Here Comes the Change: The Role of Global and Domestic Factors in Post-Pandemic Inflation in Europe*

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The world economy is currently grappling with an unprecedented inflation shock, comparable in magnitude to the 1970s, driven by a convergence of extraordinary factors. This surge raised global inflation to 8.1 percent in 2022, from 3.4 percent in 2020 and an average of 2.1 percent during 2010–20. The inflationary wave has posed a momentous challenge to developing nations and advanced economies historically accustomed to low and steady inflation rates. This paper disentangles the confluence of contributing factors to the post-pandemic rise in consumer price inflation, using monthly data and a battery of econometric methodologies covering a panel of 30 European countries over the period 2002–22. We find that while global

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factors continue to shape inflation dynamics throughout Europe, country-specific factors, including monetary and fiscal policy responses to the crisis, have also gained greater prominence in determining consumer price inflation during the pandemic period. Coupled with increasing persistence in inflation, these structural shifts call for a significant and extended period of monetary tightening and fiscal realignment.

JEL Codes: C13, C32, C33, C53, E31, E32, E37, E58, F62.

We now understand better how little we understand about inflation.
—Jerome Powell
Chair, Board of Governors of the Federal Reserve System

1. Introduction

The world economy is amid the worst inflation shock since the 1970s due to a plethora of unprecedented developments. Global inflation soared to 8.1 percent in 2022, from 3.4 percent in 2020 and an average of 2.1 percent from 2010–20. The extent and pace of this surge are not just a recurring problem in developing countries, but have also threatened to become an entrenched phenomenon worldwide, including in advanced economies with a long history of low and stable inflation. Unsurprisingly, there is now a blame game for the rise in inflation—ranging from the strong rebound in aggregate demand caused by the extraordinary policy response to the COVID-19 pandemic to global supply constraints and shock waves through international commodity markets triggered by Russia's invasion of Ukraine.

The surge in consumer price inflation has occurred worldwide, but there are considerable differences in the level of inflation and how the inflation process has changed across countries over time. We thereby aim to analyze and disentangle the confluence of domestic and external factors in explaining the evolution of inflation dynamics in Europe, where inflation reached the highest level in four decades. To this end, we use high-frequency data and employ alternative econometric methodologies, including a generalized dynamic factor model (GDFM), a standard panel model with cross-sectional correlation consideration, and the local projection (LP) method to analyze inflation dynamics in a balanced panel of 30 European countries over the period December 2002 to May 2022. We split our sample into three distinct blocks: (i) the period before the global financial crisis (GFC); (ii) the period after the GFC; and (iii) the post-pandemic period. We thus have the pre-GFC period from December 2002 to August 2008, the post-GFC period from September 2008 to December 2019, and the post-pandemic period from January 2020 to May 2022. This approach allows us to shed a particular light on post-pandemic developments and assess whether there are any structural changes in the contribution of global and country-specific factors.

Our GDFM analysis shows that global factors continue to play an essential role in shaping inflation dynamics throughout Europe, but domestic factors, including monetary and fiscal policy responses to the crisis, have become more prominent after the pandemic to the extent that they explain a larger share of the variation in inflation, especially in emerging economies. Inflation is a complex phenomenon, with multitudes of domestic and external factors directly and indirectly influencing pricing behavior. Our empirical findings confirm the role of both global and domestic developments in shaping inflation dynamics. First, we find that the observed explanatory power of global factors is significant and has remained roughly constant throughout the sample period. The share of the variance explained by global factors is about 40 percent for headline inflation and 20 percent for core inflation. Second, country-specific factors have gained greater prominence in explaining the variance of inflation dynamics during the pandemic. The share of variance explained by domestic factors increased by 10 percentage points post-pandemic. We also find heterogeneous effects of global and domestic factors in advanced and emerging market economies. While common inflation dynamics remained dominant in explaining inflation variance in advanced economies before the pandemic, the role of global and domestic factors increased in these countries after the pandemic. In the case of emerging market economies, however, the role of global factors has continued to grow even after the pandemic. However, domestic factors have gained even more significance in determining inflation dynamics across all countries post-pandemic.

We deepen the empirical analysis by estimating alternative models of inflation dynamics in a panel setting and obtaining corroborative evidence. These results show that inflation persistence is a highly significant factor across all specifications and for different measures of inflation. While the domestic output gap has a statistically significant effect on both headline and core inflation, the global output gap has only a statistically significant effect on core inflation. We also find that other global factors (international energy and non-energy commodity prices and global supply chain pressures) and the exchange rate, reflecting both global and domestic developments and policy choices, exhibit significant effects on headline and core measures of consumer price inflation in Europe. These results, robust to a battery of sensitivity checks, also indicate notable differences between advanced and emerging market economies, with global factors explaining a larger share of variation in inflation in emerging market economies. In the post-pandemic period, however, we find evidence that domestic factors have become far more critical in driving inflation dynamics across all countries.

