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The false start of disinflation – evidence from the major European economies

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Authors:
Jakub Rybacki, Polish Economic Institute and University of Warsaw, email: jakub.rybacki@uw.edu.pl, ORCID ID: 0000-0001-7248-9536
Marcin Klucznik, Polish Economic Institute, e-mail: marcin.klucznik@pie.net.pl, ORCID: 0000-0003-3665-7138
Dawid Sułkowski, Polish Economic Institute, e-mail: dawid.sulkowski@pie.net.pl, ORCID: 0009-0007-7013-0205
Substantive editing: Piotr Arak
Editors: Jakub Nowak, Małgorzata Wieteska
Graphic design: Anna Olczak
Text and graphic composition: Sławomir Jarząbek
Graphic collaboration: Sebastian Grzybowski
Polish Economic Institute
Al. Jerozolimskie 87
02-001 Warsaw

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Abstract

We examine the medium term risks for inflation related to energy crisis. Firstly, we analyse the inflation spillovers between five major EU economies — Germany, France, Italy, Spain and Poland — based on the Diebold and Yilmaz VAR framework. Our analysis shows that the magnitude of the inflation spillovers increased after the outbreak of energy crisis. We found that inflation in Poland and Spain precede the tendencies visible in the other big economies. Furthermore, we see a strong interconnectedness between the countries in the case of sticky prices, which are changed less frequently. Secondly, we analyse the impact of wage pressures in the Eurozone, focusing on the strike in the Netherlands. We show that these phenomena are likely to spillover to other EU economies, too. All in all, the factors we mention suggest that combating inflation will be a long-process.

Keywords: Inflation, Spillovers, VAR

JEL classification codes: C32, E31, E37

1. Introduction

The aim of this paper is to analyse the international risks related to inflation after the outbreak of the energy crisis in 2022. Firstly, we analysed the spillovers between the scale of rapidly growing prices and sticky inflation in the five main European economies: Germany, France, Italy, Spain, and Poland. Secondly, we measured prices pressures in the Eurozone, focusing on the Netherlands, after the wave of strikes there. We compute the VAR based on the Diebold and Yilmaz spillover indices for each of the mentioned variables. The data was estimated based on the sample from 2010 to 2023.

The research questions and conclusions are summarised below:

1. *Does inflation decrease in the countries where it showed up the earliest?:* Inflation persists in the countries that the price spillovers originated from. Poland and Spain emerged as inflation transmitters during the energy crisis. Unfortunately, the share of rapidly rising prices in these economies is stable. It is therefore difficult to expect rapid disinflation in the Eurozone as a whole.

2. *Could changes in relative prices trigger a new wave of inflation?:* The inflation of sticky prices increased more slowly than that of more flexible ones right after the energy crisis. This distorts the relative prices and probably requires another wave of adjustments in the stickiest categories. The research shows that this channel is likely to have a strong impact on inflation in other countries, as the spillovers are strong.

3. *Is there a risk of wage-led inflation?:* The interconnectedness between labour markets in the EU countries is rather low. Still, wage pressures in the Netherlands usually precede similar tendencies in the bigger economies, as the country is more internationalised. The spillover analysis suggests that the impact is small. Still, it should not be omitted.

All in all, the research outcomes suggests that combating inflation related to energy shock should be relatively long process. While most policymakers are focused on domestic developments, inflation and wage pressures have become more interconnected since the energy shocks. Inflation forecasts therefore still need to be conservative.

This paper is structured as follows: Section 2 reviews the literature on the comovement of inflation between countries and the recent surge. Section 3 presents stylised facts on wages and inflation behaviour during the energy crisis. Section 4 outlines our methodology and Section 5 presents the results. Section 6 concludes the paper.

2. Literature review

Before the COVID-19 pandemic, inflation in the Eurozone countries had consistently fallen below the inflation target for several years. The academic literature has frequently attempted to explain this phenomenon through globalisation – changes in the supply chains made it possible to lower production costs and therefore final consumer prices (Altansukh et al., 2017; Ball, 2006; Forbes, 2019). The authors have also repeatedly emphasised that shocks related to import prices or exchange rates started to have a relatively small impact on final inflation (McCarthy, 2007; Ortega, 2020). Furthermore, in the Eurozone, wage growth remained under control, characterised by moderate increases in negotiated wages (Hancké & Soskice, 2003).

