Politická ekonomie
2024, Volume 72, Issue 6
https://doi.org/10.18267/j.polek.1444
Open Access

VŠE / PRAGUE UNIVERSITY OF ECONOMICS AND BUSINESS

Examining Country-specific and Global Factors of Inflation Dynamics: The Curious Case of Baltic States

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Abstract

This article addresses the emergence of double-digit inflation in the Baltic states during 2022 and 2023, following decades of price stability. Utilizing monthly data spanning from January 2010 to February 2023, our study aims to comprehensively analyse the inflation dynamics in the Baltic context, considering both domestic and global factors. Through the application of the fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) methodologies, we identify significant influences such as exchange rate fluctuations, food and energy price movements and geopolitical events, notably the ongoing conflict in Ukraine. Our findings contribute to a deeper understanding of the determinants of inflation in the Baltic region, offering insights essential for informed policymaking aimed at mitigating vulnerabilities to future inflationary shocks.

Keywords: Inflation, Baltic states, country-specific, global factors
JEL Classification: E31; E37; E52

Citation: Petkovski, M., Kjosevski, J., Stojkov, A., Petkovská, K. B: Examining Country-specific and Global Factors of Inflation Dynamics: The Curious Case of Baltic States. *Politická ekonomie,* 2024, 72 (6), 896–992, https://doi.org/10.18267/j.polek.1444

1. Introduction

The divergence of inflation rates in the Baltic states from the rest of the European Union (EU) has raised concerns in academic and policy circles for several years. What distinguishes these small and open economies? The relatively higher inflation rates not only affect current consumer and producer behaviour but also destabilize macroeconomic fundamentals, affecting the medium-term growth potential of these economies. Such robust price growth, unseen since the mid-2000s, prompts an inquiry into the unique case of the Baltic states.

Inflation is a key determinant of the macroeconomic landscape, influencing the effectiveness of monetary policies, public finance, consumer purchasing power and business profitability. Understanding the factors driving inflation is crucial for policymakers to design effective macroeconomic strategies and ensure stability.

Price dynamics result from a complex interplay of various factors, categorized into country-specific (idiosyncratic) and global factors. Country-specific factors include economic, political and social characteristics shaping inflationary pressures, such as fiscal policies, exchange rate fluctuations and domestic demand. Global factors encompass external forces such as commodity prices, financial asset prices, international trade relationships and capital flows, which also influence inflation rates.

While existing research addresses inflation processes within the Baltic countries as a unified regional system, it has not thoroughly explored dynamic changes over time in the mechanisms through which inflation is transmitted among these economies. Investigating these time-varying effects can offer valuable insights, particularly for small, open and highly integrated economies such as those in the Baltic region. The situation presents serious challenges for policymakers and citizens, demanding measures to address the root causes of the inflation surge and mitigate its adverse effects.

In light of these considerations, this research aims to comprehensively examine inflation dynamics in the Baltic states, considering both country-specific and global factors. By investigating the underlying causes of inflationary trends, this study seeks to illuminate macroeconomic challenges and opportunities, providing valuable insights for policymakers to implement targeted and effective measures.

To achieve these objectives, this research adopts a multi-dimensional approach, combining quantitative and qualitative analyses. In econometric models, we explore historical patterns of inflation and correlations with various variables, supplemented by case studies and expert interviews for deeper insights into each member state's economic situation.

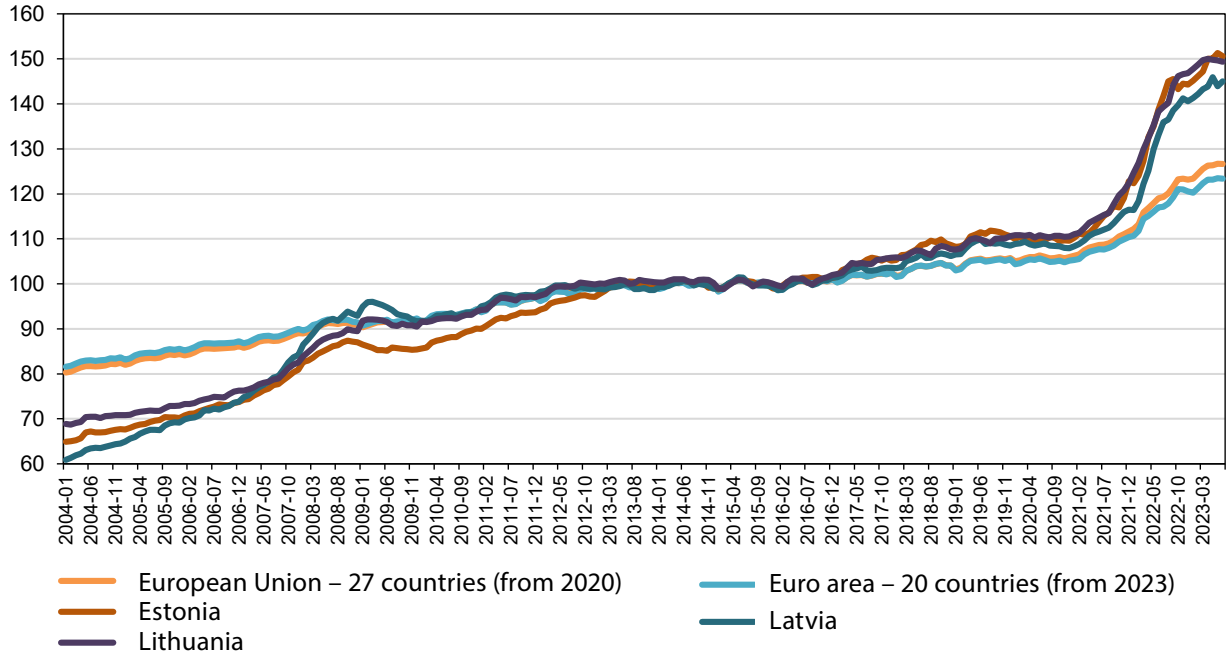
This research contributes significantly to the existing body of knowledge on inflation dynamics in the Baltic states. Making use of panel data from all three countries enhances the robustness of findings, making this the first study analysing high inflation in the Baltic states to disentangle country-specific and global determinants. The findings enrich academic literature and offer practical implications for policymakers and stakeholders seeking sustainable economic growth and stability within the broader European framework, aiding in understanding inflationary risks and opportunities and facilitating the development of resilient economies in a changing global landscape.

The remainder of the paper is structured as follows. In the next section, we briefly explain the peculiarities of the Baltic context. An overview of the existing body of empirical literature on inflation dynamics in the Baltic economies is provided in the third section, followed by detailed methodological notes in the next section. Section 5 outlines the empirical model encompassing the hypothesized key conditioning factors of inflation dynamics in the Baltic context, their expected impact and data sources. The estimation results are discussed and evaluated in the sixth section. The final section discusses key conclusions and policy recommendations.

