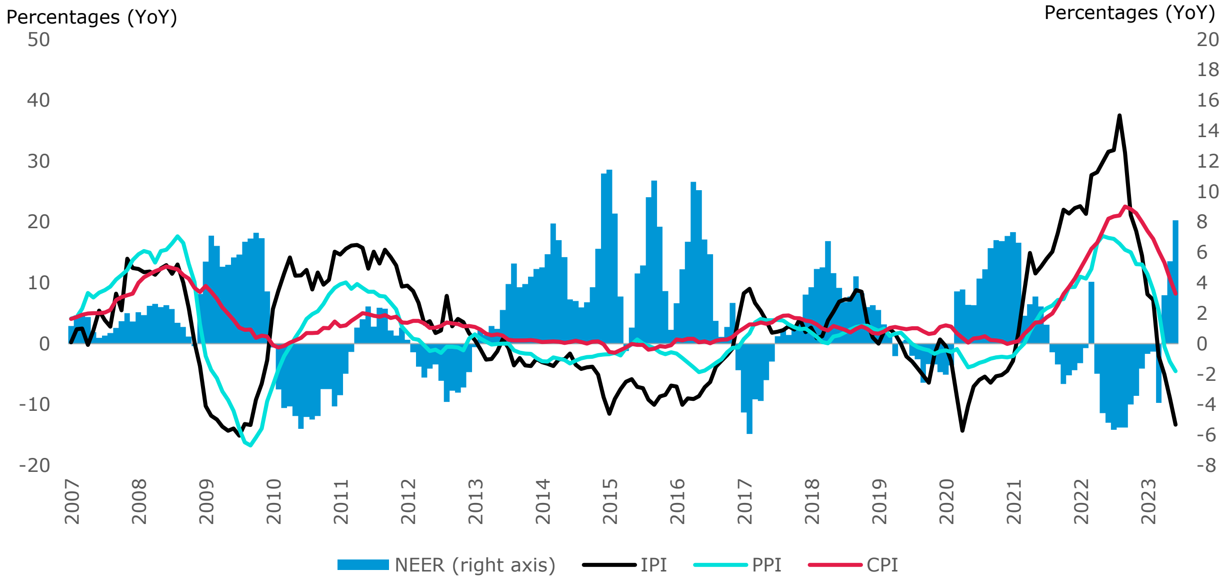


Sources: State Data Agency and Bank of Lithuania calculations.

Other factors that might limit the magnitude of ERPT to prices are market power, competition and use of local inputs. At lower levels of the pricing chain, moving to wholesalers, retailers, and ultimately consumers, companies may choose to adjust their profit margins and absorb at least some share of the initial exchange rate shock to avoid deterring buyers and to maintain their market shares. The latter (attempt to maintain market shares) in conjunction with competitive pressures from other companies suggests that ERPT will decline when going from higher to lower levels of pricing chain (ibidem). Lower ERPT at lower levels of pricing chain could also be explained by the use of local inputs. On the one hand, companies might substitute imported inputs with locally sourced ones in the face of growing prices of imports, reducing exposure to exchange rate fluctuations. On the other hand, at lower levels of pricing chain imported goods constitute a lower share of production costs, implying that the impact of ERPT might be mitigated by the decline of other costs (Osbat, Sun and Wagner, 2021).

The provided list of factors affecting the magnitude of ERPT is not exhaustive but nevertheless indicates that the ERPT to prices might not be complete and same at different levels of pricing chain. It is most likely that ERPT will be high for imports but significantly lower at lower levels of pricing chain. As suggested in Figure 3, a co-movement of nominal effective exchange rate (NEER) and prices is notable in the case of import prices (IPI). However, it is less so in the case of producer prices (PPI) and consumer prices (CPI). In addition, the development of NEER in the pre-GFC period of 2007-2008 suggests that NEER provided a buffer against rising prices of imports, as well as producer prices and consumer prices. In this period NEER was moving together with inflation. A different story is observed in the period of 2010-2012 and in 2021-2022. In these periods, Lithuania’s NEER was depreciating, while prices of imports were sharply rising. These developments indicate that imports (and other goods) were likely becoming more expensive, due to currency depreciation among other factors.

Figure 3. Development of Lithuania's NEER and inflation[28]



Sources: State Data Agency, Eurostat and Bank of Lithuania calculations.

To determine the magnitude of ERPT to prices and the extent to which fluctuations in exchange rate contribute to inflation in Lithuania, a simple vector autoregressive model (VAR) was used. The benchmark model was a four-variable VAR which consisted of nominal effective trade-weighted exchange rate, import price index (IPI), producer price index (PPI) and consumer price index (CPI). NEER, where the currencies of Lithuania's trading partners were weighted by their volume of trade with Lithuania, was used to reflect nominal exchange rate developments. Import price index, producer price index and consumer price index were included in the model to analyse the effects of shocks of nominal exchange rate changes at different stages of the pricing chain, namely, from imports to retail.

All variables were log-differenced to ensure stationarity. Two lags were included based on the Akaike information criterion. The ordering of the model's variables followed Cholesky's identification where it is assumed that the first variable has an effect on all subsequent variables, while the subsequent variables do not affect the preceding variables. This type of ordering reflects how prices are passed along the supply-pricing chain. Specifically, the ordering of variables is as follows:

$$\Delta NEER \rightarrow \Delta IMP \rightarrow \Delta PPI \rightarrow \Delta CPI$$

The impulse-response functions (IRF) used were the accumulated ones, since the variables in the log-differenced format allows one to obtain the approximate percentage change in price indices. Since the innovation is one standard deviation of NEER (in our instance, the standard deviation of log-differenced NEER was 1.19%), the results of IRFs had to be normalized to obtain the standard interpretation of pass-through as the percentage change in some price index for a 1% exchange rate shock.

Figure 4 shows the ERPT to import, producer and consumer prices. As expected, the pass-through to import prices is quite large as exchange rates have the most direct link to import prices and some imported goods (e.g. mineral products) are denominated in foreign currencies. The first month has a 41% pass-through, rising to 75% by the 12th month. In the longer run, the ERPT stabilizes at 75%. **The**

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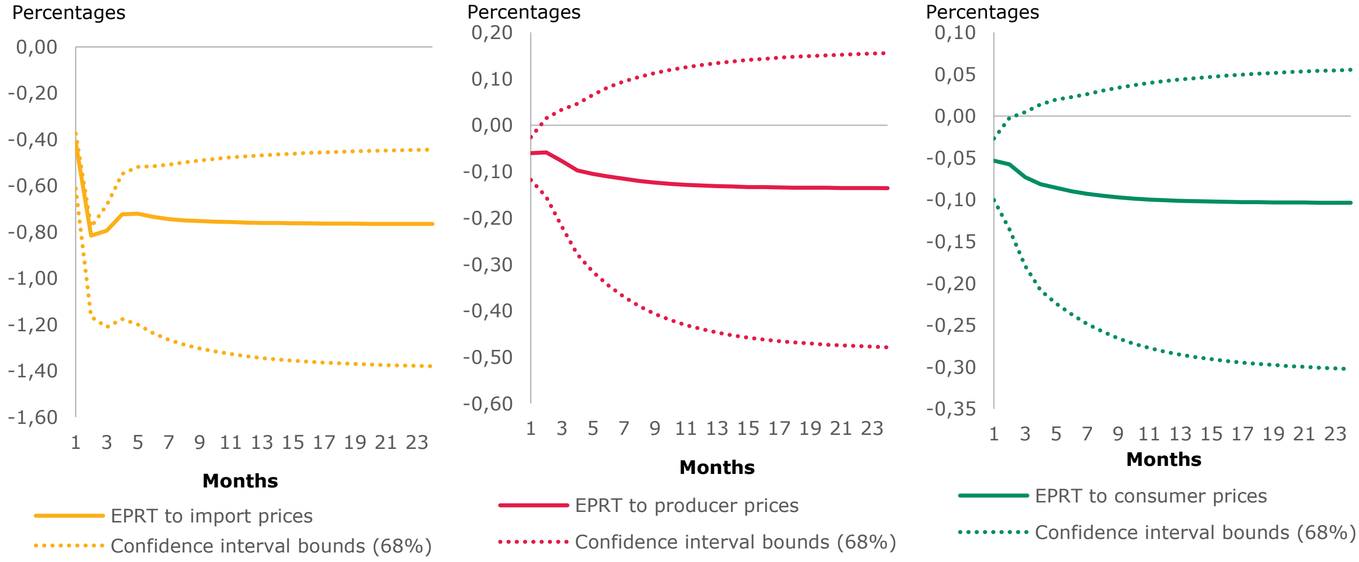
[28] Correlation coefficient between annual NEER and IPI changes was -0.64 from 2007M01 to 2023M06. Correlation coefficients between annual NEER and PPI changes and between NEER and CPI changes for the same period were -0.48 and -0.37, respectively.

results suggest that although ERPT to import prices is high, it is incomplete, implying a strong likelihood that there is no tit for tat increase in import prices following currency depreciation.

The ERPT to producer prices is much smaller. The first month has a 6% pass-through, rising to 13% by the 12th month. In the longer run, the ERPT stabilizes at 13-14%. These results are intuitive. As it was argued before, at lower levels of the pricing chain, products incorporate more local inputs and local labour, which are less affected by exchange rate movements (share of imported goods in intermediate consumption stands at roughly 35% in Lithuania). This implies lower exposure to foreign exchange rate fluctuations compared to imports. In addition, at lower levels of pricing chain, competition may persuade companies to adjust their profits margin and absorb at least some share of initial exchange rate shock to maintain their market shares constant (Ortega, Osbat and Rubene, 2020).

