Agus Dwi NUGROHO* and Muhammad MASYHURI**

Comparing the impacts of economic uncertainty, climate change, Covid-19, and the Russia-Ukraine conflict: Which is the most dangerous for EU27 food prices?

This study compares the impact of economic uncertainty, climate change, Covid-19, and the Russia-Ukraine conflict on 27 European countries (EU27) food prices. The author used panel data that combines cross section data from January 2019 – March 2023 and time series data from 27 European countries. The error correction model (ECM) and Autoregressive Distributed Lag (ARDL) were used to analyse the data. The domestic energy consumer price index, real broad exchange rate, climate change, and Russia-Ukraine armed clashes are the drivers of the short and long run rise in the EU27 domestic food consumer price index. New domestic cases of Covid-19 can increase the EU27 domestic food consumer price index in the short run but not in the long run. Meanwhile, an increase in the unemployment rate has the potential to lower the EU27 domestic food consumer price index in both the short and long run. Among all the global shocks examined in this study, changes in the real broad exchange rate have the greatest impact on the EU27 domestic food consumer price index.

Keywords: global shocks; unemployment; energy prices; real broad exchange rate
JEL classifications: E31, E64, Q18

* Faculty of Agriculture, Universitas Gadjah Mada, Yogyakarta 55281, Indonesia. Corresponding author e-mail: agus.dwi.n@mail.ugm.ac.id
** Faculty of Business and Economics, University of Pécs, Hungary
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Introduction

Over the last few decades, rising food prices have posed a danger to many countries. This problem has the potential to obstruct the achievement of the 2030 Sustainable Development Goals. Food price increases force households to spend more money on food, causing living standards to fall. This inhibits us from achieving Goal 1: no poverty. Rising food prices also jeopardise individuals' access to food, putting them at risk of hunger and failing to meet Goal 2: no hunger. Rising food prices can also impede progress toward Goal 12: responsible consumption and production. Matters are made even worse when producers and consumers compete for cheap food while disregarding environmental sustainability.

Rising food prices are also harming industrialised countries such as the members of the European Union (EU), due to both internal and external factors. Internal factors include the EU's Common Agricultural Policy (CAP), supply chain disruption issues and extreme weather events, while external factors include fluctuations in global commodity prices, exchange rate volatility, trade policies and tariffs, and rising energy prices (Bertolozzi-Caredio *et al.,* 2023).

Several European countries have experienced increases in food prices due to both internal and external factors. For example, Poland's membership in the EU has increased food prices and lowered consumer wealth (Kusz *et al.*, 2022). Romania's accession to the EU has also increased food prices by 8% and reduced social welfare by 2.6% (Hubbard and Thomson, 2007). Another example is the rise in food prices in Sweden due to bad marketing management, with product concentration increasing in local stores and regional wholesalers but decreasing in major stores (Asplund and Friberg, 2002). At the other end, competition between EU members who want to offer their citizens lower food prices has made conditions even worse, though common market regulations can help to some extent (Allen *et al.,* 2018).

Currently, the EU faces a phenomenon that has not yet been resolved, namely escalating food prices, which skyrocketed between 2022 and the first half of 2023. Households are responding by buying less or at lower prices, with more households turning to food banks for assistance. Several countries in the EU, including Spain, France, Poland, Romania, Greece, Portugal, Hungary, and Bulgaria, have implemented special measures to address food price inflation. Reduced VAT rates on food, price controls on foodstuffs, food vouchers, or taxing food retailers' excess profits are examples of such initiatives (Matthews, 2023).

The primary reasons for increased EU consumer food prices in recent years are the Covid-19 pandemic, harsh weather occurrences, animal disease outbreaks, tight global markets, and Russia's invasion of Ukraine (Matthews, 2023). Various global shocks have threatened domestic food prices in European countries. High global food prices will raise inflation in the EU, weaken the euro, and restrict agricultural trade in the medium term, while at the same time having a long term influence on the domestic economy, putting pressure on inflation. To make matters worse, changes in global food prices further increase the vulnerability of the Romanian and Bulgarian economies (Saman and Alexandri, 2018).

