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Exposure and preparedness for wartime inflation in the EU: Retrospective cluster analysis

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ABSTRACT

The impact of the Russian-Ukrainian war on energy prices contributed significantly to European price increases in 2022. The study aims to find a linkage between the performance of 24 EU countries during the energy inflation crisis and their preparedness, vulnerability or exposure. The verified hypotheses reflect on the role of initial conditions of countries and the one-year impact of energy inflation on their economic performance. The two-step analysis first creates six clusters of countries based on their energy, trade, financial and political vulnerability, and preparedness indicators. The second step is to explore the shifts of clusters in expectations on macroeconomic indicators. Specific patterns of country groups are explored in the value and evolution of wartime indicators of inflation, GDP growth, consumer and business confidence, as well as FX volatility. The exploration concludes that the entry variables of clustering are relevant, and the EU countries can be segmented by dependency, energy, financial, and political aspects. Thus, it is possible to verify the distance in risk and exposure among EU economies. The impact variables demonstrated that the extent of the inflationary effect depended on the initial conditions. In addition, the research identified protective short-term factors against energy inflation originating in a trade and war context.

KEYWORDS

inflation, war, EU, cluster analysis

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1. INTRODUCTION

Inflation in Europe remained low in the 2010s after the shock of the global financial crisis. The trend of economic recovery and upturn had continued for more than a decade, and was accompanied by global price stability. The age of a riskless European business environment was terminated first by the COVID-19 crisis in 2020 then by the Russian-Ukrainian war in 2022. Consequently, the period characterized by stable prices and moderate economic growth was followed by high inflation and economic slowdown. Although inflationary pressure became a general challenge in 2022 and 2023, its magnitude varied among countries.

There can be several factors enhancing inflation rates. The current study inquires a linkage between the inflation caused by an energy price shock as a side effect of the sanctions on Russia following its invasion of Ukraine, and the pre-war European national exposure to Russian trade and internal economic, political and structural risk factors. The conclusion made by Ferber (2023: 150) legitimates the discussion on energy inflation, namely his statement that monetary policy faces such inflation factors which '*cannot be tackled with monetary policy measures*', which made market expectations to '*decouple*' from central bank targets. The insufficiency of monetary policy was already underlined by Lepetit and Fuentes-Albero (2022) as inflation originated in real economic processes (the impact of the inflation shock is assumed to be influenced by the policy reaction). The current aim is to explore phenomena helping the EU economies from the perspective of exposure and effective policy. The idea and structure of the study are based on Czeczeli et al. (2020) focusing on the short-term preparedness for the COVID-19 crisis.

The study includes 24 EU economies. The methodology is based on multidimensional cluster analysis based on the following six input variables in the year 2021: share of renewables and biofuels in the total energy consumption;[1] weight of import from Russia in total national imports; share of Russian sources in national energy import; 5-year government bond spreads in comparison to German bonds at the end of 2021; number of coalition parties in the national government; and the annual rate of change in inflation rates.

The clustering facilitates the identification of patterns in the wartime inflation rates and the macroeconomic outcome of policy reactions a year later. The following seven impact variables were applied to demonstrate the behavior of the clusters during the first war year: HICP inflation rate; business confidence; consumer confidence; real GDP growth; exchange rate volatility; unemployment rate; and current account position.

The comparative analysis focuses on the amount of movement that the clusters experienced in the first year of the war. The initial hypothesis is that the current inflationary situation was determined by both the entry conditions before the price shock and the anti-inflationary policy actions. The main subject of the study is the quality of entry status immediately prior to the war, which originated in the pre-war policy measures made in a golden age of price-stability. The gist of the assumption is that, regarding the EU economies, differences and similarities can be revealed by surveying the pre-war preparedness and exposure and the macroeconomic impact of the war.

[1] Balsalobre-Lorente et al. (2023) focused on the impact of the sanctions against Russian oil and gas on the renewable energy adjustment. Their results support the inclusion of renewables into the impact analysis.

The structure of the paper is the following. Section 2 contains the literature review about the causes of the inflationary processes in the 2020s. In Section 3, the methodology of the research and the data are presented respectively as the bases of cluster creation. Section 4 provides an overview about the development of the entry variables and the behaviour of the clusters. Furthermore, there is an evaluation on the effects of the war on the impact variables. Section 5 concludes and discusses the findings in light of the previous literature. In the conclusions, it is emphasized that the highest rise in inflation occurred in the Central and Eastern European countries with the highest pre-war exposure to Russia and post-Soviet historical background and path dependency. Consequently, the paper argues that the inflation trend is caused by both the pre-period entry conditions and the policy reactions. The research ascertained that anti-inflationary measures taken during the first year of the war were not able to exert their effects in an effective way since the they could not prevent the energy price shock to turn into food inflation in the consecutive year as a contagion. Notably, the improvement of the quality of the economic policy measures is a necessity.

2. THEORETICAL AND EMPIRICAL BACKGROUND

First and foremost, it must be admitted that energy inflation caused by the war is not the only factor behind European inflation. The fragmentation of supply chains (Akinci et al. 2022), the stagnation and structural shifts in demand, global and regional supply shortages of certain products, the trends in the US dollar's exchange rate, and finally the reopening and revitalization of the Chinese economy all together presumably contributed to the acceleration of price increase. Kalemli-Özcan et al. (2022) highlight the importance of four factors causing high inflation. The first is the compositional effect, namely, that consumption shifted from services to products. Second, despite robust demand for goods, there has been weak correlation between foreign and GDP recovery in 2022. This phenomenon can be attributed to bottlenecks in the global supply chains. Third, structural labor shortages may also be the cause of inflation through wage pressures on the cost of production and services. Fourth, regarding euro area inflation in 2020/2021, foreign shocks and global supply chain issues played a more important role than the domestic shocks of aggregate demand. These four arguments demonstrate the outstanding significance of negative sectoral shocks among the causes of steep inflation. Consequently, the policy measures caused additional inflation which were in order to stimulate demand and compensate the loss in income.