During this period, the literature extensively examined inflation spillovers between countries. Authors highlighted the presence of international factors in shaping inflation expectations (Ciccarelli & García, 2015). Furthermore, they described how inflation was imported from the Eurozone to small open economies (Hałka & Szafranek, 2016; Iossifov & Podpiera, 2014). However, relatively little time was spent examining cross-country linkages.

The COVID-19 pandemic, coupled with the energy crisis, contributed to the unexpected rise in inflation significantly, catching forecasters off guard. Analysts at the International Monetary Fund (IMF) attribute this phenomenon to a weak ex-ante understanding of the impact of fiscal stimulus on the economy, as well as an underestimation of the disruptions caused by supply chain challenges (Koch & Noureldin, 2023). The European Central Bank started to seek profit-led inflation (Arce et al., 2023). However, this approach has proven problematic, as inflation has remained persistently high, while the Eurozone economy has started to show signs of deceleration.

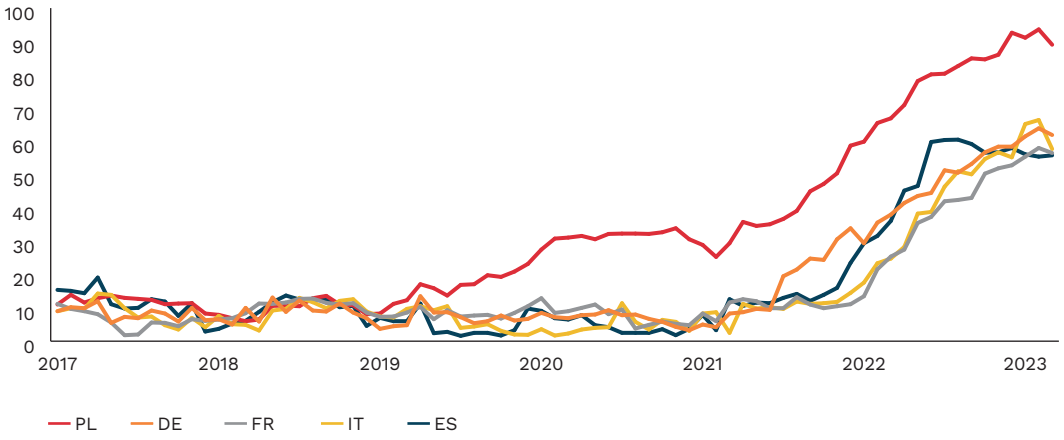
This paper focuses on spillovers, which remain less frequently discussed. The magnitude of inflation comovement varies over time (Tiwari et al., 2015). In particular, the simultaneous increase in costs across Europe is expected to be more persistent. We therefore use the framework developed by Diebold and Yilmaz to identify the countries that warrant closer examination when analysing the process of disinflation.

3. The increase in inflation after Russia's invasion of Ukraine

This section examines stylised facts about the unexpected surge in inflation during the post-Covid-19 years, with a focus on HICP inflation and the risk of a wage-price spiral.

Russia's invasion of Ukraine triggered widespread price increases. By the beginning of 2023, prices accounting for 50% of consumer expenditures had risen by over 5% per year, even in Southern Europe. However, the most significant impact was felt in Central and Eastern Europe (CEE), where inflation skyrocketed to unprecedented levels. In countries like Poland and Hungary, over 90% of prices had risen by 5% per year, the highest figure in history.

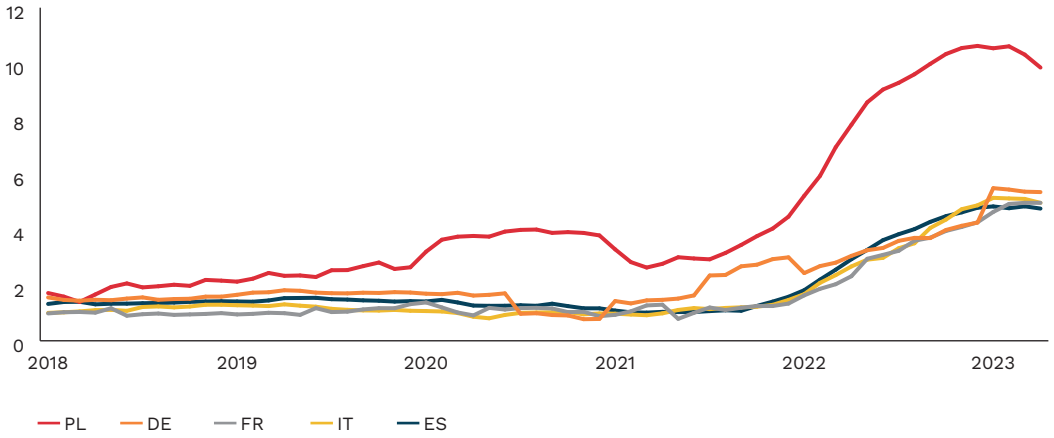
Figure 1: Share of expenditures, where prices expanded by more than 5 percent annually.