2. Context

After decades of price stability, double-digit inflation in 2022 and 2023 generated economic, political and social upheaval for both the EU and Baltic countries (Estonia, Latvia and Lithuania). According to Eurostat (2023), consumer prices increased by more than 16% in the EU during 2021 and 2022. Inflation was fuelled mainly by surging energy prices (57.6% increase over the same period) and rising food prices (19.8% increase). However, the experience of Baltic countries (Estonia, Latvia and Lithuania) is somewhat unique, as they have experienced steeply increasing consumer prices (Figure 1).

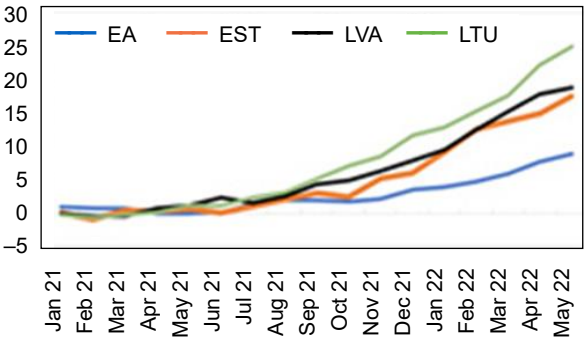
Figure 1: Harmonized Index of Consumer Prices (2015 = 100), January 2004 – August 2023



Source: Eurostat (2023)

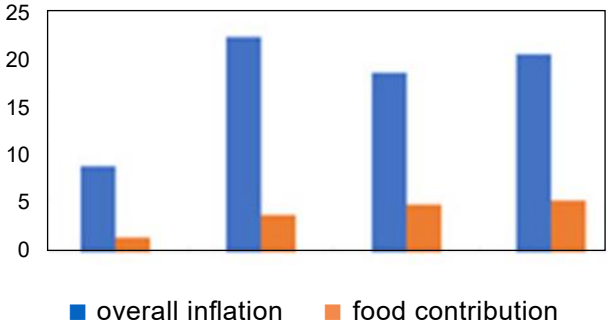
The existing literature highlights several factors, including the COVID-19 pandemic, the war in Ukraine and rising energy prices. Inflation in Latvia and Lithuania reached alarming levels, with monthly rates of 22.4% and 22.5%, in September 2022 respectively. Estonia also experienced a staggering increase in inflation, rising from 6.4% in September 2021 to 24.2% in September 2022. The soaring energy and food prices are major contributors to the high inflation rates in the region.

Figure 2: HICP food price growth in the Baltics and euro area (in %, year on year)



Source: International Monetary Fund, 2022

Figure 3: Contribution of energy to overall annual inflation (in percentage points, May 2022)



Source: International Monetary Fund, 2022

In particular, the energy component of Estonia's Harmonized Index of Consumer Prices (*HICP*) surged by a remarkable 97% between December 2020 and May 2022. This pace was four times faster than the overall inflation rate for the same period. Latvia (65%), Lithuania (72%) and the euro area (52%) also witnessed significant increases in their energy components, though not as high as in Estonia.

Within the energy price component of the *HICP*, Estonia's notable increases in electricity tariffs have been a primary factor contributing to the disparity between them and other comparative regions. When adjusted for the weight of energy in the consumer basket, this component accounted for more than half (57%) of Estonia's overall inflation during this period, as shown in Figure 2. A similar but somewhat lower direct contribution was observed for Latvia and the euro area (around 50%) and Lithuania (about 40%). All of these contributions significantly exceeded the weight of energy in the *HICP*, which ranged from 10 to 15% for these respective countries.

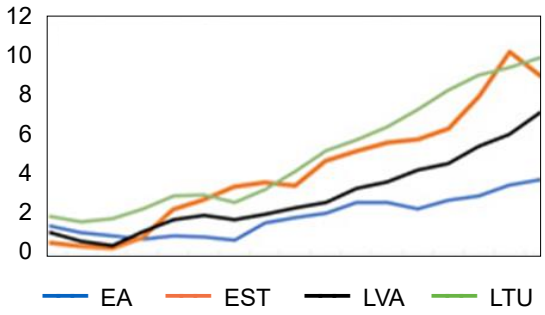
Food price inflation has played a relatively modest but increasingly significant role in the overall inflation picture. In Estonia, the direct contribution of food price inflation to overall inflation has been more substantial than in the euro area but still smaller than in the other Baltic countries. By May 2022, food price inflation in Estonia had surged to 17% year-on-year, as depicted in Figure 3. This rate was twice the euro area average but lower than the food price increases in Latvia (19%) and Lithuania (25%) in the same month.

When considering the weight of the food price component in the Harmonized Index of Consumer Prices (*HICP*), it directly accounted for approximately 17% of Estonia's overall inflation, in contrast to around 25% for Latvia and Lithuania IMF (2022). At present, the rate of food price growth has been relatively similar to the overall inflation rate, slightly below this level in Estonia and slightly above it in Lithuania. However, it is worth noting that food price growth had been notably accelerating across all these countries during the initial months of 2022.

In both the Baltic states and the euro area, inflation has been showing a broader impact. Specifically, when we focus on core inflation in Estonia (as depicted in Figure 4), there has been a significant upsurge. From 2011 to 2020, core inflation in Estonia was a mere 0.14% per month, but this figure surged to 0.6% per month through May 2022. This increase is notably similar to the inflation rates seen in Estonia's Baltic counterparts and surpasses the average core inflation in the euro area.

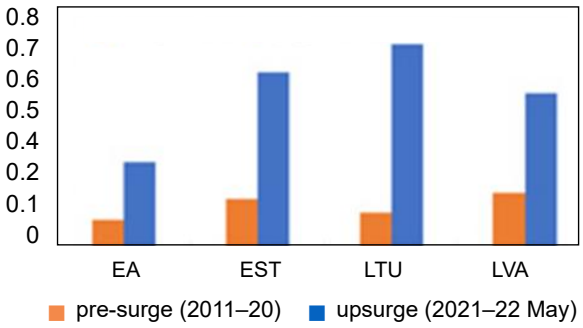
Among the Baltic countries, Lithuania experienced the highest core inflation, reaching 0.7% per month during the recent surge. The high core inflation rate in Lithuania is a sign that inflationary pressures are broad-based and not just limited to a few sectors of the economy. This is a concern for policymakers, as it suggests that inflation may be more difficult to bring under control. In contrast, the euro area has managed to keep its core inflation more restrained, hovering

Figure 4: HICP core inflation in the Baltics and euro area



Source: International Monetary Fund, 2022

Figure 5: Core inflation 2011–2022 (May)



Source: International Monetary Fund, 2022

at around half of Estonia's rate during the period of heightened inflation. Although core inflation in the euro area did increase, it did so to a lesser extent, approximately 3.5 times more compared to the period 2011–2020.