The analysis of inflation dynamics presented in this paper has important implications for the optimal conduct of monetary policy in Europe—and beyond. A plethora of developments, outside the control of policymakers, has undoubtedly contributed to the surge in inflation worldwide. However, putting the onus on global factors alone would be misleading. While much of the recent increase in inflation is a direct result of pandemic-related disruptions and Russia's invasion of Ukraine that has pushed international commodity prices higher, our analysis shows that the relative importance of global factors has not necessarily increased after the pandemic. Instead, we find that domestic developments have become influential in determining inflation dynamics with greater persistence across the board. In other words, the evolution of aggregate demand at home—and abroad—matters more than ever for the appropriate monetary policy stance to bring inflation under control. To this end, central banks should continue recalibrating monetary conditions to achieve the primary objective of price stability.

The remainder of this study is organized as follows. Section 2 provides a brief overview of the relevant literature. Section 3 introduces the data used in the analysis and presents the stylized facts. Section 4 describes our econometric framework. Section 5 presents the empirical results and a variety of sensitivity checks aimed to confirm the baseline results and provide a more granular analysis. Section 6 concludes with policy implications.

2. An Overview of the Literature

Voluminous literature exists on the fundamental determinants of inflation across countries and over time. The equilibrium rate of inflation is a function of factors determining a degree of inflation aversion, including policy preferences (Rogoff 1985), macroeconomic developments including the level of income, trade openness, and fiscal deficits (Végh 1989; Romer 1993; Campillo and Miron 1997; Lane 1997; Galí and Gertler 1999; Catao and Terrones 2005; Clark and McCracken 2006; Badinger 2009), flexibility of labor market institutions (Cukierman and Lippi 1999), type of exchange rate regimes (Levy-Yeyati and Sturzenegger 2001; Husain, Mody, and Rogoff 2005), and political and institutional factors (Cukierman 1992; Aisen and Veiga 2006). While Moore, Lewis-Bynoe, and Morgan (2012) identify domestic demand pressures, commodity price shocks, and political factors as the key determinants of inflationary episodes, other studies, building on Kydland and Prescott (1977) and Barro and Gordon (1993), find a robust relationship between institutional factors such as central bank independence and inflation (Cukierman, Webb, and Neyapti 1992; Alesina and Summers 1993; Lougani and Sheets 1997; Cottarelli, Griffiths, and Moghadam 1998; Posen 1998; Arnone, Laurens, and Segalotto 2006; Brumm 2006; Walsh 2008).

Another strand of the literature connects the macroeconomic policy trilemma to inflation, reasoning that when a country maintains a pegged exchange rate regime, it loses its monetary independence and, thus, effective control of inflation dynamics. While Hausmann et al. (1999) and Frankel, Schmukler, and Serven (2004) argue that exchange rate flexibility does not necessarily provide monetary autonomy, Shambaugh (2004) finds evidence suggesting that "countries with fixed exchange rates follow the interest rate of the base country more closely than countries with flexible exchange rates" (p. 303). In other studies, Gruben and McLeod (2002), Gupta (2008), and Badinger (2009) examine the relationship between capital account openness and inflation and find that unrestricted capital mobility lowers inflation by disciplining central banks. More recently, Cevik and Zhu (2020) show that a country's ability to conduct its own monetary policy for domestic purposes independent of external monetary influences leads to lower inflation.

The standard way of modeling inflation is built on the Phillips curve, often used to examine the effectiveness of the monetary transmission mechanism. The Phillips curve forms an empirical relationship between unemployment and wage growth—or the slack in economic activity and inflation. The most widely used model of the Phillips curve, however, is the so-called hybrid New Keynesian Phillips curve, which is derived from a model characterized by monopolistic competition and short-run price rigidity, and it is hybrid in the sense that it contains past inflation (Galí and Gertler 1999; Galí, Gertler, and López-Salido 2005). In addition to the standard model, many studies have included other determinants of inflation. For example, using a sample of emerging market economies, Kamber and Wong (2020) argue that foreign shocks, i.e., commodity price shocks, have a more substantial impact on the transitory component of inflation than trend inflation. In addition, Kamber, Mohanty, and Morley (2020) find that world oil prices and the foreign output gap have a more significant impact on emerging economies than on advanced economies over the period 1996–2018.

With rising financial openness, global value chain participation, and trade openness, inflation has developed more synchronized worldwide. The greater prominence of global factors has led to efforts to augment the standard Phillips curve with relevant global variables to improve the explanatory power. As in Auer, Borio, and Filardo (2017), the "global-centric" view of the inflation process indicates that globalization is responsible for the diminishing link between domestic slack and inflation and the intensifying link between global variables and inflation. Therefore, the globalization of inflation hypothesis suggests that deeper integration into global markets would exert downward pressure on inflation because of global competition and greater global value chain (GVC) participation that raises a degree of substitution and relocate production sites to countries with lower production costs (Bems et al. 2018). While numerous studies have investigated the role of global variables on inflation, empirical findings are mixed.

On the one hand, Ihrig et al. (2010), Förster and Tillmann (2014), Mikolajun and Lodge (2016), and Bems et al. (2018) find little support for globalization having a significant effect on inflation in advanced and emerging market economies. On the other hand, Borio and Filardo (2007) and Ciccarelli and Mojon (2010) argue that with greater globalization, international factors such as commodity prices and the global state of the economy have gained more prominence in explaining domestic inflation dynamics. Forbes (2019) confirms that global factors play a considerable role in shaping inflation, as the traditional relationship between domestic slack and inflation has weakened over time.