Source: Own computation based on Eurostat data

Prices increases became also more frequent. We analysed the frequency of pricing changes in HICP inflation and identified three indicators for sticky, flexible and standard prices. The increase in prices was accompanied by supply shocks, which particularly affected energy and food prices, triggering second-round effects. Overall, the pace of annual growth in sticky prices in 2022 was three times higher than the European Central Bank's target.

Figure 2: Sticky prices – implied with HICP indices (%YoY)



Source: Own computation based on Eurostat data

The sticky prices still did not catch up with the standard or most flexible ones. The cumulative price increases amounted to 9-11% in Germany, France, Italy and Spain and 30% in Poland (Table 1). The increase in prices which are changed more frequently was stronger. It varied from 12.3% in France to 19.2% in Germany and 31.5% in Poland. In Poland , we observed an increasing correlation between the sticky component of inflation and headline figures, indicating a higher magnitude of price increases, which equalised the difference. As a result, we cannot rule out a similar phenomenon in the Eurozone.

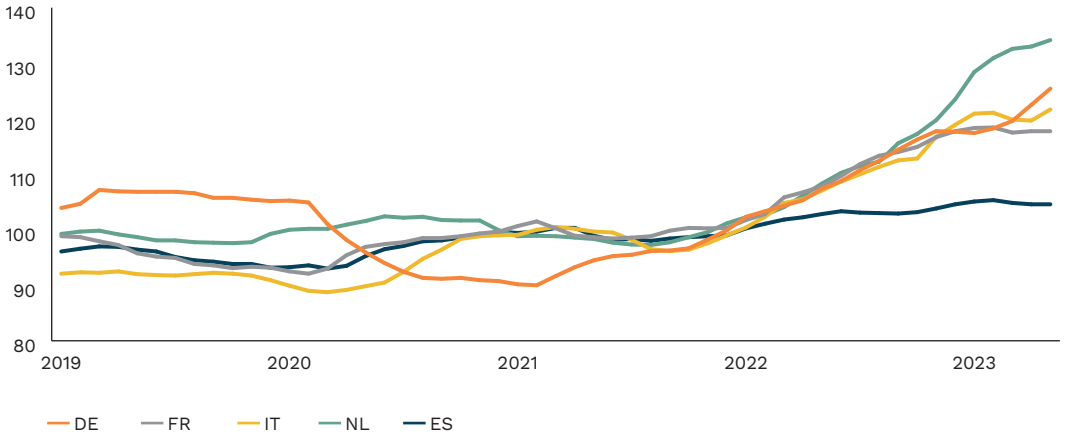
Table 1: Cumulated prices' increase from 2020 by the frequency of changes

Frequency	DE	ES	FR	IT	PL
Sticky	10.2	10.0	10.8	9.2	30.2
Standard	19.2	15.4	12.3	13.1	31.6
Flexible	48.0	30.4	27.9	46.9	46.0

Note: the detailed derivation of sticky prices index is described in the section 4
Source: Own calculations

The rapid price increase triggered wage pressure in the Eurozone. We summarise the Google Trends search related to wage increases in the Eurozone countries. Interest among Internet users is twice as high as during the pre-pandemic years.

Figure 3: Internet queries related to wage increase – Google Trend Indices (2018.1 = 100)



Note: Indices were queried based on the following words “Gehaltserhöhung” (Germany), “Augmenter” (France), “Aumento” (Italy, Spain), “Loonsverhoging” (Netherlands). 12-months moving average were applied
Source: Google

4. Methodology

We used the framework proposed by Diebold and Yilmaz (2012) to measure spillovers between the EU's five largest economies: Germany, France, Italy, Spain and Poland. Our analysis focuses on two indicators related to inflation: the share of prices prone to inflation above 5%, and sticky prices. These indices were computed using disaggregated HICP data. We also include an analysis of the spillovers in wage pressures among EU countries using high-frequency information from Google searches. First, we discuss our computation method for these indicators and then we introduce Diebold and Yilmaz's method, which we used for our analysis.