Beyond the four arguments above, the current analysis presumes that the Russian-Ukrainian war, which created supply-side barriers and consequently multiplied energy prices in 2022, was one of the major causes of European inflation. Bobeica et al. (2023) identified the factors of euro zone inflation, and from their conclusion, impacts of two events are explicit and recognizable. First, long before the war, energy prices began to rise and led to inflation since April of 2021. Second, nonetheless, the outbreak of the war massively accelerated energy inflation and kept its 30–40% share among the factors behind price increases until the end of 2022. Meanwhile, in parallel, food inflation started to become the dominant source of consumer inflation in the second half of 2022. Moreover, after decomposing the inflation factors to sensitive and non-sensitive industries for energy price, the high energy inflation massively determined inflation indirectly in the first months of 2023, through the energy-sensitive industries (see Fig. 2 in

Czeczeli et al. 2023). A Wavelet analysis by Andreani and Giri (2023) confirmed the prolonged effect of energy inflation and indicated a multi-year frequency band of energy price shocks. Furthermore, Huntington and Liddle (2022) calculated that rising energy cost actually can have a long-term detrimental impact on economic growth. Their research on OECD panel data revealed a trade-off between energy inflation and recession, with a 10% energy price increase causing a 0.15 percentage point reduction in growth.

According to Claeys and Guetta-Jeanrenaud (2022), the primary driver of inflation in Europe were the large increases in energy costs since the beginning of 2021. However, similarly to the varying headline inflation, consumers suffered substantially diverse energy price increases across countries. Hobijn et al. (2022) also highlighted regarding Europe that the cost of food and energy played a decisive factor in rising inflation. There were 20 out of 26 European countries where more than 50% of the acceleration in inflation was attributable to food and energy price changes. There were other co-movements in price instability related to income expansion due to fiscal stimulus and wage rigidity in tight labor markets. The commodity market has proved to be an important determinant too, as commodities are usually denominated in US dollars. Due to the appreciation of the dollar, commodity prices – including food, energy or construction materials –increased almost in all other countries. The magnitude of this effect on macroeconomic indicators depends on the energy intensity of the individual countries.

Several studies made attempts to estimate the weight of inflation factors in different dimensions. Giovanni et al. (2022) concluded that 40% of the price increase can be related to supply and 60% to demand factors. The inflationary effects of deglobalization (Rogoff 2022) and the expectations can be highlighted, too (Haidari – Nolan 2022; Bernanke 2022; Bonatti et al. 2022; Mester 2022; Coibon et al. 2020). Based on the collection by Czeczeli et al. (2023), eight groups of European policy measures can be distinguished: fuel price control, energy price control, food price control, interest rate and wage control, measures related to taxation and subsidies, price compensation, one-time allowances, and the adjustment of supply and demand.

The following hypotheses motivated the current research based on the theory and empirics cited above:

- The first hypothesis is that initial economic conditions determine the national reaction capability and, thus, the extent of the negative economic impact of the war. Consequently, clusters of EU countries can be segmented according to entry variables just before the wartime.
- The second hypothesis is that the impact variables reflect the deterioration of economic state, to varying extent.
- The third hypothesis is that the homogeneity of clusters in terms of impact factors changed throughout the first year of the conflict, as evidenced by the difference in minimum and maximum values in the clusters.

3. METHODOLOGY AND DATA

The initial framework of the methodology is a cluster analysis. Its purpose is to elaborate and reveal the economic conditions and the degree of pre-war exposure of EU economies to Russia. The segmentation of country groups allows for conclusions to be drawn about the similarities

and differences in preparedness and trends connected to the price shock of the war. The number of EU countries can be considered to be a small sample, that is why it is reasonable to use hierarchical clustering. Grouping was based on six entry variables. These variables represent the following characteristics:

- Exposure to Russia regarding energy imports and total imports. The European countries have been buyers of Russian crude oil, natural gas and refined oil products, in various dependencies inherited from the pre-war decades. This market is particularly endangered physically by the war, limited by EU sanctions and determined by the availability of the rest of the world's fossil energy supply.[2] The total import from Russia represents the overall trade dependency of European economies. The higher the Russian share in a national energy imports or total imports, the bigger the exposure and risk.
- Energy exposure measured by the share of renewables. Local renewable energy capacity is a crucial factor in reacting effectively to inflation and shortage of supply in the case of transportable fossil energy.
- Domestic fundamental risk is indicated by the government bond spreads. Energy inflation resulted in the necessity for the rise in fiscal spending and subsidies. The initial default risk determines the cost and room for fiscal expansion (implicitly, it represents the relative riskiness of public debt considered by the market).
- The initial level of inflation before the war includes all inflationary impacts which were implied by the economic revival following the COVID-19 crisis and lock-down, the frictions in global supply chains, or fiscal and monetary policies. This can be deterministic on the initial level of the energy inflation impact of the war.
- Number of coalition parties in the national government expresses the political room for maneuver. As the short-term capability for reaction is in focus, this political indicator attempts to include the institutional rigidity and complexity of policy decision-making. It can be noted that according to Hagen and Harden (1996), more parties in the coalition weaken the discipline of the government. Meanwhile, Alesina and Perotti (1999) established that coalition governments are more likely to postpone fiscal adjustment than single party governments. This is called '*non-cooperative free rider decision making*' by Hughes-Hallett et al. (2003).

Each of the variables can be measured on a metric measurement scale. Accordingly, the Ward procedure is applied which is a merging hierarchical clustering method.[3] Distance was calculated by the square Euclidean distance.[4]

The process of data collection revealed that Czechia, Lithuania, and Luxemburg were outlier countries. For methodological reasons, these countries are not included in the database. The period prior to the war is one year long and refers to April 2021 and March 2022. The entry variables for clustering are the following:

[2]Xin and Zhang (2023) demonstrated the economic regression impact of imposing sanctions or loosing trade networks with an evolutionary game modelling.