The ERPT to consumer prices is even lower, as it compounds the incomplete pass-through reasons. In addition, a relatively large share of consumer prices consists of services (around 30% of CPI consists of services), which are more affected by domestic price pressures (e.g. labour costs). This means that consumer prices are further less exposed to exchange rate fluctuations. The estimated ERPT to consumer prices is 10% at longer horizons.

Figure 4. ERPT to import, producer and consumer prices[29]

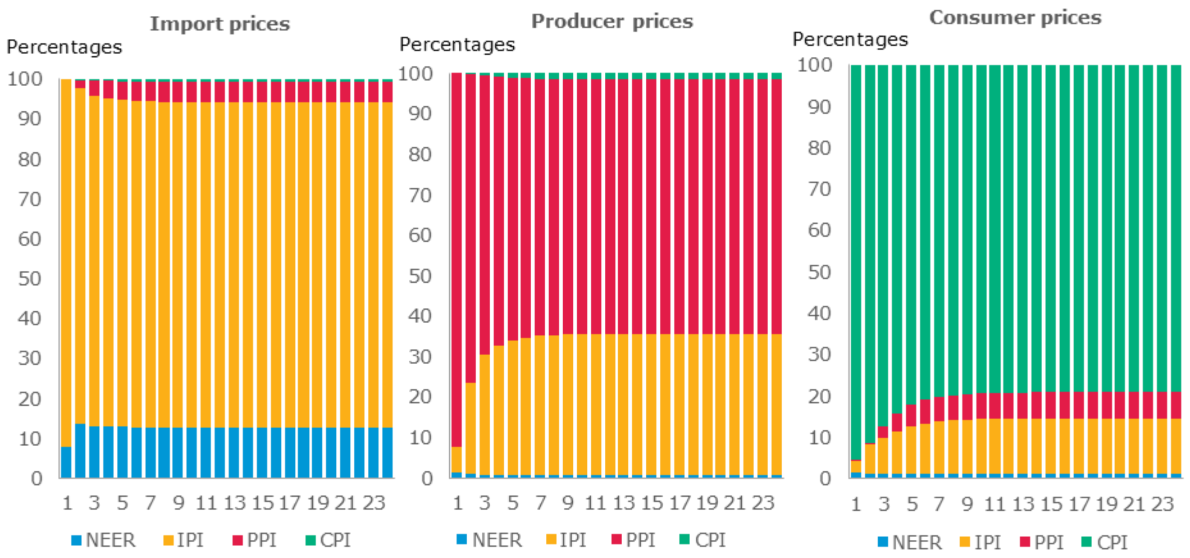


Variance decompositions also reveal several relevant points (Figure 5). In the longer run (12-24 months), slightly more than 10% of variability of import prices is explained by exchange rate fluctuations, while the rest is explained by the import price fluctuations themselves. This implies that there are other factors which were not included in the model but are more important in explaining the development of import prices. As could be expected, the explanatory power of exchange rate movement falls further at the lower levels of pricing chain. Exchange rate movement explains only around 1% of variability of producer and consumer prices. Variability of producer prices is better explained by import prices: the latter explains slightly more than 30% of their variability. As for consumer prices, import prices and producer price movements explain roughly 13% and 6% of their variability, respectively. These results are intuitive

[29] The broad confidence bounds are because the IRFs used were accumulated ones. As the effects are accumulated over time, small uncertainties or errors in the estimation of each individual IRF accumulate. This accumulation of errors leads to wider confidence bounds. If simple IRFs were used, then the lower confidence interval would always be above -1.

because, as shown before, some imports are used directly as intermediate consumption goods and as final consumption goods. In addition to this, some producer goods are sold domestically, meaning that consumer prices are also affected by producer prices.

Figure 5. Variance decomposition for import, producer and consumer prices



Sources: State Data Agency and Bank of Lithuania calculations.

The IRF and variance decomposition analysis corroborate the general finding in the literature that the impact of the exchange rate on prices weakens along the pricing chain. Although nominal exchange rate plays a relatively important role in explaining development of import prices, its explanatory power as well as its impact fall sharply when it comes to producer and consumer prices. Factors other than exchange rate fluctuations are more important in explaining the development of these prices. It should also be mentioned that although the results for longer horizons become less statistically significant, while VAR estimations using Cholesky identification may suffer from problems of imposing strong contemporaneous restrictions, the estimated results are in line with the those found in the existing literature on ERPT in Lithuania (Comunale, 2019, also see Appendix "Literature review of exchange rate pass-through in Lithuania and other Baltic countries"), namely that EPRT to import prices is incomplete, while EPRT to other prices at lower levels of the supply chain is even lower. This indicates the likelihood that although depreciation of the euro contributed to increasing inflation in the most recent inflation period (2021–2022) in Lithuania, its impact on producer and consumer prices was very limited.

References

Comunale, M. (2019). An investigation of the exchange rate pass-through in the Baltic states. CEIS Working Paper No. 469. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3455217

Ortega, E., Osbat, C., & Rubene, I. (2020). The transmission of exchange rate changes to euro area inflation. Economic Bulletin Articles, 3. Available at: https://ideas.repec.org/p/ecb/ecbops/2020241.html.

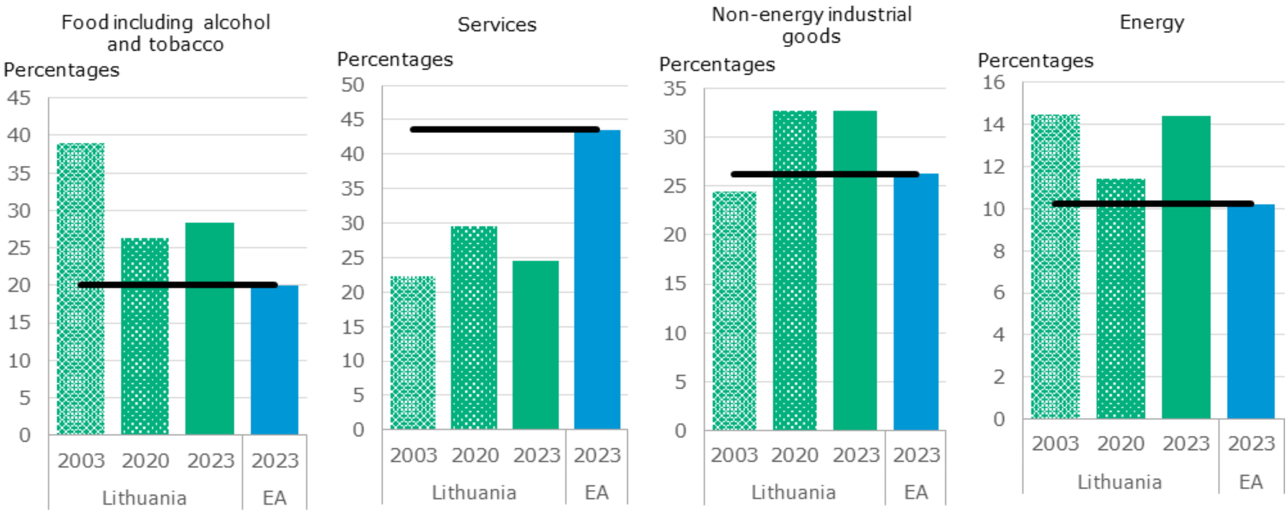
Osbat, C., Sun, Y., & Wagner, M. (2021). Sectoral exchange rate pass-through in the euro area. ECB Working Paper No. 2021/2634. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3992189.

2.6. A COMPARISON OF CONSUMPTION BASKET ITEM WEIGHTS AND PRICE LEVELS IN LITHUANIA AND THE EURO AREA

The structure of the consumption basket is different in Lithuania and other EA countries. This leads to different item weights for inflation calculation (Figure 1). Analysing the main inflation aggregates (food including alcohol and tobacco, NEIG, energy, and services), it can be seen that the biggest differences exist in the weights of services and food. In 2023, for example, the weight of food including alcoholic beverages and tobacco is 28 percent in Lithuania but only 20 percent in the euro area. In the case of services, it is the opposite. The share of services in the consumption basket in Lithuania (25%) is lower than in the euro area (44%). Based on Bank of Lithuania calculations[30], different weights compared to the euro area had an upward effect of about 1.6 percentage points on the Lithuanian average annual headline inflation rate (compared to EU - about 1.2) in 2022.

In countries with a higher standard of living, households tend to spend less on basic needs and more on services. The same trends are observed in the development of the Lithuanian economy. With the rising standard of living, the weight of food including alcohol and tobacco decreased from 39 percent in 2003 to 28 percent in 2023 while the weight of services increased from 22 percent in 2003 to 25 percent in 2023. These changes were even greater if assessed based on developments by 2020: in that year, the weight of food including alcohol and tobacco stood at 26 percent, that of services at 30 percent. Shocks that have occurred since 2020, such as COVID-19, affected consumption patterns. For example, because during the lockdowns access to restaurants was restricted, more people cooked at home. In general, restrictions on the consumption of services resulted in a shift in consumer spending from services to goods during the pandemic. In addition, recent increases in the prices of food including alcohol and tobacco contributed to a higher weight of this item in 2021-2023, potentially lowering the share of spending on services as well.

Figure 1. Item weights of consumption basket in Lithuania and EA



Source: Eurostat.