Share of rapidly increasing prices and sticky prices – derivation of indices

First, we present the composition of our inflation indices. We calculated the share of expenditure for which prices are growing by at least 5% per year. We used the information about COICOP at the highest level available — that is, if public disaggregation at the 6-digit level exists, we used that figure; otherwise, we compile 5-digit categories. The share is derived as the sum of consumer basket weights for the categories in which the annual rate of change is greater than 5%, in line with Formula 1:

$$share_t = \sum_i a_t * w_{i,t}\,, where\ a_t = \begin{cases} 1 & \pi_{i,t} \geq 5 \\ 0 & \pi_{i,t} < 5 \end{cases} \quad (1)$$

where i is the variable iterating between COICOP categories, $\pi_{i,t}$ denotes the annual inflation rate and $w_{i,t}$ denotes the weight of the COICOP categories in the HICP basket.

In the case of sticky prices, we selected the categories at the 5-digit COICOP level or 4-digit level when more detailed data was unavailable. We then filtered the monthly rate at which they increased. We computed the standard deviation of the monthly inflation rate for each category and sort them from the lowest to the highest variability. We then classified each category based on the simple rule:

$$Category_i = \begin{cases} Sticky & \sigma \in 1st\ Quartile \\ Standard & \sigma \in 2nd\ and\ 3rd\ Quartile \\ Flexible & \sigma \in 4th\ Quartile \end{cases} \quad (2)$$

The classification was made separately for each country. This means that our aggregates contain different products or services between countries. Similarly, the contribution of each component – that is, sticky, standard and flexible prices – to the final inflation is based on the country-specific weighting scheme.

Diebold and Yilmaz indices

Next, we present the spillover indices proposed by Diebold and Yilmaz that rely on the generalised vector autoregression (VAR) framework, which removes any dependence of results on variable ordering. The standard VAR model can be represented by the following formula:

$$y_t = \sum_{i=1}^{p} \emptyset_i y_{t-i} + e_t \, , e \sim N(0, \Sigma) \tag{3}$$

where y_t is N-variable vector and e_t is a vector of independently and identically distributed disturbances. Each covariance stationary autoregressive process can be expressed as an infinite MA process:

$$y_t = \sum_{i=0}^{\infty} A_i e_{t-i} \tag{4}$$

where A_0 is an N x N identity matrix and other coefficient matrices A_i obey the recursion

$$A_i = \sum_{i=1}^{p} \emptyset_i A_{i-p} \tag{5}$$

The use of moving average coefficients enables the derivation of transformations such as impulse response functions and variance decompositions. We are particularly interested in the latter to determine the proportion of inflation or wage growth that results from spillovers from other variables. However, to calculate variance decomposition, orthogonal innovation is required, which can be achieved through a Cholesky decomposition. It should be noted that such results are dependent on the ordering of variables.

Diebold and Yilmaz proposed a generalised variance decomposition based on the work of Pesaran and Shin (1998). The approach proposed by Diebold and Yilmaz focuses on shocks that hit only one equation at a time. To define the Generalized Impulse Response Function (GIRF) of vector y_t to the shock on j-th equation ($\delta_{j,t}$) in the horizon l, the following formula is used:

$$GIRF\left(l, \delta_{j,t}, \omega_{t-1}\right) = E(y_{t+l} \mid e_{j,t} = \delta_{j,t}, \omega_{t-1}) - E(y_{t+l} \mid \omega_{t-1}) \tag{6}$$

where ω_{t-1} is the matrix of initial, historical values needed to compute conditional expectations and $\delta_{j,t}$ is the vector of the corresponding shocks. The

linear VAR model with no identification restriction is independent of history (ω_{t-1}). The GIRF Function reduces to:

$$GIRF(l, \delta, \omega_{t-1}) = A_l \delta \tag{7}$$

where δ is the vector of shocks ($\delta_1, \delta_2, ..., \delta_k$). We are interested in a situation in which the shock is limited to the *j*-th equation. Assuming the normality of error term *e* and setting a shock to the *j*-th element of the error vector, the unscaled GIRF of the shock is provided by following equation:

$$GIRF\left(l, \delta_j, \omega_{t-1}\right) = A_l \, \Sigma \mathrm{s_j} \sigma_{j,j}^{-1} \delta_j \tag{8}$$

The selector vector s_j takes the value of 1 for the *j*-th variable and 0 otherwise. The term $\sigma_{j,j}$ represents an element of variance-covariance matrix $\sum$ of random disturbances introduced in Formula 1 and δ_j is the magnitude of the shock.

