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The globalisation of inflation in the European emerging countries[1]

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Abstract

This paper studies inflation globalisation in the European emerging countries by measuring inflation co-movement across the region and assessing how local inflation rates reacted to global factors. The analysis covers central and eastern European countries which are members of the European Union but do not currently belong to the euro area. The results confirm sizeable inflation co-movement and a significant influence exerted by global factors on the inflation rate in emerging Europe. The euro area inflation rate and the output gap in the euro area are the external factors with the strongest impact, thereby underlining the strong ties of the region with the single currency area. The sensitivity of the consumer price (CPI) inflation rate in the region to global price dynamics firmly increased after 2014, whereas the alignment of producer price inflation with international inflation developments occurred even earlier, after the global financial crisis. Nevertheless, core CPI inflation and GDP deflator inflation were less correlated with the corresponding global inflation indicators, emphasising the still prominent role of domestic factors in driving price changes in the region.

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1. Introduction

Globalisation has been shaping economies worldwide over the past few decades. The global financial crisis brought to the surface the ample scale of the build-up of cross-border economic and financial linkages. Among various topics concerning globalisation, this paper picks up on discussions regarding inflation globalisation. Inflation rates are currently more synchronised across countries than prior to the crisis, pointing to a higher correlation between business cycles and strong external factors that are making the inflation rate in different countries follow a similar path. Ciccarelli and Mojon (2010) found that global inflation acts as an attractor for domestic inflation. From a historical perspective, Mumtaz, Simonelli and Surico (2011) reported evidence of both inflation regionalisation and inflation globalisation, with regional factors being the leading drivers of price level. However, cross-border interconnections have repercussions not just for the macroeconomic environment, but also for financial markets (Hofmann and Takáts (2015), Eickmeier, Gambacorta and Hofmann (2013)).

There is broad consensus in the literature that trade and energy prices – or, more generally, commodity prices – are key determinants of inflation globalisation (Auer and Mehrotra (2014), Forbes, Kirkham and Theodoridis (2017), Kamber and Wong (2018), Kearns (2016), Sussman and Zohar (2018)). Auer, Borio and Filardo (2017) suggested that the expansion of global value chains (GVCs) acted as a catalyst for the transmission of foreign prices into the economy. International competition between producers is another mechanism that fosters assimilation of global dynamics (Binici, Cheung and Lai (2012), Forbes (2018)). Kearns (2016) referred to implicit competition, where prices abroad could affect local producer prices even when there is no effective trade. Additionally, Mishkin (2009) considered that international competition stimulates companies to improve productivity, thus causing the inflation rate to fall.

The majority of studies examine inflation globalisation in the advanced economies, but emerging markets too display close and complex economic ties to the rest of the world. According to Rogoff (2003), emerging countries with fixed exchange rate regimes had lower inflation rates during 1991–2001, in line with declining inflation in the advanced economies. Hałka and Szafrański (2015) applied common factor analysis to disaggregated price indices in central and eastern European countries and found that inflation is correlated with the oil price and the inflation rate in the euro area. Nevertheless, Jašová, Moessner and Takáts (2018) found that inflation globalisation strengthened in developed economies after the global financial crisis, but weakened in the emerging markets. On the same note, Jordà and Nechio (2018) outlined a more synchronised inflation rate in advanced economies because of the credit boom-bust that preceded the crisis. Despite this, Jordà and Nechio (2018) observed that inflation in many Asian and Latin American countries stayed low and close to inflation rates in the developed economies after the crisis although those countries did not face a rising unemployment rate or a credit boom-bust cycle.

Other authors are of the view that while inflation has become more globalised, domestic factors continue to have material significance for the inflation rate. Carney (2017) analysed the structure of inflation and found that only some components are globalised, so that foreign price dynamics do not undermine the effectiveness of domestic monetary policy. He suggests the price changes in the service sector remained heterogeneous across countries and what actually drove the commonality in inflation was commodity prices, international trade, the global cycle of interest rates and the global financial crisis. Jordan (2015) argued that, in the case of

Switzerland, the correlation between global and the CPI imported goods inflation soared during 1994–2008, but imported inflation was influenced solely by the short-term fluctuations in global price dynamics.

Starting from the related literature, this paper assesses inflation globalisation in European emerging countries, by assessing the co-movement of inflation rates across the region and assessing how inflation's sensitivity to external factors has evolved. The study focuses on the central and eastern European countries which are members of the European Union but do not currently belong to the euro area. The country coverage comprises Bulgaria, the Czech Republic, Croatia, Hungary, Poland and Romania (hereinafter referred to as EM Europe).

The CPI inflation rates in EM Europe dropped significantly in 2013 and reached historical lows, even negative figures in many cases, during 2014–2016. The CPI inflation rate in EM Europe, computed as the GDP-weighted average of national CPI inflation rates, was lower than in the euro area or OECD countries throughout 2014– 2016. Thereafter, the inflation rate in the region followed a normalisation process and gradually returned to values in the vicinity of 2 percent, below the figures recorded in 2013. In the same period, EM Europe experienced rapid economic expansion and tight labour market conditions, which were supposed, on the contrary, to fuel inflationary pressures.

One explanation could be a potentially greater influence exerted by external factors, which might have led to inflation co-movement in the region and closer inflation alignment to global dynamics. Bearing in mind that the inflation rate in the euro area was for the most part of 2014–2018 significantly lower than 2 percent, it raises the question of whether the persistently weak global inflation and global slack guided inflation in EM Europe below the level that domestic factors would have warranted.

In this paper, inflation globalisation is defined as the impact of exogenous factors on domestic inflation. Global prices are already partially internalised by EM Europe given the region's close economic and financial relations with the euro area. Therefore, the analysis focuses on just the exogenous global component. Nevertheless, as economies in the region continue converging to the euro area, a larger share of global trends will turn endogenous.

The paper's results are consistent with the presence of inflation globalisation in EM Europe. The phenomenon emerged in the wake of the global financial crisis, but it became more pronounced starting in 2014. It has been manifested by a high sensitivity to global factors, such as the euro area inflation rate and the output gap in the euro area, which also drove inflation co-movement in the region.

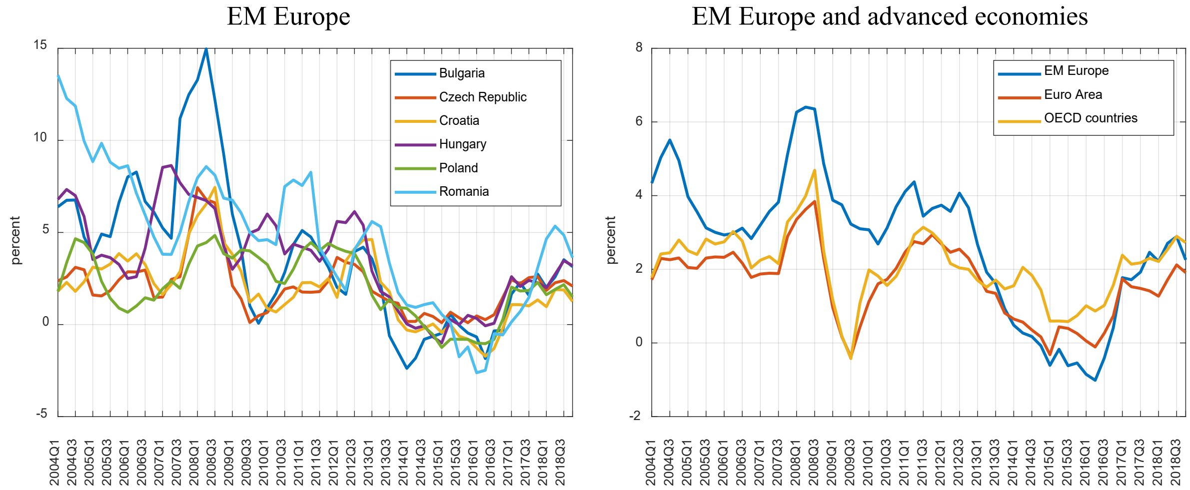
The inflation measures most responsive to foreign developments were the CPI inflation rate and the producer price index (PPI) inflation. Core CPI inflation and GDP deflator inflation in the region were less sensitive to global factors. Consequently, my findings highlight that inflation in EM Europe is linked to the evolution of international prices, albeit domestic factors continue to significantly influence the course of inflation. Central banks in the region have therefore retained a crucial role in guiding inflation towards levels compatible with their primary objective of preserving price stability, in spite of surging global influences.

The remainder of the paper is organised as follows. Section 2 presents some stylised facts about inflation in EM Europe. Section 3 describes the methodology for determining inflation's response to global factors, together with the dataset. Section 4 reports the empirical results. Section 5 provides evidence of the results' robustness, and Section 6 concludes.

2. Inflation in EM Europe: stylised facts

The CPI inflation rates in EM Europe displayed a downward trend between 2004[3] and 2016, reaching historical lows during 2014–2016, mostly even in negative territory. In the subsequent two years, inflation marked a rebound, in line with the development of global inflation, but it remained in the vicinity of the 2 percent benchmark adopted by the major central banks in the world (Figure 1).