In the first five months of 2022, the trend of accelerating core inflation continued. The average monthly core inflation rate reached 0.9% in Estonia, which, while below the 1.1% observed in both Latvia and Lithuania, still significantly exceeded the 0.4% observed in the euro area (IMF, 2022).

Another contributing factor to higher inflation in the Baltics was the limited economic impact of the pandemic in the region and the subsequent strong and rapid recovery. Expansionary fiscal and monetary policies, along with robust domestic demand pressures, added to the inflationary pressures. Additionally, a change in the Estonian pension system allowed individuals to withdraw their pension savings early, leading to increased private consumption and further inflationary pressures (Müller, 2023).

Households are seeing their purchasing power eroded, as their wages are not keeping pace with the rising prices. This is especially true for low-income households, who spend a larger share of their income on essential goods such as food and energy. Businesses are also facing challenges due to the high inflation rates. Businesses are facing higher costs of inputs such as energy and labour, which could lead to lower profits and job losses. This is especially true for small businesses, which have less pricing power than large ones. The high inflation rates are also a challenge for policymakers in the Baltic states. They are trying to balance the need to control inflation with the need to support economic growth. They are also facing pressure from the European Central Bank (ECB) to raise interest rates, which could slow economic growth.

3. Literature Review

Even though academic literature on inflation dynamics in Baltic countries is scarce, a wide range of factors influencing inflation has been explored. From a chronological perspective, the studies have focused on (i) disinflation efforts in the early transition period, (ii) determinants of inflation dynamics during the Global Financial Crisis (GFC), and (iii) post-crisis inflation developments.

Hansen and Pancs (2001) investigated the emergence of a Phillips curve in Latvia after 1996, with a graphical representation suggesting a negative relationship between unemployment and actual inflation. However, they expressed reservations about the reliability of their discovery. Bitans *et al*. (2001) estimated a basic Phillips curve for Latvia but offered limited assessment of its specification and robustness.

Vetlov (2002) engaged in an informal discussion regarding the factors influencing inflation in Lithuania after the country regained its independence. He observed that before the currency-board era, inflation was influenced by factors such as a decline in output, energy price shocks and price liberalization. In the currency-board period, inflation was affected by the adjustment of relative prices, undervaluation of the national currency (litas), increases in administrative prices and the Balassa-Samuelson effect. Vetlov (2001) conducted an econometric analysis of dollarization in the Lithuanian economy.

According to the findings of Masso and Staehr (2005), traditional single-equation estimations did not yield satisfactory outcomes. However, the use of panel data estimations provided more promising results. Their main conclusion was that the observed gradual disinflation in the Baltic countries can be largely attributed to their adjustment to international prices. This indicates that changes in global prices have had a significant impact on the inflation trends in the region. Another crucial aspect highlighted in the study is the role of stringent fixed exchange rate systems in controlling inflation. These systems exert downward pressure on inflation directly and also influence expectations regarding future inflation, contributing to stable price levels.

Interestingly, the study revealed that measures of excess capacity on the labour market have not had a noticeable effect on inflation in the Baltic countries. However, industrial output gaps have shown some explanatory power, indicating that production levels have played a role in shaping inflationary dynamics. Furthermore, the research emphasized that real oil price shocks have an immediate impact on inflation but their effect is short-lived. This suggests that oil price fluctuations have a temporary influence on inflation trends in the Baltic countries.

Benkovskis *et al*. (2009) used a dynamic panel data model to estimate the determinants of inflation in the Baltic countries. The authors found that monetary policy, demand shocks and supply shocks all have significant effects on inflation in the region. In addition to monetary policy,

demand shocks and supply shocks, the study also revealed that exchange rate fluctuations can influence inflation in the Baltic countries. The authors observed that changes in the exchange rate can lead to adjustments in import prices, affecting overall price levels in the region. Furthermore, the paper highlighted the importance of external factors such as global commodity prices, which can have spillover effects on inflation dynamics in the Baltic states. Understanding these determinants can assist policymakers in formulating more effective strategies to manage inflation and ensure economic stability in the region.

Berlemann (2014) examined the level and determinants of individual inflation aversion in the Baltic countries. The author found that inflation aversion is high in the Baltics and that it is influenced by several factors, including age, income and education. The study also highlighted the impact of historical experience on inflation aversion, as individuals who lived through periods of high inflation exhibit higher levels of aversion. Furthermore, the paper suggested that economic stability and credible monetary policies play crucial roles in shaping individuals' attitudes towards inflation. These findings have significant implications for policymakers in the Baltic states, as understanding the determinants of inflation aversion can help design more effective communication strategies and monetary policies to ensure public support and trust in the central banking system.

Dima *et al*. (2019) explored the potential presence of contagion effects in the inflation patterns of the Baltic nations. They employed a time-varying parameter vector autoregression (VAR) model along with stochastic volatility analysis to accommodate potential shifts in the underlying structures of the data as time progresses. The paper identified several regime shift episodes between January 1996 and April 2015, suggesting changes in the impact of individual inflation dynamics during these periods. However, despite these shifts, the study did not find significant evidence of breaks in the interlinkages between the inflation rates of the Baltic countries. It seems that the inflation rates in the region are closely linked, even though there might have been a decline in associated impacts after 2010. Interestingly, the findings indicate that Lithuania's inflation exhibits some idiosyncratic features, suggesting that its inflation behaviour may be influenced by factors unique to the country, setting it apart from the inflation dynamics of the other Baltic nations. The use of a time-varying parameter VAR with a stochastic volatility framework allowed the authors to capture changes in the relationships and dynamics of inflation over time, which could provide valuable insights into the interconnectedness of the Baltic countries' economies.

These are only a few papers that have investigated the determinants of inflation in the Baltic states. Their findings suggest that several factors, both domestic and external, can affect inflation in the region. These factors include monetary policy, demand shocks, supply shocks, inflation expectations and the exchange rate.

It is important to note that determinants of inflation would vary over time. For example, the importance of cost-push factors may be greater in some periods. The impact of inflation shocks may also vary depending on the overall economic conditions. Overall, the literature on the determinants of inflation in the Baltic states is still evolving. However, the findings of the papers reviewed here provide a useful starting point for understanding the factors that can affect inflation in the region.

4. Methodology

Our empirical approach relies on panel data analysis. Before implementing the econometric method, it is crucial to verify some tests. One crucial diagnostic test for panel data involves investigating cross-sectional dependence. This essentially means whether the error terms across different groups (countries, firms, *etc.*) in the data are correlated. The presence or absence of this dependence determines the appropriate estimation method for the panel data model. Several tests can be used to detect cross-sectional dependence, including the Breusch-Pagan LM test, the Pesaran scaled LM and CD tests and the Baltagi *et al.* bias-corrected scaled LM test. These tests all share a common null hypothesis: there is no correlation between the error terms across groups in the data. (See Section 6 for more details.)