[3]During the merging process, based on the pre-calculated and aggregated distance values, the clusters with the lowest increase in variance within the cluster are merged. When using a hierarchical clustering method it is necessary to take into account and filter the outliers before the formation of the clusters. One possible way is to use the shortest distance method (Simon 2006; Sajtos – Mitev 2007).

[4]Euclidean distance formula: $d(x,y)^2 = \sum_{k=1}^{n} (x_k - y_k)^2$.

- RUEN: share of Russia in energy imports of the country, %, 2020;
- RUIMP: share of Russia in the imports of the country, %, 2021;
- RENEW: percentage of total energy consumption made up of renewables and biofuels, based on Eurostat data. This indicates how much a country depended on renewables in its energy mix in 2020;
- INFL: annual average rate of change in the all-items HICP indicator, at the end of 2021;
- SPREAD: 5-year government bond premia compared to German bonds at the end of 2021;
- POL: number of parties in the government collation at the end of 2021.

After the clusters are separated, seven additional short-term economic impact variables of the impact of the war are analyzed: inflation, GDP, unemployment, current account, consumer confidence, business confidence, and foreign exchange volatility. The period of the impact variables is one year, between April 2022 and March 2023, as the first short-term period of war resulted in an energy price shock starting on the 24th February 2022, and macroeconomic variables applied are available in monthly or quarterly aggregation. The impact variables are composed to reflect the developments of the year following the outbreak of the war. Furthermore, it is important to mention that not merely the impact, but the entry characteristics are part of the evaluation as well. The assumption is that preparedness and exposure created differences among EU countries regarding both the entry and the impact variables of the war, and the differences can be revealed. The impact variables are the following:

- HICP: annual rate of change in all-items HICP inflation, on a monthly basis;
- GDP: real GDP growth rate on a quarterly basis, taking into account the annual rate of change;
- UNEMP: monthly and total unemployment rate, expressed in percentages;
- CA: current account balance as a percentage of GDP, on a monthly basis;
- CCI: consumer confidence indicator, on a monthly basis;
- BCI: business confidence index, on a monthly basis;
- FX: exchange rate volatility, measured by the monthly standard deviation of the currency exchange rate, non-eurozone countries to euro, eurozone members on the dollar/euro rate (Table 1).

4. RESULTS

4.1. The results of clustering

Each cluster was demarcated in an attempt to create the most homogeneous country groups possible. The results are illustrated with the dendrogram in Fig. 1.[5] To form the appropriate groups, it is necessary to conduct homogeneity tests and examine the standard deviation of the individual country groups in relation to the total standard deviation, to ensure the homogeneity of the clusters created. Based on all of these considerations, the version including six clusters

[5]The number of clusters can be determined several ways: based on the relative size of clusters, the elbow criterion and the distances (Sajtos – Mitev 2007). These aspects were all taken into consideration during the formation of clusters.

Table 1. Descriptive statistics

	Mean	Standard deviation	Min	Max	Data Source
RUEN	0.24	0.16	0.02	0.57	*Eurostat*
RUIMP	0.04	0.03	0.00	0.12	*ComTrade*
RENEW	0.20	0.12	0.02	0.49	*Eurostat*
INFL	0.03	0.01	0.01	0.05	*Eurostat*
SPREAD	42.79	36.67	0.00	141.20	*Bloomberg*
POL	3.50	1.73	1	7	*Google*
HICP	11.19	4.38	3.10	26.20	*Eurostat*
GDP	4.42	3.18	−4.40	13.10	*Eurostat*
UNEMP	5.90	2.48	13.00	13.00	*Eurostat*
CA	−1.86	7.25	−19.30	21.70	*Eurostat*
CCI	−26.13	9.72	−57.90	1.90	*Eurostat*
BCI	96.27	7.12	74.60	111.50	*OECD*
FX	0.24	1.09	0.00	7.48	*Eurostat*

Source: authors.

proved to be the most homogeneous. The assignment of the countries into clusters resulted in a distribution synthesized in Table 2.

As far as item numbers are concerned, the groups were created with almost identical sizes, including four or five and, in a single case, two countries. The separation of the clusters can be observed in Figs 2–5. During the formation of the groups, variables related to the extent of exposure to Russia can be considered as key indicators in three clusters (Fig. 2). These clusters are Cluster 1, Cluster 2 and Cluster 4. Figures 2 and 3 present the indicators related to energy exposure and price level, where the separation of individual clusters can also be observed (Cluster 1, Cluster 2, Cluster 3). Furthermore, the disjunction among the clusters is demonstrated by the inflation and the share of renewable energy as a composition of macroeconomic status in Fig. 4.

The group of figures composed in Fig. 12 in appendix present a comparative visualization of cluster homogeneity which includes the mean, the minimum and the maximum values of grouping variables per cluster. The following can be established about the entry status of groups of EU countries into the age of higher energy prices.

- Concerning RENEW, Cluster 3 and 6 are the most homogeneous.
- Regarding POL, clusters include various sizes of coalition governments. Thus, they are very heterogeneous regarding the political aspect, except Cluster 6, which is very homogeneous with single-party governments.
- In the case of RUEN, Clusters 1 and 2 are the most homogeneous, and they have the lowest value.