Figure 1. Inflation rate (2004–2018)



Notes: 1. EM Europe = Bulgaria, Czech Republic, Croatia, Hungary, Poland and Romania. 2. The inflation rate in EM Europe was computed as the GDP-weighted average of domestic inflation rates.
Sources: BIS, Eurostat, OECD, author's calculations.

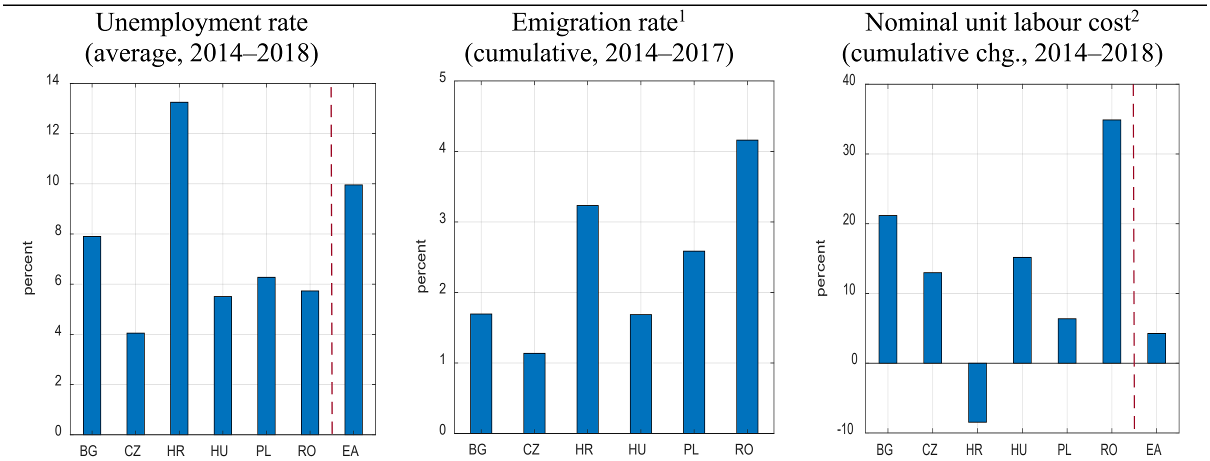
The trend inflation decline in EM Europe during the period under review was accompanied by elevated volatility, which, however, seems to have lessened in recent years, after the gap vis-à-vis the euro area inflation rate narrowed considerably.

By international standards, the inflation rate in EM Europe, computed as the GDP-weighted average of national inflation rates, was elevated before 2014 at levels of around 4 percent. Inflation rates also varied considerably across the region, especially prior to the global financial crisis, when the countries analysed recorded inflation rates significantly above 2 percent. Nevertheless, the inflation rate in EM Europe dropped in 2013, moving even below the inflation rate in the euro area and OECD countries[4] during 2014–2016. In the next two years, the inflation rate in the region picked up, but maintained a narrow differential vis-à-vis corresponding global levels.

[3] The period 2004–2018 ensures data representativeness and comparability among the countries analysed. The European Union began its enlargement process vis-à-vis central and eastern Europe in 2004.
[4] Of the countries under review, the Czech Republic, Hungary and Poland are OECD members. However, given the very small share of these economies in the total size of OECD economies as well as the prolonged review period, the inflation rate in the Czech Republic, Hungary and Poland is assumed to have had no material influence on the aggregated inflation rate in OECD countries.

The relatively muted level of inflation in EM Europe between 2014 and 2018 is to some extent surprising, given the robust economic growth rates and tight labour market conditions in the region over this period. Wages increased in the context of economic convergence to the euro area while emigration flows reduced labour supply, driving the unemployment rate in EM Europe below the euro area figure. Nominal unit labour cost growth exceeded in almost all countries in the region that of the euro area during 2014–2018 (Figure 2).

Figure 2. Evolution of labour market conditions in EM Europe and the Euro area



Notes: 1. The emigration rate is expressed as the share of the total number of persons who emigrated between 2014 and 2017 in the total population as of 1 January 2017. 2. The nominal unit labour cost is computed as the ratio of labour costs to labour productivity. 3. BG = Bulgaria, CZ = Czech Republic, HR = Croatia, HU = Hungary, PL = Poland, RO = Romania, EA = Euro area.
Sources: Eurostat, author's calculations.

Additionally, the plunge in the oil price between the end of 2014 and beginning of 2016 – a major cause of the suppressed inflation rate worldwide during that period – began in fact one year after the inflation rate in EM Europe had started to fall. The rate of inflation was already close to the zero or even negative in the region in the first quarter of 2014. This observation supports the hypothesis that the oil price correction was not the only external driver of inflation. Other factors, such as international competition and global slack – or, more generally, sluggish global demand – seem to have played a role, too.

Table 1. Inflation statistics for EM Europe (percent, quarterly data for 2004–2018)

	CPI inflation rate		Core CPI inflation rate		PPI inflation		GDP deflator inflation	
	Mean	St.dev.	Mean	St.dev.	Mean	St.dev.	Mean	St.dev.
Bulgaria	3.68	3.93	2.33	3.31	4.09	5.41	4.18	4.06
Czech Republic	2.10	1.56	1.18	1.04	1.47	3.20	1.53	1.55
Croatia	1.98	1.92	1.40	1.15	2.16	3.84	2.09	1.83
Hungary	3.60	2.51	2.78	1.53	4.24	4.84	3.40	2.00
Poland	2.11	1.74	1.16	0.88	2.87	3.37	2.19	1.98
Romania	4.67	3.71	3.79	2.72	5.96	6.33	7.06	5.27

Sources: BIS, Eurostat, author's calculations.

A broader view of inflation in the region between 2004 and 2018 reveals that energy and food prices pushed up the CPI inflation rate, which in turn was, on average, significantly above the core CPI inflation rate. PPI and GDP deflator inflation stayed higher than the CPI inflation rate in most countries in the region, meaning that producers absorbed some of the cost increases and transferred them to retail prices only partially. It could also be an expression of the material productivity gains that allowed companies to maintain access to markets in the face of rising production costs. Data on volatility back the resilience of the CPI inflation rate and core inflation to the more fluctuating production costs, as the standard deviation was larger for the PPI and GDP deflator (Table 1).

Inflation rate co-movement in EM Europe had increased significantly starting in 2014 and stabilised thereafter at around 80%. Another notable development was the even earlier advance of commonality in the PPI inflation, also up to around 80% after the global financial crisis. Nevertheless, these developments were not reflected by alternative inflation measures, such as the core CPI inflation rate and GDP deflator inflation, which exhibited a medium to low level of synchronisation of about 40%. The co-movement of the two indicators has actually weakened in recent years, offering no solid evidence yet of long-term regional alignment (Figure 3).

Figure 3. Inflation in EM Europe: percentage of variance explained by the first principal component (five-year rolling window)

Percentage of variance explained by the first principal component for the CPI inflation rate and core CPI inflation rate

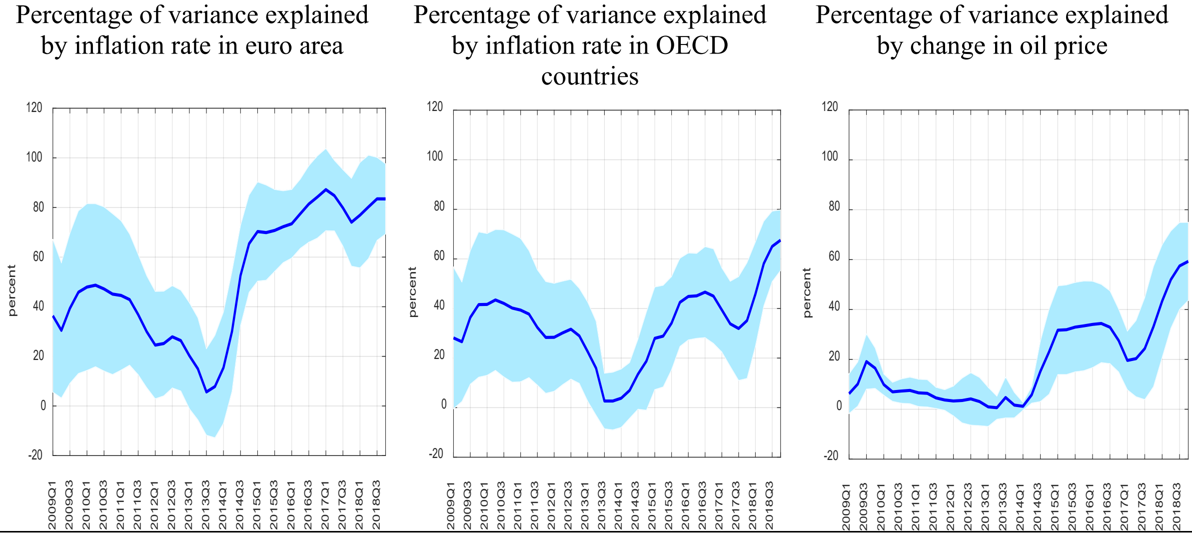
Percentage of variance explained by the first principal component for the PPI inflation and GDP deflator inflation

Notes: The percentage of variance explained by the first principal component was computed using principal component analysis. A search for potential outliers and data series normalisation (to obtain data with zero mean and unit standard deviation) were performed before running the principal component analysis, as proposed by Stock and Watson (2005) and Eickmeier, Gambacorta and Hofmann (2013). According to Stock and Watson (2005), an observation is an outlier if its absolute median deviation is larger than six times the interquartile range.
Source: Author's calculations.