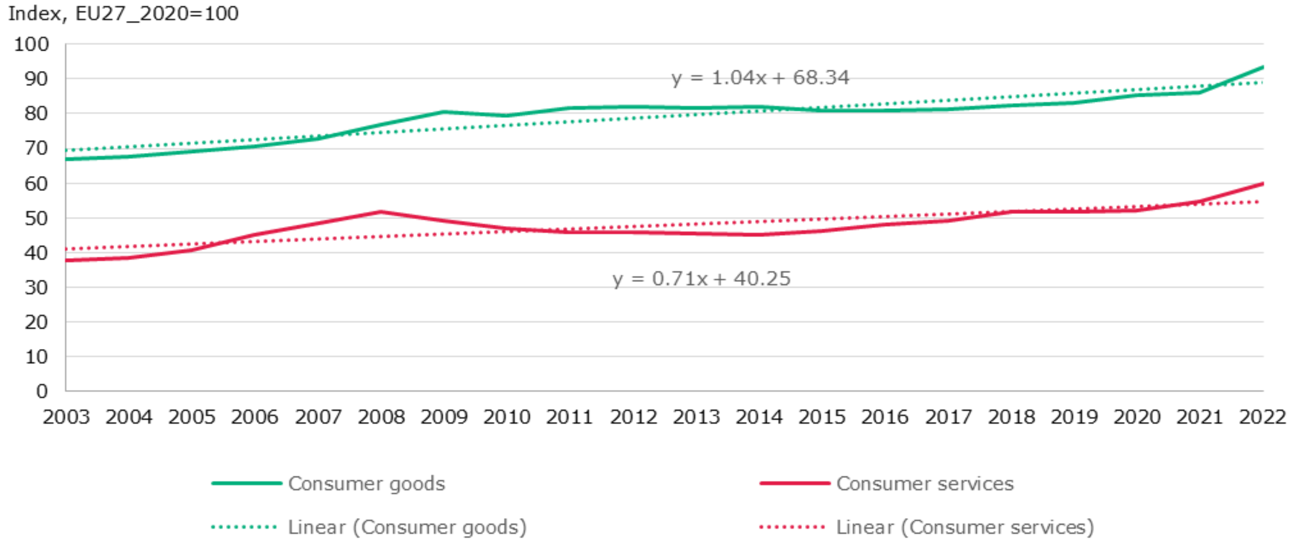
As the standard of living approaches the EU average, the price level also converges (Figure 2). The price level of consumer goods in Lithuania was only 66.9 percent of the average price level in the EU in 2003,

[30] Calculated based on third COICOP level.

but it increased to 93.6 percent in 2022. The same trends, on a different level, are observed in the prices of consumer services in Lithuania, which increased from 37.9 percent of the average price level in the EU in 2003 to 59.7 percent in 2022. Economic theory suggests that in the absence of trade barriers and in the presence of free competition and price flexibility, identical goods should cost the same price in different countries. This implication is reflected in actual data – the price level of consumer goods is much closer to the corresponding EU average than the price level of consumer services.

Judging on the basis of linear trends, price convergence during the analyzed period was quite consistent. The convergence of goods prices was higher than that of services prices (Figure 2). Differences in price levels and the effect of price convergence on inflation differentials are further analysed in the next sub-section.

Figure 2. Evolution of the price levels of goods and services in Lithuania



Source: Eurostat.

2.7. CAN PRICE LEVEL CONVERGENCE EXPLAIN LONGER-TERM DIFFERENCES IN INFLATION RATES ACROSS EURO AREA COUNTRIES?

Despite having the same currency and free movement of goods, capital and labour in the euro area, the inflation rates differ across member states. New EU member states tend to have persistently higher inflation. In this sub-section, we analyse how much of the inflation difference across the EA can be explained by remaining price level differences.

The economic literature on inflation differentials has examined the underlying explanation behind differences in inflation across countries. Typically, it shows that new EU member states tend to have persistently higher inflation because of convergence, which naturally takes place in the monetary union with free movement of goods, capital, and labour. It is important to understand underlying causes of inflation differentials across countries, as higher inflation can signal not just convergence but also overheating processes, leading to the appreciation of real exchange rates and making the relevant countries less competitive in international markets. Thus, determining the size and effects of convergence is an important question, as it allows for better overall economic policymaking.

Output gaps and effective exchange rates are the two variables most often used to explain inflation differentials across countries. Honohan and Lane (2003) analysed inflation differentials across EMU economies over the period 1999-2001, including as explanatory factors both these two variables as well as the speed of price level convergence. They found that nominal effective exchange rates are the main explanatory variable for inflation differentials in many countries. The findings indicate that a currency depreciation of 3.5 percent leads to a single-point increase in inflation. To illustrate, the paper gave the example of Ireland, whose currency depreciated by 11 percent in the period from 1998 to 2000. Much of the remaining difference in inflation was explained by variations in output gaps and price level convergence. The latter effect is estimated to add an additional percentage point of inflation in economies 30 percent below the average price level. Stylianou (2022) used a similar methodology to analyse euro area countries over the period 1999–2018. Even with the extended time frame, he found very similar results for both the output gap and nominal effective exchange rates, indicating that the original paper's findings are robust. However, Stylianou (2022) does include price level convergence in its set of explanatory variables.

The Balassa (1964) and Samuelson (1964) effect is another common explanation for inflation differences. This approach suggests that economy can be split into two sectors with differing properties, one of tradable goods and one of non-tradable goods. The tradable goods sector is exposed to foreign competition because the prices of goods are determined by international markets while the non-tradable goods sector is solely determined by domestic factors. Because international markets are generally more capital-intensive and are exposed to rapid technological progress, their productivity increases more quickly than that of the non-tradable goods sector. This would warrant higher wages in the tradable goods sector and vice versa. However, because wages tend to rise uniformly in all sectors, the prices of non-tradable goods increase without a corresponding improvement in productivity. Such an effect has a direct implication on inflation differentials because it systematically increases inflation in EU economies that are catching up. (Halpern & Wyplosz, 2001; Mihaljek & Klau, 2003; De Broeck & Sløk, 2006).

We ran multivariate panel regressions to analyse whether price level convergence affected the inflation differential across eurozone countries over the period 2002–2022. We included control variables to avoid potential bias in the coefficients caused by underspecification. As mentioned previously, our approach closely follows the methodology used by Honohan and Lane (2003). The general model specification can be written as follows:

$$\pi_t^i - \pi_t^{EU} = \underbrace{\beta\left(P_{t-1}^i - P_{t-1}^{EU}\right)}_{\text{Price level convergence}} + \overbrace{\delta\left(\mathbb{z}_{t-1}^i - \mathbb{z}_{t-1}^{EZ}\right)}^{\text{other factors}} + \epsilon_t, \quad (1)$$

where π_t^i and π_t^{EU} are the annual inflation rates for country *i* and the eurozone, respectively. In the same manner, P_t^i is the annual national price level for country *i*, and P_t^{EU} is the annual average European Union price level. z_t^i represents any control variable that may influence inflation divergence for country *i* and z_{t-1}^{EU} represents the respective controls at the European Union level. Note that by using the specification above, we assume that in the long run, countries will achieve a steady state with an identical price level.

Further expanding the general model specification, we combine the eurozone variables into a time dummy ϕ_t and include three variables into our $\mathbb{z}_t^i$ vector:

$$\pi_t^i = \phi_t + \underbrace{\beta\, P_{t-1}^i}_{\text{Price level convergence}} + \overbrace{\delta_1 \Delta NEER_{t-1}^i}^{\text{Nominal effective exchange rate}} + \overbrace{\delta_2 GAP_{t-1}^i}^{\text{Output gap}} + \overbrace{\delta_3 FISC_{t-1}^i}^{\text{Fiscal stance}} + \epsilon_t. \quad (2)$$

Variable $NEER_{t-1}^i$ represents nominal effective exchange rates. GAP_t^i is the national output gap and $FISC_t^i$ is the difference between government lending and borrowing, representing country i's fiscal balance.

Nominal effective exchange rates. This variable is defined as a weighted average of bilateral nominal exchange rates, where the trade volumes of the country of interest with its respective foreign trade partners are used as weights. The link between nominal exchange rates and inflation differentials is not simple; to understand it better, it is useful to consider an example. Assume a monetary union and another country, call it country A, that it trades with. If country A's currency appreciates, its exports become more expensive for the monetary union. Thus, the monetary union experiences a negative supply shock, which leads to higher inflation, and vice versa, meaning that there is a direct relationship between changes in the bilateral exchange rate and inflation. However, this channel alone would not affect inflation differentials *among* monetary union countries. The essence of the argument is that not all countries in the monetary union will be affected in the same way. The countries that engage in large amounts of trade with country A will experience a potentially pronounced economic effect, yet those that have (relatively) little or no trade with country A will experience only a relatively small *direct* exchange rate effect, if any. Precisely here the role of weights based on the amount of trade comes into play. If a given country (of the monetary union) trades heavily with country A, then its nominal effective exchange rate will change relatively substantially, but if it does not, then the nominal effective exchange rate will not be affected. The inclusion of nominal effective exchange rates as an explanatory variable for inflation differentials allows us to control for these effects. Honohan and Lane (2003) found that nominal effective exchange rates are the main explanatory variable, with a coefficient of -0.28. When Kovács (2003) tried to replicate the results, he found that the coefficient of the effective exchange rate decreased from -0.28 to -0.17 and became statistically insignificant. By contrast, Stylianou (2022) replicated the study using data over a much longer time span and found that the results from the original study are very robust.

Deficit. A temporary increase in government expenditure typically has a short-to-medium run expansionary effect on real aggregate demand and output. However, if it happens to push the economy beyond its supply-side potential, domestic inflationary pressures will emerge. Therefore, if some countries engage in more fiscal stimulus than others, this can directly affect inflation differentials. Also relevant is that fiscal stance is highly endogenous to the business cycle and that, in the EU context, it is subject to European regulations such as the Stability and Growth Pact. Possibly because of these reasons, many studies have failed to find any significant relationship between fiscal policy and inflation differentials (Honohan & Lane, 2003; Stylianou, 2022; Checherita-Westphal et al., 2023). Acknowledging that such effects may be small and / or insignificant, we nevertheless include government deficit in our model specifications.