Several studies have examined global shocks in recent years, often focusing on their impact on food prices. However, they have so far only looked at the impact of individual global shocks. In fact, current food prices are the result of the interaction of numerous global shocks occurring at the same time. Hence, this study attempts to investigate the concurrent impact of numerous global shocks on food prices in EU27, something which does not appear to have been attempted before. It aims to enhance academics' knowledge of the impact of interactions between global shocks and at the same time, to assist policymakers. The global shocks examined in this study include economic uncertainty (represented by the unemployment rate, domestic energy consumer price index,

and real broad exchange rate), climate change (represented by temperature change), Covid-19, and the Russia-Ukraine conflict.

Theoretical and empirical background

This study views inflation as caused by a supply-demand imbalance during a period of global shock. On the supply side, the global shock has resulted in a product supply shortage in the market because of difficulties in carrying out production and distribution processes. During this time, new challenges arose, most notably increased production costs. Hence, the first inflation theory considered in this study is the cost-push theory. Steuart established at least three main strands of cost-push theory. The first was his view of the price level as a non-monetary phenomenon determined by the same forces that govern prices for certain products. The second section of Steuart's cost-cutting ideology supplements the first. Prices are said to move independently of money because general prices are a genuine phenomenon. The third strand of Steuart's cost-push doctrine follows logically from the second. After denying that money drives or influences prices, he contended that causation goes from prices to (velocity-augmented) money. Basically, this theory links inflation to growing production costs amid a continual flow of demand. A rise in these "input costs" will almost certainly reduce a producer's profit. As a result, some producers may elect to pass on these additional expenses to the consumer by charging higher prices for the same unit of products (Humphrey, 1998).

On the demand side, a global shock can cause producers to be unable to meet consumer demand, due to the difficulties they face in supplying products and consumer panic buying. This study therefore applies the demand-pull theory of inflation, which views continued price increases as being the due to demand-pull factors driven by monetary policy rather than cost-push pressures. This theory holds that inflation is driven solely by excessive demand, which a restrictive monetary policy is the appropriate, and, in effect, costless response (Schwarzer, 2018).

According to the literature, the first factor that causes food prices to rise is unemployment. According to the Phillips curve model, unemployment and inflation have a negative relationship. This is true in many countries where an increase in the number of unemployed people leads to lower wages, production costs, and inflation. This relationship exists in both the short and medium run (Liargovas and Psychalis, 2022). Rising energy prices are the second factor that increases food prices. The price of crude oil affects food prices in two ways: supply and demand. On the supply side, crude oil has a direct impact on agricultural production factors via energy-intensive inputs such as fertiliser. As global oil prices rise, so do transportation costs, increasing food prices. On the demand side, the high price of crude oil has driven a search for alternative inputs such as biofuels, resulting in increasing competition for agricultural products used for both food and fuel (Widarjono *et al.,* 2020).

Monetary policy has also had an impact on food prices, and this is the third factor. When a country's real exchange rate rises, the value of inflation rises (Egilsson, 2020). Climate change is the next factor that increases food prices. Climate change reduces real output from its potential level and shifts the supply curve to the left, leading to a decrease in output supply and an increase in food prices (Iliyasu *et al.,* 2023). Climate change will reduce agricultural productivity (between 2% and 15%) and raise food prices (between 1.3% and 56%) globally by 2050 (Delincé *et al.,* 2015).

