# Eurozone inflation in times of crises: an application of cluster analysis

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Budapest University of Technology and Economics, Faculty of Economic and Social Sciences, Department of Finance, Budapest, Hungary This investigates study whether homogeneous clusters can be identified among Eurozone countries based on the main HICP (harmonized index of consumer prices) sub-indicators between the first quarter of 2019 and the last quarter of 2023. We use hierarchical cluster analysis to explore how different Eurozone member countries can be grouped according to the different components of the HICP that reflect differences in the main causes of inflation. We point out that the factors discussed in the inflation theory literature that affect different groups of economic agents in different ways can also be interpreted geographically within the Eurozone.

Baltic countries tend to follow inflation paths that are different from those of other member states, but outliers also exist among the most advanced economies in the EU. Diverging inflation patterns have much to do economic convergence, but with the dispersion of monthly inflation rates suggests that administrative pricing and policy considerations, particularly energy policy, may be responsible for most of the divergence in inflation and will largely determine the emergence of clusters from 2022 onwards.

Keywords: inflation dispersion, energy price shocks, Eurozone, cluster analysis In light of the results of our study, we conclude that there may be significant differences in the adjustments of individual countries compared to the policy measures that are optimal from the European Central Bank's perspective.

### Introduction

Inflation is understood as a general phenomenon in modern economies. Economists perceive moderate inflation to be a necessary corollary of healthy economic growth. Therefore, the European Central Bank's (ECB) medium-term inflation target is 2%, which has been a symmetric target since 2021, expressing that both upward and downward deviations from the target are undesirable (Baumann et al. 2022, ECB 2024). However, in recent years, high inflation has already become damaging in many areas of the economy, an economic phenomenon the ECB did not have to face until the 2020s.

The low-inflation environment in the Eurozone between 2010 and 2020 could be associated with the theoretical concept of a liquidity trap (Novák–Tatay 2021). The demand shock of the Covid-19 crisis also kept inflation low. The economic opening up after the pandemic increased consumer prices on an upward path. The next wave of price increases was caused by the Russia–Ukraine conflict (Bareith et al. 2024). Among the most often cited causes of inflation are demand-pull, cost-push effects, and even inflation as a 'monetary phenomenon'; that is, money-induced effects also exercise a strong interplay in the explosion of prices in the various economic segments. The ECB is the single monetary authority for the Eurozone, and the euro is the currency of the Eurozone countries. However, the economies of the individual countries differ in several ways. A wide range of economic studies shows that inflation can have different effects on economic agents in various situations. The same economic effects may trigger different rates of price increases in economies with different structures. An example is the emergence of unprecedented divergent inflation rates in recent years in some Eurozone countries.

Figure 1





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Source: ECB (2024), own editing.

As shown in Figure 1, while Estonia's HICP reached 24.16% in the third quarter of 2022, Finland's inflation rate remained below the Eurozone average and did not even reach 9% at its peak. Therefore, the maximum inflation rate in Estonia was more than 2.5 times that in Finland. Central bank responses to inflation shocks vary across regions and may even be ineffective in economically and socially distinct regions (Kuncoro 2020) because inflation components may differ across countries. The impact of central bank responses on these components may vary in effectiveness (Bareith–Fertő 2023).

This study examines countries that had similar HICP values between the first quarter of 2020 and the last quarter of 2023, and the components behind the major deviations. We study the most significant changes in the inflation components of the economies with the highest HICP values, and assess whether homogeneous clusters can be identified across Eurozone countries resulting from a one-way evolution of the inflation components. For our analysis, we use descriptive statistics and cluster analysis as a methodological tool.

Thus, our study sheds light on whether despite the single-currency area, the application of a single monetary policy may pose challenges for the economies of individual member countries. This study contrasts the analysis of inflation components with previous research on inflation divergence within the Eurozone economies. In doing so, we also aim to show that the factors discussed in the inflation theory literature, which affect different groups of economic agents differently, can be interpreted in geographical terms within the Eurozone.

# Theoretical issues in inflation developments in the Eurozone

Before the formation of the Eurozone, many researchers delved into the issue of inflation convergence in European countries. The convergence was spectacular in the decade preceding the introduction of the euro. However, after some successful years, the problem of widening inflation differentials became the main scope of attention. Among others, the ECB (2003), Honohan-Lane (2003), Engel-Rogers (2004), Weber-Beck (2005), Rogers (2007), and Fritsche-Kuzin (2008), provide accounts of decelerating inflation convergence and widening inflation differentials after the launch of the common currency, whereas Honohan-Lane (2004) observe some inflation convergence after 2001. The ECB (2003) finds that a significant portion of the discrepancy in inflation is explained less by weighting differences in national HICPs and much more by administrative price dispersion. Analysing both structural and cyclical differences, the ECB argues that much can also be accounted for by the import dependence on oil and the openness of the economies; thus, the depreciation of the euro could greatly affect some countries, while leaving others almost untouched. Honohan-Lane (2003) resent the lack of stronger inflation convergence in the Eurozone, which they partly attribute to weaknesses of the common currency, whereas in a subsequent study they demonstrate that the dollar's depreciation helps