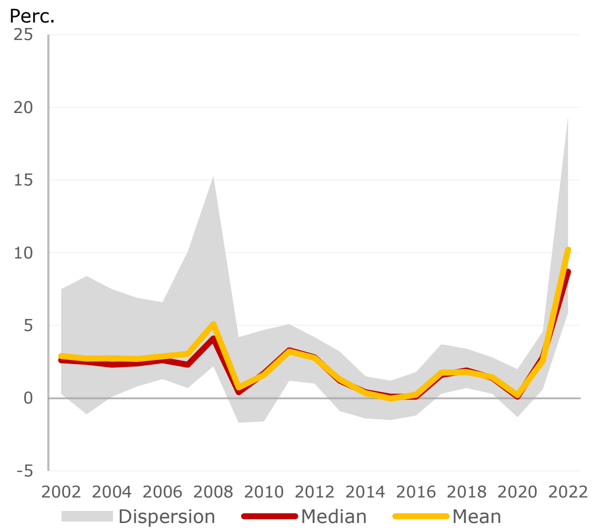
Output gap. It is a fact of life that EU economies experience different shocks and use different mechanisms for dealing with them. The effectiveness of these mechanisms varies considerably. In addition, all eurozone countries have different consumption patterns, making every recession unique. We account for the differences in cyclical situation across countries by including a measure of output gap in the set of explanatory variables. Both Honohan and Lane (2003) as well as Rogers (2002) found the coefficient of the output gap to be around 0.3 during the late 1990s, meaning that 1 pp increase in the output gap would lead to 0.3 pp higher inflation. Newer data from 1999 to 2018 showed that the effect was a bit larger, around 0.5 (Stylianou, 2022). Despite the multitude of studies finding the variable significant, using it in empirical analysis may have some (practical) problems. For example, Checherita-Westphal et al. (2023) argue that fiscal policy does not have a direct effect on inflation differentials in EA-19 but instead acts indirectly through the output gap, which suggests that the variable may have endogeneity issues.

As in Honohan and Lane (2003), we use a pooled OLS estimator. However, to guard against potential reverse causation whereby the output gap, nominal effective exchange rate, and fiscal stance are influenced by the inflation rate, we also conduct instrumental variables (Generalized method of moments, GMM) estimation, where we instrument for the fiscal impulse, nominal effective exchange rate, and the output gap using lagged values of these variables.

The data used in this section were collected from the Eurostat database. We consider five different dependent variables: HICP inflation and HICP excluding energy inflation (both calculated as the annual average rate of change of all items in the corresponding index), GDP deflator inflation, personal consumption expenditure (PCE) inflation, and wage growth, the latter three calculated as percentage changes from the previous period. We also use four independent variables. To measure (differences in) price levels, we used Eurostat indices of national price levels normalized by the average price level of all European union countries (rescaling the series to 100 in year 2020). We also used Eurostat series of the annual rate of change of nominal effective exchange rates. Fiscal deficit was calculated as the difference between government lending and borrowing expressed in percent of gross domestic product. Lastly, we constructed the output gap series as the log difference between chained GDP annual levels and the trend calculated using Hodrick-Prescott filter (with the smoothing parameter set to 30).

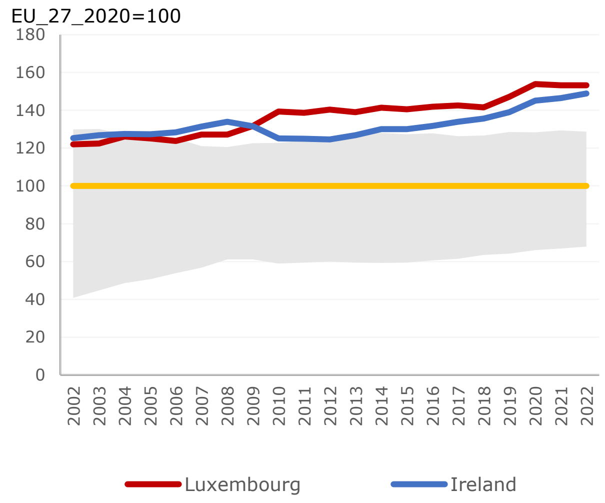
Figure 1 shows the mean, median and range of inflation rates across EU countries over time. We can see that while inflation rates diverged significantly in some episodes, the price levels tended to converge during the period analysed, especially if Luxemburg and Ireland are excluded. (See Figure 2)

Figure 1. Distribution of inflation rates



Source: Eurostat, Authors' calculation

Figure 2. Distribution of price levels



Source: Eurostat, Authors' calculation

The results of our estimations can be seen in Table 1. The first four equations assess the individual relationships between the dependent variable and the four different independent variables estimated using OLS. The fifth and sixth equations combine all the variables in a single model and the seventh provides results using GMM estimator. The results from GMM estimates do not seem radically different, but the effect of lagged price level has increased somewhat.

Table 1. Eurozone HICP differentials.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lagged price level	-0.022***				-0.025***	-0.024***	-0.026***
Lagged effective exchange rates		-0.23***			-0.26***	-0.26***	-0.38***
Deficit			0.05*		0.06*		0.03
Output gap				0.14***	0.13***	0.13***	0.34***
R^2	0.68	0.66	0.65	0.67	0.73	0.72	0.67
Adjusted R^2	0.66	0.64	0.63	0.65	0.71	0.70	0.65
Estimation				OLS			GMM
Time effects				Included			
Data				2002-2022			

Note: ***, **, and * refer to the statistical significance at 1%, 5%, and 10%, respectively.

The first explanatory variable in Column 5 is the lagged price level. Its coefficient of -0.025 indicates that economies with price levels 40 percent below the European average tend to have one percentage point higher inflation. While currently no country in the eurozone has a price level that low, the estimated effect is still quite apparent in many countries. For example, it follows that in 2022, the effect of price level convergence increased inflation in Lithuania and Latvia by 0.65 and 0.5 percentage points, respectively.

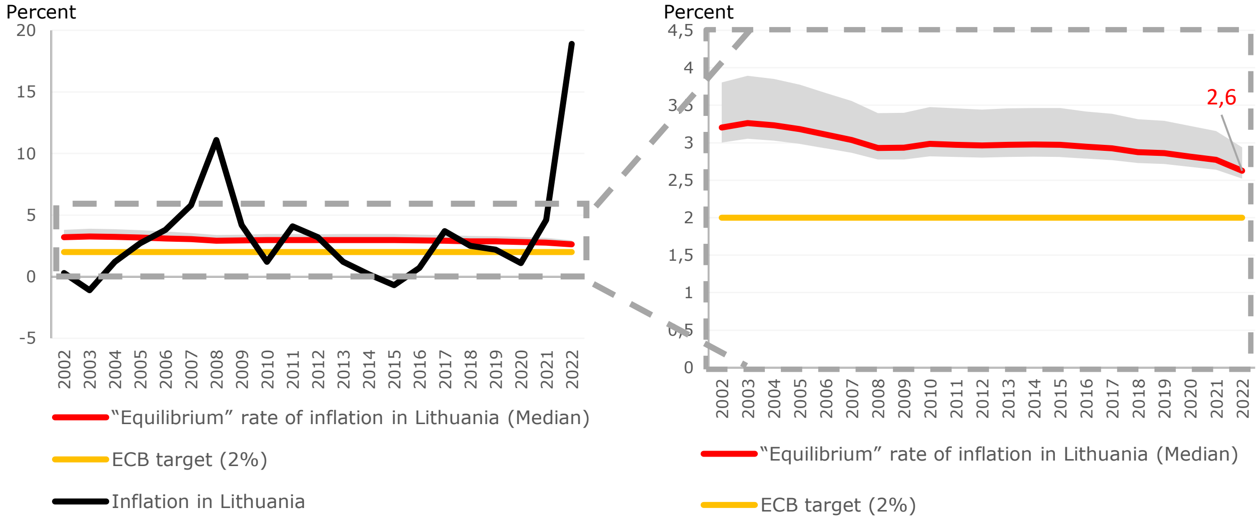
The coefficient associated with lagged changes in the effective exchange rate is estimated to be -0.26, which implies that a currency depreciation of 4 percent leads to a single point increase in inflation.

In our regression estimation, the coefficient of fiscal deficit is marginally statistically significant but has the "wrong" sign. On theoretical grounds, one would expect that an increase in deficit would have an expansionary effect on the economy and thus lead to higher inflation. Yet the obtained estimation result implies that a decrease in the deficit by one percentage point causes a 0.06 percentage point increase in inflation. One possible explanation is that when inflation is high, governments try to decrease it by cutting spending. To account for this, a sixth OLS estimation was made excluding government net borrowing; however, it did not change the results in any significant way.

Last, the output gap and HICP inflation seem to have a positive relationship. This makes theoretical sense because the output gap is used as a control for differences in the economic cycle. However, the coefficient of 0.13 indicates that an 8-point deviation from potential output can explain only one percentage point of inflation, a relatively low effect compared to those reported by other studies (Honohan and Lane, 2003; Stylianou, 2022).

At the time Lithuania joined the EU in 2004, it had relatively low price level. In 2004, Lithuania's price level was 51 percent below the euro union average. However, price convergence progressed rapidly, and by 2022, the price level gap has decreased to 26 percent. Figure 3 illustrates the effect such rapid convergence had on "equilibrium" inflation in Lithuania. The yellow line is the current ECB inflation target rate, and the red line is the median estimate from our models of price level convergence that implies an "equilibrium" rate of inflation in Lithuania. As can be seen, on average, the price level convergence increased Lithuania's inflation by around a single point over the 20-year period. However, it should be noted that, depending on the model used, the estimated effect varies by about half a point. The implied inflation differential diminishes as the price level gap declines, and at the end of the sample period, the median estimate for inflation differential is 2.6%, surrounded by modelling uncertainty (2.5-2,9%).

Figure 3. Price level convergence implied "equilibrium" rate of inflation in Lithuania



Source: Authors' calculations.