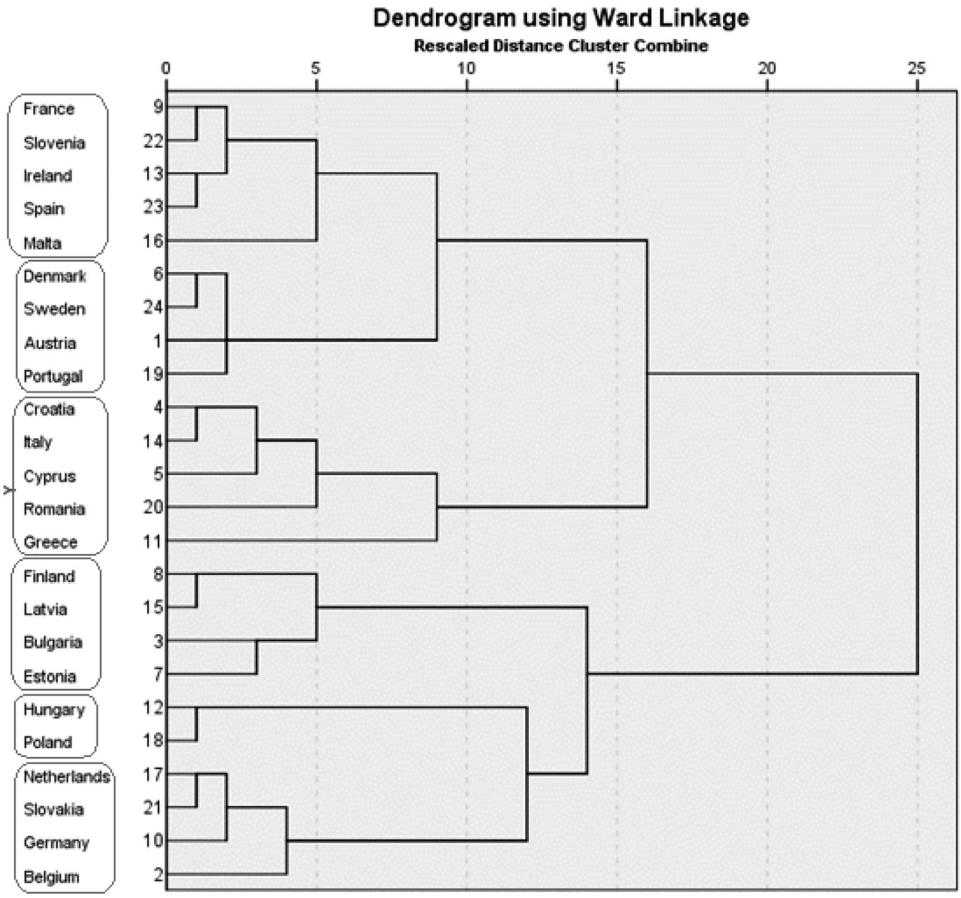

Fig. 1. Dendrogram of the cluster analysis
Source: authors.

Table 2. Clusters

Cluster 1: No trade dependency on Russia	France, Ireland, Malta, Slovenia, Spain
Cluster 2: High share of renewables	Austria, Denmark, Portugal, Sweden
Cluster 3: Low spread with energy exposure to Russia	Belgium, Germany, Netherlands, Slovakia
Cluster 4: Flexible sensitivity to sanctions	Bulgaria, Estonia, Finland, Latvia
Cluster 5: High spread, average dependency	Croatia, Cyprus, Greece, Italy, Romania
Cluster 6: Most vulnerable	Hungary, Poland

Note: the designations are relative to other groups in each case.
Source: authors.

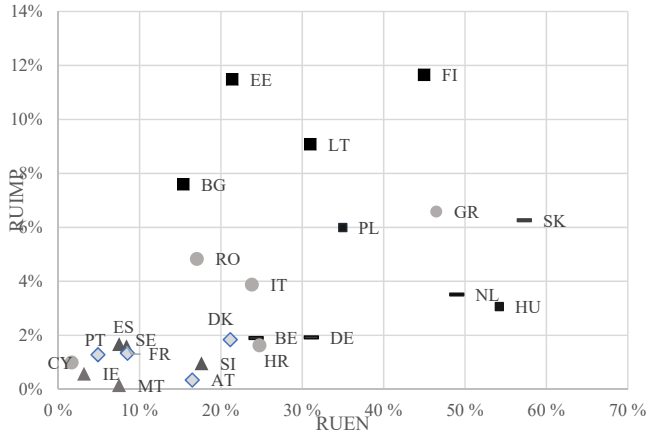

Fig. 2. Grouping according to imports of Russian energy (horizontal axis) and overall imports from Russia (vertical axis)
Source: authors, based on Eurostat data.

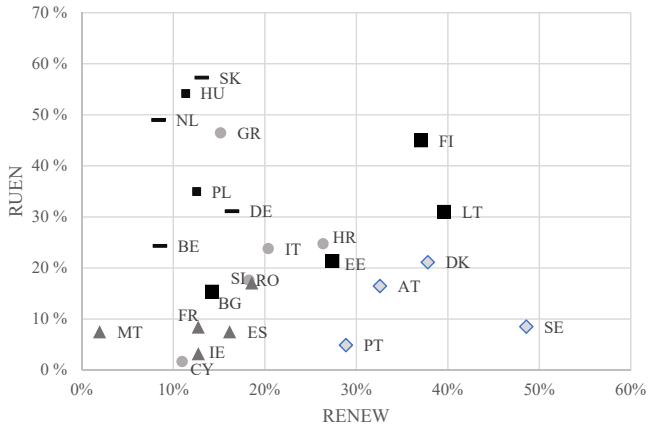

Fig. 3. Grouping according to the share of renewable energy resources (horizontal axis) and imports of Russian energy (vertical axis)
Source: authors, based on Eurostat data.

- Regarding entry inflation, it can be established that there are no big differences between the clusters, but it is the most homogeneous in the case of Clusters 3 and 6.
- The SPREAD values are quite homogeneous in the case of Clusters 2, 3 and 6.
- Regarding RUIMP, Clusters 1 and 2 are the most homogeneous, but there is no large heterogeneity anyway inside the other country groups either.