reach a stronger convergence. The Balassa–Samuelson effect also emerges as a relevant argument with strong empirical justification for less-developed member states, but could only account for a negligible part of the headline Eurozone HICP (ECB 2003, Honohan–Lane 2003). Weber–Beck (2005) although confirm that the inflation target of the ECB is sustainable but also pinpoint that inflation convergence decelerated after the second half of the 1990s, and even greater dispersion became a reality after the introduction of the euro. Rogers (2007) arrives at similar conclusions by comparing the results with US data and emphasizes the differences between Eurozones 11 and 17, as well as non-tradables, even showing lower convergence. Furthermore, Busetti et al. (2007) find two separate clusters based on CPI data in 1998–2004: a lower inflation group comprising Germany, France, Belgium, Austria, and Finland, and a higher inflation one comprising Spain, the Netherlands, Greece, Portugal, and Ireland, whereas Italy remained an outsider. According to Fritsche-Kuzin (2008), clustering is more observable along close geographical positions, with no overall convergence detectable based on the CPI.

The discussion reached its zenith during the global financial crisis when European economies experienced above average price volatility which was mainly attributable to energy and commodity price changes. According to Orphanides (2012), the ECB had to resort to rate increases in July 2008 despite the economic slowdown and inflation dropping from 4.1% in July 2008 to -0.6% in July 2009. Following a long period of subdued inflationary processes, especially after 2012, which was interlinked with subperiods of deflation, the dilemma of strong inflation differentials resurfaced in 2021, triggered by supply chain disruptions and energy price shocks following the onset of the Covid-19 pandemic. Furthermore, with the new entrants from the post-Soviet bloc from 2011 onwards, the economic structures in the currency zone became even more diverse.

The theoretical reasoning behind the importance of common inflation dynamics in the Eurozone can be derived from the main postulates of the optimal currency area (OCA) theory. In practice, the ECB is often attacked by critical remarks concerning its one-size-fits-all monetary policy which causes low nominal interest rates for countries with relatively high inflation rates and, therefore, a potential for a credit boom, whereas excessively high interest rates for countries with low inflation result in excessively high real rates that further decelerate growth or even exacerbate recessionary tendencies. First, the major concern surrounding episodes of inflation divergence is primarily related to differences in the cost and price competitiveness of countries with differing real exchange rates, leading to a current account deficit in high-inflation and surplus in low-inflation economies, such as after the global financial crisis. Second, debt financing is more difficult in countries with low inflation because of the aforementioned higher real interest rates that cause further fiscal discrepancies in the Eurozone, where fiscal policy coordination is still moderate.

Stylianou (2023) conducted a panel examination of the Eurozone's inflation processes from its beginning until 2018 and identified three major structural reasons for dissimilar inflation dynamics among member states: externalities, hurdles to

convergence in the tradable goods sector, and the differing productivity dynamics resulting in productivity differentials and diverging price developments in the nontradable goods sector, as explained by the Balassa–Samuelson effect. These are all accompanied by market rigidities mainly owing to distinguishable characteristics of structural reforms, both from the perspective of the time requirement and the strength of their effect. Furthermore, Stylianou's empirical investigation points out that the major causes of inflation differentials are the impact of changes in the nominal exchange rate, output gap, and productivity differentials (representing the Balassa–Samuelson effect), whereas fiscal policy does not evidently contribute to it.

# HICP developments and components in Eurozone countries between 2020 Q1 and 2023 Q4

The last year with 'normal' economic conditions was 2019, before the Covid-19 outbreak. In 2019, the HICP of Eurozone countries developed in each quarter as shown in Figure 2.

Figure 2



HICP developments in 2019 in Eurozone countries and the Eurozone average

Note: AT: Austria; BE: Belgium; CY: Cyprus; DE: Germany; EE: Estonia; EL: Greece; ES: Spain; FI: Finland; FR: France; HR: Croatia; IE: Ireland; IT: Italy; LT: Lithuania; LU: Luxembourg; LV: Latvia; MT: Malta; NL: Netherlands; PT: Portugal; SI: Slovenia; SK: Slovakia. Source: ECB (2024), own editing.