Source: Authors' calculations.

Note: "equilibrium" rate of inflation is calculated by assuming that (1) inflation in the euro area is 2 percent, (2) the only factor driving inflation differential in Lithuania is price level difference. The red line denotes median estimate across the models. The grey area provides dispersion of our estimates across the models.

References

Balassa, B. (1964). The Purchasing-Power Parity Doctrine: A Reappraisal. *Journal of Political Economy*, Vol. 72(No. 6), 584–596. Link here.

Checherita-Westphal, C., Leiner-Killinger, N., & Schildmann, T. (2023). Euro Area inflation differentials: The role of Fiscal Policies Revisited. ECB Working Paper No. 2023/2774. Link here.

De Broeck, M., & Sløk, T. (2006). Interpreting real exchange rate movements in transition countries. *Journal of International Economics* Volume 68, Issue 2, 368-383. Link here.

Halpern, L., & Wyplosz, C. (2001). Economic transformation and real exchange rates in the 2000s: the Balassa-Samuelson connection. ECE Discussion Papers Series 2001_1. Link here.

Honohan, P., & Lane, P. R. (2003). Divergent inflation rates in EMU. *Economic Policy*, 18(37), 357–394. Link here.

Kovács, M. A. (2003). How Real Is the Fear? Investigating The Balassa-Samuelson effect CEC5 Countries In The Prospect Of EMU Enlargment. Conference on Monetary Strategies for Accession Countries. Link here.

Mihaljek, D., & Klau, M. (2003). The Balassa-Samuelson effect in Central Europe: A disaggregated analysis. Social Science Research Network. Link here.

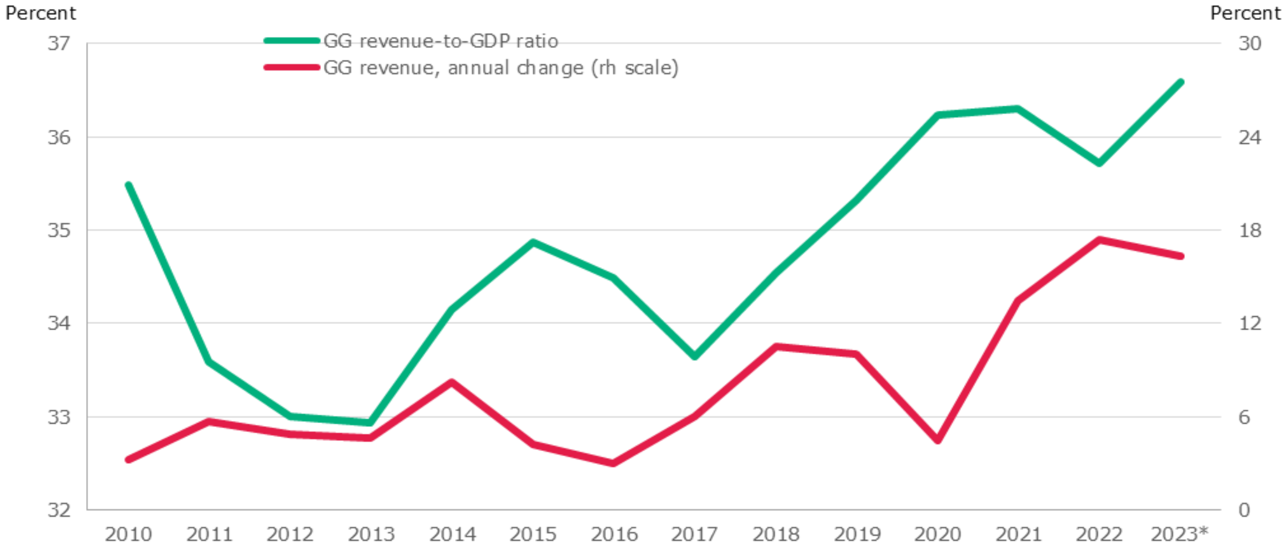
Samuelson, P. A. (1964). Theoretical notes on trade problems. *The Review of Economics and Statistics*, 46(2), 145–154. Link here.

Stylianou, T. (2022). Inflation Differentials Among European Monetary Union Countries: an Empirical Evaluation with Structural Breaks. National Institute Economic Review, 1–19. Link here.

3. IMPLICATIONS OF TEMPORARY ACCELERATION IN INFLATION FOR PUBLIC FINANCES

Since the onset of the COVID-19 pandemic in 2020, the growth of general government (GG) revenue in Lithuania has been resilient and extremely strong (see Figure 1a). Even in the pandemic year 2020, the growth of general government revenue slowed only marginally and remained positive despite stagnating overall economic activity. Starting from 2021, the annual growth rate of GG revenue accelerated and peaked at 13.5% and 17.3% in 2021 and 2022 respectively. As a result, GG revenue-to-GDP ratio increased significantly: from an average of 34% in 2011-2019 to nearly 36% in 2022. GG revenue in Lithuania experienced buoyancy across all major revenue categories (see Figure 1b). Thus, starting from Q1 2021 and until Q2 2023, increasing revenues from direct taxes (personal income tax, PIT, and corporate income tax, CIT) pushed up the total GG revenue-to-GDP ratio by 1.8 p.p., rising revenues from indirect taxes (mainly VAT and excise duties) added 1.6 p.p. and social contributions contributed 1.3 p.p. on average per quarter. At the same time, nominal GDP has been increasing by 15% yoy every quarter as a result of growing real economic activity and, more importantly, rising price level. However, GG revenue-to-GDP ratio rose despite a rapid increase in the denominator (see green line in Figure 1a and green and yellow bars in Fig. 1b).

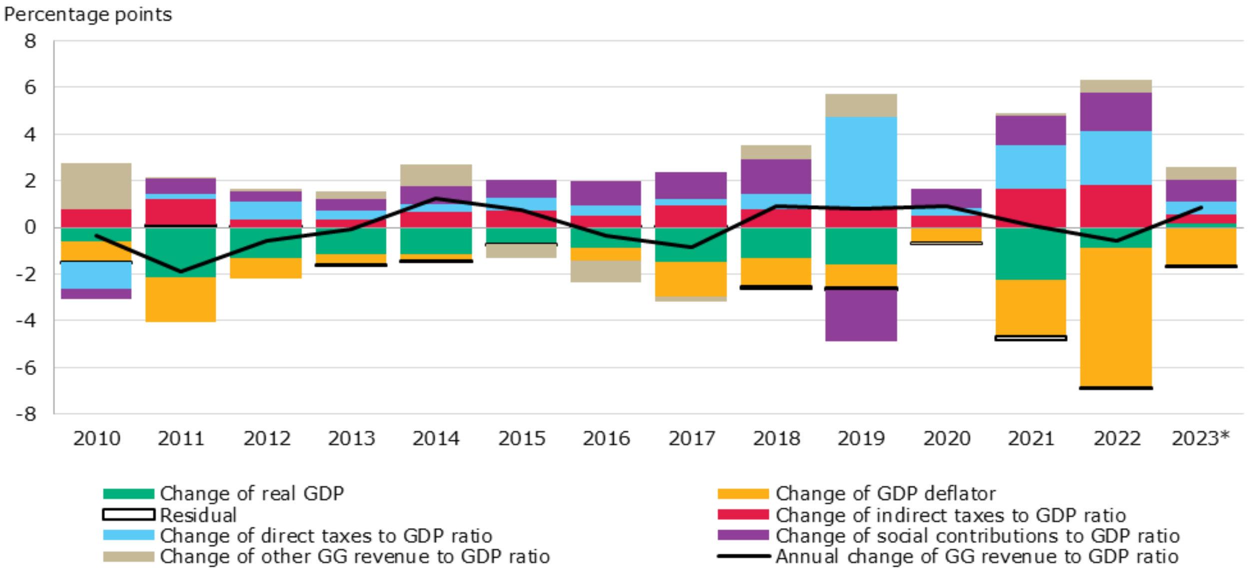
Figure 1a. Dynamics of GG revenue in Lithuania



Source: National data agency and Bank of Lithuania calculations.
* Data for 2023 include available GG revenue and GDP data for Q1 and Q2 only. Revenue to GDP ratio and annual change are calculated using four quarter moving sums in Q2 2023.

Rapid price growth has a significant effect on numerator and denominator of the revenue ratio; however, its transience is not clear yet. A better understanding of the drivers of the buoyant tax revenue is key not only to assessing the sustainability of Lithuania's public finances and their outlook but, even more importantly, to estimating the government's room for manoeuvre to accommodate future economic shocks and undertake additional permanent expenditure, if needed. Understanding whether higher revenues are temporary or permanent has an impact on the assessment of sustainability of public finances, because it has implications for the measurement of structural deficit. This section aims to quantify the factors underlying the recent increase of tax receipts in Lithuania.

Figure 1b. Decomposition of change of Lithuania's General Government revenue ratio to GDP.



Source: National data agency and Bank of Lithuania calculations.
* Data for 2023 include available GG revenue and GDP data for Q1 and Q2 only. Change of revenue to GDP ratio and contributions are calculated using four quarter moving sums of respective revenue items as of Q2 2023.