Price changes in the service sector were mostly heterogeneous in the region. Economic activity in EM Europe has been predominately service-oriented, so that a lower synchronisation of core inflation and the GDP deflator inflation reflects more independent patterns for service prices.

As the next step, we compute the relationship between domestic inflation and global inflation indicators to assess the role of global factors behind the increased commonality in inflation dynamics across the region. According to the methodology proposed by Ciccarelli and Mojon (2010), the correlation can be measured as the R-squared of a regression where domestic inflation is the dependent variable whilst an intercept and the global inflation indicators are the explanatory variables. A five-year rolling window analysis shows how the interaction of local inflation with external factors evolved over time. The outcome for the CPI inflation rate is presented in Figure 4, while the rest of the results, referring to the PPI inflation, core inflation and the GDP deflator, are detailed in the Appendix (Figure A).

Figure 4. CPI inflation rate in EM Europe: percentage of variance explained by global inflation (five-year rolling window, median value +/- 1 standard deviation)



Note: Following Ciccarelli and Mojon (2010), the percentage of variance explained by global inflation refers to the R-squared of a regression in which the domestic measure of inflation in each country in the region is the dependent variable whilst the explanatory variables are an intercept and global inflation.
Source: Author's calculations.

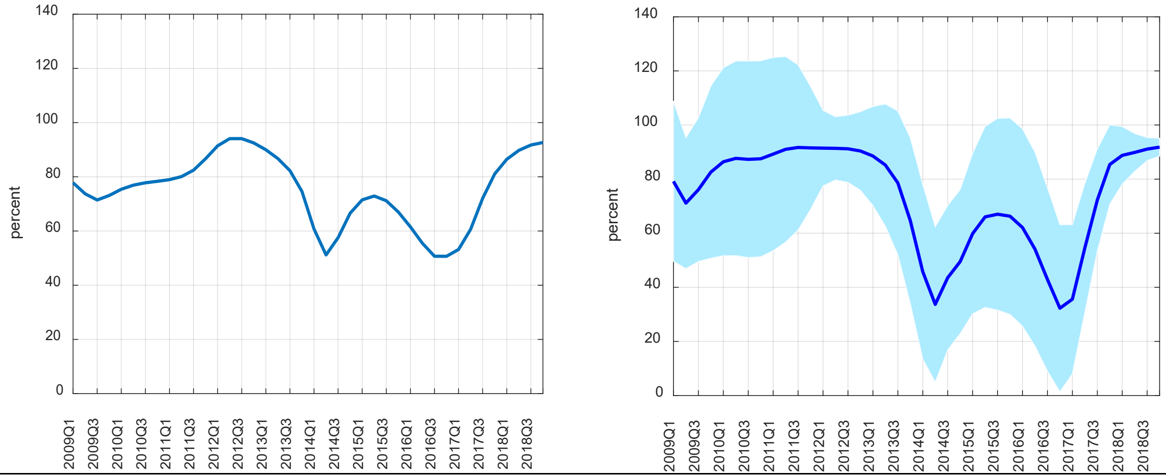
The share of inflation's variance explained by global inflation measures rose significantly after 2014. The correlation between domestic and euro area inflation rates strengthened the most, up to roughly 80%, followed by the correlation with the inflation rate in OECD countries (above 60%) and the change in oil prices (close to 60%). The results for PPI inflation yield similar results. The correlation between the PPI inflation in the region and that in both euro area and OECD countries exceeded 80% in 2018, while the PPI inflation's relationship with the change in oil prices was also highly significant (correlation of approximately 70%). Nevertheless, the share of core CPI inflation and GDP deflator inflation variances explained by global factors was less pronounced, displaying just short-lived increases.

The global financial crisis aligned business cycles, proxied by the output gap, across the region, causing co-movement to soar even above 90% during 2012. Nevertheless, as turmoil decreased in intensity, synchronisation retreated and returned to the post-crisis level by 2018. The same pattern was observed for the relationship between output gaps in the region, on the one hand, and the euro area's output gap, on the other. This is an indication that co-movement in the region was driven by the individual alignment of all business cycles in EM Europe with the euro area. Interestingly, the increase in correlation that took place in 2018 was accompanied by a narrow dispersion across the region, meaning that recent years have brought greater homogeneity with regard to country positioning in the economic cycle (Figure 5).

Figure 5. Business cycle synchronisation across EM Europe and correlation with the Euro area business cycle

Percentage of variance of the output gap explained by the first principal component in EM Europe (five-year rolling window)

R-squared of the output gap in EM Europe regressed on an intercept and output gap in the Euro area* (five-year rolling window, median value +/- 1 standard deviation)



Notes: Data source for the output gap is the European Commission (AMECO database). The data, initially with annual frequency, were interpolated using a cubic spline to attain quarterly data. *According to the methodology of Ciccarelli and Mojon (2010).
Source: Author's calculations.

Nevertheless, between 2014 and 2016, a period of subdued inflation in EM Europe and the Euro area, the correlation between domestic and euro area business cycles temporarily declined (Figure 5). The period 2014–2016 coincided with the severe oil price drop that forced inflation rates to co-move across the region, despite the less homogenous evolution of business cycles in EM Europe and the Euro area.

3. Methodology and data

The results outlined above highlight the transmission of global inflation to EM Europe and call for deeper and more comprehensive analysis. The following analysis examines inflation globalisation in EM Europe using in-sample sensitivity and out-of-sample prediction analysis. In that respect, the paper proposes a two-step methodology which evaluates inflation's sensitivity to external developments. The global factors tested include the oil price, inflation in the euro area, inflation in OECD countries, a measure of imported inflation (trade-weighted inflation rate) and the output gap in the euro area.

3.1. In-sample sensitivity analysis

The methodology starts from a baseline regression that aims to determine the role of domestic factors in driving the inflation rate in EM Europe. Afterwards, the baseline regression is augmented with a global factor in order to obtain the overall picture of the inflation process in EM Europe. The technique can be seen as a dynamic bottom-up approach which begins with an idiosyncratic assessment and then broadens the perspective by adding exogenous factors. The baseline equation is:

$$\pi_{it} = \mu_i + \rho(L)\pi_{it} + \gamma y_{it} + \varepsilon_{it} \quad (1)$$

where π_{it} denotes the inflation rate in country *i* at time *t*, μ_i is the intercept, $(L)\pi_{it}$ is the lagged inflation rate and y_{it} is the output gap. The relation is estimated with quarter-on-quarter changes in the price level (CPI inflation rate), and the data are seasonally adjusted. The output gap, initially with annual frequency, was interpolated using a cubic spline to attain quarterly data.

The lagged inflation rate in equation (1) controls for inflation persistence (Arslan, Jašová and Takáts (2016), Hondroyiannis and Lazaretou (2004), Kozicki and Tinsley (2002)). Equation (1) serves as the baseline model in our assessment, whereas the augmented model adds a vector of global factors to the domestic fundamentals, as follows:

$$\pi_{it} = \mu_i + \rho(L)\pi_{it} + \gamma y_{it} + \begin{pmatrix} \Delta P\_oil_t \\ \pi\_EA_t \\ \pi\_OECD_t \\ TW\pi_{it} \\ y\_EA\_orth_{it} \end{pmatrix} + \varepsilon_{it} \quad (2)$$

Here, ΔP_oil_t is the quarterly change in the oil price at time *t*, π_EA_t is the quarterly inflation rate in the euro area, π_OECD_t is the quarterly inflation rate in OECD countries, $TW\pi_{it}$ is the quarterly trade-weighted inflation rate in country *i* at time *t*, and $y\_EA\_orth_{it}$ is the orthogonal output gap in the euro area relative to the output gap in country *i*.

The trade-weighted inflation rate is a proxy for global inflation, be it imported or filtered into the local economy through indirect trade channels. I depart from Jordan (2015), who introduced import-weighted global inflation, but enlarge the scope of the indicator by including both exports and imports. The motivation is to detect, in addition to directly imported goods prices, other indirect implications, such as the influence exerted on inflation rate by foreign competition or foreign prices in markets where local producers are competitive. Hence, the trade-weighted inflation rate is calculated with the formula:

$$TW\pi_{it} = \sum_{j=1}^{k} \pi_{jt} \frac{Trade_{ijt}}{Trade_{it}} \quad (3)$$

where $TW\pi_{it}$ is the trade-weighted inflation rate for country *i* at time *t*, π_{jt} is the inflation rate in the trading partner j, $Trade_{ijt}$ denotes the trade between country *i* and country j, and $Trade_{it}$ is the total foreign trade conducted by country *i*. The traditional oil-exporting countries were removed from the sample of trading partners, as energy price variations are not necessarily related to the inflation rate in energy-exporting countries.

The output gap in the euro area is orthogonalised relative to the output gap in each of the European emerging countries, in order to remove the correlation between the variables. The orthogonal output gap in the euro area insulates the global demand component, which is not interrelated with demand in EM Europe. The augmented model discriminates between the idiosyncratic business cycle and the exogenous state of global demand.