Generalised impulse response functions can be used in the derivation of the forecast error variance decompositions. In this case, the output describes the share of the variance in the variable accounted for by the innovations in the *j*-th variable in the VAR. In this case, we scale the impulse δ_j to the value of $\sqrt{\sigma_{j,j}}$. The *h-step-ahead* forecast variance of *i*-th equation on the *j*-th variable can be expressed with following formula:

$$\theta_{i,j}(h) = \frac{\sigma_{i,i}^{-1} \sum_{l=0}^{h} (\mathrm{s_i}' A_l \Sigma \mathrm{s_j})^2}{\sigma_i^2(h)} \tag{9}$$

A shortcoming of forecast variance calculated in this way is that the contributions of the shocks do not add up to one if the covariance matrix of the error is not a diagonal matrix. This makes interpreting them problematic. There are several methods to overcome these issues; for example, by computing the forecast variance in a different way (such as Lanne & Nyberg, 2016). However, the approach proposed by Diebold and Yilmaz is far simpler – it assumes the normalisation of the selected variance decomposition through all the available decompositions:

$$\theta_{i,j}^{norm}(h) = \frac{\theta_{i,j}(h)}{\sum_{k=1}^{N} \theta_{i,k}(h)} \tag{10}$$

Diebold and Yilmaz proposed several indices to quantify the spillovers in a VAR model. The first index is the total spillover index, which measures the contribution of spillovers of shocks across all the variables to the total forecast error variance.

$$Total\ Spillover\ Index(h) = \frac{\sum_{i,j=1,\ i \neq j}^{N} \theta_{i,j}^{norm}(h)}{N} * 100 \tag{11}$$

The pair of indices describe spillovers transmitted and received from the i-th variable – we calculate the spillover coming from or to a particular source as a share of the total spillover. The formulas are:

$$Received\ Spillovers\ Index_i(h) = \frac{\sum_{j=1,}^{N} \theta_{i,j}^{norm}(h)}{N} * 100$$
$$Transmitted\ Spillovers\ Index_i(h) = \frac{\sum_{j=1,}^{N} \theta_{j,i}^{norm}(h)}{N} * 100 \quad (12)$$

Based on those two indices, we can calculate the net spillover, as the difference between the spillovers received and transmitted. The formula is:

$$Net\ Spillovers\ Index_i(h) = Transmitted\ Spillovers\ Index_i(h) - Received\ Spillovers\ Index_i(h) \quad (13)$$

Application of Diebold and Yilmaz's indices

We apply the above-mentioned spillover indices to three variables. The first is the share of expenditures for which prices are growing at over 5% per year. The index contains values from zero to one and tell us how widespread inflation is.

The second is the monthly change in the sticky prices inflation index, which shows the underlying trend in inflation processes.

The third is the change in the Google trends indices concerning pay rises: *Gehaltserhöhung* in Germany, *Augmenter* in France, *Aumento* in Italy and Spain, and *Loonsverhoging* in the Netherlands. The index contains values from zero to 100. The maximum number represents the highest number of searches during the week. Each other value is proportional to the maximum; for example, 50 indicates that the number of searches was half the maximum.

We used this information instead of official statistics, as they are published with very frequently (weekly and monthly) and, contrary to the negotiated wage indices, are forward rather than backward-looking. In other words, the most comprehensive index by the ECB only shows pay rises as a result of agreements that have been concluded, rather than ongoing ones. Although this does not provide us with a precise measure of price growth, it gives us a relatively reliable indicator of general sentiment.

5. Results

This section presents our results. We started by calculating the spillovers between countries of the ratios of rapidly increasing prices in the HICP basket. Then we analysed the sticky prices. Finally, we provide estimates of the spillovers between wage searches.

Spillovers during the energy crisis

Spillovers played a moderate role in the prices where a rapid increase in inflation occurred. The variance decomposition suggests that, after a horizon of one year (12 months), approximately 50-65% of variance is related to innovations in the home country inflation. These may be either idiosyncratic price shocks or shocks that hit all the economies analysed simultaneously. We test three specifications with a different number of lags; from 2 to 4. The total spillover index remains stable and ranges from 38% to 44%. The total variance decomposition for the VAR specification with 3 lags is presented in Table 2.

Table 2: Forecast Variance Decomposition – share of rapidly increasing prices (%)

Country	Source of innovation in the decomposition of forecast variance				
	DE	FR	IT	ES	PL
DE	59	8	5	11	17
FR	8	50	14	18	11
IT	6	14	48	18	13
ES	9	12	1	63	15
PL	16	4	5	17	58

The table displays the percentage contribution of innovations in share of rapidly growing prices from the countries listed in row 2 to the total inflation forecast variance of the country in column 1 after one year. Sample used in the estimation contains the data from 2017 to April 2023.