To this aim, we closely follow an approach, proposed by Miralles and Pages (2023), wherein tax revenue changes are decomposed into four determinants. The first determinant rests on the idea that, more generally, tax revenues are collected when statutory tax rates are applied to the tax bases defined by the applicable tax law. In analytical work, this juridical construction is usually transposed into the multiplication of an effective tax rate (defined as a ratio of actual revenue raised to its total tax base) and a tax base, which is proxied by a National Accounts item or a combination of these deemed to reflect the true tax base, defined by law (e.g., a macroeconomic variable such as private consumption expenditure is usually used as a proxy of a tax base for VAT, which taxes value added of certain goods and services, consumed by the final consumer). In addition, the use of National Accounts items has another important advantage, because it enables the decomposition of tax revenue dynamics into parts, related to a real and price component. This is feasible because most National Accounts are associated with their volume indicator and their own deflator. Consequently, the tax base can be proxied by the real macroeconomic variable and its price component and changes in this macroeconomic tax base translate into tax revenue changes via a historical elasticity, unique to each tax. The second determinant tries to capture effects of legislative changes on tax revenue and is usually referred to as a "fiscal measure". These legislative changes are caused by government's discretionary decisions and affect the effective tax rate, which fluctuates over time. Governments usually undertake these discretionary decisions in exceptional economic circumstances with an aim to influence the economy by changing the level and type of taxes, the extent and composition of spending, the degree and form of borrowing, etc. The third and final component captures the difference between observed and estimated revenues and is interpreted as a residual. Residuals may arise out of an imperfect coincidence of macroeconomic base and the true tax base, as well as out of the inaccurate estimation of fiscal measures or elasticities. Thus, using this framework, tax revenue changes can be dissected accordingly:

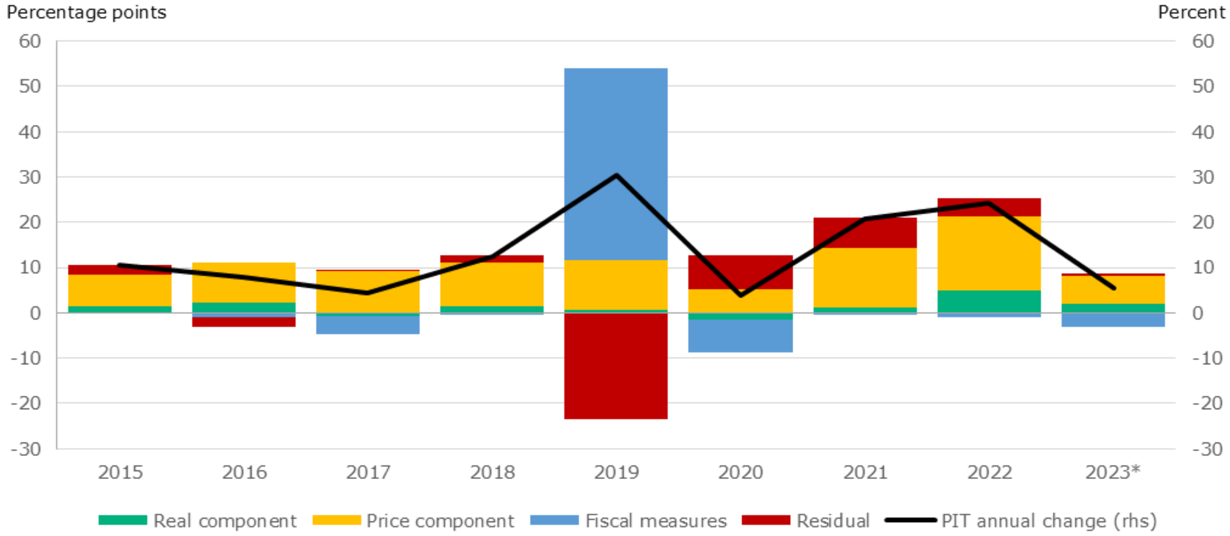
$$\Delta revenues = \sigma \times (\Delta price\ component + \Delta real\ component) + fiscal\ measures + \varepsilon,$$

where σ represents a historical elasticity, $(\Delta price\ component + \Delta real\ component)$ reflects the impact of a macroeconomic base, which is decomposed to the price and real (or volume) component, *fiscal measures* captures the impact of legislative changes on tax revenue changes and ε depicts a residual or unexplained part of revenue dynamics. In empirical studies pertaining to Lithuania (e.g., Price et al. (2014)), historical elasticities have been estimated to approximate a value of 1. For analytical simplicity, in this exercise we assume these elasticities to be exactly equal to 1. Our examination is concentrated on the primary three taxes of Lithuania: value-added tax (VAT), personal income tax (PIT) and social security contributions (SCC). Given that VAT is levied on value added of goods and services at the final stage of consumption, the macroeconomic base for VAT is selected as private consumption expenditure, with its deflator serving as the price component; whereas for social contributions and personal income tax, the real component is chosen based on the change in the number of employees in the country, and the price component reflects the change in the average wage.

As regards fiscal measures, there are many discretionary legislative changes and decisions that had an impact on certain revenue items in the period 2015 – 2023 Q2. The most important ones, which are included in our analysis, are listed in the table of Annex 2.

Figures 2a, 2b and2c show the results broken down for each of the taxes considered. Using the period up to 2021 as a reference, all taxes experienced a significant acceleration of annual growth rates from 2021, which persisted up to Q2 2023. For example, as visible from Figure 2a, average annual growth rate of revenue from PIT equaled 0.6% in 2015–2020 (excluding exceptional year 2019, where financing of the so-called main part of old age pensions was transferred from Social Security Fund's budget to the state budget and PIT and SSC rates were recalculated (PIT rate increased from 15% to 20%, whereas the overall rate of SSC decreased from 40.2% to 21.3% and employer's and employee's SSC were merged and assigned to the latter), while in 2020–2023 annual growth accelerated up to 2.7% on average. Similarly, collections of SSC in 2015–2020 (excluding year 2019 due to reasons mentioned above) increased by 8.9% per year on average, while in 2020–2023 average annual growth accelerated up to 12.4% (see Figure 2b). Accelerated growth is more clearly visible in the case of VAT revenue, which increased by 6.4% on average in 2015-2020 and by 13.5% in 2020-2023. From all three decompositions above it is evident that, from the beginning of 2021, the price component significantly contributed to the accelerated growth rate of revenue from PIT, SSC and VAT, compared to the average impact of prices before 2021 (Figures 2a, 2b, 2c). As illustrated in Figure 1 of Section 1.1, HICP inflation in Lithuania started to accelerate from Q3 2021 and peaked in Q4 2022. Therefore, the price component had the highest contribution to the growth rates of all three revenue categories. Starting in 2023, the price component's influence on the growth of analyzed revenue categories began to diminish in line with slowing inflation.

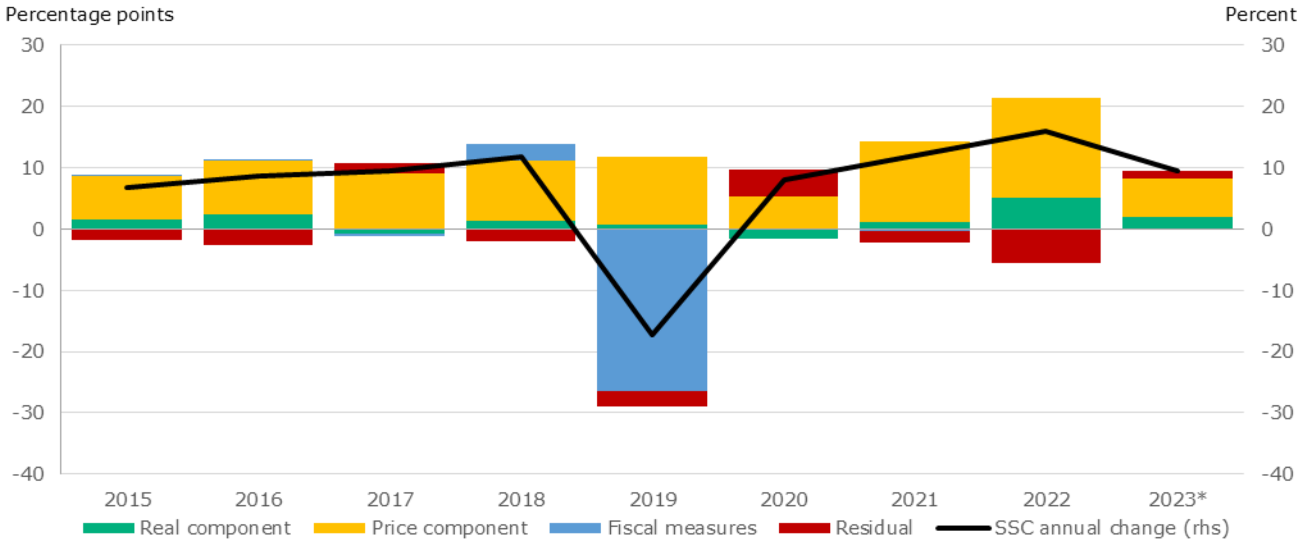
Figure 2a. Decomposition of change of revenue from PIT



Source: National data agency and Bank of Lithuania calculations.

* Data for 2023 include available PIT revenue, average wage and employment data for Q1 and Q2 only. Change of PIT revenue and contributions are calculated using four quarter moving sums of respective variables as of Q2 2023.