The methodology applied for orthogonalisation was proposed by Jašová, Moessner and Takáts (2018). Following these authors' technique, the output gap in the euro area is regressed on an intercept and output gap in EM Europe. In the next step, the orthogonal output gap in the euro area equals the estimated intercept plus the residuals obtained from the panel estimation. The two equations can be observed below:

$$y\_EA_t = \mu_i + \rho y_{it} + \varepsilon_{it} \quad (4)$$

$$y\_EA\_orth_{it} = \widehat{\mu_i} + \widehat{\varepsilon_{it}} \quad (5)$$

The goal of the in-sample sensitivity analysis is to identify the global factors with a material influence on the inflation rate in EM Europe. It focuses on the robustness of the estimated coefficient on global factors, as well as on the improvement in explanatory power of the baseline model, measured by the adjusted R-squared of the regression.

3.2 Out-of-sample forecasting analysis

The short-run sensitivity analysis is complemented with a more medium-term out-of-sample forecasting exercise, considering a set of candidate local and global predictors, for time horizons of four and eight quarters ahead. The objective is to establish whether the global factors had significant out-of-sample predictive power and how they perform relative to domestic factors.

I opted for an approach analogous to the short-term sensitivity assessment, consisting of a baseline regression which is subsequently augmented with domestic or global factors. Based on the methodology and notations proposed by Stock and Watson (2002) and Ciccarelli and Mojon (2010), the approach considered a random walk model (equation (6)) and an autoregressive model (equation (7)), which both serve as benchmark, as well as an autoregressive model augmented with a vector of local and global factors (equation (8)). Hofmann (2008) applied a similar forecasting method to assess the ability of monetary indicators and of various economic and financial indicators to predict inflation in the euro area. The three forecasting equations are specified as follows:

$$\pi_{it+h} = \pi_{it} + \varepsilon_{it+h} \quad (6)$$

$$\pi_{it+h} = \mu_i + \rho(L)\pi_{it} + \varepsilon_{it+h} \quad (7)$$

$$\pi_{it+h} = \mu_i + \rho(L)\pi_{it} + \gamma(L)\begin{pmatrix} y_{it} \\ u_{it} \\ \Delta ER_{it} \\ \Delta NEER_{it} \\ \Delta P\_oil_t \\ \pi\_EA_t \\ \pi\_OECD_t \\ TW\pi_{it} \\ y\_EA_t \end{pmatrix} + \varepsilon_{it+h} \quad (8)$$

The forecasted inflation rate is computed as $\pi_{it+h} = \left(\frac{400}{h}\right) \ln(\frac{P_{it+h}}{P_{it}})$ and refers to the annualised average inflation rate in the price level (P_{it}) over the coming h quarters.

In the augmented autoregressive model, y_{it} denotes the output gap in country *i* at time *t*, u_{it} is the unemployment rate, ΔER_{it} is the quarterly change in the exchange rate against EUR, $\Delta NEER_{it}$ is the quarterly change in the nominal effective exchange rate, ΔP_oil_t is the quarterly change in the oil price expressed in USD, π_EA_t is the quarterly euro area inflation rate, π_OECD_t is the quarterly inflation rate in OECD countries, $TW\pi_{it}$ is the quarterly trade-weighted inflation rate, and y_EA_t is the output gap in the euro area. The latter variable is tested here separately from domestic output gap, therefore it is not necessary to orthogonalise the euro area's output gap in this case.

The first four variables belong to the internal factors, which are presumed to affect the inflation rate in EM Europe. The subsequent five indicators are proxies for global factors, and their role is to capture inflation globalisation in the region.

The stylised facts on the inflation rate in EM Europe suggest that inflation globalisation is a continuous, non-linear process. The intensity of the influence of global factors varied, depending on the magnitude of external factors, the domestic capacity to absorb exogenous shocks and economic convergence to the euro area. These issues are addressed by estimating the model successively, for a 10-year rolling window, using panel data with country fixed effects (Ciccarelli and Mojon (2010), Clausen and Clausen (2010)). The predictive accuracy is calculated by the root mean square error (RMSE).

3.3. Data

The data cover Bulgaria, the Czech Republic, Croatia, Hungary, Poland, Romania, the Euro area (aggregated data) and OECD countries (aggregated data). The set of indicators and the data sources are detailed in the Appendix (Table A.1). The sample period is 2004Q1–2018Q4, backdated with two additional years of data when applying out-of-sample forecasting of the inflation rate for eight quarters ahead. The motivation was to have the same forecast period for the four-quarter and eight-quarter time horizon. The year 2004 was preferred as the starting point because it ensures representativeness and comparability across EM Europe, given that the European Union began its eastward expansion in 2004.

Quarterly, seasonally adjusted data were used in estimations. The annual data (e.g. the output gap) were interpolated using a cubic spline to obtain quarterly frequency. When computing the trade-weighted inflation rate for each of the central and eastern European countries, a dataset comprising bilateral trade with 55 countries together with the inflation rate for every trading partner was selected. All the EU members were among the 55 foreign partners considered. The traditional oil-exporting countries were excluded from the list of trading partners, as energy prices are captured in the model via the oil price. The trade volume with the selected 55 countries is representative of the scope of the analysis, as it accounted for 90.5% of the total trade conducted by EM Europe during 2004–2018. The euro area was the largest trading partner of EM Europe, with a ratio of 56.5% of total trade.

4. Results

4.1. Results for the in-sample sensitivity analysis to global factors

All the global factors tested were statistically significant, at the 1% significance level, and improved the explanatory power of the baseline model. The number of lags for domestic inflation was optimally chosen using the AIC criterion. The best fit was obtained by augmenting the baseline equation with the CPI inflation rate in the euro area. According to estimation results, a 1 percentage point fall in the CPI inflation rate in the euro area was associated with a 0.813 percentage points decrease in the inflation rate in EM Europe – robust evidence of the euro area inflation rate being extremely important for the inflation rate in central and eastern Europe. The adjusted R-squared of the baseline regression rose by 0.09 or 21.3%, from 0.423 to 0.513, when the euro area inflation rate was added into the equation (Table 2).

Other external factors that had a sizeable impact on inflation in the region were the trade-weighted inflation rate and the change in the oil price. For example, a 1 percentage point increase in the trade-weighted inflation rate corresponded to a 0.818 percentage points rise in the inflation rate in EM Europe. Additionally, a 1 percentage point higher/lower oil price was associated with a 1.088 percentage points rise/decline in the inflation rate in EM Europe. With regard to the adjusted R-squared of the baseline regression, it increased by 0.086 (20.3%) and 0.055 (13%) when the trade-weighted inflation rate and the change in the oil price, respectively, were added into the equation.

Table 2. Estimation results (dependent variable: CPI inflation rate; estimation period: 2004Q1–2018Q4)

Symbol	Variable	(1)	(2)	(3)	(4)	(5)	(6)
π_{t-1}	Inflation rate (one lag)	0.392*** [7.462]	0.359*** [7.150]	0.275*** [5.454]	0.340*** [6.609]	0.260*** [5.068]	0.362*** [6.824]
π_{t-2}	Inflation rate (two lags)	0.232*** [4.508]	0.230*** [4.698]	0.179*** [3.733]	0.224*** [4.522]	0.171*** [3.550]	0.214*** [4.168]
y_t	Output gap	0.042*** [3.575]	0.043*** [3.901]	0.039*** [3.685]	0.038*** [3.363]	0.034*** [3.116]	0.041*** [3.576]
ΔP_oil_t	Delta oil price		1.088*** [6.084]				
π_EA_t	CPI inflation rate Euro area			0.813*** [7.996]			
π_OECD_t	CPI inflation rate OECD				0.428*** [5.316]		
$TW\pi_t$	Trade-weighted inflation rate					0.818*** [7.753]	
$y\_EA\_orth_t$	Orthogonal output gap Euro area						0.082*** [2.855]
No. of countries		6	6	6	6	6	6
No. of observations		348	348	348	348	348	348
Adjusted R-squared		0.423	0.478	0.513	0.466	0.509	0.435
Country fixed effects		Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects		No	No	No	No	No	No

Note: ***/**/* indicates 1/5/10% significance level; *t*-statistic in brackets.
Source: Author's calculations.

Nevertheless, the marginal effect of changes in external conditions on the inflation rate in EM Europe before and even during the global financial crisis, on top of what the internal factors would have explained, was less robust. Global factors emerged as important determinants of local inflation mostly after the crisis. Particularly, the oil price change and the inflation rate in OECD countries gained in influence on EM Europe's inflation rate after 2010. A 1% fall in the oil price corresponded to a 1.506% decline in the inflation rate in the region, pointing to the large amplitude of the oil price shock that significantly adjusted the existing price level, as well as the expectations concerning a potential further drop in the oil price and its subsequent impact on inflation (Table 3).

The robust results obtained for the inflation rate in OECD countries after the global financial crisis could reflect that EM Europe, while remaining structurally interlinked with the euro area, became more integrated in the global economy than before the crisis. The global inflation process in the world's leading economies has become increasingly relevant for the price changes in central and eastern Europe.