The next factor to be considered is the Covid-19 pandemic which has repeatedly disrupted global supply chains. On the supply side, farmers faced difficulty accessing their agricultural land to sow, fertilise, control pests, and harvest. Farmers and traders were perplexed by labour shortages and wholesale market closures in the early days of the lockdown due to Covid-19 concerns (Cariappa *et al.,* 2022). On the demand side, the uncertainty caused by the pandemic's novelty and a widespread lack of understanding about the duration of lockdowns caused panic buying of essential products. Given the inelastic character of food consumption, this significant increase in demand will have had an impact on food prices (Emediegwu and Nnadozie, 2023). The last factor to have caused an increase in food prices is the Russia-Ukraine conflict. Global soybean prices rose 8.91% in March 2022, followed by rises of 0.03% and 0.46% in April and May, respectively. Maize prices rose faster than soybean prices, hitting 14.66% in March 2022, 3.77% in April 2022, and 0.95% in May 2022, respectively. Wheat experienced the greatest price increase of any food product, climbing by 24.53% in March, 1.85% in April, and 5.45% in May 2022 (Nasir *et al.,* 2022).

Based on the above, the following hypotheses were set:

Hypothesis 1: an increase in the unemployment rate will reduce EU food Consumer Price Index.

Hypothesis 2: an increase in the domestic energy CPI will increase EU food Consumer Price Index.

Hypothesis 3: an increase in the real broad exchange rate will increase EU food Consumer Price Index.

Hypothesis 4: an increase in temperature change will increase EU food Consumer Price Index.

Hypothesis 5: an increase in domestic Covid-19 cases new case will increase EU food Consumer Price Index.

Hypothesis 6: an increase in the Russia-Ukraine armed clashes will increase EU food Consumer Price Index.

Materials and Methods

This study employed panel data, which combines time series and cross-sectional data. The time-series data in this study are from January 2019 until March 2023. The cross-section data are from 27 EU countries. Several variables will

be analysed in this study (Table 1). The first variable is the food consumer price index as the dependent variable. This index measures the price change between the current and reference periods of the average basket of foods purchased by households. Six explanatory variables are thought to influence the food consumer prices index. First, the unemployment rate: the share of the labour force that is without work but available for and seeking employment. Second, the domestic price of energy index: a benchmark for the domestic energy market. Third, real broad effective exchange rate: calculated as weighted averages of bilateral exchange rates adjusted for relative consumer prices. Fourth, temperature change: annual updates of mean surface temperature change statistics by country. Fifth, domestic Covid-19 new cases: the most recent public health case of Covid-19 in humans induced by SARS-COV-2 infection. Sixth, the Russia-Ukraine conflict: the number of armed clashes that occurred between Russia and Ukraine.

The impact of economic uncertainty, climate change, Covid-19 or the Russia-Ukraine conflict on food prices in 27 EU countries (i) every month (t) will be assessed using the model:

$$FPI_{it} = \beta_0 + \beta_1 UNE_{it} + \beta_2 ECPI_{it} + \beta_3 REER_{it} + \\ + \beta_4 TEMP_{it} + \beta_5 COV_{it} + \beta_6 RUC_{it} + \varepsilon_i \quad (1)$$

The empirical analysis begins with the Levin Lin Chu (LLC) unit root test before the estimation. The stationarity test was performed to eliminate spurious regression caused using nonstationary time-series data throughout the period:

$$\Delta Y_{it} = \alpha Y_{it-1} + \sum \beta_{it} \Delta Y_{it} - j + X_{it}\delta + v_{it} \quad (2)$$

Y_{it} is the pooled variable, X_{it} is an exogenous variable, v_{it} is the error term.

Next, the relationships between non-stationary variables must be examined using a cointegration test. The Johansen cointegration test was used in this study to compare the trace statistic and maximum eigenvalue values for cointegration (Shrestha and Bhatta, 2018). The long-run relationship or equilibrium of various variables is shown by cointegration. However, the economic variables in this study frequently experience disequilibrium in the short term. These differences necessitate adjustments to correct for disequilibrium, which are known as error correction models (ECM) (Wooldridge, 2016):

$$EG_t = FPI_{it} - \beta_0 - \beta_1 UNE_{it} - \beta_2 ECPI_{it} - \\ - \beta_3 REER_{it} - \beta_4 TEMP_{it} - \beta_5 COV_{it} - \beta_6 RUC_{it} \quad (3)$$

EG_t is a disequilibrium error.