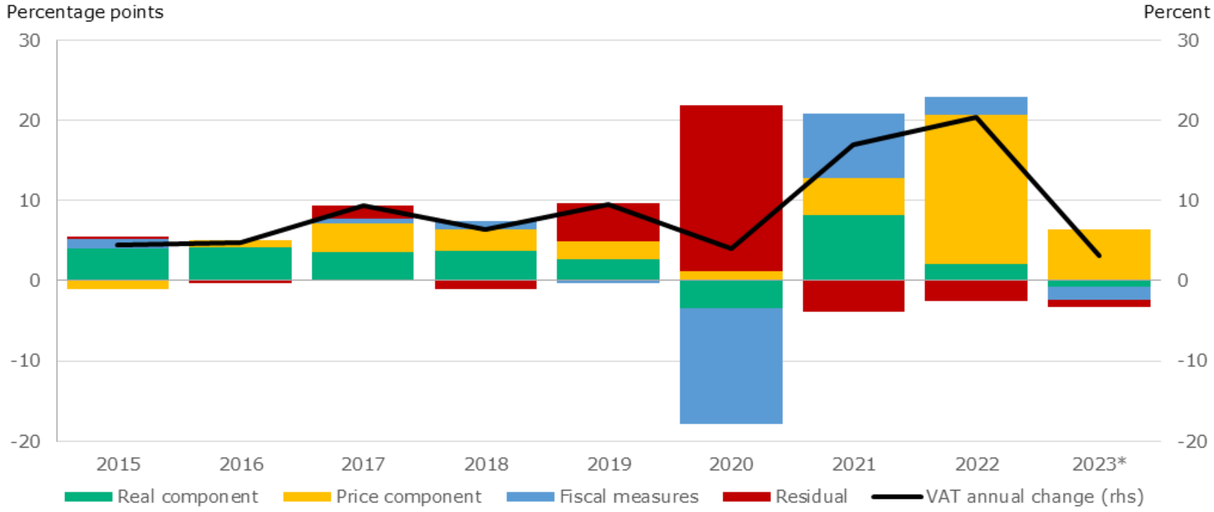
Figure 2b. Decomposition of change of revenue from SSC



Source: National data agency and Bank of Lithuania calculations.

* Data for 2023 include available revenue from SSC, average wage and employment data for Q1 and Q2 only. Change of revenue from SSC and contributions are calculated using four quarter moving sums of respective variables as of Q2 2023.

Figure 2c. Decomposition of change of revenue from VAT



Source: National data agency and Bank of Lithuania calculations.

* Data for 2023 include available VAT revenue and GDP data for Q1 and Q2 only. Change of VAT revenue and contributions are calculated using four quarter moving sums of respective variables as of Q2 2023.

In addition to legislative changes, which affected PIT and SSC in 2019 due to implemented tax changes, VAT decomposition points to significant fiscal measures in 2020-2021. These are mostly related to discrete fiscal measures implemented by the government since the onset of the COVID-19 pandemic. Among other measures to support businesses during the COVID-19 lockdown, companies were temporarily permitted to defer their VAT payments. As a result, VAT obligation due jumped from the multiannual average level of 0.3% of GDP before the pandemic to 1% of GDP in 2020. However, starting from Q2 2021, businesses began settling these outstanding VAT obligations, which resulted in faster growth of VAT revenues in 2021 and, to lesser extent, in 2022, compared to the growth rate implied by the dynamics of tax base for VAT (private consumption expenditure).

Our decompositions show that in 2021-2022 the observed remarkable increase in tax revenue collected by the Lithuanian government was significantly affected by strong growth of the macroeconomic bases and implemented fiscal measures. As regards the impact of inflation, over 60% of the increase in receipts from personal income tax and social contributions can be attributed to the rise in the price component, whereas in the case of VAT nearly 30% of the overall growth rate in 2021-2022 could be attributed to increasing prices. These findings are consistent with the study by Miralles and Pages (2023). In their research, the authors analyzed rapid GG revenue growth in Spain and found similar results: when a country experiences a rise in price levels, the price component of VAT, PIT, and SSC also increases, accounting for a more significant variation in the growth of these variables compared to other factors.

More generally, our results for Lithuania are in line with findings in other papers. For example, Staehr, Tkačevs and Urke (2023) recently analyzed twelve euro area countries and found that an increase of 1 percentage point in the HICP inflation rate leads to an average improvement of around 0.7 percentage point in the primary balance. This positive effect of inflation on the primary balance arises mostly from the revenue side. A higher rate of HICP inflation results in an increase in the ratio of direct and indirect tax to GDP while having no discernible effect on social security. Similarly, Bańkowski et al. (2023) underlines that the impact of inflation on public finances depends on several factors, among which the most important are: (i) the nature and size of the inflation shock; (ii) the discretionary fiscal response to the inflation shock; (iii) institutional aspects of government budgets (e.g. price indexation of some public expenditure and characteristics of tax systems); and (iv) the monetary policy reaction. Conventionally, a higher inflation rate is expected to improve public finances, at least in the short term, as it raises government revenues, while public expenditure tends to only increase with a lag. However, when some of the indirect and delayed effects are considered, Bańkowski et al. (2023) conclude that limited, albeit instantaneous, tax revenue increases and the partial reaction on the expenditure side led to a broadly neutral overall effect on the euro area budget balance in 2022. However, in subsequent years, due to indexation schemes spending pressures intensify and more than offset the benefits on the revenue side, leading to nearly 0.5% of GDP deterioration in the budget balance level in 2024. Bańkowski et al. (2023) stresses that overall slight adverse impact of price pressures on public finances derives from the nature of the inflation surprise, predominantly originating from an external supply shock.

To sum up, our calculations show that recent acceleration of an increase in the price level had a significant impact on growth rate of general government revenues. These findings are consistent with existing research, which finds at least a temporary improvement in GG balance resulting from high inflation. However, in the longer period the end-effect of inflation is less clear due to the lagging reaction of GG expenditure through indexation schemes. Therefore, this analysis warns that it would not be wise to make long-term spending decisions based on the rapid increase in GG revenue witnessed in 2021-2022. As inflation decelerates, there will be a corresponding slowdown in the nominal GDP growth and the rise in the prices of goods and services. This would naturally drag on the growth of state revenue from primary taxes because of their application to the nominal prices and wages. Because spending pressures usually take time to arise due to backward-looking indexation schemes, they potentially can more than offset the benefits on the revenue side from inflation. Similarly, revenue growth in a high inflation environment has some implications for short-term government spending. If a country relies on the rapid revenue growth in inflationary period and takes on short-term spending decisions (for example, compensating households and businesses for the loss of real savings or income), it might be forced eventually to translate them into permanent expenditures for various reasons: general rigidity of public expenditure, difficulty of reducing these temporary expenditures because social and political sensitivities, etc. Consequently, without consistent revenue streams, in a high-inflation environment, newly introduced short-, medium- or long-term expenditures combined with delayed indexation and political cycle could lead to larger budget deficits and higher debt ratio over the medium and long term, when the economic cycle reverses. Hence, in high inflation periods, to ensure sustainable public finances, it is essential to prudently and judiciously plan changes in state expenditures over the next few years.

In the case of Lithuania, all these findings have the following implications. Although automatic indexation of public expenditure is rather rare, the size of several expenditure defining fiscal variables, such as the value of basic old-age pension, state-supported income, basic social payment, basic value of pension for widows and widowers, minimum wage etc., are approved every year by the government's discrete decisions, which usually take into account the dynamics of prices, among other factors. Therefore, as described by Checherita-Westphal et al. (2022), this manner of setting expenditures (for example, in case of pensions) could be described as partially automatic. As a result, the same conclusion applies: spending decisions should not be based on the recent rapid increase in GG revenue, as without consistent revenue streams they might lead to significant challenges in the future.

References

García-Miralles, E., & Martínez Pagés, J. (2023). Government revenue in the wake of the pandemic. Tax residuals and inflation. Economic Bulletin, 2023/Q1, 16. doi: 10.53479/29791

Price, R., T. Dang and Y. Guillemette (2014), "New Tax and Expenditure Elasticity Estimates for EU Budget Surveillance", OECD Economics Department Working Papers, No. 1174, OECD Publishing, Paris.

Staehr, K., Tkačevs, O., Urke, K. Fiscal Performance under Inflation and Inflation Surprises: Evidence from Fiscal Reaction Functions for the Euro Area, Working paper 4 (2023).

Bańkowski, K., Bouabdallah, O., Checherita-Westphal, C., Freier, M., Jacquinot, P., Muggenthaler, Ph.

"Fiscal policy and high inflation" Economic Bulletin Articles, European Central Bank, Vol. 2. 2023.

Checherita-Westphal, C. Public wage and pension indexation in the euro area: an overview, Occasional paper No. 299, 2022.

ANNEXES

1 ANNEX. TIMELINE OF ECB MONETARY POLICY NORMALIZATION AND TIGHTENING DECISIONS

- 16 December 2021:
  - Announced reduction in APP (asset purchase programme) monthly pace: €40bn in 2022Q2, €30bn in 2022Q3. From October - €20 billion per month for as long as necessary.
  - PEPP (pandemic emergency purchase programme) pace lower in 2022Q1 than in 2021Q4 and expected to discontinue at end-March 2022.
  - TLTRO-III special conditions to end June 2022.
- 3 February 2022:
  - No new decisions.
- 10 March 2022:
  - Faster reduction of APP monthly purchases: €40bn in April, €30bn in May and €20bn in June. Option to end net purchases in 2022Q3.
  - Any adjustments to the key ECB interest rates will take place some time after the end of net APP purchases (no longer "shortly before") and will be gradual.
- 14 April 2022:
  - Incoming data reinforce GovC's expectation that net APP should be concluded in Q3.
- 9 June 2022:
  - End of net purchases of APP as of 1 July 2022.
  - Governing Council intends to raise all 3 ECB interest rates by 25bps at July meeting.
  - Another increase in interest rates is expected in September.
  - Beyond September, GovC anticipates a gradual but sustained path of further increases in interest rates.
- 21 July 2022:
  - All three interest rates[31] increased by 50 bps, DFR (deposit facility rate) at zero.
  - At the upcoming meetings, further normalisation of interest rates will be appropriate.
  - Transmission Protection Instrument (TPI) can be activated to counter unwarranted, disorderly market dynamics that pose a serious threat to the transmission of monetary policy across the EA.
- 8 September 2022:
  - All three interest rates increased by 75 bps, DFR at 0.75%.
  - Governing Council expects to raise interest rates further over the next several meetings.
- 27 October 2022:
  - All three interest rates increased by 75 bps, DFR at 1.5%.
  - Governing Council expects to raise interest rates further.
  - Interest rates applicable to TLTRO III will be adjusted from 23 November and banks will be offered additional voluntary early repayment dates.
  - Remuneration of minimum reserves set to DFR.
- 15 December 2022:
  - All three interest rates increased by 50 bps, DFR at 2.0%.
  - Governing Council expects to raise interest rates further. Interest rates will still have to rise significantly at a steady pace to reach sufficiently restrictive levels.
  - From the start of March 2023, APP portfolio will decline by €15 billion per month on average until the end of Q2 2023.
- 2 February 2023:
  - All three interest rates increased by 50 bps, DFR at 2.5%.
  - Governing Council intends to raise interest rates by another 50 bps in March. It will then evaluate the subsequent path of its monetary policy.