Table 3. Estimated coefficients of global factors in the augmented regressions (dependent variable: CPI inflation rate; individual regression for each global factor)

Symbol	Variable	Pre-crisis period (2004Q1–2008Q2)	Post-crisis period (2010Q1–2018Q4)
ΔP_oil_t	Delta oil price	1.142 [1.658]	1.506*** [5.668]
π_EA_t	CPI inflation rate Euro area	1.073*** [2.947]	1.207*** [8.339]
π_OECD_t	CPI inflation rate OECD	0.260 [1.097]	0.730*** [5.485]
$TW\pi_t$	Trade-weighted inflation rate	0.722** [2.087]	1.157*** [7.801]
$y\_EA\_orth_t$	Orthogonal output gap Euro area	0.160 [1.410]	0.150*** [2.604]
	No. of countries	6	6
	No. of observations	96	204
	Country fixed effects	Yes	Yes
	Time fixed effects	No	No

Notes: The regressions were estimated separately for each global factor; ***/**/* indicates 1/5/10% significance level; *t*-statistic in brackets.
Source: Author's calculations.

After the crisis, the euro area inflation rate increased the baseline model's explanatory power by 0.188 (67.9%), and the trade-weighted inflation rate expanded it by 0.17 (61.4%), whereas the change in the oil price improved the adjusted R-squared obtained for domestic factors by 0.1 (36.1%) (Table 4).

Table 4. Change in the explanatory power of the baseline regression when augmented with global factors (dependent variable: CPI inflation rate)

Pre-crisis period (2004Q1–2008Q2)		Post-crisis period (2010Q1–2018Q4)	
Model	Change in adj. R-squared relative to the baseline model (BM)	Model	Change in adj. R-squared relative to the baseline model (BM)
BM + π_EA_t	0.066**	BM + π_EA_t	0.188***
BM + $TW\pi_t$	0.030**	BM + $TW\pi_t$	0.170***
BM + ΔP_oil_t	0.016	BM + ΔP_oil_t	0.100***
BM + π_OECD_t	0.002	BM + π_OECD_t	0.094***
BM + $y\_EA\_orth_t$	0.009	BM + $y\_EA\_orth_t$	0.021***

Notes: The models are reported in descending order of change in adjusted R-squared during the post-crisis period. π_EA_t is the inflation rate in the euro area, $TW\pi_t$ is the trade-weighted inflation rate, ΔP_oil_t is the change in the oil price at time *t*, π_OECD_t is the inflation rate in OECD countries, and $y\_EA\_orth_t$ is the orthogonal output gap in the euro area. ***/**/* indicates 1/5/10% significance level and corresponds to the *t*-statistic of the global factors' coefficients.
Source: Author's calculations.

The sound statistical significance of the inflation rate in the euro area during the post-crisis period, combined with the weaker significance of the orthogonal output gap in the euro area in the same period, might suggest that the oil price drove to a great extent not just the inflation rate in EM Europe, but similarly the euro area inflation rate.

The robust result for the trade-weighted inflation rate in the post-crisis period, which was outpaced only by the euro area inflation rate, suggests that trade linkages propel the transmission of global inflation. The Euro area is the largest trading partner of EM Europe, so that this finding enforces the general consideration that inflation in the euro area is more relevant for the inflation in EM Europe than inflation in OECD countries, even though the region's integration in the world economy has intensified in the wake of the global financial crisis.

The lower marginal contribution of the orthogonal output gap in the euro area to the baseline model mirrors the two regions' business cycle co-movement. The residual after extraction of the correlation between the output gap in the Euro area and EM Europe is less relevant for the inflation rate in central and eastern Europe. Foreign demand originating in the euro area fostered the synchronisation of economic cycles and facilitated the transmission of foreign prices to the region's economies.

4.2 Out-of-sample forecast results

Inflation forecasting four quarters ahead shows that the autoregressive model augmented with several domestic and global factors outperformed the random walk and the autoregressive model. However, the output gap in the euro area is indicated as the strongest predictor by the RMSE (Table 5).

Table 5. Results of the out-of-sample forecasting of the CPI inflation rate in EM Europe (panel estimations with country fixed effects, 10-year rolling window, **four quarters ahead**, median, forecast period: 2016Q1–2018Q4)

No.	Model	Factor	RMSE (h=4 quarters)
1	AR + y_EA_t	Euro area output gap	1.214
2	AR + ΔP_oil_t	Oil price	1.341
3	AR + π_OECD_t	OECD inflation rate	1.374
4	AR + $TW\pi_{it}$	Trade-weighted inflation rate	1.375
5	AR + y_{it}	Domestic output gap	1.395
6	AR + ΔER_{it}	Exchange rate	1.417
7	Autoregressive model (AR)	-	1.428
8	AR + $\Delta NEER_{it}$	Nominal effective exchange rate	1.429
9	AR + π_EA_t	Euro area inflation rate	1.443
10	AR + u_{it}	Unemployment rate	1.531
11	Random walk model (RW)	-	1.856

Notes: The models are reported in ascending order of RMSE, from the preferred predictor downwards.
Source: Author's calculations.

Other external factors, such as the change in the oil price and the inflation rate in OECD countries proved to be good predictors of the inflation rate in EM Europe, although with a weaker accuracy. Bearing in mind that the external factors performed better in predicting the course of inflation in the region one year in advance, at least under my model's assumptions and given the data constraints, this suggests that inflation over near-term horizons is driven mostly by exogenous factors. These results probably reflect the characteristics of a small open economy like the central and eastern European countries, which makes them vulnerable to external shocks.

The predictive power of global factors is confirmed by the results obtained when extending the forecasting time horizon to eight quarters ahead. The output gap in the euro area was the preferred inflation rate predictor in EM Europe, with RMSE of 1.859, significantly below the figures observed for the two benchmarks. The change in the nominal effective exchange rate ranked second, from factors tested, but its predictive accuracy fell behind the random walk model (Table 6).

Table 6. Results of the out-of-sample forecasting of the CPI inflation rate in EM Europe (panel estimations with country fixed effects, 10-year rolling window, **eight quarters ahead**, median, forecast period: 2016Q1–2018Q4)

No.	Model	Factor	RMSE (h=8 quarters)
1	AR + y_EA_t	Euro area output gap	1.859
2	Random walk model (RW)	-	1.920
3	AR + $\Delta NEER_{it}$	Nominal effective exchange rate	2.088
4	AR + ΔP_oil_t	Oil price	2.089
5	AR + π_OECD_t	OECD inflation rate	2.100
6	Autoregressive model (AR)	-	2.100
7	AR + ΔER_{it}	Exchange rate	2.102
8	AR + y_{it}	Domestic output gap	2.182
9	AR + $TW\pi_{it}$	Trade-weighted inflation rate	2.210
10	AR + u_{it}	Unemployment rate	2.235
11	AR + π_EA_t	Euro area inflation rate	2.239

Notes: The models are reported in ascending order of RMSE, from the preferred predictor downwards.
Source: Author's calculations.

Among benchmarks, the autoregressive model performed better over the four-quarter time horizon, whilst the random walk model revealed lower RMSE over the longer, eight-quarter time horizon, similarly to the results obtained by Hofmann (2008). The smoothness of the average inflation rate forecasted improves the performance of the random walk model over longer time horizon.

The robust ability of the external business cycle to predict the inflation rate in EM Europe over four and eight-quarter time horizon suggests a deep integration with the euro area economy. Consequently, the development of global factors must be given due consideration for the assessment of risks to price stability. External factors are predominantly relevant for short-term inflation movements, but their influence extended to the medium-run dynamics of inflation in central and eastern Europe after the global financial crisis.

5. Robustness check

The results' robustness is tested by applying two additional checks. First, the country sample is split by monetary policy regime into inflation targeting countries (the Czech Republic, Hungary, Poland and Romania, hereinafter referred to as IT countries) and non-inflation targeting countries (Bulgaria and Croatia, hereinafter referred to as non-IT countries) which pegged their currencies to EUR. Second, the inflation rate is replaced in the methodology with the alternative inflation measures described earlier, specifically the PPI inflation, the GDP deflator inflation and core CPI inflation.

5.1. Robustness check with regard to monetary policy regime

The baseline regression, which estimates the relationship between the domestic output gap (explanatory variable) and the inflation rate (dependent variable) on a quarterly basis, is run separately for the IT and non-IT countries in EM Europe using panel data with country fixed effects. The baseline equation is further augmented with global factor and re-estimated for the two sub-samples.

All the external factors tested were statistically significant and improved the explanatory power of the baseline model after the global financial crisis, regardless of the monetary policy regime (Appendix: Tables A.2 and A.3). In case of the IT countries, the estimated coefficients for the global factors were mostly statistically significant even before the crisis, but with a lower significance. The less robust outcome for the pre-crisis period remains in line with the increased inflation rate dispersion across the region at that time.

Global factors such as the inflation rate in the euro area, the trade weighted inflation rate and the change in oil prices provided the largest improvement in adjusted R-squared after the crisis for the IT sub-sample, by 0.186, 0.174 and 0.123, respectively. When performing the estimations for the sub-sample of countries with a fixed exchange rate regime, the relevance of the most robust global factors to local inflation actually strengthened. The inflation rate in the euro area and the trade-weighted inflation rate sustained the improvement in adjusted R-squared after the crisis by 0.198.