The dependent and explanatory variables are rarely in equilibrium, so it is necessary to observe the disequilibrium relationship:

$$\Delta FPI_{it} = b_0 + b_1 \Delta UNE_{it} + (b_1 + b_2) UNE_{it-1} + \\ + b_3 \Delta ECPI_{it} + (b_3 + b_4) ECPI_{it-1} + b_5 \Delta REER_{it} + \\ + (b_5 + b_6) REER_{it-1} + b_7 \Delta TEMP_{it} + \\ + (b_7 + b_8) TEMP_{it-1} + b_9 \Delta COV_{it} + \\ + (b_9 + b_{10}) COV_{it-1} + b_{11} \Delta RUC_{it} + \\ + (b_{11} + b_{12}) RUC_{it-1} - \lambda FPI_{it-1} + e_t \quad (4)$$

Δ = first difference and $\lambda = 1 - \Phi$.

This study also uses Autoregressive Distributed Lag (ARDL) as a comparison for the results of ECM analysis (robustness check) (Wooldridge, 2016):

$$\Delta FPI_{it} = b_0 + b_1 \sum_{q=1}^{q=n} \Delta UNE_{i,t-q} + b_2 UNE_{i,t-1} + \\ + b_3 \sum_{q=1}^{q=n} \Delta ECPI_{i,t-q} + b_4 ECPI_{i,t-1} + b_5 \sum_{q=1}^{q=n} \Delta REER_{i,t-q} + \\ + b_6 REER_{i,t-1} + b_7 \sum_{q=1}^{q=n} \Delta TEMP_{i,t-q} + b_8 TEMP_{it-1} + \\ + b_9 \sum_{q=1}^{q=n} \Delta COV_{i,t-q} + b_{10} COV_{it-1} + \\ + b_{11} \sum_{q=1}^{q=n} \Delta RUC_{i,t-q} + b_{12} RUC_{it-1} + e_t \quad (5)$$

Results

The average domestic food consumer price index (FCPI) in the EU27 is 115.18, with swings of approximately 12.19% (14.04) (Table 2). Domestic Covid-19 new cases (COV) had the highest mean and standard deviation (132,550.12 and 492,816.86, respectively). Temperature change (TEMP) has the lowest average and standard deviation, with values of 2.15 and 1.66, respectively. The standard deviation of the domestic energy consumer price index (ECPI) is four times its mean value, showing that this variable changed significantly across the EU27 over the study period (January 2019 – March 2023). Other variables in this study had various means and standard deviations, including the unemployment rate (UNE) of 6.66 and 3.20, the real broad exchange rate

Table 1: Description of the variables used**.**

Variable	Symbol	Source	Expected sign
Domestic food consumer price index	FCPI	FAO	
Unemployment rate (%)	UNE	World Bank	–
Domestic energy consumer price index	ECPI	World Bank	+
Real broad exchange rate	REER	Federal Reserve	+
Temperature change (°C)	TEMP	FAO	+
Domestic Covid-19 new case (person)	COV	John Hopkins University	+
Russia-Ukraine armed clashes (total events)	RUC	The Armed Conflict Location & Event Data Project	+

Source: Own composition

(REER) of 100.24 and 3.26, and the Russia-Ukraine armed clashes (RUC) of 137.63 and 247.43.

The Levin Lin Chu (LLC) unit root test is used to produce a stationary variable in this study (Table 3). The unit root test reveals that TEMP and COV are stationary at level, but other variables are not stationary at level. The non-stationary variables must be transformed into first or second differences to be stationary. As a result, FCPI, UNE, ECPI, REER, and RUC are stationary at the first-difference level.

The results of the cointegration test reveal that the variables in the models have a long run relationship (Table 4). This means that the FCPI, UNE, ECPI, REER, TEMP, COV, and RUC variables are cointegrated. It is indicated by the trace statistics value is higher than the critical value at the 1% confidence level.