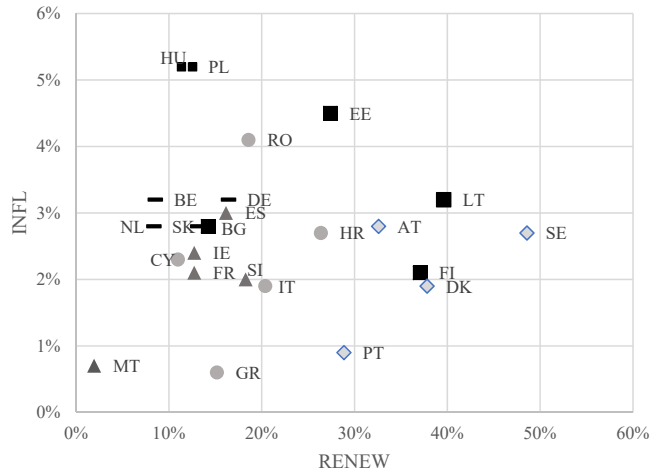

Fig. 4. Grouping according to the share of renewable energy resources (horizontal axis) and the inflation rate (vertical axis)
Source: authors, based on Eurostat data.

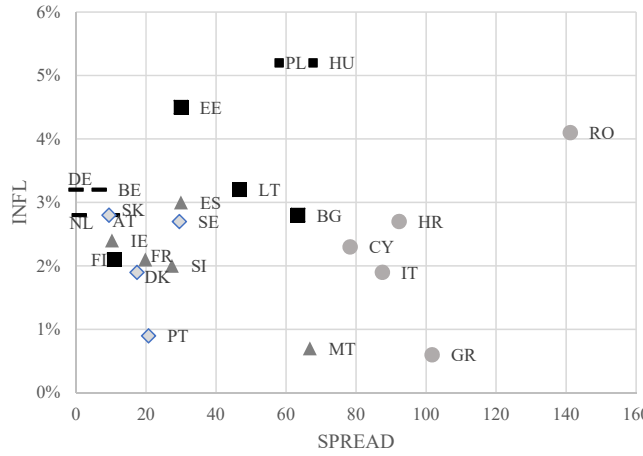

Fig. 5. Grouping according to the 5-year government bond spreads (horizontal axis) and the inflation rates (vertical axis)
Source: authors, based on Eurostat data.

4.2. Behavior of impact variables by clusters

Seven indicators assigned to all clusters were examined. Two moments of each indicator were compared, the year before and the year after the outbreak of the Russian-Ukrainian war. These comparative pairs are presented in Figs 6–11, where the minimum, maximum and mean values

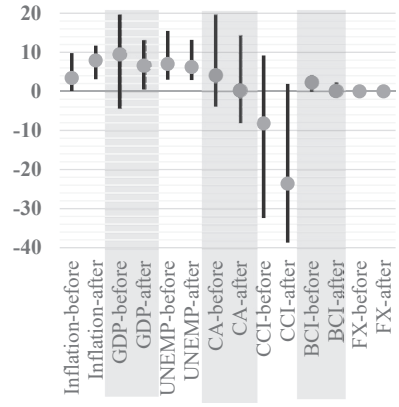

Fig. 6. Cluster 1 impact variables
Note: The edges of a candlestick indicate the minimum and maximum, and the dot indicates the mean.
Source: authors.

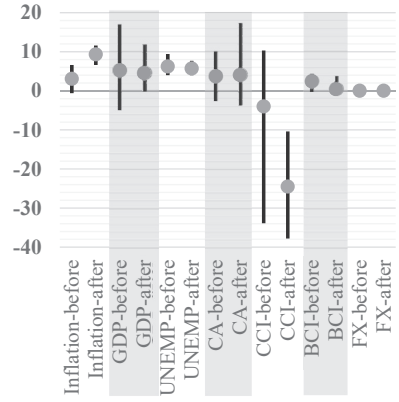

Fig. 7. Cluster 2 impact variables
Note: The edges of a candlestick indicate the minimum and maximum, and the dot indicates the mean.
Source: authors.

of the groups are indicated by candlestick charts. Mean consumer confidence, business confidence and corresponding GDP growth deteriorated after the war in every cluster. These developments clearly demonstrate the negative effects of the exogenous shock in 2022. It can be established that the unemployment ratio did not indicate risk, but it had a small decline in every cluster generally, and it behaved very homogenously inside the clusters. The exchange rate volatility did not change or indicate any risk in the first five clusters. It is important to note that including eurozone countries was a stability factor. Although Bulgaria is not yet in the eurozone, its FX peg secured a fixed rate, while, in the case of Croatia, the accession to the euro

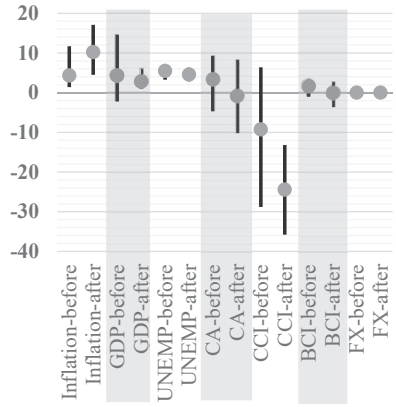

Fig. 8. Cluster 3 impact variables
Note: The edges of a candlestick indicate the minimum and maximum, and the dot indicates the mean.
Source: authors.

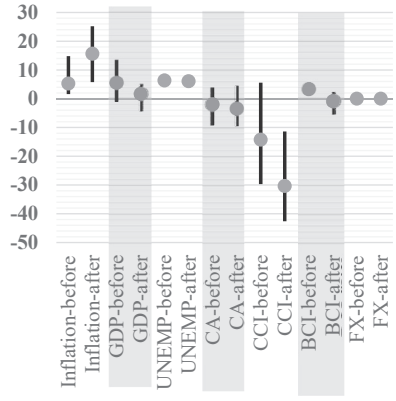

Fig. 9. Cluster 4 impact variables
Note: The edges of a candlestick indicate the minimum and maximum, and the dot indicates the mean.
Source: authors.

zone resulted in FX stability. In the case of Romania, Sweden and Denmark, the volatility was very low and faded into the cluster average.