The floating exchange rate that accompanies inflation targeting regimes allowed for a greater absorption of external shocks, making the inflation rate less sensitive to spillovers. On the other hand, in countries in the region with fixed exchange rates pegged to the EUR the inflation rate was more sensitive to foreign inflation. The results are in accordance with Rogoff (2003) and Kearns (2016), who detected stronger inflation alignment with the global trend in countries with fixed exchange rate regimes.

The out-of-sample forecasting indicates that the output gap in the euro area and the trade-weighted inflation rate are the preferred predictors for the inflation rate in the IT countries. The RMSEs were 1.075 for the autoregressive model augmented with the output gap in the euro area and 1.158 for the one augmented with the trade-weighted inflation rate, when forecasting four quarters ahead. Moreover, the output gap in the euro area enhanced its predictive accuracy when extending the time horizon to eight quarters ahead (Appendix: Tables A.4 and A.5). Relatively similar results were obtained for the non-IT countries, but they were possibly affected by the relatively limited size of the data sample (Appendix: Tables A.6 and A.7).

As a consequence, inflation globalisation in EM Europe appears robust and holds across different monetary policy regimes. The inflation rate in the non-IT countries was more closely aligned with short-term global inflation fluctuations, in comparison with the IT countries, but even this difference dissipated when the time frame was extended over one or two years. The lesser monetary policy autonomy in the non-IT countries has been mostly offset in the long run by the convergence of all countries in the region to the euro area, regardless of the nature of the exchange rate regime.

5.2. Robustness check with regard to different inflation measures

The sensitivity assessment for alternative measures of inflation led to comparable results and further supported the conclusion that the external inflation environment became relevant for inflation in EM Europe after the crisis. Similarly to the CPI inflation rate, the PPI inflation rate yielded statistically significant results. All the global factors analysed improved the explanatory power of the baseline model after the crisis, when running the estimations for the PPI inflation. The global factors with the greatest influence on the PPI inflation in EM Europe were the PPI inflation in the euro area and OECD countries, with adjusted R-squared increased by 0.412 and 0.321, respectively.

In contrast, core CPI inflation and the GDP deflator inflation were less interrelated across the region and thereby less correlated with the corresponding indicators in the euro area and OECD countries. There is some indication that external factors also affect these two inflation measures, especially the orthogonal output gap in the euro area. It boosted the adjusted R-squared of the baseline regression by 0.06 (52.6%) when running estimations for the GDP deflator prior to the crisis and by a lower amplitude for core inflation after the crisis. This notwithstanding, the domestic fundamentals accounted for most of the variation recorded by core CPI inflation and the GDP deflator in central and eastern Europe (Appendix: Tables A.8 to A.10).

The out-of-sample forecasting exercise confirms the key role played by global factors in driving the region's PPI inflation. The oil price change was the preferred predictors for four quarters ahead, whereas it remained among the predictors which outperformed the two benchmarks, when extending the time horizon to eight quarters (Appendix: Tables A.11 and A.12.).

Nevertheless, the predictive accuracy of core inflation rate and GDP deflator was more balanced between local and global factors. The out-of-sample analysis detected domestic factors as essential for the course of core inflation rate and GDP deflator in EM Europe, although it can be observed an influence of global factor on the two alternative inflation measures, as well (Appendix: Tables A.13 to A.16.).

6. Conclusions

This paper presents empirical evidence supporting the notion of significant inflation globalisation in central and eastern Europe. The results suggest that inflation in EM Europe displayed increased co-movement and a high degree of sensitivity to external factors since 2014. The alignment of PPI inflation with global developments occurred even earlier, after the global financial crisis. Core inflation and GDP deflator inflation were less synchronised across the region and domestic fundamentals dominated their dynamics. Among the global factors examined, the euro area inflation rate and the output gap in the euro area had the strongest influence on EM European inflation rates, thereby confirming the strong ties of the region with the euro area.

The results further suggest that countries in the region with inflation targeting regimes were over the short term less affected by external inflation developments than countries with fixed exchange rates. Notwithstanding, over longer time horizons, e.g. one or two years ahead, all countries are similarly exposed to external dynamics. Their status as small open economies along with their convergence to the euro area fosters structural linkages with the single currency block and, beyond, with the rest of the world, regardless of the monetary policy regime.

The analysis explicitly indicates trade as a transmission channel of global inflation trends. This takes the form of imported prices, foreign competition and external demand for domestic products. That said, inflation globalisation in the European emerging countries might be facilitated by other indirect or less obvious catalysts, such as global value chains, the sharing economy or technology. Exploring the role of these factors was however beyond the scope of this paper and is left for future research.

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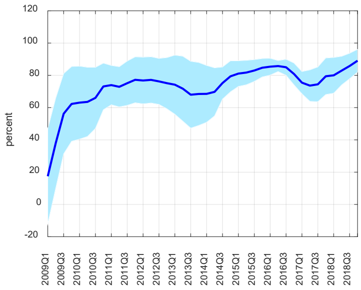
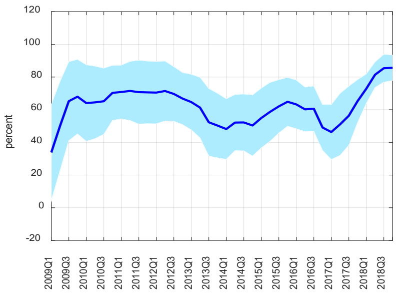
Appendix

Figure A.1. Inflation in EM Europe: percentage of variance explained by the global factors (five-year rolling window, median value +/- 1 standard deviation)

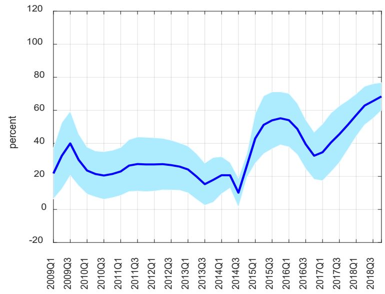
Percentage of PPI inflation's variance explained by PPI inflation in euro area



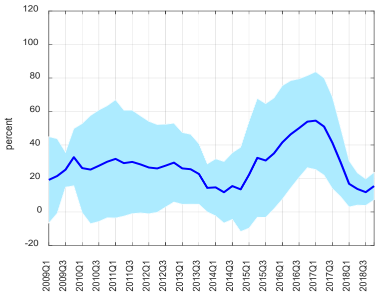
Percentage of PPI inflation's variance explained by PPI inflation in OECD countries



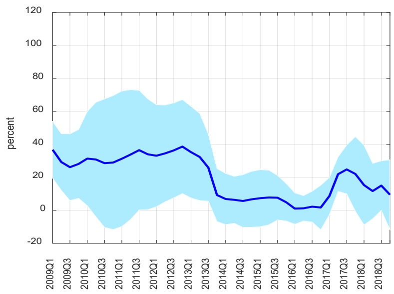
Percentage of PPI inflation's variance explained by the change in oil price



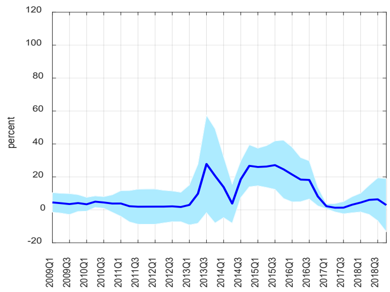
Percentage of core inflation's variance explained by core inflation in euro area



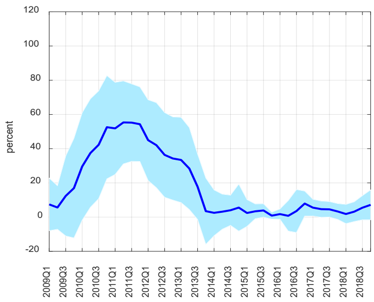
Percentage of core inflation's variance explained by core inflation in OECD countries



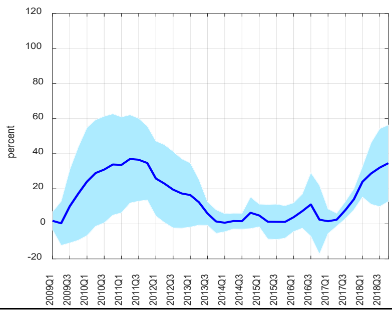
Percentage of core inflation's variance explained by the change in oil price



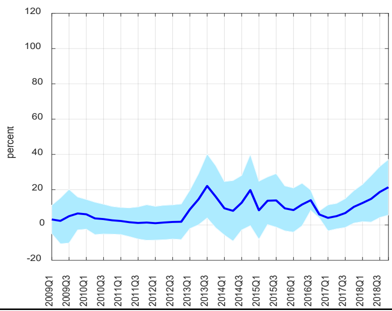
Percentage of GDP deflator inflation's variance explained by GDP deflator inflation in euro area



Percentage of GDP deflator inflation's variance explained by GDP deflator inflation in OECD countries



Percentage of GDP deflator inflation's variance explained by the change in oil price



Note: According to Ciccarelli and Mojon (2010), the percentage of variance explained by global inflation refers to the R-squared of a regression in which the domestic measure of inflation in each country in the region is the dependent variable, whilst the explanatory variables are an intercept and global inflation.
Source: Author's calculations.