Following the cointegration test, the Akaike Information Criteria (AIC) test is required to determine the optimal lag length that will be employed in the ARDL model. The length of lag for each variable in this study varies substantially. The dependent variable FCPI is optimal at level 6. Meanwhile, the independent variable has an optimal lag at level 0 (UNE and ECPI), lag 4 (RUC), lag 5 (REER), and lag 6 (TEMP and COV).

The first variable to be observed in ECM is RESID, where the probability is less than 0.05, indicating that the model is valid (Table 5). The RESID indicates that the previous month's error term was corrected for within the current month at a convergence speed of 0.0868. Four tests must be passed in the ARDL model. The Breusch-Godfrey Serial Correlation Lagrange Multiplier (LM Test) results reveal that the ARDL model has no autocorrelation because the probability is bigger than 0.05 (0.9486). Because the Chi-square probability from the Breush-Pagan-Godfrey test is greater than the significance threshold of 0.05, the ARDL model is likewise free of heteroscedasticity (0.6974). The third test is long run form and bounds, which shows that the F-statistics value is significant at the 0.05 level, indicating that the short run and long run models are cointegrated (57.4186). The stability test shows the ARDL model is stable because the probability is below 0.05. According to the CUSUM and CUSUM^2 graphs, the results are robust for policy moderation.

The ECM and ARDL analyses show consistent results and directions in which the independent variables influence the dependent in both the short and long run. Domestic energy consumer price index (ECPI), real broad exchange rate (REER), climate change (TEMP), and Russia-Ukraine armed clashes (RUC) are the drivers of the short and long run rise in the EU27 domestic food consumer price index (FCPI) (Table 5). ECPI will increase FCPI by 0.0008 (ECM and ARDL) in the short run and 0.0006 (ECM) / 0.0007 (ARDL) in the long run. FCPI has grown by 1.5176 (ECM) / 1.4221 (ARDL) in the short run and 1.3041 (ECM) / 0.6551 (ARDL) in the long run due to the rise in REER. The FCPI has risen by 0.2210 (ECM) / 0.1288 (ARDL) in the short run and 0.5077 (ECM) / 0.3993 (ARDL) in the long run because of TEMP. The last factor that influences FCPI rises is RUC, which is 0.0221 (ECM) / 0.0226 (ARDL) in the short run and 0.0350 (ECM) / 0.0294 (ARDL) in the long run.

Table 2: Descriptive statistics for the variables used.

Variable	Mean	Std. Dev
FCPI	115.18	14.04
UNE	6.66	3.20
ECPI	752.35	3,273.27
REER	100.24	3.26
TEMP	2.15	1.66
COV	132,550.12	492,816.86
RUC	137.63	247.43

Source: Own composition

Table 3: Levin Lin Chu (LLC) unit root test.

Variable	Level	Significance
FCPI	1st difference	–6.118***
UNE	1st difference	–15.096***
ECPI	1st difference	–16.650***
REER	1st difference	–21.228***
TEMP	At level	–17.614***
COV	At level	–8.705***
RUC	1st difference	–13.969***

Note: ***: sig 0.000.
Source: Own composition

Table 4: Cointegration test.

Hypothesized No. of CE (s)	Trace statistics
None	668.2506***
At most 1	336.6493***
At most 2	224.0664***
At most 3	129.2176***
At most 4	73.6106***
At most 5	34.5934**
At most 6	16.9216**

***: sig 0.000; **: sig 0.01.
Source: Own composition

Domestic Covid-19 new cases (COV) only increase FCPI in the short run. COV has only boosted FCPI by 0.0000004 (ECM) in the short run. Meanwhile, the unemployment rate (UNE) has the potential to lower FCPI in the EU27 in both the short and long run. UNE is the only variable that reduces FCPI with a short run impact of -0.7546 (ECM) / -0.6501 (ARDL) and long run: -0.5816 (ECM) / -0.5388 (ARDL).

ARDL analysis also demonstrates the impact of the prior month's independent variables on the dependent variable. The prior month's FCPI, REER, and TEMP were all able to raise the present FCPI. Meanwhile, RUC in the prior month produced a decrease in the current FCPI. COV in the prior month is an independent variable that influences the present FCPI in diverse ways.