Source: Own calculations

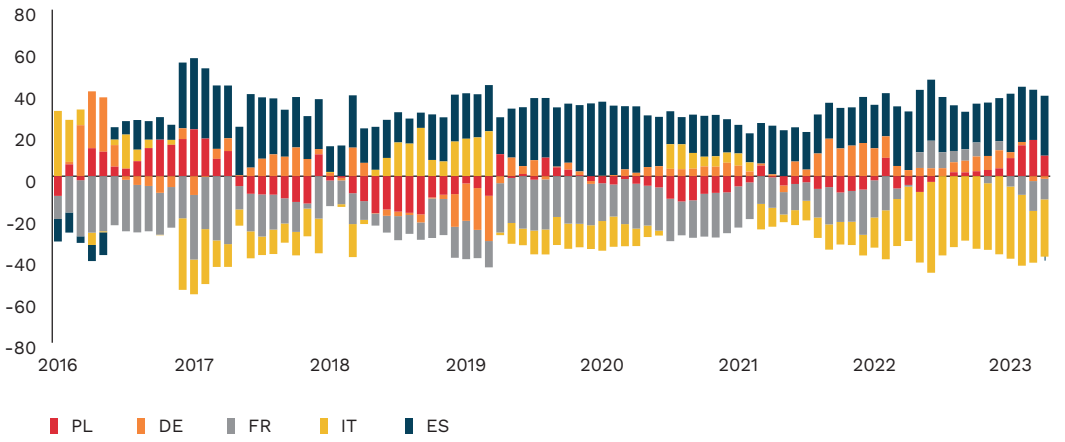
Spain and the countries in CEE were net transmitter of the inflation. The directional spillover indices revealed two significant relationships: one between Poland and Germany, and another between Spain and its neighbours, Italy and France. However, it should be noted that the methodology used does not determine the economic justifications for these spillovers. The leading relationships observed in these countries may be attributed to factors such as the swift implementation of decisions by multinational corporations.

Table 3: Diebold and Yilmaz indices – share of rapidly increasing prices.

Country	Transmitted	Received	Net
DE	36.4	37.7	-1.3
FR	42.9	48.8	-5.9
IT	24.8	50.2	-25.4
ES	63.8	34.0	29.8
PL	44.5	41.7	2.8

Source: Own calculations

Figure 4: Diebold and Yilmaz dynamic net spillover indices



Note: Positive number indicates country is an inflation transmitter. Sum of columns is always equal to zero. Calculations based on 6 years rolling time window.

Source: Own calculations

The magnitude of the spillovers from Spain is stable over time, whereas those from Poland increased in 2022. We computed the dynamic DY indices based on the rolling six-year time windows. Spanish inflation persistently

precedes inflation in other Eurozone countries. In the case of Poland, the leading relationship emerged with the energy shock. Similarly, countries that usually have the lowest inflation, like Italy or France, are currently receiving higher inflation abroad. The structure of the net spillovers is presented in Figure 4. Given the persistence of inflation in both Poland and Spain, a rapid deceleration in core inflation seems implausible now.

Sticky prices – a new risk to inflation

The new risk related to spillovers emerged from sticky prices. In the second step in our analysis, we estimated the VAR model using the monthly price changes in the sticky price index. Our model showed that, in this case, only 23-44% of inflation is generated domestically. Most of the contribution comes from abroad; the magnitude of the inflation imported via foreign channels increased after the energy shock.

Table 4: Forecast Variance Decomposition – monthly changes of sticky prices (%)

Country	Source of innovation in the decomposition of forecast variance				
	DE	FR	IT	ES	PL
DE	40	8	21	17	14
FR	9	23	21	22	25
IT	10	2	33	22	33
ES	8	3	27	31	31
PL	12	3	21	20	44

The table displays the percentage contribution of innovations in sticky inflation from the countries listed in row 2 to the total forecast variance of the country in column 1 after one year. Sample used in the estimation contains the data from 2017 to April 2023.

Source: Own calculations

Again, the major net transmitters of the sticky price increase are Poland and Spain. The transmission occurs mainly from the CEE region, as inflation there was much stronger than in the Eurozone. The major countries, France and Germany, are classified as receivers; the inflation in these two economies reacted more slowly than in less developed EU countries. For a summary of the spillover indices, see Table 5.