Table A.1. Data sources

Indicator	EM Europe	Euro area	OECD countries	Trading partners of EM Europe
Consumer Price Index	BIS	BIS	OECD	BIS
Core inflation rate	Eurostat	Eurostat	OECD	-
GDP deflator	Eurostat	Eurostat	OECD	-
Producer Price Index	Eurostat	Eurostat	OECD	-
Output gap	European Commission (AMECO database)	European Commission (AMECO database)	-	-
Unemployment rate	Eurostat	Eurostat	-	-
Exchange rate	Eurostat	-	-	-
Nominal effective exchange rate	Eurostat	-	-	-
Emigration	Eurostat	-	-	-
Total population	Eurostat	-	-	-
Labour costs	Eurostat	Eurostat	-	-
Foreign trade	Eurostat	-	-	Eurostat
Oil price	BIS			

Notes: Core inflation in EM Europe and Euro Area refers to the HICP inflation rate excluding energy, food, alcohol and tobacco. Core inflation in OECD countries refers to the CPI inflation rate excluding food and energy.

Table A.2. Change in the explanatory power of the baseline regression when augmented with global factors (dependent variable: CPI inflation rate, IT countries in EM Europe)

Pre-crisis period (2004Q1–2008Q2)		Post-crisis period (2010Q1–2018Q4)	
Model	Change in adj. R-squared relative to the baseline model (BM)	Model	Change in adj. R-squared relative to the baseline model (BM)
BM + π_EA_t	0.092***	BM + π_EA_t	0.186***
BM + $TW\pi_t$	0.039*	BM + $TW\pi_t$	0.174***
BM + ΔP_oil_t	0.035*	BM + ΔP_oil_t	0.123***
BM + π_OECD_t	0.032*	BM + π_OECD_t	0.105***
BM + $y\_EA\_orth_t$	-0.004	BM + $y\_EA\_orth_t$	0.017**

Notes: π_EA_t is the inflation rate in the euro area, $TW\pi_t$ is the trade-weighted inflation rate, ΔP_oil_t is the change in the oil price at time *t*, π_OECD_t is the inflation rate in the OECD countries, $y\_EA\_orth_t$ is the orthogonal output gap in the euro area. ***/**/* indicates 1/5/10% significance level.
Source: Author's calculations.

Table A.3. Change in the explanatory power of the baseline regression when augmented with global factors (dependent variable: CPI inflation rate, non-IT countries in EM Europe)

Pre-crisis period (2004Q1–2008Q2)		Post-crisis period (2010Q1–2018Q4)	
Model	Change in adj. R-squared relative to the baseline model (BM)	Model	Change in adj. R-squared relative to the baseline model (BM)
BM + π_EA_t	0.040	BM + π_EA_t	0.198***
BM + $TW\pi_t$	0.012	BM + $TW\pi_t$	0.198***
BM + ΔP_oil_t	-0.025	BM + ΔP_oil_t	0.047**
BM + π_OECD_t	-0.031	BM + π_OECD_t	0.061***
BM + $y\_EA\_orth_t$	0.027	BM + $y\_EA\_orth_t$	0.024*

Notes: π_EA_t is the inflation rate in the euro area, $TW\pi_t$ is the trade-weighted inflation rate, ΔP_oil_t is the change in the oil price at time *t*, π_OECD_t is the inflation rate in the OECD countries, $y\_EA\_orth_t$ is the orthogonal output gap in the euro area. ***/**/* indicates 1/5/10% significance level.
Source: Author's calculations.

Table A.4. Results of the out-of-sample forecasting of the CPI inflation rate in EM Europe (IT countries, panel estimations with country fixed effects, 10-year rolling window, **four quarters ahead**, median, forecast period: 2016Q1–2018Q4)

No.	Model	Factor	RMSE (h=4 quarters)
1	AR + y_EA_t	Euro area output gap	1.075
2	AR + $TW\pi_{it}$	Trade-weighted inflation rate	1.158
3	AR + π_OECD_t	OECD inflation rate	1.167
4	AR + ΔP_oil_t	Oil price	1.188
5	AR + ΔER_{it}	Exchange rate	1.241
6	AR + $\Delta NEER_{it}$	Nominal effective exchange rate	1.241
7	Autoregressive model (AR)	-	1.257
8	AR + π_EA_t	Euro area inflation rate	1.259
9	AR + u_{it}	Unemployment rate	1.424
10	AR + y_{it}	Domestic output gap	1.545
11	Random walk model (RW)	-	1.949

Notes: The models are reported in ascending order of RMSE, from the preferred predictor downwards.
Source: Author's calculations.

Table A.5. Results of the out-of-sample forecasting of the CPI inflation rate in EM Europe (IT countries, panel estimations with country fixed effects, 10-year rolling window, **eight quarters ahead**, median, forecast period: 2016Q1–2018Q4)

No.	Model	Factor	RMSE (h=8 quarters)
1	AR + y_EA_t	Euro area output gap	1.715
2	Random walk model (RW)	-	1.941
3	AR + $\Delta NEER_{it}$	Nominal effective exchange rate	1.947
4	AR + ΔER_{it}	Exchange rate	1.961
5	Autoregressive model (AR)	-	1.965
6	AR + π_OECD_t	OECD inflation rate	1.978
7	AR + ΔP_oil_t	Oil price	1.984
8	AR + $TW\pi_{it}$	Trade-weighted inflation rate	2.073
9	AR + u_{it}	Unemployment rate	2.130
10	AR + π_EA_t	Euro area inflation rate	2.144
11	AR + y_{it}	Domestic output gap	2.148

Notes: The models are reported in ascending order of RMSE, from the preferred predictor downwards.
Source: Author's calculations.

Table A.6. Results of the out-of-sample forecasting of the CPI inflation rate in EM Europe (non-IT countries, panel estimations with country fixed effects, 10-year rolling window, **four quarters ahead**, median, forecast period: 2016Q1–2018Q4)

No.	Model	Factor	RMSE (h=4 quarters)
1	AR + ΔP_oil_t	Oil price	1.281
2	AR + y_{it}	Domestic output gap	1.313
3	AR + π_OECD_t	OECD inflation rate	1.397
4	AR + $TW\pi_{it}$	Trade-weighted inflation rate	1.422
5	AR + π_EA_t	Euro area inflation rate	1.424
6	Autoregressive model (AR)	-	1.431
7	AR + ΔER_{it}	Exchange rate	1.439
8	AR + u_{it}	Unemployment rate	1.493
9	AR + y_EA_t	Euro area output gap	1.604
10	AR + $\Delta NEER_{it}$	Nominal effective exchange rate	1.654
11	Random walk model (RW)	-	1.856

Notes: The models are reported in ascending order of RMSE, from the preferred predictor downwards.
Source: Author's calculations.

Table A.7. Results of the out-of-sample forecasting of the CPI inflation rate in EM Europe (non-IT countries, panel estimations with country fixed effects, 10-year rolling window, **eight quarters ahead**, median, forecast period: 2016Q1–2018Q4)

No.	Model	Factor	RMSE (h=8 quarters)
1	Random walk model (RW)	-	1.919
2	AR + y_EA_t	Euro area output gap	2.302
3	AR + y_{it}	Domestic output gap	2.419
4	AR + ΔP_oil_t	Oil price	2.436
5	AR + π_OECD_t	OECD inflation rate	2.501
6	AR + $\Delta NEER_{it}$	Nominal effective exchange rate	2.503
7	AR + ΔER_{it}	Exchange rate	2.517
8	Autoregressive model (AR)	-	2.517
9	AR + u_{it}	Unemployment rate	2.553
10	AR + π_EA_t	Euro area inflation rate	2.561
11	AR + $TW\pi_{it}$	Trade-weighted inflation rate	2.599

Notes: The models are reported in ascending order of RMSE, from the preferred predictor downwards.
Source: Author's calculations.

Table A.8. Change in the explanatory power of the baseline regression when augmented with global factors (dependent variable: Producer Price Index (PPI) inflation)

Pre-crisis period (2004Q1–2008Q2)		Post-crisis period (2010Q1–2018Q4)	
Model	Change in adj. R-squared relative to the baseline model (BM)	Model	Change in adj. R-squared relative to the baseline model (BM)
BM + ΔP_oil_t	0.093***	BM + ΔP_oil_t	0.312***
BM + PPI_EA_t	0.101***	BM + PPI_EA_t	0.412***
BM + PPI_OECD_t	0.127***	BM + PPI_OECD_t	0.321***
BM + $TW\pi_t$	0.076***	BM + $TW\pi_t$	0.279***
BM + $y\_EA\_orth_t$	-0.003	BM + $y\_EA\_orth_t$	0.013**

Notes: ΔP_oil_t is the change in the oil price at time *t*, PPI_EA_t is the PPI inflation rate in the euro area, PPI_OECD_t is the PPI inflation rate in the OECD countries, $TW\pi_t$ is the trade-weighted inflation rate, $y\_EA\_orth_t$ is the orthogonal output gap in the euro area. ***/**/* indicates 1/5/10% significance level.
Source: Author's calculations.