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[31] Deposit facility rate, rate on the main refinancing operations, and rate on the marginal lending facility.

- 16 March 2023:
    - All three interest rates increased by 50 bps, DFR at 3.0%
- 4 May 2023:
    - All three interest rates increased by 25 bps, DFR at 3.25%.
    - The Governing Council expects to discontinue the reinvestments under the APP as of July 2023.
- 15 June 2023:
    - All three interest rates increased by 25 bps, DFR now at 3.5%.
- 27 July 2023:
    - All three interest rates increased by 25 bps, DFR now at 3.75%.
    - Remuneration of minimum reserves set at 0%.
- 14 September 2023:
    - All three interest rates increased by 25 bps.

LITERATURE REVIEW OF EXCHANGE RATE PASS-THROUGH IN LITHUANIA AND OTHER BALTIC COUNTRIES

Study	Sample period	Methodology	Country	ERPT to import prices	ERPT to consumer prices
Bitans (2004)	1998M1-2003M6	VAR with Cholesky	EE	-	0.21 (1Q) - 0.34 (4Q, 8Q)
			LV	-	0.13 (1Q) - 0.26 (4Q, 8Q)
			LT	-	0.22 (1Q) - 0.28 (4Q) - 0.39 (8Q)
Dabušinskas (2003)	1995 Q1-2003Q1	Single equation ARDL - SUR	EE	0.4 (long-run)	not significant
Maria-Dolores (2009)	2000M1-2006M12	Single equation methods (with and without error correction models)	LV	0.9 (short-run) - 0.76 (long-run)	between 0.24 and 0.36
Berine and Bij sterbosch (2009)	1998M1-2008M4	Cointegrated VAR - VECM	EE	-	0.06 (2Q) - 0.16 (4Q) - 0.57 (8Q) - 0.92 (long-run)
	1996M1-2008M4		LV		0.36 (2Q) - 0.44 (4Q) - 0.51 (8Q) - 0.97 (long-run)
	1998M1-2008M4		LT		0.15 (2Q) - 0.21 (4Q) - 0.46 (8Q) - 0.44 (long-run)
Jimborean (2013)	1996Q1-2010Q2	Dynamic (panel GMM and) country-by-country	EE	1.07 (1Q)	0.33 (1Q)
			LV	0.56 (1Q)	0.05 (1Q not significant)
			LT	0.47 (1Q)	0.07 (1Q, not significant)
Carriere-Swallow et al. (2016)	2000M1-2015M12	Reduced-form-specification - Local projections	EE	-	0.48 (4Q) - 0.22 (8Q)
			LV		0.26 (4Q) - 0.68 (8Q)
			LT		0.39 (4Q) - 0.64 (8Q)
Comunale (2019)	1999Q1-2017Q4	Reduced-form-equations - bivariate relations	EE	-	0.33 (1Q) - 0.85 (4Q)
			LV	-	0.33 (1Q) - 0.85 (4Q)
			LT	-	0.33 (1Q) - 0.85 (4Q)
		Reduced-form-equations - Philips-curve-type	EE	-	0.00 (1Q) - 0.2 (4Q)
			LV	-	0.61 (1Q) - 1.85 (4Q)

Study	Sample period	Methodology	Country	ERPT to import prices	ERPT to consumer prices
		specification	LT	-	0.00 (1Q) - 0.25 (4Q)
		Bayesian VAR - price-to-exchange-rate ratio to foreign exchange shock	EE	0.47 (1Q) - 0.32 (4Q)	0.22 (1Q) - 0.28 (4Q)
			LV	1.08 (1Q) - 0.83 (4Q)	0.32 (1Q) - 0.59 (4Q)
			LT	1.35 (1Q) - 0.62 (4Q)	0.28 (1Q) - 0.36 (4Q)
		Bayesian VAR - price-to-exchange-rate ratio to relative monetary policy shock	EE	0.36(1Q) - 0.30(4Q)	0.20 (1Q) - 0.26 (4Q)
			LV	0.17(1Q) - 0.16(4Q)	0.38 (1Q) - 0.67 (4Q)
			LT	-0.35(1Q) - -0.20(4Q)	0.20 (1Q) - 0.36 (4Q)
		Bayesian VAR - time varying price-to-exchange-rate ratio	EE	0.16 (0.16)	0.13 (0.11)
			LV	0.43 (0.38)	0.37 (0.17)
			LT	0.10 (0.15)	0.07 (0.06)
		Local projections - foreign exchange shocks from euro area to Bayesian VARs	EE	0.21 (1Q) - 0.51 (4Q)	0.12 (1Q) - 0.16 (4Q)
			LV	0.49 (1Q) - 0.85 (4Q)	-0.10(1Q) - -0.24(4Q)
			LT	0.17 (1Q) - 0.58 (4Q)	0.09 (1Q) - 0.21 (4Q)
		Local projections - relative monetary policy shocks from euro area Bayesian VARs	EE	0.31 (1Q) - 0.48 (4Q)	0.36 (1Q) - 0.45 (4Q)
			LV	0.70 (1Q) - 1.24 (4Q)	0.04 (1Q) - 0.01 (4Q)
			LT	1.14 (1Q) - 1.70 (4Q)	0.10 (1Q) - 0.20 (4Q)
		Local projections - foreign exchange shocks from euro area to Bayesian VARs	EE	-	0.12 (1Q) - 0.16 (4Q)
			LV	-	-0.10(1Q) - -0.24(4Q)
			LT	-	0.09 (1Q) - 0.21 (4Q)
		Local projections - relative monetary policy shocks from euro area Bayesian VARs	EE	-	0.36 (1Q) - 0.45 (4Q)
			LV	-	0.04 (1Q) - 0.01 (4Q)
			LT	-	0.10 (1Q) - 0.20 (4Q)

TECHNICAL APPENDIX

The J-lags Bayesian vector autoregression (BVAR) models in subsections 2.1., 2.2., and 2.3. all have the following reduced forms:

$$y_t' = c + \sum_{j=1}^{J} y_{t-j}' B_j + \varepsilon_t'$$

where y_t' is a vector of endogenous variables (the data), c is a vector of constants, B_j is a matrix of reduced-form parameters, and ε_t' is a vector of innovations ($\varepsilon_t' \sim \mathrm{N}(0, \Sigma)$). The reduced-form innovations ε_t' are not meaningful for our structural analyses. Their mapping to a structural interpretation requires restrictions. In Sub-sections 2.1. and 2.2. we assume restrictions, which in our framework consists of keeping N shock impulse response matrices that satisfy specific signs (N = 10,000 in our case, see Rubio-Ramirez et al. (2010) for details on the exact algorithm). In contrast, the identification in Sub-section 2.3. relies on a Cholesky decomposition of the posterior variance-covariance matrices Σ. We rely on either Minnesota or Normal-Wishart priors, both of which require a Gibbs sampling algorithm. Further details on the estimators and the algorithms used to compute the structural shocks are available upon request.

Reference

Rubio-Ramirez, J. F., Waggoner, D. F., & Zha, T. (2010). Structural vector autoregressions: Theory of identification and algorithms for inference. The Review of Economic Studies, 77(2), 665-696.

2 ANNEX. FISCAL MEASURES USED IN THE ANALYSIS TO DECOMPOSE CHANGES OF CERTAIN REVENUE ITEMS.

Revenue item affected:	**PIT**	**SSC**	**VAT**
Brief description of fiscal measures (a year or a time period affected by a certain fiscal measure)	Changes of non-taxable minimum income (increasing threshold, ceiling of application, etc.) (2015-2023). Changes of additional non-taxable minimum for children (2016, 2018). Changes of minimum wage (2015-2023). Changes in taxation for individuals engaged in individual activities (self-employed) (2018-2019). Introduction of 1-year "tax holiday" for new small firms and self-employed people (2018). Transfer of the main part of old-age pension to the state budget (from social security fund's budget) and recalculation of PIT and SSC rates (2019). Introduction of progressive PIT rate of 27% (and 20%) for a certain threshold exceeding labour income (other income, excluding dividends and self-employed) (2019-2021). COVID-19-related PIT tax deferrals and their settlement payments (2020-2022).	Changes of enrolment rules and contributions to the II pension pillar of pension system (2015-2018). Changes of minimum wage (2015-2023). Changes of wages for public sector employees (2015-2019). Merger of rates of employee and employer social security contributions (2019-2020). Transfer of the main part of old-age pension to the state budget (from social security fund's budget) and recalculation of PIT and SSC rates (2019-2020). Introduction and changes of "ceiling" and "floor" for social security contributions (2017-2021).	Changes in the main rate and reduced VAT rates (2015, 2017-2019, 2021-2023). COVID-19-related VAT deferrals and their settlement payments (2020-2022). Compensation of VAT for central heating for households (2022).

Source: A list of relevant fiscal measures included in this analysis is in line with a broader list of measures, which on a regular basis is provided by the Bank of Lithuania to the ESCB Working Group on Public Finance (WGPF) in a form of fiscal questionnaire. The effects of those measures are usually official *ex ante* estimates provided by government institutions. These estimates are collected by the Bank of Lithuania from various sources: explanatory notes of draft laws, press announcements of government institutions, draft budgetary plans, etc.