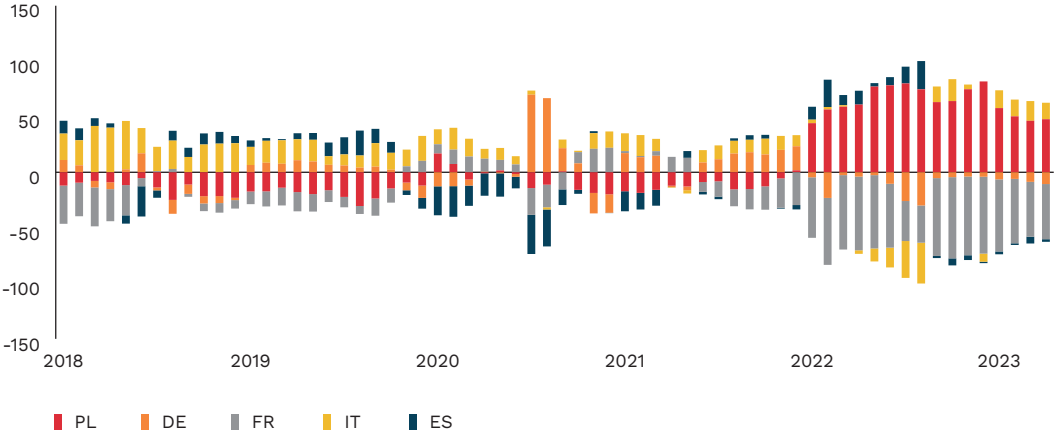
Table 5: Diebold and Yilmaz indices – monthly changes of sticky prices

Country	Transmitted	Received	Net
DE	38.36	60.2	-21.8
FR	16.17	77.1	-61.0
IT	89.27	66.7	22.5
ES	81.56	68.6	13.0
PL	102.89	55.6	47.3

Source: Own calculations

The magnitude of the spillovers is not stable over time; it increases with the rise of inflation. The rolling six-year time window total spillover index increased from 40% in 2018 to 65%, after the start of the war in Ukraine. The contribution increased during the period of higher inflation. This phenomenon is likely to continue in the coming quarters as most EU countries have experienced a lower increase in sticky prices compared to overall inflation. The transmitters and receivers are presented on Figure 5.

Figure 5: Diebold and Yilmaz dynamic net spillover indices – sticky prices



Note: Positive number indicates country is an inflation transmitter. Sum of columns is always equal to zero. Calculations based on 6 years rolling time window.

Source: Own calculations

Wage price spiral risk – evidence from Google searches

An additional risk for the persistence of inflation is related to wage spillovers from the Netherlands. The estimate of the Diebold Yilmaz indices suggests a lower interconnection compared to inflation. Approximately 27-35% of the variance is related to wage pressure in neighbouring economies. Still, the structure is unfavourable – a decomposition of the forecast variance shows that the Netherlands is the biggest transmitter, while Spain and Germany are among the biggest receivers.

Table 6: Forecast Variance Decomposition – wage indices (%)

Country	Source of innovation in the decomposition of forecast variance				
	DE	FR	IT	NL	ES
DE	76	3	7	11	3
FR	1	75	3	9	12
IT	3	4	75	17	1
NL	8	5	9	75	3
ES	7	11	8	14	60

The table displays the percentage contribution of innovations in inflation from the countries listed in row 2 to the total inflation forecast variance of the country in column 1 after one year.

Source: Own calculations

Two countries are linked to stronger spillovers from wage pressures: Italy and the Netherlands. The net indices are presented in Table 7. The case of Italy is likely to reflect the situation in the southern EU countries; the labour market slack there is the lowest and wages are increasing slowly. Still, if wages are increasing there, it is likely to lead to adjustments in the other countries, too. The Netherlands is probably the most internationalised EU economy – it is the first EU country to reflect global trends.

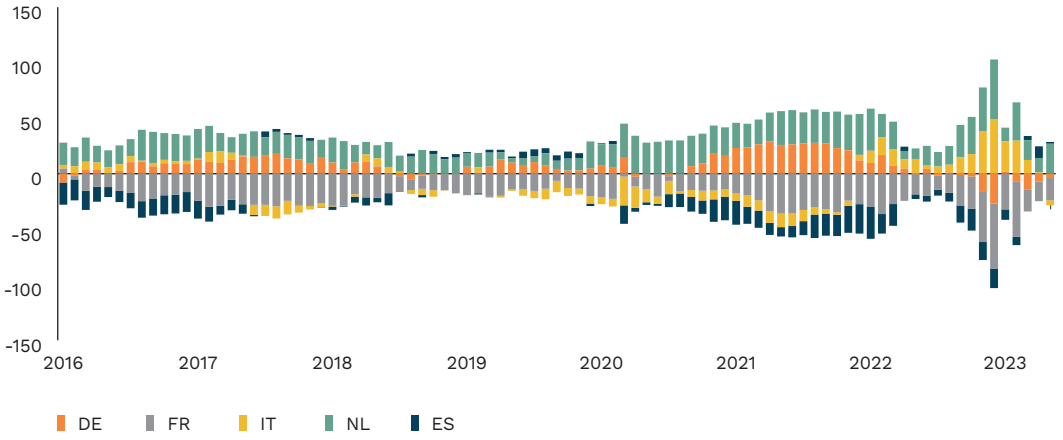
Table 7: Diebold and Yilmaz indices for the European Union biggest countries