Finally, it is a universal phenomenon that while consumer confidence experienced a big drop and reserved its high heterogeneity, business confidence shifted to a minimum extent, which can be named calm and stable. Moreover, BCI has been very homogenous, not only within the groups but among all of the countries included.

Figure 6 demonstrates the observable relationships in Cluster 1 (France, Ireland, Malta, Slovenia, Spain). The no-trade-dependency countries can be characterized with low imports from Russia, including low imports of Russian energy, relatively low levels of renewables, and

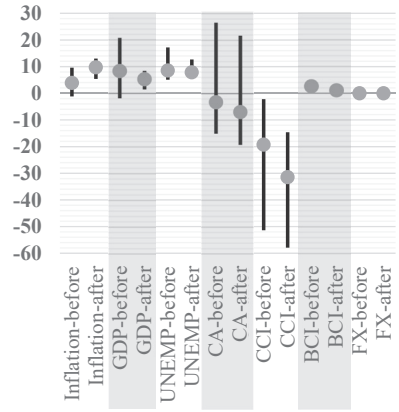

Fig. 10. Cluster 5 impact variables
Note: The edges of a candlestick indicate the minimum and maximum, and the dot indicates the mean.
Source: authors.

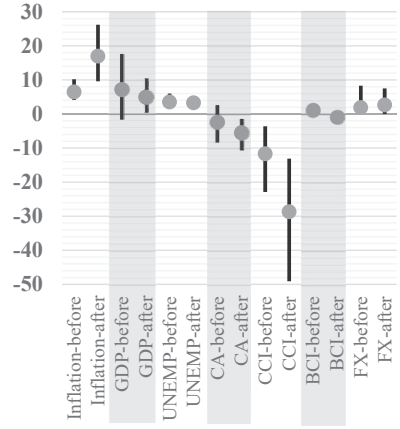

Fig. 11. Cluster 6 impact variables
Note: The edges of a candlestick indicate the minimum and maximum, and the dot indicates the mean.
Source: authors.

low initial levels of inflation. Their inflation rose but remained under 10%, the smallest among the clusters' averages. Average GDP growth declined, but still remained above 5% and the group became more homogeneous in this regard. Although they are named independent in trade with Russia, their current account deteriorated slightly.

Figure 7 represents the developments in Cluster 2 (Austria, Denmark, Portugal, Sweden). These countries have had the highest share of renewables in their energy mix. Similarly to Cluster 1, the initial level of inflation was low and did not exceed 10 percent, while the homogeneity of the group increased. Their average GDP growth did not decrease significantly, they

experienced the lowest decline, but it became more homogenous. Their consumer confidence index deteriorated. The unique impact is that their current account position improved, though, its heterogeneity increased.

Cluster 3 includes the countries with the lowest spreads on government bonds accompanied by high energy exposure to Russia (Belgium, Germany, Netherlands, Slovakia). From Fig. 8, the following features can be diagnosed about them. First, their average inflation was not significantly higher than in the previous two clusters (around 10% after one year of war), but its heterogeneity increased with a maximum of 17%. Their small GDP growth moderation took shape in absolute homogeneity. These countries suffered the largest decline in their current accounts. Consumer confidence decreased, business confidence remained heterogeneous.

Cluster 4 refers to the countries with relatively high exposure to trade with Russia and energy imports from Russia. Therefore, they are sensitive to the effects of trade and energy sanctions (Bulgaria, Estonia, Finland, Latvia). However, they also have a high initial share of renewables, which gave them an opportunity for flexible adaptation. Concerning their impact variables, they produced the second largest increase in inflation, the biggest deterioration in GDP growth, the second biggest decline in the consumer confidence indicator, the worst shift in the business confidence index and the smallest improvement (decrease) in the unemployment rate. The relatively high share of renewable energy (accompanied by their policy actions in 2022) did not save them from negative real economic effects. Homogeneity improved in the case of GDP growth but dispersed regarding inflation and BCI (see Fig. 9).

The members of Cluster 5 entered the period of the war with high risk expressed in spreads but without extraordinary dependency on Russia (Croatia, Cyprus, Greece, Italy, Romania). Besides the highest spreads, other entry variables were at the averages in comparison to other clusters. These countries experienced the second biggest decline in GDP growth, and their consumers became the most pessimistic. The distance between the minimum and maximum declined in case of GDP growth and inflation (Fig. 10).

Cluster 6 consists of two countries, Hungary and Poland, which had the highest entry inflation (5.2%), energy import dependency on Russian oil and gas above the average, accompanied by a low initial share of renewables. Only the single party governments strengthened their adaptation capability. That is why they are named the most vulnerable cluster. Based on the comparative examinations, it can be highlighted that this group experienced the largest exchange rate volatility and the highest increase in inflation, too. Partly, due to the initially very low level of unemployment, this decreased to the lowest extent, which is consistent with the highest level of inflation, which confirms the Phillips curve hypothesis. Furthermore, the cluster had to face the second largest drop in both consumer and business confidence. The heterogeneity of the group increased in the dimension of inflation and consumer confidence, while GDP growth, current account and FX volatility improved the homogeneity in dynamics (Fig. 11).[6]

5. DISCUSSION AND CONCLUSION

As Gros (2023) explained, energy inflation is complex. This is supported by this paper, which as a new aspect shows the importance of entry conditions, exposure and preparedness, using

[6]Figure 13 in appendix summarizes the most important conclusions of the previous paragraphs.

cluster analysis with entry and impact variables. The entry conditions selected in the survey confirm the statement by Ferber (2023) and Lepetit and Fuentes-Alberto (2022) that the energy inflation in 2022 was not manageable merely by the central banks. As entry conditions of trade and energy structure resulted in various levels of impact, the need for non-monetary instruments increased. Although the current conclusions focus on energy inflation and refer to the war many times, it is not in contradiction to Moessner et al. (2023) or Akinci et al. (2022), who emphasize the global factors beyond the war. Initial conditions proved to be deterministic concerning the global shocks on prices. Kalemni-Özcan et al. (2022) identified four factors of inflation, and the current exposure and preparedness model supplements it with a fifth one.