Next, we must test the stationarity of variables. Within the context of panel unit root testing (checking for non-stationarity in panel data), there are two main generations of tests. (See Section 6 for more details.) The first generation assumes that the error terms in each group are independent. However, this assumption may not always hold. The second generation of panel unit root tests addresses this limitation by allowing for potential cross-sectional dependence. These tests aim to provide more accurate results even when the error terms are correlated across groups. It is important to note that, unlike the Bai–Ng and Harris–Li tests, most second-generation panel unit root tests assume the presence of a unit root (non-stationarity) in the data themselves.

Furthermore, we conduct two-panel cointegration tests, namely Pedroni (1999) and Kao (1999). Pedroni (1999) introduced seven-panel cointegration test statistics, with four based within dimensions and three between dimensions. These statistics offer a non-parametric variance ratio and *t*-statistics. Additionally, in our empirical analysis, we utilize other cointegration tests such as the Kao (1999) test, based on the Engle–Granger two-step procedure and imposing homogeneity on the panel members. It tests the null hypothesis of no cointegration using an ADF-type test.

After confirming the presence of cointegration using appropriate tests, the subsequent step involves estimating the long-term relationship among the variables. The literature presents several methods for estimating panel cointegration models and in this study, we choose the fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) estimators for specific reasons.

Firstly, ordinary least squares (OLS) tend to be biased and inconsistent when applied to cointegrated panels (Kondovski, 2021). DOLS and FMOLS address issues of small-sample bias and endogeneity bias by considering leads and lags of the first-differenced regressors, as highlighted by Kao and Chiang (2000). Moreover, for panels with a larger time dimension (T), the generalized method of moments (GMM) dynamic estimator is less effective, especially when T significantly exceeds the cross-sectional dimension (N). In our study, where T = 158 exceeds N = 3 significantly, GMM becomes less suitable. Additionally, these chosen estimators offer the flexibility to accommodate heterogeneity in cointegrated vectors, as emphasized by Pedroni (1999; 2001).

However, we prefer the DOLS parametric approach over the FMOLS non-parametric one. FMOLS imposes additional requirements, such as all variables being integrated of the same order (I(1)) and the regressors themselves not being cointegrated, as noted by Masih and Masih (1996). Furthermore, the FMOLS estimator might exhibit bias in finite samples with panel data, according to Kao and Chiang (2000). DOLS also controls for endogeneity by incorporating leads and lags of the differences of the regressors, thereby mitigating endogenous feedback, as discussed by Lean and Smyth (2010) and Afonso and Jalles (2013).

5. Data

In the majority of empirical studies focusing on inflation dynamics, the dependent variable is typically defined as the first difference in the consumer price index (CPI) divided by the CPI in the previous year to obtain the inflation rate, not the percentage change in the inflation rate.

This approach has been employed in studies such as Deniz *et al*. (2016), Cardoso and Vieira (2016) and Choi *et al*. (2018). Alternatively, some studies have used the current inflation level, represented by the consumer price index, as the dependent variable, as seen in Inoue (2005), Kalimeris (2011) and Posso and Tawadros (2013).

Less frequently, the dependent variable has been defined as the change in the GDP deflator (Alfaro, 2005) or the rate of real money value depreciation (Chrigui *et al*., 2011; Bogoev *et al*., 2012). A commonly shared practice in the literature to address the issue of heteroscedasticity is to work with the dependent variable in its logarithmic form, denoted as log(INF). This approach is favoured as it helps mitigate the impact of outliers and accounts for potential non-linear relationships, a method advocated by Catão and Terrones (2005). In our paper, we use as a dependent variable the Harmonized Index of Consumer Prices (*HICP*). The *HICP* is a measure of inflation that is considered more reliable than the consumer price index (CPI) for several reasons: (1) international comparability, (2) methodology, (3) coverage, and (4) treatment of owner-occupied housing. Overall, the *HICP* is a more accurate and comprehensive measure of inflation than the CPI and is therefore a better indicator of overall price changes.

The first explanatory variable that we consider is the domestic output gap. Almost all studies investigate determinants of inflation as a measure of the output gap. Different transformation of the variable is used in various studies, including the GDP per capita level, the percentage change of GDP per capita, deviation of actual from estimated potential GDP, *etc*. (Mafi-Kreft and Kreft, 2006; Kwon *et al.*, 2009; De Grauwe and Schnabl, 2008; Staehr, 2010; Deniz *et al*., 2016). In our cases, given the unavailability of monthly GDP series, we follow Binici *et al*. (2022) and use the seasonally adjusted Industrial Production Index (*IPI*) as a proxy to calculate the domestic output gap.

The inclusion of nominal exchange rate in inflation equations is often interpreted according to the standard macroeconomic model as an approximation of the monetary policy effect along the monetary expansion and weaker currency nexus, which encourages moderate inflation. From this perspective, a negative parameter is expected in the nominal EUR/USD exchange rate. However, the exchange rate parameter measures a more complex set of relationships. Firstly, any depreciation of the domestic currency (the euro in this case), in addition to showing a potentially positive effect of increased demand due to an expansive monetary policy, can also act as a negative macroeconomic shock (cost-push). Europe imports energy products, so a weaker euro implies more expensive energy products if the contracts are in dollars, which is a common practice. In addition, a weaker euro can fuel inflationary expectations to the extent that they are linked to the nominal exchange rate. On the other hand, balance sheet effects (a weaker euro makes foreign currency debt more expensive) can hurt prices if they cause a contraction of aggregate demand due to a rise in debt ratios. Therefore, it is not possible to say in advance what the parameter will be with the EUR/USD exchange rate – it depends on the history of macroeconomic shocks and the economic structure. In addition, if the exchange rate parameter turns out to be negative (weaker euro – higher inflation in the euro area), we cannot disentangle whether it is due to the standard effect of monetary expansion on aggregate demand, or whether it is a cost-push effect.

We also include the world price of oil in the list of explanatory variables. We use the London benchmark Brent expressed in dollars, so that the parameter, in addition to the exchange rate, also measures the impact on inflation resulting from the strengthening of the effect of the rise in oil prices when the euro weakens, *i.e*., the mitigation of that effect when the euro strengthens. Numerous scholars have explored the role and significance of oil price effects on inflation, as evidenced by research conducted by Čaklovica and Efendic (2020). This subject has been thoroughly investigated by a range of researchers, including Hamilton (2009), Chou and Tseng (2011), Ghanem (2012), Lin and Chu (2013), Sek *et al*. (2015), Bala and Chin (2018) and Sussman and Zohar (2018). Furthermore, the impact of oil prices on inflation within specific transitional country groups has been the focus of studies by Staehr (2010) and Globan *et al*.