Table 5: Determinant factors of the food prices in the 27 European countries.

Short run				
Variable	ECM		ARDL	
	Coeff.	Std. Error	Coeff.	Std. Error
D(FCPI(–1))	–	–	0.1286* (2.2300)	0.0577
D(FCPI(–2))	–	–	0.1349** (2.7902)	0.0483
D(FCPI(–3))	–	–	0.1384*** (3.7417)	0.0370
D(FCPI(–4))	–	–	–0.0219 (–0.8774)	0.0250
D(FCPI(–5))	–	–	0.0304 (1.9026)	0.0160
D(UNE)	–0.7546*** (–5.7580)	0.1310	–0.6501*** (–5.0995)	0.1275
D(ECPI)	0.0008*** (5.7218)	0.0001	0.0008*** (6.0262)	0.0001
D(REER)	1.5176*** (22.0535)	0.0688	1.4221*** (20.7868)	0.0684
D(REER(–1))	–	–	0.5880*** (3.5254)	0.1667
D(REER(–2))	–	–	0.5698*** (4.0645)	0.1402
D(REER(–3))	–	–	0.3685*** (3.312)	0.1113
D(REER(–4))	–	–	0.3669*** (4.7498)	0.0772
D(TEMP)	0.2210*** (4.5077)	0.0490	0.1288* (2.0045)	0.0642
D(TEMP(–1))	–	–	0.2638* (2.1846)	0.1208
D(TEMP(–2))	–	–	0.0737 (0.6739)	0.1093
D(TEMP(–3))	–	–	0.2406* (2.5292)	0.0951
D(TEMP(–4))	–	–	0.1490 (1.8418)	0.0809
D(TEMP(–5))	–	–	0.1388* (2.1315)	0.0651
D(COV)	0.0001 (1.6754)	0.0001	–0.0001 (–0.2497)	0.0001
D(COV(–1))	–	–	0.0001 (0.8359)	0.0001
D(COV(–2))	–	–	–0.0001*** (–4.2496)	0.0001
D(COV(–3))	–	–	0.0001 (1.0025)	0.0001
D(COV(–4))	–	–	–0.0001 (–1.5206)	0.0001
D(COV(–5))	–	–	0.0001** (2.8587)	0.0001
D(RUC)	0.0221*** (34.3609)	0.0006	0.0226*** (30.9459)	0.0007
D(RUC(–1))	–	–	–0.0086*** (–3.7360)	0.0023
D(RUC(–2))	–	–	–0.0091*** (–5.2736)	0.0017
D(RUC(–3))	–	–	–0.0077*** (–7.8508)	0.0010

Short run				
Variable	ECM		ARDL	
	Coeff.	Std. Error	Coeff.	Std. Error
RESID01(–1)	–0.0868*** (–7.2405)	0.0120	–	–
C	0.01404 (0.1426)	0.0985	1.0555*** (3.3770)	0.3125
Adj. R^2	0.6447		LM test	0.9486
F–stat	357.4326		Chi Square	0.6974
			F–statistic	57.4186***
Long run				
Variable	ECM		ARDL	
	Coeff.	Std. Error	Coeff.	Std. Error
UNE	–0.5816*** (–8.0831)	0.0719	–0.5388*** (–4.8870)	0.1102
ECPI	0.0006*** (8.0606)	0.0001	0.0007*** (5.7292)	0.0001
REER	1.3041*** (18.0985)	0.0721	0.6551*** (4.0468)	0.1619
TEMP	0.5077*** (3.6495)	0.1391	0.3993*** (3.4125)	0.1170
COV	0.0001 (1.1113)	0.0001	–0.0001 (–0.3384)	0.0001
RUC	0.0350*** (36.4972)	0.0010	0.0294*** (14.9549)	0.0020
C	–18.0693* (–2.5018)	7.2225	0.8746*** (3.3150)	0.2638
Adj R^2	0.6410			
F–statistic	410.3930***			