Regarding the hypotheses, first, the study proved that EU clusters can be created with initial conditions. The EU countries could be segmented, and the six entry variables were relevant. The Ward method resulted in six groups of countries by entry exposure to energy imports and overall imports from Russia, substitution capability with renewable energy, fundamental risk and preparedness demonstrated by initial inflation and bond spread, and finally, the institutional indicator of the composition of governments and thus their ability to swiftly enact policies. The clustering output indicated the distance in risk and exposure among the EU countries.

As a matter of the second hypothesis, the exploration of impact variables verified that the different clusters were hit by the sanctions against Russia and the energy inflation to various extents. Although the shifts usually happened in the same direction, the clusters reacted in different degrees. According to the cluster results, import and energy dependency on Russia strengthened the negative impact on inflation and current account imbalance. Consequently, trade and energy diversification was an effective preventive strategy to avoid the negative impacts of a non-economic conflict. In the case of declining consumer and business confidence, the initial value proved to be more deterministic than the threat of the war and energy inflation, but the scale of shift towards negative expectations differed among the clusters. The GDP growth ratio moderated differently too. However, euro zone membership or strict pegging to the euro was a stabilizer and a protective factor against inflation.

The candlestick diagrams supported the third hypothesis. In several impact variables, the clusters got through a change of deviation from the mean, which confirms the assumption that the homogeneity of the clusters was modified by the first year of the war. Nevertheless, there is no clear general tendency overall. It can be surely stated that GDP growth and unemployment became less dispersed in the clusters. The opposite happened with business confidence which's heterogeneity stagnated or increased. Current accounts mostly developed into a more heterogeneous mix, while FX volatility reserved its homogeneity.

Overall, the conclusion is that the larger the energy and import dependency on Russia was, the higher the increase in inflation in a cluster, although but lower initial inflation reduced the risk of this increase. In addition, the high share of renewables in the energy mix protected Cluster 2 against deterioration in GDP growth and the current account. Nevertheless, Cluster 4 demonstrates that countries with an appraisable share of renewable energy were not automatically saved from big moderation in GDP growth (it can be assumed that their geographical and trade position were factors, too.)

Inflation rates increased the most in the Central and East European countries, namely, in the Baltic countries, Hungary, Poland and Bulgaria, where the exposure to Russia was high anyway. These countries are similar in many features, including their path dependency, which can

explored by further research. Deeper linkages can also be the focus of future research, since the current study did not reveal causational effects. The various levels in the decrease in unemployment demands an exploration, too. This phenomenon might be linked to the price-wage spiral during high inflation. Likewise, the differing deterioration of current accounts deserves research, too. Finally, the general deterioration of the economic impact variables underlines that anti-inflationary policy measures during the first year of the war were not effective. Hence, it is a challenge for both policy and economics to improve the quality of preventive and reactive measures for price stability.

Broader conclusions can be extended from the findings. First, cluster movements demonstrate that rising inflation has always resulted in lower growth prospects, most likely due to cost inflation. Second, on the basis of the candlestick charts, rising cost inflation appears to create convergence between countries where the internal standard deviation of the country groups decreased in most indicators for negative trends. The third conclusion appears from the origin of the cost inflation shock, as it is caused by real economic – and, moreover, real external – factors, instead of nominal adjustment of prices. Consequently, national economic policy can prepare for cost inflation shocks by using real economic instruments (in the current case, real economic instruments mean for example parallel and alternative energy networks, direct investments). Nevertheless, in case of known risks, the prevention of cost inflation shock is possible. The war began not in 2022, but seven years earlier, albeit with lower intensity. Simultaneously, real economic instruments exclude the merely monetary solution of energy inflation, but prioritize the application of fiscal policy and its real-term instruments.