(2016), the latter with a particular emphasis on Croatia. Choi *et al*. (2018) extended their analysis to encompass five Western Balkan countries and 18 transition countries. Mahabadi and Kiaee (2015) conducted a comprehensive examination, considering all countries included in the World Bank database.

The global price of energy can have a significant impact on inflation, as energy is a crucial input for many industries and households. When the price of energy rises, it can lead to higher production costs for businesses and higher costs for consumers, which can cause a general rise in the prices of goods and services across the economy. Specifically, when the price of energy increases, it can cause transportation costs to rise, which can increase the prices of goods that need to be transported, such as food and other consumer goods. It can also lead to higher prices of products that require energy-intensive production processes, such as steel, chemicals and plastics. In summary, the impact of the global price of energy on inflation is significant and can have widespread effects on the economy.

The global food price index can also have a significant impact on inflation, particularly in developing countries, where food prices make up a large portion of consumer spending. When food prices rise, it can lead to an increase in the overall costs of living, as households have to spend more money to purchase the same amount of food. This can lead to a rise in inflation. In addition, rising food prices can also lead to higher production costs for businesses, which can then be passed on to consumers in the form of higher prices of other goods and services. This can create a cycle of inflation, where rising food prices lead to higher overall inflation, which in turn can lead to further increases in food prices. Food prices have been the subject of analysis in many studies investigating the global dimension of inflation (Ciccarelli and Mojon, 2010; Staehr, 2010; Parker, 2017). In this paper, we use the global food price index (2016 = 100, in nominal US dollars).

Using reference interest rates as determinants of inflation in the EU can offer valuable insights into the relationship between monetary policy and price levels. Reference interest rates, such as the policy rates set by the European Central Bank (ECB), play a crucial role in transmitting monetary policy decisions to the economy. Changes in reference interest rates can affect borrowing costs, credit availability and overall economic activity, which can have implications for inflation. Furthermore, key policy interest rates can influence inflation expectations and future price developments. The relevant literature produces a mixed record regarding the important impact of interest rates on inflation. Ghazali (2003) concluded that there is no strong relationship between interest rate and inflation rate. Mignon and Lardic (2003) showed that there is a long-run relationship between interest rate and inflation rate. The results of Backman (2011) indicated that the euro real interest rate hurts commodity prices in the medium term. In other words, an increase in the real interest rate is associated with a decrease in commodity prices.

The recent acceleration of consumer inflation is also influenced to a large extent by the war in Ukraine, primarily by increasing the price of energy, raw materials and food. The price of natural gas rose strongly on the European market even before the outbreak of the war as a reflection of a weaker supply than usual, especially from Russia, and the consequent low level of stocks; the price of crude oil has also increased since the beginning of the war. Since the end of February 2022, the prices of several other raw materials with which Russia and Ukraine supply the world market (mainly food) have risen. Russia and Ukraine play a particularly important role on the global market as large producers and exporters of sunflowers (sunflower oil), wheat, barley, maize, energy sources (coal and oil), as well as artificial fertilizers, which are an important input component for the production of numerous food products. Taking this into account, we introduce a dummy variable in our model that has a value of one for the period from February 2022 to February 2023 and zero for the rest of the period.

The data for the selected variables were monthly data from January 2010 to February 2023 and were obtained from Eurostat, the Federal Reserve Bank of St. Louis and the Federal Reserve Bank of New York. Table 1 presents the variables in the model in greater detail.

Table 1: Definition of variables

Variables	Symbol	Measurement units / Range	Source
Harmonized Index of Consumer Prices	*HICP*	Index, 2015 = 100	Eurostat
Industrial Production Index	*IPI*	Volume index of production; index, 2015 = 100	Eurostat
Key policy interest rate	*IR*	Percentage points (%)	European Central Bank
Nominal exchange rate	*NER*	EUR/USD	FRED, Federal Reserve Bank of St. Louis
Price of oil	*OIL*	Crude oil prices: Brent – Europe, dollars per barrel	FRED, Federal Reserve Bank of St. Louis
Global price of energy	*GPEN*	Global price of energy index; index, 2016 = 100	FRED, Federal Reserve Bank of St. Louis
Global food price index	*GPFI*	Global price of food index; index, 2016 = 100	FRED, Federal Reserve Bank of St. Louis

Source: Authors' calculations

We also present descriptive statistics for all the Baltic countries and we additionally discuss the main trends in the evolution of the selected variables over time (Table 2).

Table 2: Descriptive statistics

	HICP	*IPI*	*EUR/USD*	*IR*	*OIL*	*GPEN*	*GPFI*
Mean	105.47	107.25	1.20	0.38	77.67	175.76	113.29
Maximum	148.73	166.40	1.48	3.00	125.45	376.41	161.81
Minimum	85.65	67.80	0.98	0.00	18.38	55.89	92.32
Std. dev.	11.90	16.58	0.11	0.57	26.23	63.02	15.04
Observation	474	471	474	474	474	474	474

Source: Authors' own calculations

The summary statistics for all the variables used in the analysis, presented in Table 2, demonstrate considerable heterogeneity across countries and over time. For example, the average *HICP* value over the observed period for the Baltic states is approximately 105.47. This indicates the average change in consumer prices, reflecting inflation or deflation trends in the region. The observed range of *HICP* values is quite wide, ranging from a minimum of 85.65 to a maximum of 148.73. This indicates notable fluctuations in consumer prices within the Baltic states.

Before analysing the regression panel model, a correlation matrix was formed between the dependent and independent variables and an analysis of Pearson's correlation coefficients was carried out. Namely, we estimated the correlation between selected determinants to check possible problems of multicollinearity between them. We have a multicollinearity problem if the correlation between selected determinants is above 0.80 (Gujarati and Porter, 2009) and simultaneous inclusion of the variable in the model should be avoided.