***: sig 0.000; **: sig 0.01; *: sig 0.05.
Source: Own composition

Discussion

The rise in UNE is one of the reasons behind the drop in FCPI. This finding is consistent with the Phillips curve, which measures economic activity and demand pressures on inflation using the aggregate unemployment rate (Ricardo, 2005). This also occurs at the EU country level, like in Greece, where the link between the two variables is also negative: an increase in unemployment promotes a fall in inflation (Liargovas and Psychalis, 2022). However, this could change because further developments show that the relationship between inflation and unemployment growth is weakening, raising concerns that the Phillips curve has disappeared or become flatter (Ricardo, 2005). Conditions in the EU can change quickly because the relationship between these two variables tends to be reversed (Liargovas and Psychalis, 2022).

The increase in ECPI has led to an increase in FCPI in the EU. Our findings are consistent with the findings of Sohag *et al.* (2023), who found that rising global energy prices have increased EU food inflation. The transformation of raw commodities and the transportation of food to the final consumer both require energy. According to economic theory, the unpredictable ECPI influences production, processing, and transportation costs, which will be passed on to consumers in the form of higher FCPI (Shiferaw, 2019). Increased ECPI also compelled food-producing countries to reduce their exports. The country prefers to use food production as a substitute for producing biofuels to save money on energy purchases (Gozgor and Memis, 2015). In addition, EU imports of biofuel crops are expected to more than double. Biofuel production is increasingly competing with food production for limited natural resources. The rising demand for biofuel crops will raise domestic prices by 25%, while total agri-food price inflation in the EU will be 3% (Tabeau *et al.,* 2011).

REER, as predicted, has increased FCPI in the EU. This finding is consistent with a study from Hájek and Horváth (2016) which found that changes in REER and FCPI follow the same trend, with changes in REER being transmitted 50% to FCPI in the EU. The influence on FCPI will be felt in the EU one year after the REER shock. In addition, during the period of crisis and uncertainty covered by this study, there were devaluations in the Euro and local currencies (REER rise), as well as a dramatic fall in domestic income and labour expenses, while the EU FCPI continued to climb. The increase in this FCPI was due to three factors: an increase in taxes, high reliance on imported food, and a disturbance in the function of food intermediaries (particularly supermarkets) (Konstantinidis, 2016).

Climate change and extreme weather events have added new uncertainties and risks to agricultural yield. Average and extreme temperatures in the EU have risen in recent

decades, resulting in a disruption of the plant's reproductive period, appearance and quality, and food production. This is worsened by the fact that no member country in the EU has an agricultural sector that is completely adapted to climate change (resilient) (Mutua Ndue and Goda, 2021). Furthermore, rising temperatures will encourage weed development, alter the frequency and duration of pest attacks and plant diseases, and reduce the effectiveness of pesticides. Sugar, bread and cereals, and grapes are the most closely affected by extreme weather occurrences in the EU. Likewise, rising temperatures have disrupted meat, egg and milk production in the EU livestock sector (Lin and Ma, 2022). Food price hikes may result from reduced food production due to import and export restrictions and market regulation effects. Aside from that, the main step taken by the EU to mitigate climate change is the usage of renewable energy. The 'EU 20-20-20' programme expressly calls for a 20% reduction in greenhouse gases (GHG) by 2020, as well as a 20% increase in renewable energy consumption in the EU by 2020 (Calvin *et al.,* 2014). However, this approach is inherently problematic due to its use of renewable energy from plants, which increases competition for food and thus raises its prices.

COV is one of the causes of the increase in FCPI in the EU, although only in the short run. Food prices are rising across Europe as a result of additional COVID-19 cases government stringency measures and containment health efforts (Hamulczuk and Skrzypczyk, 2021). In the EU, lockdown attempts included mandating people to stay at home except for certain exceptions, closing shops, restaurants, and cafes other than supermarkets, and limiting the number of people who could gather Some farmers had difficulty finding seasonal workers, notably in the fruit and vegetable businesses (Matthews, 2020). Many food businesses in the EU, such as bakeries and restaurants, went out of business due to bankruptcy or government restrictions (Kraus *et al.,* 2020). However, these effects were in the end short-lived due to the resilience of the EU food supply chain, the ability of EU producers and consumers to adjust well, and good governance policy (such as opening 'green lane' border crossings) (Matthews, 2020).