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Appendix

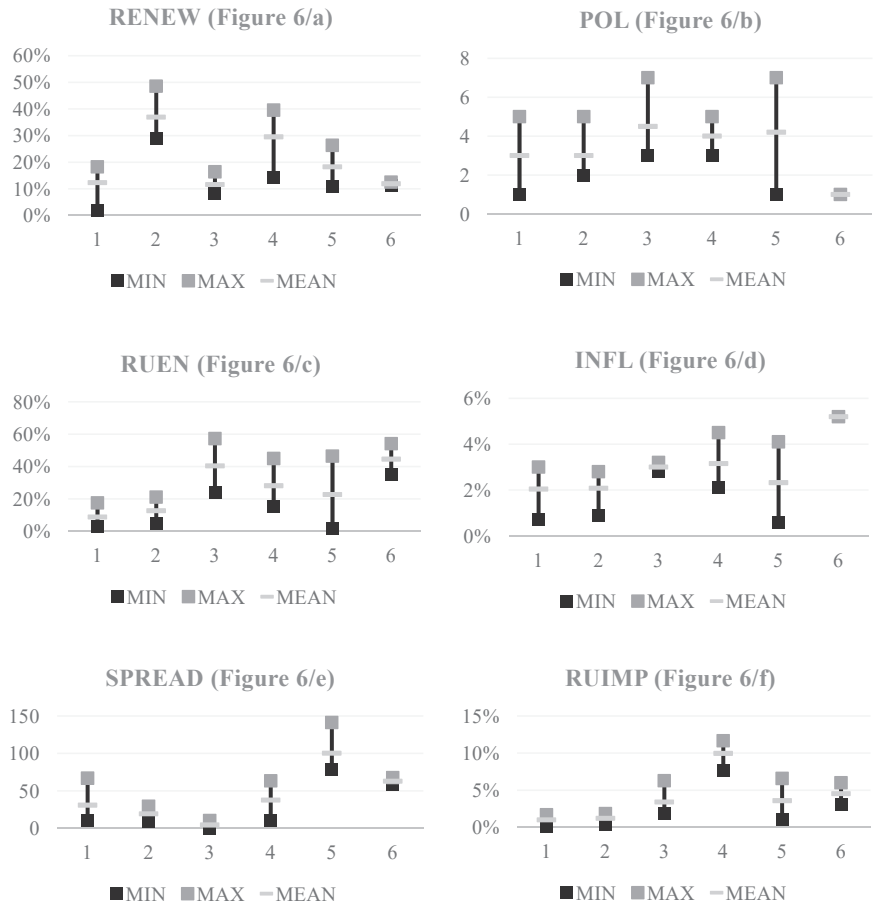

Fig. 12. Group behavior of cluster-forming variables (horizontal axis: cluster number; rate of variable (vertical axis)
Source: authors.

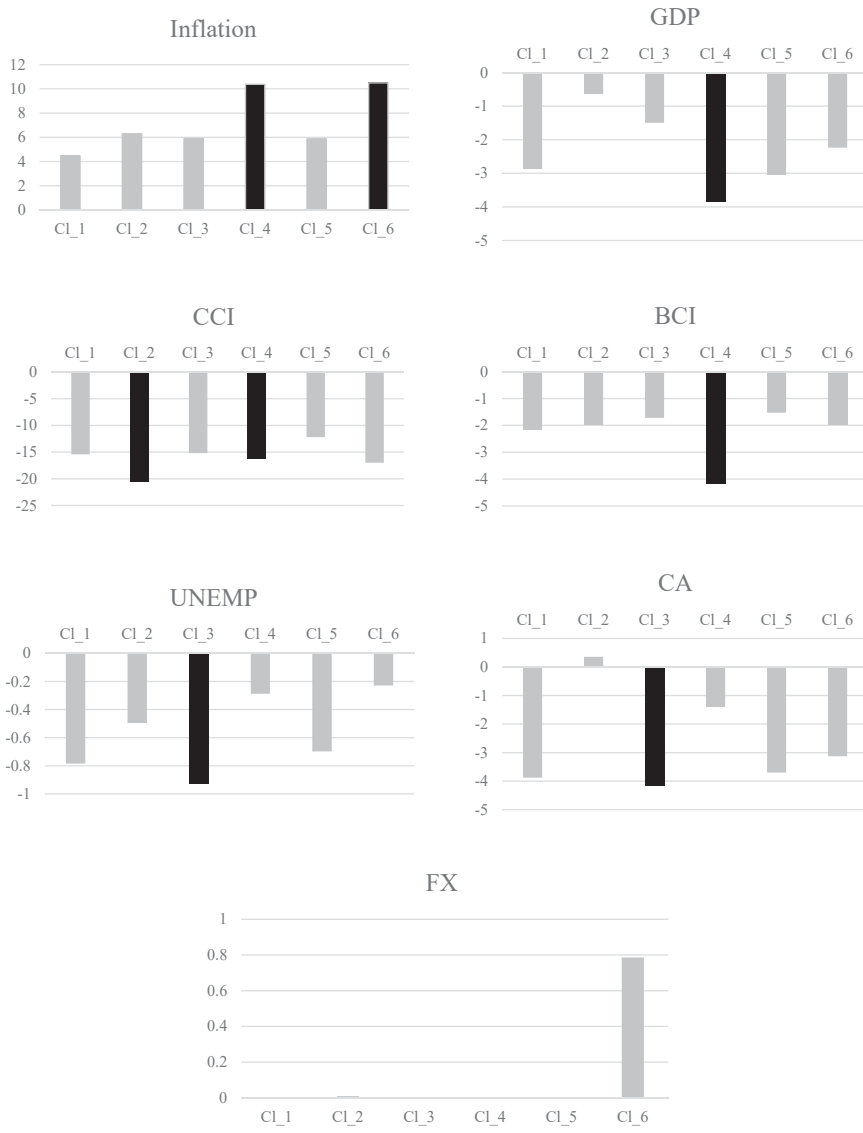

Fig. 13. Changes in the cluster means between the two periods
Source: authors.

Table 3. Cluster inputs

	RENEW (%)	RUEN (%)	SPREAD	POL	INFL (%)	RUIMP (%)	Cluster
FR	13	8	19.8	5	2	2	1
IE	13	3	10.3	3	2	1	1
MT	2	7	66.8	1	1	0	1
SI	18	18	27.4	4	2	1	1
ES	16	8	30	2	3	2	1
BE	9	24	6.6	7	3	2	3
DE	16	31	0	3	3	2	3
NL	8	49	0.9	4	3	4	3
SK	13	57	10.4	4	3	6	3
BG	14	15	63.4	3	3	8	4
EE	27	21	30	3	5	11	4
FI	37	45	10.9	5	2	12	4
LT	40	31	46.7	5	3	9	4
HR	26	25	92.3	5	3	2	5
CY	11	2	78.3	7	2	1	5
GR	15	46	101.7	1	1	7	5
IT	20	24	87.5	5	2	4	5
RO	19	17	141.2	3	4	5	5
HU	11	54	67.7	1	5	3	6
PL	13	35	58	1	5	6	6
AT	33	16	9.4	5	3	0	2
DK	38	21	17.4	3	2	2	2
PT	29	5	20.7	2	1	1	2
SE	49	9	29.5	2	3	1	2

Source: authors.