In 2019, Eurozone HICP values were below the 2% target in all quarters on average. They hovered around 1.4% in the first two quarters, and around 1% in the third and fourth quarters. Latvia's HICP was the highest in the first quarter. This was followed by the Netherlands (2.5%) and Slovakia (2.4%). In the second quarter, Latvia's HICP increased to 3.3% and Estonia's to 2.9%. Lithuania, the Netherlands, and Slovakia were also slightly above 2.5%. In the third quarter, Slovakia had the highest index at 3%. Latvia and the Netherlands followed with 2.8%. In the fourth quarter, Slovakia's HICP was 3.1% and the Netherlands' was 2.7%. Latvia's index, the third highest, fell to 2.1%. In Q4 2019, all other Eurozone countries' HICPs remained below 2%.

After a period of generally low inflation from 2010 to 2019, negative inflation rates were again recorded in the Eurozone in 2020. However, unlike previous years, 2020 was already determined by Covid-19 pandemic. This year was defined by the collapse of the world economy, including that of the EU. The collapse of the supply of goods was accompanied by a decrease in consumption. The quarterly HICP values are as shown in Figure 3.

Figure 3



HICP developments in 2020 in Eurozone countries and the Eurozone average

The HICP values remained consistently below the ECB target throughout 2020 represented by the Eurozone average. From the second quarter onwards, they fluctuated around the zero level, with the Eurozone rate moving to a slightly negative range in the third quarter.

The HICP levels in Lithuania and Slovakia remained above 2% in the first quarter of the year, but these countries also recorded lower levels in the following quarters. However, for the entire year, the rates in these two countries were the highest in the Eurozone.



HICP developments in 2021 in Eurozone countries and the Eurozone average

In the first quarter of 2021, the Eurozone's HICP was still 1.3%. Subsequently, the values began to increase. In the second quarter, it approached the ECB's inflation target with a rate of 1.8%. In the next two quarters, it exceeded the target. In the last quarter of 2021, it was above 4%. In Q4 2021, the HICP of all Eurozone countries rose above 2%.

In the first quarter of 2021, Austria, Germany, and the Netherlands had the highest HICPs. In the second quarter, Estonia, Lithuania, and Luxembourg had the highest values. Subsequently, Estonia, Lithuania, and Latvia had the highest HICPs in the third and fourth quarters. In the third quarter, Estonia and Lithuania had HICPs above 5%. By the fourth quarter, Estonia and Lithuania's indices increased to over 9%, while Latvia's rate reached 7%. The quarterly HICP values are as shown in Figure 4.

Figure 4

Source: ECB (2024), own editing.

In the three countries with the highest HICPs in the given period, the quarterly price increases for each product category were as shown in Appendix, Figure A1.

In Q1 2021, countries with the highest HICPs also experienced moderate price increases for all product categories. One outlier was the price increase in alcoholic beverage and tobacco product category in the Netherlands. In the second quarter, Estonia experienced the highest increase for the education group. In Lithuania and Luxembourg, the price changes for transport were the highest. In the third quarter of 2021, in Estonia and Lithuania, the price increase for housing, water, electricity, gas and other fuels category was the highest, followed by an increase in the transport category. In Q3, transport prices reached their highest levels in Latvia, with the housing, water, electricity, gas and other fuels category ranking second. In Q4 2021, a situation similar to that in Q3 emerged in terms of the order of price increases for each product category.

However, although the order remained unchanged, the rate of the increase in price rises jumped, as shown in Figure 5.

Figure 5





In 2022, the average HICP of the Eurozone continued to increase, rising from 6.13% in Q1 2022 to 9.97% in Q4 2022. During the year, the HICP significantly

exceeded the ECB's target in each quarter, with each member country's HICP exceeding 4% in Q1 2022, 5% in Q2, 6% in Q3, and rising further to 6.5% in Q4. In all quarters, the Baltic countries – Estonia, Latvia, and Lithuania – had the highest HICPs among the Eurozone member states. The HICPs of all three countries reached their highest levels in the third quarter; Estonia's rate peaked at 24.17%, Lithuania's at 21.5%, and Latvia's at 21.57%.

The quarterly price increases for each product category in the three countries with the highest HICPs are as shown in Appendix Figure A2.

In Estonia and Lithuania, housing, water, electricity, gas and other fuels recorded the largest price increases in each quarter of the year. In Latvia, the highest price increase was still recorded for transport in the first quarter, and in the following quarters, the highest price increases were recorded for housing, water, electricity, gas and other fuels. The rate of increase was extreme in all these cases. The highest price increase for housing, water, electricity, gas and other fuels in Q1 2022 was recorded in Lithuania at 37%. In 2022 Q2 and Q3, Estonia again recorded the highest price increases for the product category of housing, utility expenses and fuels at 65.0 and 74.1%, respectively. In 2022 Q4, the highest price increase for the housing, water, electricity, gas and other fuels category was again recorded in Lithuania at 51.2% as illustrated by Figure A2 (see in Appendix).