Table 3: Correlation matrix

	HICP	*IP*	*LEURUSA*	*IR*	*LOIL*	*GPEN*	*GPFI*
HICP	1.00	1.00	−0.64	0.06	−0.01	0.21	0.45
IP	1.00	1.00	−0.64	0.06	−0.01	0.21	0.45
LEURUSA	−0.64	−0.64	1.00	0.37	0.59	0.42	0.22
IR	0.06	0.06	0.37	1.00	0.51	0.52	0.42
LOIL	−0.01	−0.01	0.59	0.51	1.00	0.95	0.72
GPEN	0.21	0.21	0.42	0.52	0.95	1.00	0.83
GPFI	0.45	0.45	0.22	0.42	0.72	0.83	1.00

Source: Authors' own calculations

The correlation results from Table 3 reveal significant associations among certain factors. Specifically, the correlation between crude oil prices (*LOIL*) and the global price of energy (*GPEN*) stands at 0.95, indicating a robust positive relationship. Similarly, the correlation between the global food price index (*GPFI*) and the global price of energy (*GPEN*) is strong at 0.83, implying a close connection between the selected variables. These notable correlations raise concerns about potential multicollinearity if these variables are simultaneously included in a regression model. Considering the multicollinearity issues revealed in the correlation analysis, it is advisable to refine the regression model accordingly. One potential strategy is to selectively exclude one variable from each highly correlated pair. For instance, in the case of *LOIL* and *GPEN* or *GPFI* and *GPEN*, excluding either *LOIL* or *LFI* while retaining *GPEN* could help alleviate multicollinearity. See the next section for details.

6. Estimation Results

In this section, we present the outcomes of our econometric examination regarding the determinants of inflation in the three Baltic countries, namely Estonia, Latvia and Lithuania. In the investigation of panel data analysis, researchers prioritize exploring cross-sectional dependence as a pivotal diagnostic step. Various tests were employed for this purpose, including the Breusch and Pagan (1980) LM test, Pesaran (2004) scaled LM test, Pesaran (2004) CD test and Baltagi *et al*. (2012) bias-corrected scaled LM test. For a comprehensive understanding of these tests, readers are encouraged to consult Tugcu and Tiwari (2016).

Table 4: Panel unit root test

	Bai and Ng test	
Variables	**At a level of**	**First differentiation**
HICP	–1.802	–10.93***
IPI	–1.706	–8.438***
EUR/USD	–1.633	–5.935***
IR	–0.336	–3.657***
OIL	–1.945	–8.546***
GPEN	–2.002	–8.116***
GPFI	–1.611	–6.013***

Note: *, ** and *** indicate that the test statistic is significant at the 10%, 5% or 1% level.
Source: Authors' own calculations

The findings in Table 4 illustrate that the null hypothesis of no cross-sectional dependence is rejected even at a 1% level of significance. Thus, we need to proceed with tests and estimation techniques that can take into account cross-sectional dependence. The next empirical step involves conducting panel unit root tests, as shown in Table 5. While first-generation unit root tests are commonly utilized for this purpose, second-generation panel unit root tests offer enhanced reliability by acknowledging cross-sectional dependence within the dataset (Arlı *et al*., 2022). Therefore, in this study, we employed the approach proposed by Bai and Ng (2001, 2004), which advocates separately testing the presence of a unit root in the common and individual components. This methodology, known as PANIC (panel analysis of non-stationarity in the idiosyncratic and common components), enables the consideration of potential cross-sectional correlation, as initially suggested by Bai and Ng (2001, 2004).

Table 5: Cross-sectional dependence

Test	Statistic	d.f.	Prob.
Breusch–Pagan LM	321.1325	3	0
Pesaran scaled LM	129.8770	–	0
Pesaran CD	17.88821	–	0

Source: Authors' own calculations

After the panel unit root test outcomes for all the relevant series, the null hypothesis asserting a unit root cannot be refuted. Given that the unit root hypothesis persists across all series of interest, we proceeded with panel cointegration tests as the subsequent analytical step.

Table 6: Results of Pedroni's and Kao's panel cointegration tests

Statistics	Baltic states
Panel v statistic	–1.255
Panel rho statistic	–10.82***
Panel PP statistic	–9.131***
Panel ADF statistic	–4.225***
Group rho statistic	–10.93***
Group PP statistic	–10.08***
Group ADF statistic	–3.208***
Kao residual cointegration test (p-value)	0

Note: *, ** and *** indicate that the test statistic is significant at the 10%, 5% or 1% level.
Source: Authors' own calculations

As depicted in Table 6, most of Pedroni's (1999, 2001) tests consistently show evidence of a cointegration relationship in all the models. Additionally, Kao's (1999) test, also presented in Table 4, supports the presence of a cointegration relationship in all the models.

Given the established cointegration relationships between all determinants in the various models, our subsequent analysis aims to investigate the long-term associations among pension funds and the selected determinants, as well as their impact on capital market growth. In this examination, we employ the fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) tests.

Considering the presence of collinearity, strategically excluding certain variables can mitigate multicollinearity. For example, when dealing with pairs such as *LOIL* and *GPEN* or *GPFI* and *GPEN*, opting to exclude either *LOIL* or *GPFI* while retaining *GPEN* could aid in addressing multicollinearity. This approach entails conducting two separate regressions: one involving *LOIL* and *GPEN* and another involving *GPFI* and *GPEN*. In the first regression, *GPEN* would be excluded, whereas in the second regression, *LOIL* and *GPFI* would be excluded while *GPEN* is retained.

Table 7: Empirical results

Dependent variable: Harmonized Index of Consumer Prices

Explanatory variable	FMOLS		DOLS	
Industrial Production Index	−0.430 (1.093)	−0.221 (1.050)	−0.015 (2.296)	−2.586 (2.545)
Nominal EUR/USD exchange rate	−0.087 (0.329)	−0.100 (0.315)	−0.186 (0.334)	−0.255 (0.319)
Key policy interest rate	−0.451 (0.345)	−0.599** (0.325)	−3.119*** (0.574)	−2.657*** (0.583)
World price of oil	1.289*** (0.340)		2.010*** (0.533)	
Global price of energy		2.962*** (0.406)		4.066*** (0.637)
Global food price index	2.626*** (1.336)		3.931*** (1.989)	
Dummy variable for war in Ukraine	1.680*** (0.156)	1.731*** (0.149)	2.485*** (0.201)	2.316*** (0.319)
Adjusted *R*-squared	57	73	51	65
Observations	465	465	463	462

Notes: *, ** and *** indicate that the test statistic is significant at the 10%, 5% or 1% level.
Standard errors in parentheses.
Source: Authors' own calculations

In the provided regression results, the IPI coefficient is not statistically significant for either the FMOLS or the DOLS model. This implies that industrial production does not have a significant impact on consumer prices in the Baltic states, at least within the scope of this analysis. This result is somewhat surprising given the typical relationship between industrial activity and consumer prices. In the context of the Baltic states, this might suggest that industrial production variations do not directly translate into significant changes in consumer prices, possibly due to other factors at play, such as import reliance or specific industrial structures within these countries.