Table A.9. Change in the explanatory power of the baseline regression when augmented with global factors (dependent variable: core inflation rate)

Pre-crisis period (2004Q1–2008Q2)		Post-crisis period (2010Q1–2018Q4)	
Model	Change in adj. R-squared relative to the baseline model (BM)	Model	Change in adj. R-squared relative to the baseline model (BM)
BM + ΔP_oil_t	-0.001	BM + ΔP_oil_t	0.000
BM + $core\ \pi\_EA_t$	0.004	BM + $core\ \pi\_EA_t$	0.052***
BM + $core\ \pi\_OECD_t$	-0.005	BM + $core\ \pi\_OECD_t$	0.014**
BM + $TW\pi_t$	0.003	BM + $TW\pi_t$	0.040***
BM + $y\_EA\_orth_t$	-0.006	BM + $y\_EA\_orth_t$	0.021**

Notes: ΔP_oil_t is the change in the oil price at time *t*, $core\ \pi\_EA_t$ is the core inflation rate in the euro area, $core\ \pi\_OECD_t$ is the core inflation rate in the OECD countries, $TW\pi_t$ is the trade-weighted inflation rate, $y\_EA\_orth_t$ is the orthogonal output gap in the euro area. ***/**/* indicates 1/5/10% significance level.
Source: Author's calculations.

Table A.10. Change in the explanatory power of the baseline regression when augmented with global factors (dependent variable: GDP deflator inflation)

Pre-crisis period (2004Q1–2008Q2)		Post-crisis period (2010Q1–2018Q4)	
Model	Change in adj. R-squared relative to the baseline model (BM)	Model	Change in adj. R-squared relative to the baseline model (BM)
BM + ΔP_oil_t	0.000	BM + ΔP_oil_t	0.001
BM + $GDPdefl\_EA_t$	0.022*	BM + $GDPdefl\_EA_t$	0.001
BM+$GDPdefl\_OECD_t$	0.004	BM+$GDPdefl\_OECD_t$	-0.002
BM + $TW\pi_t$	0.000	BM + $TW\pi_t$	0.022**
BM + $y\_EA\_orth_t$	0.060***	BM + $y\_EA\_orth_t$	0.002

Notes: ΔP_oil_t is the change in the oil price at time *t*, $GDPdefl\_EA_t$ is the GDP deflator inflation rate in the euro area, $GDPdefl\_OECD_t$ is the GDP deflator inflation rate in the OECD countries, $TW\pi_t$ is the trade-weighted inflation rate, $y\_EA\_orth_t$ is the orthogonal output gap in the euro area. ***/**/* indicates 1/5/10% significance level.
Source: Author's calculations.

Table A.11. Results of the out-of-sample forecasting of the Producer Price Index (PPI) inflation in EM Europe (panel estimations with country fixed effects, 10-year rolling window, **four quarters ahead**, median, forecast period: 2016Q1–2018Q4)

No.	Model	Factor	RMSE (h=4 quarters)
1	AR + ΔP_oil_t	Oil price	3.409
2	AR + y_{it}	Domestic output gap	3.409
3	AR + u_{it}	Unemployment rate	3.440
4	AR + y_EA_t	Euro area output gap	3.485
5	AR + $TW\pi_{it}$	Trade-weighted inflation rate	3.529
6	AR + PPI_EA_t	Euro area PPI	3.553
7	AR + PPI_OECD_t	OECD PPI	3.584
8	AR + $\Delta NEER_{it}$	Nominal effective exchange rate	3.637
9	Autoregressive model (AR)	-	3.639
10	AR + ΔER_{it}	Exchange rate	3.672
11	Random walk model (RW)	-	5.115

Notes: The models are reported in ascending order of RMSE, from the preferred predictor downwards.
Source: Author's calculations.

Table A.12. Results of the out-of-sample forecasting of the Producer Price Index (PPI) inflation in EM Europe (panel estimations with country fixed effects, 10-year rolling window, **eight quarters ahead**, median, forecast period: 2016Q1–2018Q4)

No.	Model	Factor	RMSE (h=8 quarters)
1	AR + y_{it}	Domestic output gap	4.805
2	AR + u_{it}	Unemployment rate	4.812
3	AR + PPI_OECD_t	OECD PPI	4.818
4	AR + ΔP_oil_t	Oil price	4.819
5	AR + $\Delta NEER_{it}$	Nominal effective exchange rate	4.853
6	AR + ΔER_{it}	Exchange rate	4.861
7	Autoregressive model (AR)	-	4.873
8	Random walk model (RW)	-	4.899
9	AR + y_EA_t	Euro area output gap	4.934
10	AR + PPI_EA_t	Euro area PPI	4.971
11	AR + $TW\pi_{it}$	Trade-weighted inflation rate	5.837

Notes: The models are reported in ascending order of RMSE, from the preferred predictor downwards.
Source: Author's calculations.

Table A.13. Results of the out-of-sample forecasting of the core inflation rate in EM Europe (panel estimations with country fixed effects, 10-year rolling window, **four quarters ahead**, median, forecast period: 2016Q1–2018Q4)

No.	Model	Factor	RMSE (h=4 quarters)
1	AR + $\Delta NEER_{it}$	Nominal effective exchange rate	0.700
2	AR + ΔP_oil_t	Oil price	0.711
3	AR + ΔER_{it}	Exchange rate	0.715
4	Autoregressive model (AR)	-	0.731
5	AR + y_EA_t	Euro area output gap	0.773
6	AR + $core\ \pi\_OECD_t$	OECD core inflation rate	0.808
7	AR + $TW\pi_{it}$	Trade-weighted inflation rate	0.817
8	AR + y_{it}	Domestic output gap	0.867
9	Random walk model (RW)	-	1.003
10	AR + u_{it}	Unemployment rate	1.052
11	AR + $core\ \pi\_EA_t$	Euro area core inflation rate	1.107

Notes: The models are reported in ascending order of RMSE, from the preferred predictor downwards.
Source: Author's calculations.

Table A.14. Results of the out-of-sample forecasting of the core inflation rate in EM Europe (panel estimations with country fixed effects, 10-year rolling window, **eight quarters ahead**, median, forecast period: 2016Q1–2018Q4)

No.	Model	Factor	RMSE (h=8 quarters)
1	AR + ΔP_oil_t	Oil price	0.755
2	AR + $TW\pi_{it}$	Trade-weighted inflation rate	0.758
3	AR + y_EA_t	Euro area output gap	0.800
4	AR + $\Delta NEER_{it}$	Nominal effective exchange rate	0.813
5	Autoregressive model (AR)	-	0.825
6	AR + ΔER_{it}	Exchange rate	0.829
7	AR + u_{it}	Unemployment rate	0.889
8	AR + $core\ \pi\_EA_t$	Euro area core inflation rate	0.891
9	AR + $core\ \pi\_OECD_t$	OECD core inflation rate	0.898
10	AR + y_{it}	Domestic output gap	0.952
11	Random walk model (RW)	-	1.116

Notes: The models are reported in ascending order of RMSE, from the preferred predictor downwards.
Source: Author's calculations.

Table A.15. Results of the out-of-sample forecasting of the GDP deflator inflation in EM Europe (panel estimations with country fixed effects, 10-year rolling window, **four quarters ahead**, median, forecast period: 2016Q1–2018Q4)

No.	Model	Factor	RMSE (h=4 quarters)
1	AR + y_EA_t	Euro area output gap	1.105
2	AR + $GDPdefl\_OECD_t$	OECD GDP deflator inflation	1.138
3	AR + y_{it}	Domestic output gap	1.166
4	AR + ΔP_oil_t	Oil price	1.223
5	AR + $TW\pi_{it}$	Trade-weighted inflation rate	1.250
6	AR + $\Delta NEER_{it}$	Nominal effective exchange rate	1.506
7	Autoregressive model (AR)	-	1.514
8	AR + ΔER_{it}	Exchange rate	1.517
9	AR + $GDPdefl\_EA_t$	Euro area GDP deflator inflation	1.755
10	AR + u_{it}	Unemployment rate	1.763
11	Random walk model (RW)	-	3.727

Notes: The models are reported in ascending order of RMSE, from the preferred predictor downwards.
Source: Author's calculations.

Table A.16. Results of the out-of-sample forecasting of the GDP deflator inflation in EM Europe (panel estimations with country fixed effects, 10-year rolling window, **eight quarters ahead**, median, forecast period: 2016Q1–2018Q4)

No.	Model	Factor	RMSE (h=8 quarters)
1	AR + y_EA_t	Euro area output gap	0.926
2	AR + y_{it}	Domestic output gap	1.212
3	AR + $GDPdefl\_EA_t$	Euro area GDP deflator inflation	1.368
4	AR + $GDPdefl\_OECD_t$	OECD GDP deflator inflation	1.380
5	AR + ΔP_oil_t	Oil price	1.402
6	AR + $TW\pi_{it}$	Trade-weighted inflation rate	1.495
7	AR + ΔER_{it}	Exchange rate	1.503
8	AR + $\Delta NEER_{it}$	Nominal effective exchange rate	1.520
9	AR + u_{it}	Unemployment rate	1.540
10	Autoregressive model (AR)	-	1.543
11	Random walk model (RW)	-	4.116

Notes: The models are reported in ascending order of RMSE, from the preferred predictor downwards.
Source: Author's calculations.

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