Figure 6



HICP developments in 2023 in Eurozone countries and the Eurozone average

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In 2023, the average HICP in the Eurozone was on a downward path as shown in Figure 6. It fell from 8% in Q1 2023 to 2.73% in Q4 2023. In the first quarter of 2023, all member states except Luxembourg (4.5%) still had HICPs at or above 5%. From Q2 onwards, an increasing number of member states' values fell to approximately 2% or below. Estonia, Latvia, and Lithuania had the highest HICPs in the first quarter. The three countries with the highest indicators in the second quarter were Slovakia (12.5%), Latvia (11.8%) and Estonia (11.1%). In the third and fourth quarters, Austria, Croatia, and Slovakia were added to the high inflation group.

The quarterly price increases for each product category in the three countries with the highest HICPs are as shown in Appendix, Figure A3.

In the first quarter of 2023, the three countries with the highest HICPs still saw the highest increases in housing, water, electricity, gas and other fuels. The rate of price increases was 31.1% (Estonia) 32.6% (Lithuania), and 44.7% (Latvia). In the second quarter of the year, Latvia continued to see the most significant price increases in the housing, water, electricity, gas and other fuels category, at a rate of 24.47%. In Estonia and Slovakia, food and non-alcoholic beverages recorded the largest increases, with rises of 20.77% and 22.03%, respectively. In the third quarter, the largest increases in the HICP were recorded in Austria (6.77%), Croatia (7.93%), and Slovakia (9.63%). In Austria and Croatia, the highest increases were recorded for restaurants and hotels, with values of 11.33% and 16.07%, respectively. In Slovakia, the prices of food and non-alcoholic beverages underwent the most significant changes, rising by 13.73%. In the fourth quarter, HICPs in Austria, Croatia, and Slovakia were again the highest among the Eurozone countries (5.17%; 5.87%; and 7.1%, respectively). In Austria and Croatia, the highest price increases were recorded in the restaurant and hotel product category, with rates of 9.63% and 12.9%, respectively. In Slovakia, education recorded the highest price increase at 14.8%.

At the beginning of the functioning of the (Economic and Monetary Union) EMU, the highest inflation levels were detected in Spain, Greece, Ireland, and Portugal. Recent empirical results reveal that Baltic countries have accounted for the largest portion of the differing dynamics in recent years, along with Slovakia and Slovenia to a lesser extent. Their differing inflation behavior is largely due to the aforementioned Balassa–Samuelson effect and, therefore, can be explained by an equilibrium phenomenon. However, the period after 2021, especially following the outbreak of the Russia–Ukraine conflict, has directed attention to the importance of energy policy and food price developments. Large fluctuations in individual countries' inflation rates and deviations around the average Eurozone inflation were caused not only by the price of gas and other energy holders but also by the way economic policies reacted to energy shocks.

Gern et al. (2023) embarked on unravelling the main causes of the unprecedented inflation levels in the Eurozone in 2022. They found that the upsurge in price levels was mostly due to energy and food prices. In general, the dispersion and magnitude

of inflation was not as dramatic in core inflation as in headline inflation. Since 2021, inflation rates were steadily rising and Baltic countries recorded the highest levels of price-level changes in 2021 and 2022, followed by the Netherlands and Slovakia. At the beginning of 2021, the main drivers of inflation were related to supply chain disruptions and material shortages accompanied by recuperating demand, from the middle of 2021; however, the rise in gas and, less forcefully, in oil prices made European policymakers anxious. Additionally, supply bottlenecks encountered a fortified demand side owing to loose monetary policy and fiscal policy stimulation packages introduced during the pandemic. The energy crisis reached its peak in 2022 owing to geopolitical conflicts affecting countries in a dissimilar fashion because of the variability of the energy policy mix adopted by member states, the household subsidization policy and other price regulations of governments, and the institutional setup of energy supply.

### **Examining inflation differences and similarities**

#### Methodology of the analysis

We conducted a hierarchical cluster analysis of Eurozone economies using the Euclidean distance for individual quarters. Hierarchical cluster analysis is an iterative process that defines the grouping of objects with various characteristics based on a well-defined distance metric. The iterative process can be conducted by merging (agglomeration schedule) or splitting (partitioning) groups according to the similarity or dissimilarity of their characteristics (Arabie et al. 2005, Altman 2024). Among the two types of hierarchical cluster analyses, we utilized the agglomeration schedule offered by SPSS. In this case, the first two closest clusters define the inclusion of other observations in the same or other clusters and later it is not possible to reshuffle this grouping. The initial structure of the clusters was not revised during the repetition of the agglomerative algorithm (Altman 2024). In our analysis, aside from involving all 20 Eurozone countries separately in the sample, we also included the Eurozone average to find which countries belong to the most representative group of the Eurozone concerning inflation components. The 21 observation units were agglomerated into seven clusters, because this number of clusters proved to be most adequate for separating at least two major groups of countries. Data were normalized based on z-scores. The cluster analysis begins with the first quarter of 2019 and ends with the fourth quarter of 2023 to shed light on the dissimilarities in how the highinflation environment affected Eurozone countries in the years before and after the outbreak of the Russia–Ukraine conflict and the ensuing energy (and food) crisis. The clusters are based on the major components of the consumer basket used to measure HICP: clothing and footwear; communication; education; alcoholic beverages and tobacco; food and non-alcoholic beverages; furnishings, household equipment, and routine house maintenance; health; housing, water, electricity, gas and other fuels; miscellaneous goods and services; recreation and culture; restaurants and hotels; and transport. Data were collected from the ECB Data Portal. The monthly inflation rates were arithmetically averaged to obtain quarterly values. While clustering individual countries, we did not consider the HICP weights. By analysing the inflation components quarterly, we observe both country-specific and seasonal characteristics of inflation. It should be noted here that the average Eurozone inflation rates are averages weighted by the size of the final consumption of the economies included; therefore, inflation in the larger member countries is a proxy for the Eurozone average.