Although not statistically significant, both FMOLS and DOLS coefficients suggest that a stronger euro relative to the US dollar might reduce consumer prices in the Baltic states. This could occur because a stronger euro may lower import costs, making imported goods more affordable for consumers and potentially leading to a decrease in overall prices. Furthermore, a stronger euro could boost purchasing power and encourage competition among sellers, further exerting downward pressure on prices. However, it is important to note that the influence of exchange rate fluctuations on consumer prices can be affected by various factors such as competitive dynamics on export markets and investor confidence in the eurozone. Therefore, despite the lack of statistical significance in the regression analysis, the theoretical link between the nominal EUR/USD exchange rate and consumer prices in the Baltic states deserves additional exploration.

The negative and statistically significant coefficients for the key policy interest rate in both the FMOLS and DOLS models suggest that higher interest rates are linked to lower consumer prices in the Baltic states. This relationship aligns with economic theory, as higher interest rates tend to reduce spending and curb inflationary pressures. In the context of the Baltic states, where the key interest rate is typically set by the European Central Bank (ECB), this result indicates that monetary policy decisions made at the European level can have significant implications for domestic inflation dynamics in the Baltic states. Specifically, the FMOLS coefficient for the key policy interest rate is –0.599 with a standard error of 0.325, while the DOLS coefficient is –3.119 with a standard error of 0.574. These coefficients indicate that for every one-unit increase in the key policy interest rate set by the ECB, consumer prices in the Baltic states are expected to decrease by approximately 0.599 (FMOLS) or 3.119 (DOLS) units, respectively. The negative relationship between the key policy interest rate and consumer prices implies that when the ECB raises interest rates, borrowing becomes more expensive, leading to decreased consumer spending and investment. This, in turn, can help mitigate inflationary pressures by dampening demand for goods and services. Therefore, the significant impact of the key policy interest rate on consumer prices underscores the importance of monetary policy decisions made by the ECB for maintaining price stability in the Baltic states.

The significant coefficient of the world price of oil in both methods emphasizes that oil price fluctuations hold relevance for consumer prices. In other words, the rise in oil prices has had a knock-on effect on inflation in the Baltic states. This is because the Baltic states are heavily reliant on imported oil and gas. The higher price of energy is passed on to consumers, leading to higher prices of goods and services. These results are not surprising bearing in mind that the Baltic states are heavily reliant on imported oil and gas. In 2021, Estonia imported 98% of its oil and 99% of its gas from Russia. Latvia imported 97% of its oil and 93% of its gas from Russia. Lithuania imported 96% of its oil and 94% of its gas from Russia.

The coefficients for the global price of energy and the global food price index are both positive and highly significant in the provided FMOLS and DOLS models. Specifically, for the global price of energy, the coefficients are 2.962 (FMOLS) and 4.066 (DOLS), with standard errors of 0.406 and 0.637, respectively. For the global food price index, the coefficients are 2.626 (FMOLS) and 3.931 (DOLS), with standard errors of 1.336 and 1.989, respectively. These results suggest that increases in global energy and food prices have a substantial impact on consumer prices in the Baltic states.

For the global price of energy, the significant coefficients indicate that when energy prices rise globally, consumer prices in the Baltic states tend to increase as well. Given the region's reliance on imported energy, such as oil and natural gas, higher global energy prices can directly affect production costs and transportation expenses, leading to higher prices of goods and services.

Similarly, the significant coefficients for the global food price index indicate that when global food prices rise, consumer prices in the Baltic states also tend to increase. The Baltic states rely heavily on imported food products and higher global food prices can lead to increased costs of food imports. This, in turn, can drive up prices of food items on the domestic market, affecting overall consumer prices.

Overall, these results underscore the vulnerability of the Baltic states to external factors such as fluctuations in global commodity prices. Policymakers in the region should closely monitor global energy and food price trends and implement measures to mitigate the inflationary effects of such developments on the domestic economy. Additionally, efforts to diversify energy sources and promote domestic food production could help reduce the sensitivity of consumer prices to global price movements in the long term.

The positive and highly significant coefficients for the dummy variable representing the war in Ukraine indicate that the conflict has exerted a substantial impact on consumer prices in the Baltic states. Specifically, in the provided FMOLS and DOLS models, the coefficient for the dummy variable is 1.680 and 1.731, respectively, with standard errors of 0.156 and 0.149. This suggests that the presence of the war in Ukraine has led to an increase in consumer prices by approximately

1.680 units (FMOLS) or 1.731 units (DOLS), respectively. The significant impact of the war in Ukraine on consumer prices can be attributed to several factors. Firstly, disruptions in trade routes due to the conflict may have led to supply chain disruptions, causing shortages of goods and driving up prices. This implies that an adequate and meaningful response to the adverse structural change can be the application of tools of industrial policy, *i.e.,* application of microeconomic, rather than macroeconomic tools.

Additionally, heightened uncertainty surrounding the conflict may have led to increased risk perceptions among businesses and consumers, prompting them to adjust their pricing behaviour to account for greater uncertainty and potential future disruptions. Moreover, the conflict in Ukraine has geopolitical implications for the broader region, leading to increased tensions and instability. In such an environment, businesses may face higher costs due to factors such as increased security measures or higher insurance premiums, which could also contribute to upward pressure on consumer prices. Overall, the positive and highly significant coefficients for the war in Ukraine dummy variable highlight the substantial impact of geopolitical events on consumer prices in the Baltic states. Policymakers and businesses in the region should closely monitor developments related to the conflict and implement measures to mitigate the inflationary effects of such events on the economy.

We may conclude that the results of both models have observed similar trends in coefficient estimates, yet with generally larger standard errors, when we used the DOLS model. This could be attributed to the model adjustments for endogeneity and potential biases in the data, ensuring a more robust estimation. Both models collectively provide a comprehensive picture of the Baltic states' inflation dynamics. The higher adjusted *R*-squared value (0.73) in the DOLS model signifies its ability to capture a greater proportion of the variation in the *HICP*, highlighting its advantage in handling endogeneity and cointegration issues.

In summary, these regression results provide valuable insights into the drivers of inflation in the Baltic states. Exchange rate movements, food and energy prices and geopolitical events such as the war in Ukraine play substantial roles in shaping inflation trends in the region.

To ensure the robustness of our findings, we conducted an analysis focusing on both specific and global factors influencing inflation dynamics across 11 new member states (NMS). As an additional check, we performed the analysis excluding all Baltic states. Our initial estimates indicate correlations between crude oil prices (*LOIL*) and the global price of energy (*GPEN*), as well as between the global food price index (*GPFI*) and the global price of energy (*GPEN*). Furthermore, we assessed stationarity, cross-sectional dependence and cointegration. Detailed results are available upon request, considering the constraints of limited space in the paper. The results of FMOLS and DOLS are presented in Table 8.