The conflict between Russia and Ukraine influences food access and production costs in the EU. The European agricultural business imports a variety of commodities, including food, raw materials, animal feed, fertiliser, and energy. Due to the dispute, global food prices have risen to the point where importing countries, like as the EU, must face the consequences through increased FCPI (Nasir *et al.,* 2022). Fertiliser has become scarcer and more expensive, making production costs rise. This situation makes it harder for farmers to produce and threatens to raise food prices, hurting food affordability and access (Rabbi *et al.,* 2023). Meanwhile, many EU countries rely heavily on Russia for oil and gas imports: more than 75% natural gas in Czechia, Latvia, Hungary, Slovakia, and Bulgaria is imported; over 75% of oil and petroleum in Slovakia, Lithuania, Poland, and Finland is likewise imported; and the amount of solid fuel imported in Cyprus, Estonia, Latvia, Denmark, Lithuania, Greece, and Bulgaria again exceeds 75% (Astrov *et al.,* 2022). Limited oil and gas imports raise distribution costs in the EU, and food importers will find it much harder to finance the expenses of food imports, which will be passed on to EU consumers in the form of higher domestic food prices (Rabbi *et al.,* 2023).

REER is the most dangerous global shock for EU27 countries. Given that these 27 countries have an integrated food supply chain and coordination mechanism, this makes perfect sense. As a result, if a non-REER shock occurs, all countries will collaborate to solve it, either by optimising food supplies among countries or by accelerating renewable energy use. This is not the case if the shock takes the form of euro fluctuations. This phenomenon is related to the 27 countries' reliance on food imports from outside the eurozone. If the euro swings, imported food will become more expensive, causing domestic prices for food to rise.

Conclusions and recommendations

The domestic energy consumer price index, real broad exchange rate, climate change, and Russia-Ukraine armed clashes are the drivers of the short and long run rise in the EU27 domestic food consumer price index. Domestic Covid-19 new cases only increase the EU27 domestic food consumer price index in the short run. Meanwhile, the unemployment rate has the potential to lower the EU27 domestic food consumer price index in both the short and long run. The findings also support the theory of cost-push and demand-pull factors during global shocks. This situation has fostered an increase in production factors, causing producers to raise selling prices, which is then transmitted to consumers. On the other hand, because consumers are worried during a period of global shock, product demand rises rapidly.

Four steps can be recommended with a view to maintaining food price stability during global shocks: first, implementing effective monetary policy, notably in fixing the exchange rate. This can be accomplished by keeping the money supply and interest rates stable, allowing EU countries to keep the Euro and local currencies appreciating; second, implementing environmentally friendly technology and efficient economic activities to reduce the impact of climate change. This can be done by imposing a policy to increase and support the use of renewable energy (from wind, solar, geothermal, and others), organic farming, precision technology, and wise economic activities in EU27 countries; third, increasing labour productivity to maintain domestic food supplies and reduce inflation. These actions can be carried out through funding policies for extension and training of agricultural personnel, agricultural modernisation, and support for young farmers under the Common Agricultural Policy scheme; and fourth, increasing collaboration with other countries to ensure smooth food and supply chains, reduce food dependence on just one country, and aid in the resolution of regional disputes as well as the handling of other global issues.

The most important limitation of this study is the short time frame. The accessible data only extends to March 2023, although the effects of the major global shocks outlined here can be expected to continue until the end of 2023. Therefore, future studies will seek to extend the time frame so that the impact of global shocks can continue to be observed. In

addition, it is important to include competition between EU countries as an influencing variable to gain more insight into the implementation of food price policy in the future.

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