We also calculated the standard deviation of the monthly inflation rates across Eurozone economies to determine which components of the HICP were the most volatile during the period examined.

#### **Results of the analysis**

Based on the clustering results, we can ascertain that the low- and high-inflation periods showed dissimilar patterns; however, no repeating seasonal (quarterly) behavior of country groupings could be observed. As 4-5 countries typically do not belong to any cluster in the quarterly samples, we found using seven clusters as the optimal point for evaluating the results, as by this number, mostly a minimum number of two but very often 3-4 well-identifiable clusters could be marked off. Countries which did not follow suit with any other member states were considered 'outliers' (see in Appendix, Table A1 for detailed results). Based on the 20 quarters examined, Spain is the most representative country of Eurozone inflation dynamics, as it never separated from all other countries and only joined another group of countries different from the Eurozone average in 2023 Q2. The second most stable Eurozone members are Germany and France (deviating only twice from the major group, once as an 'outlier'; France in 2020 Q1 and Germany in 2021 Q3). Italy, Belgium and Finland stayed mostly in the dominant Eurozone cluster as well, showing only 'individualistic' behavior in the 2022-2023 high-inflation period. Austria joined a Central European cluster five times, instead of the main Eurozone group, out of which three instances happened in the year 2023. Luxembourg went together with Southern and Central European clusters six times out of the 20 observations instead of keeping with the 'mainstream'. Portugal and Croatia were less stable, showing extreme values or joining other than the main Eurozone group, only six to seven times altogether, out of which six occurred in the case of Croatia and five in Portugal during the 2022-2023 period.

The Netherlands and Ireland show the most distinctive characteristics in the dynamics of their main inflation components. In over 10 cases, they do not belong to any cluster, and in at least 15 times out of the 20 quarters, their inflation processes

are different from the Eurozone average. The special tax regimes in the Netherlands and Ireland significantly impact the economic structure of these countries, which may also lead to differences in HICP developments in these economies (Tatay et al. 2022).

Among the old EU members, Greece was the sole player seven times. Estonia and Lithuania do not belong to any cluster 10 times, along with Slovakia 7 times and Malta 6 times out of the 20 observations. Latvia, Estonia and/or Lithuania form a 'Baltic cluster' in half of the groupings sometimes with non-Baltic countries together which can be fairly described as a Central European group in 2023 with Slovakia, Slovenia three times and even Croatia and Austria joining twice. Cyprus is the second most frequent after Latvia (nine times) and belongs to a cluster different from the Eurozone average which mostly pools other Southern European countries (Greece, Malta, Italy, France, and Portugal). This 'Southern cluster' coincides with the group of Baltic countries in 2020, but in 2023, it goes separately with Luxembourg, Finland, and Ireland as members. Conversely, in 2021 and 2022 Cyprus enrolls with the Eurozone average, and the 'Southern cluster' disappears. Slovakia also goes in separate ways in the majority of the cases (nine times in a different cluster and seven times solo), detaching from the Baltic group after the first quarter of 2019 to join forces with Slovenia, Austria, or Croatia, and then returning to the Baltic group in 2023.