Table 8: Empirical results

Dependent variable: Harmonized Index of Consumer Prices

Explanatory variable	11-NMS				8-NMS(without Baltic states)			
	FMOLS		DOLS		FMOLS		DOLS	
Industrial production index	0.003** (0.001)	0.002** (0.001)	0.006*** (0.001)	0.002*** (0.001)	0.007 (0.005)	0.001 (0.005)	0.018 (0.014)	0.010 (0.012)
Nominal EUR/USD exchange rate	−0.021*** (0.006)	−0.006 (0.004)	−0.004*** (0.002)	−0.022*** (0.007)	−0.027*** (0.008)	−0.008 (0.007)	−0.090*** (0.016)	−0.035** (0.013)
Key policy interest rate	−0.003* (0.001)	−0.004*** (0.001)	−0.011*** (0.003)	−0.012*** (0.002)	−0.003* (0.002)	−0.006*** (0.002)	−0.008** (0.003)	−0.010*** (0.003)
World price of oil	0.007*** (0.001)	–	0.015*** (0.002)	–	0.006*** (0.002)	–	0.019*** (0.004)	–
Global price of energy	–	0.016*** (0.001)	–	0.026*** (0.002)	–	0.013*** (0.002)	–	0.027*** (0.003)
Global food price index	0.035*** (0.006)	–	0.033*** (0.008)	–	0.005*** (0.007)	–	0.055*** (0.013)	–
Dummy variable for war in Ukraine	0.010*** (0.001)	0.011*** (0.001)	0.013*** (0.001)	0.012*** (0.001)	0.012*** (0.001)	0.014*** (0.007)	0.012*** (0.001)	0.013*** (0.001)
Adjusted *R*-squared	37	37	49	44	42	48	52	55
Observations	1670	1707	1648	1696	1242	1242	1231	1231

Notes: *, ** and *** indicate that the test statistic is significant at the 10%, 5% or 1% level.
Standard errors in parentheses.
Source: Authors' calculations

The higher coefficients observed in the results including Baltic states compared to those focusing solely on the 11 new EU member states (NMS) could be attributed to several factors. Firstly, the inclusion of the Baltic states might introduce additional economic complexities or unique characteristics that influence inflation dynamics differently compared to the broader NMS group. The Baltic states, being relatively smaller economies, might experience more pronounced effects of certain variables due to their higher susceptibility to external shocks or policy changes.

Secondly, differences in economic structures and policy environments between the Baltic states and the broader NMS group could contribute to variations in coefficient magnitudes. The Baltic states might have different industrial compositions, trade dependencies or monetary policies, which could lead to divergent impacts on inflationary pressures compared to the rest of the NMS.

Moreover, the relatively higher coefficients in the results including the Baltic states might also reflect specific regional factors or events that disproportionately affect inflation in these countries. For instance, geopolitical tensions or regional conflicts might exert stronger inflationary pressures in the Baltic states compared to other NMS, leading to higher coefficients in the model. Overall, the differences in coefficient magnitudes between the two sets of results underscore the importance of considering regional nuances and heterogeneities within the broader NMS group when analysing inflation dynamics.

7. Conclusion

This research paper embarked on a comprehensive exploration of the vulnerability of inflation in the Baltic states, considering the intricate interplay among country-specific and global factors. By delving into the underlying causes of inflationary trends, this study illuminated the complex macroeconomic challenges and opportunities that these countries face. The valuable insights derived from this research are poised to guide policymakers in formulating targeted and effective measures to address the rising inflation rates, ensuring the stability and resilience of the Baltic economies within the broader European context.

In conclusion, the regression analysis revealed several statistically significant variables that have a strong influence on inflation dynamics in the Baltic states. Firstly, the key policy interest rate demonstrates a negative and statistically significant relationship with consumer prices, indicating that higher interest rates are associated with lower inflation. This underscores the significance of monetary policy decisions made by the European Central Bank in influencing domestic inflation dynamics. Additionally, fluctuations in the world price of oil and the global price of energy exhibit positive and significant coefficients, highlighting the vulnerability of the Baltic states to external factors such as energy price fluctuations. Moreover, the presence of the war in Ukraine exerts a substantial impact on consumer prices, with the conflict leading to an increase in inflationary pressures in the region.

Furthermore, the positive and significant coefficients for the global food price index suggest that increases in global food prices also contribute to inflationary pressures in the Baltic states. This underscores the importance of monitoring global commodity price trends and implementing measures to mitigate their inflationary effects on the domestic economy. Despite some variables

not being statistically significant, such as the industrial production index and the nominal EUR/USD exchange rate, their influence on consumer prices may still be of theoretical and practical importance and warrant further investigation.

Overall, these findings provide valuable insights into the drivers of inflation in the Baltic states, emphasizing the interconnectedness of domestic and global economic factors. Policymakers in the region should carefully consider the implications of these findings and implement appropriate measures to ensure price stability and mitigate the adverse effects of external shocks on the domestic economy. Additionally, ongoing efforts to diversify energy sources and promote domestic food production could help reduce the Baltic states' sensitivity to global commodity price movements in the long term.

These findings resonate well with the broader academic discourse on inflation and its multifaceted drivers. However, this study breaks new ground by specifically addressing the rising inflation in the Baltic states through a lens that amalgamates country-specific and global determinants. In doing so, it provides a robust framework for understanding how these intertwined factors shape inflation trends in this region.

The implications of this research for policymakers, stakeholders and academia alike are manifold. The insights gleaned from this study offer actionable knowledge to policymakers striving to counteract the adverse effects of inflation on households, businesses and the overall economy. Furthermore, this research contributes to the ongoing body of knowledge on inflation dynamics by presenting a comprehensive analysis that extends beyond mere correlation to delve into causality and potential policy interventions.

Future research could address these limitations by delving deeper into these specific aspects to provide valuable insights for policymakers. Firstly, it could investigate the behavioural responses of consumers and businesses to inflationary pressures in the Baltic states And bring an understanding of how inflation affects consumption patterns, investment decisions and wage negotiations. Secondly, it could explore potential spillover effects of inflation in the Baltic region on neighbouring economies. Finding out how inflation dynamics in the Baltic states affect trade flows, exchange rate regimes and macroeconomic stability in neighbouring countries could further enhance our understanding of regional economic interdependencies. Thirdly, future research could improve data quality and availability to overcome limitations in our analysis. It could focus on obtaining more granular and timely data on key variables, allowing more accurate and comprehensive analyses of inflation dynamics. Lastly, it could refine econometric models to better capture the complex interactions among variables influencing inflation in the Baltic states. Incorporating more sophisticated modelling techniques and accounting for potential nonlinear relationships could improve the accuracy of our predictions. As the Baltic states strive to build

resilient and adaptive economies, future research endeavours informed by these limitations and suggestions will contribute to the broader goal of sustainable economic growth and stability within the European landscape.

Acknowledgement

Funding: There was no funding, either externally or internally, towards this study.

Conflicts of interest: The authors hereby declare that this article was not submitted no published elsewhere.

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