Country	Transmitted	Received	Net
DE	22.5	32.5	-10.0
FR	18.8	29.2	-10.4
IT	43.9	30.4	13.5
NL	50.4	35.5	14.9
ES	30.8	38.9	-8.1

Source: Own calculations

The overall magnitude of the spillovers is moderate. The total spillover index oscillates around 35-40%, similarly to the share of prices increasing rapidly. Still, the magnitude can increase rapidly during a period of stress; a similar phenomenon was visible at the beginning of 2023, with the wave of wage-related strikes in the Netherlands. A synchronous rise in wage pressure therefore remains a risk that should not be overlooked.

Figure 6: Diebold and Yilmaz dynamic net spillover indices – wage pressure



Note: Positive number indicates country is an inflation transmitter. Sum of columns is always equal to zero. Calculations based on 6 years rolling time window.

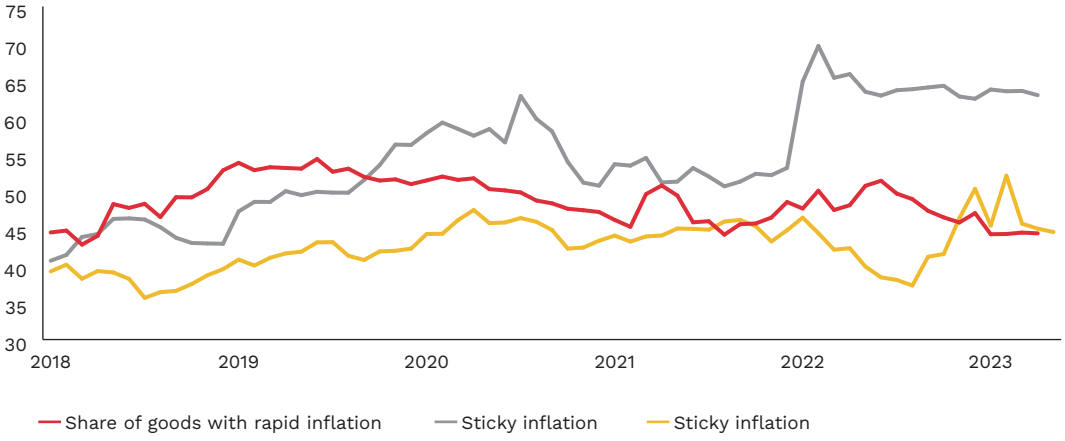
Source: Own calculations

6. Conclusion

This paper has examined the potential channels of inflation spillovers between EU's largest countries. Although the cross-country transmission of rapidly increasing prices is rather moderate, the countries that are transmitter still experience the more widespread inflation, which suggests the risk of higher inflation in the Eurozone as a whole. The spillovers in the sticky prices seem to increase with a higher magnitude of prices increases. This remains an important channel that could prolong the period of high inflation.

Overall, the magnitude of inflation spillovers between countries increased after the energy crisis (Figure 7). Again, the Diebold and Yilmaz framework suggests that the biggest impact is visible in the case of sticky prices. This phenomenon shows one reason why predictions obtained using standard modeling frameworks such as the Philips curve, which were based on data from a period of low inflation, undershoot the actual increase in prices.

Figure 7: Diebold and Yilmaz – Total spillover indices.



Note: Calculations based on 6 years rolling time window.
Source: Own calculations

Additional risks are linked to wage increases. Our framework shows little interconnectedness between the situation on the labour market in the Euro-zone countries. Still, the spillover increases during periods of perturbations. The Netherlands emerges as a transmitter, systematically preceding certain tendencies that can be seen in other countries. Given the heightened wave of wage-realted strikes there, we see wage-led inflation as an important factor that could prolong the period of higher inflation.

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