Overall, the largest Eurozone economies unequivocally define the evolution of headline inflation in the monetary union. This is mainly because of the weighting used in the calculation of the Eurozone HICP, as mentioned above. The new members who joined after 2007, one following the other, still show a divergent inflationary pattern which mostly manifests in high-inflation periods which especially seen in 2022-2023. Nonetheless, with the Netherlands and Ireland recording the most dissimilar inflation sub-indices, the inflation convergence process reveals a more nuanced division line in the Eurozone than one that simply separates old and new members. Interestingly, Slovakia did not become an outlier from the Eurozone with its above average overall inflation rate in 2020 Q1 and Q2 (2.9% and 2%, respectively); only Lithuania (2.5%) stood out as the second most inflationary economy in 2020 Q1 and the Netherlands (1.27%) in 2020 Q2, whereas the lowestinflation countries (Greece, Cyprus, and Estonia) formed a separate cluster in 2020 Q3 and Q4, not including Ireland, with negative inflation rates. From 2021 Q2, Estonia, Latvia, and Lithuania started producing above-average HICP rates because of high transport, housing, and energy price increases. Estonia and Lithuania still belong to the same cluster in 2021 Q3 and Q4, and Latvia and Lithuania in 2021 Q2. In general, Latvia was closer to the Eurozone average in 2021, and Estonia had very low inflation in communication at the same time and high price increases in education. In 2022, Slovakia, Croatia, and the Netherlands often approached the Baltic countries in the overall CPI; however, only Slovakia and Latvia merged into the same cluster. The Baltics only reunited in 2022 Q4 when all inflation components reached above

10% levels, apart from clothing and communications lagging continuously behind, whereas Estonia and Lithuania remained outliers in most quarters in 2022. In 2023, Austria, Croatia, and Slovakia had comparably high inflation rates, with the Baltic countries often joining the same cluster as Latvia and Lithuania and even exceeding their rates by the end of the year. While inflation pressure in housing, energy, and food prices, and restaurant and hotel services were continuously easing, transport became even cheaper in the Baltic countries. In Austria, Croatia, and Slovakia, food inflation persisted and spread to the catering business. Estonia only converged to the other two neighbouring countries in the last quarter of 2023 in the same cluster, by the time all individual indices dropped below 10%, probably because clothing and furnishing experienced significantly higher inflation, while restaurant and hotel services experienced significantly lower inflation than the average of the Baltics, with housing and energy costs starting to decrease earlier.

As is clearly observable from quarterly statistics, the countries with the highest inflation figures between 2021 and 2023 experienced the most extreme price changes (sometimes even in negative territories) in education, communication, food, housing, utility services, fuel, and transport, while the dispersion of inflation was highest in the same components (see in Appendix, Table A2). In the overall period (2019-2023), the monthly dispersion of inflation rates, on average, was greatest in the sub-index of housing, utilities and fuel, and second greatest in education; the maximum value was reached in August 2022 for the first category and in May 2019 for the second category. Transport, food, and clothing also had higher-than-average standard deviations, whereas less volatility was detected in furnishing, health, and miscellaneous goods and services. The monthly inflation rates of member states deviated by 2-3% in most of the inflation components from the mean on average. This finding seems to be mostly consistent with that of ECB (2003) in recent years; a significant portion of the monthly inflation differences are explained by administrative prices and policy regulations. Among the Eurostat data series on administrative prices, the following categories enjoy priority: water supply, refuse and sewage collection, electricity, heat energy, and combined passenger transportation. The Baltic countries, Croatia, Slovakia, and Slovenia, have a relatively high share of regulated prices in all these categories (especially heat energy), except for transport, where only Estonia and Slovenia have some intervention. Ireland does not have such regulations. The rest of the countries apply non-market pricing more moderately with different emphases (water is more important in the Southern countries, heat energy in the Northern ones, and sewage and refuse collection and transport in Austria, France, Germany, Greece, Italy, Luxembourg, Portugal, and Spain). Interestingly, Belgium and Ireland have the highest (generally above 30%) shares of regulated prices for hospital services. Additionally, Luxembourg and Lithuania underwent significant indirect tax rate modifications from 2022 onwards, with Luxembourg introducing sharp tax rate increases and Lithuania introducing tax rate cuts based on the difference between the baseline HICP and HICP at constant tax rate figures of the Eurostat. Furthermore, Latvia and the Netherlands implemented major tax reforms during this period.

In the long run, it is not only the share and diversity of administrative prices that may account for above- or below-average inflation dynamics. In the Baltic countries and Slovakia, we can observe a continuous appreciation of the real exchange rate (counted against a 36-country basket) over the entire period considered, and Croatia and even the Netherlands often show similar characteristics in periods when the entire Eurozone follows a depreciating tendency. These countries all have high (above 100%) trade openness, and Slovakia's export and import activities are only exceeded by Luxembourg, Ireland, and Malta for all partner member states and by none outside the Eurozone (we have no data for Malta in this case). Outside Eurozone destinations, trade is an important source of income for Luxembourg and the Baltics, closely following Slovakia. This high level of trade openness, accompanied by a lower initial level of productivity, suggests a strong manifestation of the Balassa-Samuelson effect in postsocialist countries. To better capture the possible presence of the effect, we construct a non-tradable to tradable price index from the HICP components and observe real productivity growth figures. Between 2019 Q1 and 2021 Q3, the price ratio of nontradables to tradables was always greater than one in Estonia and Lithuania (apart from 2020 Q2 in Estonia) and between 2020 Q3 and 2022 Q1 in Latvia and Slovakia. Between 2022 Q2 and 2023 Q2, the opposite was observed (tradable price increases exceeded non-tradable dynamics) in the Baltics (but not in Slovakia). Ireland showed patterns very similar to those of the Baltic countries, although with a continuously depreciating real exchange rate in non-crisis periods. In 2023 Q3 and Q4, all countries in the Eurozone experienced a greater upswing in domestic services than in internationally competitive products. In the quarters preceding the outbreak of the Russia-Ukraine conflict, Estonia showed an above-the-Eurozone average productivity growth every quarter, while Latvia, Lithuania, and Slovakia went below it only twice; after 2022 Q1, the Baltics suffered a much stronger downfall than the rest of the currency zone. Ireland behaved similarly to the Baltics with even more extreme figures, but among the countries with above-average trade openness and/or real exchange appreciation, Malta, the Netherlands, Luxembourg, and Croatia had no salient productivity increases in general. The case of the Netherlands is the most peculiar: its overall HICP is among the highest in the Eurozone on average which is mostly due to sharply changing alcoholic beverages and housing expenses accompanied by mostly declining communication prices both before and after the onset of the energy and food crisis, while the sharply falling educational prices before the crisis turn to above 50% quarterly increases from 2022 Q4. Despite these particularities, the Balassa-Samuelson effect is still seemingly able to explain the differences in inflation dynamics, but not in times of energy and food price shocks.

Depalo–Lo Bello (2024) confirms that protuberant inflation in the years between 2020 and 2023 is largely due to simultaneous energy and food price increases and shortages and, to a much lesser extent, due to domestic labour market tensions.

Simultaneously, diverging national price-control measures and tax policies have had significant impacts on the timing of inflation shocks in individual economies. According to Eurostat, considerable variation exists in the energy mix across countries. Therefore, energy dependence does not explain the clustering of member states during the period under review.

#### Conclusions

According to the literature on inflation dispersion in Eurozone economies, geographic vicinity, trade openness, and economic convergence through the Balassa–Samuelson effect largely explain the dissimilarities in inflation processes. However, as the cluster analysis in this study demonstrated, similar inflation patterns can evolve in countries catching up from lower initial welfare levels, as we experienced in the case of Baltic countries and the most advanced member states owing to similar exposure to external inflation shocks such as energy and food inflation. While Spain, Germany, and France remain mostly together with the Eurozone average, partly because they carry the greatest weight in the calculation of the Eurozone average, the Netherlands and Ireland are the most different from the rest of the currency zone. The reasons behind the divergent inflation drivers also seem to be related to economic or price regulations, especially energy policy, energy dependence, the structure of traded goods, public services, and taxation. Our analysis shows that this is particularly measurable when inflationary shocks occur.

Many products and services in consumer baskets are non-competitive. These include a part of the educational services, housing and utility services, restaurant services, local transport. Future price changes for these goods may vary significantly across countries. Changes in price ratios may also imply changes in consumer baskets. Monetary policy targeting inflation in the Eurozone essentially follows the path of the biggest advanced economies because of the calculation weights of the average HICP in the Eurozone. However, the HICP values of some member states, especially smaller ones, may differ significantly from the average HICP, as confirmed by our cluster analysis. The ECB's toolbox does not allow it to deal with such deviations adequately. Their effect on the Eurozone HICP headline is negligible. This could place a different burden on households and companies in individual member states and could damage the growth prospects of some economies, mainly through the appreciation of the real exchange rate, credit booms, and an increase in real public debt in low-inflation economies.

The inflation rates in small member states can thus significantly differ from the Eurozone average. As the ECB bases its policy actions on the average inflation rate in the Eurozone, significant deviations may occur from the optimal policy actions that can be justified based on the situation of small member countries. This carries considerable adjustment risks, which is particularly evident if the starting point for inflation is non-monetary. Therefore, small, less-developed, and more vulnerable economies should make responsible decisions when they commit to entering the Eurozone.

# Appendix

Figure A1







Rates of price increases for each product category in the three countries with the highest HICP values in 2022



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Rates of price increases for each product category in the three countries with the highest HICP values in 2023



routine house maintenance Source: ECB (2024), own editing.



- Housing, water, electricity, gas and other fuels
- Miscellaneous goods and services
- Recreation and culture
- Restaurants and hotels



#### Table A1

Cluster classifications of euro area countries between 2019 and 2023

Year	Q1	Q2	Q3	Q4
2019	Outliers: CY, IE, LT,	Outliers: NL, SK, EL,	Outliers: EE, LT, MT,	Outliers: EE, LT, NL,
	NL, EL, MT	IE, CY	NL, EL	IE, LV
	2 clusters	2 clusters	2 clusters	2 clusters
	1. cluster: Eurozone	1. cluster: Eurozone	1. cluster: Eurozone	1. cluster: Eurozone
	average	average	average	average
	3. cluster: EE, LV,	3. cluster: LV, LT, EE	2. cluster: PT, IE, IT,	7. cluster: SI, SK
	LU, SK, SI		CY	
2020	Outliers: LT, IE, EE,	Outliers: IE, EE, LT,	Outliers: IE, LT, MT,	Outliers: IE, LT, NL,
	EL, FR	MT, PT	NL	SI
	2 clusters	2 clusters	3 clusters	3 clusters
	1. cluster: Eurozone	1. cluster: Eurozone	1. cluster: Eurozone	2. Eurozone
	average	average	average	1. SK, LU, AT
	2. cluster: CY, MT	2. cluster: LV, EL, CY	2. cluster: CY, EE,	3. LV, EL, CY, EE
			EL, LV	
			7. cluster: SI, SK	
	Outliers: IE, EL, CY,	Outliers: SK, GR, IE,	Outliers: DE, SK, MT,	Outliers: SK, MT, NL,
	NL, LV	PT	SI	SI
2021	2 clusters	3 clusters	3 clusters	3 clusters
2021	1. cluster: Eurozone	2. cluster: Eurozone	2. cluster: Eurozone	1. cluster: Eurozone
	5. cluster: SK, LT	1. cluster: LV, LT, AT	1. cluster: AT, BE, LV	2. cluster: LV, DE
		3. cluster: MT, EE	4. cluster: LT, EE	3. cluster: LT, EE
	Outliers: LT, SK, NL,	Outliers: EE, HR, LT,	Outliers: EE, HR, LT,	Outliers: IE, IT, NL,
2022	EE	NL	PT	PT
	3 clusters	3 clusters	3 clusters	3 clusters
	1. cluster: Eurozone	1. cluster: Eurozone	1. cluster: Eurozone	1. cluster: Eurozone
	3. cluster: IE, FI	5. cluster: LU, SI	2. cluster: IE, FI, BE	2. cluster: LV, LT, EE
		6. cluster: LV, SK		3. cluster: HR, SK
	Outliers. EE, HR, NL	Outliers: EE, EL, BE,	Outliers: NL, FI, IE,	Outliers: IE, HR, SK
	4 clusters	NL	PT, EE	3 clusters
2023	2. cluster: Eurozone	3 clusters	3 clusters	4. cluster: Eurozone
	1. cluster: AT, EL	1. cluster: Eurozone	2. cluster: Eurozone	1. cluster: SI, LV, LT,
	3. cluster: MT, LU, IT,	3. cluster: PT, LU, IE,	1. cluster: SI, SK, LV,	EE, AT
	IR, FR, CY	ES, FI, CY	LT, HR, AT	3. cluster: PT, FI, CY
	6. cluster: SK, LV, LT	6. cluster: SK, SI, LV,	3. cluster: LU, MT, IT,	2. cluster: BE, NL
	1	LT, HK	EL, CY	

Notes: In the table above 'outliers' are countries which do not belong to any cluster with other member states. The numbering of the clusters only indicates the phase at which they separated from other countries until seven different units were identified.

The most stable countries in line with Eurozone inflation: DE (outlier: 2021 Q3, once in a separate cluster in 2021 Q4); FR (in 2020: outlier, in 2023 in a separate cluster); IT (in separate cluster: 2023, 2019, outlier in 2022); ES (separate cluster: 2023); BE (separate cluster: 3, outlier: 1 – 2023); PT (separate cluster: 3, outlier: 4); LU (separate cluster: 6); FI: (outlier: 1-2023, separate cluster: 3).

The most extreme countries. IE: (outlier: 12 out of 20), separate cluster: 5); NL: (outlier: 14, separate cluster: 1); EE: (outlier: 10, separate cluster: 10, separate cluster: 10); MT (outlier: 6, separate cluster: 4); EL: (outlier: 7, separate cluster: 5); SK: (outlier: 7, separate cluster: 9); LV: (outlier: 2, separate cluster: 14); CY: (outlier: 3, separate cluster: 9); SI (separate cluster: 7, outlier: 3).

#### Table A2

	13
Standard deviation of monthly inflation rates in the Eurozone (20	))
between 2019 and 2023	

Inflation component		Minimum	Average
Alcoholic beverages, tobacco		1.52	2.39
Clothing and footwear	6.57	0.88	2.69
Communication		1.88	2.84
Education		2.54	6.33
Food and non-alcoholic beverages		0.86	2.56
Furnishings, household equipment and routine house maintenance		1.03	1.77
Health		0.99	2.10
Housing, water, electricity, gas and other fuels		1.67	7.04
Miscellaneous goods and services		0.99	2.14
Recreation and culture		1.88	2.84
Restaurants and hotels		0.95	2.64
Transport		1.10	2.96

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