The literature on post-pandemic inflation is developing fast, and preliminary evidence is inconclusive with mixed results. Using historical data, Bonam and Smădu (2021) find that major pandemics in the past have induced a considerable decline in trend inflation over an extended period. However, the disinflationary effects of a pandemic vary with policy responses, which are unprecedented in the case of COVID-19, with expansionary fiscal and monetary measures aimed at preventing tightening credit conditions, bankruptcies, and mass layoffs. The fast rebound of economic activities due to vaccines, lifting lockdowns, and telework could have exerted upward pressure on consumer price inflation. At the same time, supply chain disruptions contribute to rising inflation when firms can pass the increasing costs to consumers. Ha, Kose, and Ohnsorge (2023) provide early evidence for the collapse in global demand, lowering inflation during the initial stage of the COVID-19 pandemic, followed by the strong recovery in economic activity pushing consumer prices higher.

3. Data Overview and Stylized Facts

We construct a balanced panel data set of monthly observations covering 30 European countries over the period 2002–22.[1] The dependent variable is either the headline or core measure of consumer price inflation, which is computed as follows:

$$\pi_{c,t} = \left(\frac{CPI_{c,t}}{CPI_{c,t-12}} - 1 \right) * 100,$$

where $\pi_{c,t}$ denotes headline or core inflation in country c at time t based on CPI series, which are drawn from the Eurostat and national statistics institutions in the case of non-EU countries in

[1]The list of countries is presented in Appendix Table A.1.

the sample. Both headline and core inflation are based on the harmonized indices, thus comparable across countries in our sample. Following the literature, we select domestic and global variables as described below to analyze inflation dynamics before and after the pandemic. These series are obtained from various sources, including Eurostat, the International Monetary Fund (IMF), the Organisation for Economic Co-operation and Development (OECD), and the World Bank.[2] Although other variables, such as the exchange rate regime and monetary policy independence, could be important in determining inflation dynamics, the availability of monthly data limits the choice of variables. In addition, these variables are considered long-term structural factors, which would be less likely to be affected by post-pandemic developments. To obtain a more granular analysis, we include an additional variable, such as inflation forecasts, but data availability limits the number of countries and periods for the analysis.

Domestic Variables. In explaining inflation, the standard Phillips curve accounts only for domestic variables, including lagged inflation, inflation forecasts, and the domestic output gap.

- *Lagged Inflation:* Inflation tends to exhibit significant persistence over time, which is mainly due to price stickiness. Assuming that inflation is positively correlated with its own lags, we use lagged inflation as a measure of persistence. Lagged inflation refers to the inflation rate from the previous month, calculated on a year-on-year basis.
- *Domestic Output Gap[3]:*A measure of the slack in real economic activity is obtained by using the Hamilton (2018) filter to isolate the cyclical fluctuations and trend. Given the unavailability of the monthly GDP series, we use the seasonally adjusted industrial production index (IPI) as a proxy to calculate the domestic output gap. Our results remain unchanged when we use alternative filters, such as the Hodrick-Prescott (HP) filter.

[2]The list of data sources is presented in Appendix Table A.2.

[3]We acknowledge the absence of demand-side factors (including a measure of fiscal policy) in the regression model, mainly because incorporating fiscal policy at a monthly frequency is not possible. Nevertheless, the domestic output gap should partially capture the demand-side factors.

Global Variables. The globalization of inflation hypothesis suggests that as countries integrate into a higher level of global markets, downward pressure on prices is expected due to the competition that takes a more global aspect. As in Borio and Filardo (2007), Auer, Borio, and Filardo (2017), and Forbes (2019), inflation becomes more "global-centric" if global variables gradually develop into dominant factors shaping the inflation dynamics. Take, for instance, the GVC participation. Firms constantly look for ways to reduce costs, and one way to achieve that goal is to relocate production sites to countries with lower costs, which, in turn, makes domestic inflation dynamics more sensitive to global factors.

- *Global Output Gap:* Empirical evidence on the link between inflation and the slack in global economic activity is mixed.[4] Significant positive effects of global demand pressures are usually associated with higher headline inflation, whereas contrary outcomes are found in core inflation. We use the Hamilton (2018) filter to calculate the global output gap measure by resorting to the world IPI constructed by Baumeister and Hamilton (2019), which is closely associated with the general level of economic activity. Our results remain unchanged when we use alternative filters, such as the HP filter.
- *Global Energy and Non-energy Prices:* Global energy prices measure energy-related prices, including coal, natural gas, oil, and propane, while global non-energy prices include industrial inputs, food and beverages, and fertilizers. Commodity price fluctuations could have a direct impact on headline inflation and influence core inflation indirectly through input prices and inflation expectation that captures second-round impact. This measure is constructed based on a monthly year-on-year growth rate.

[4]While Borio and Filardo (2007), Forbes (2019), and Jasova, Moessner, and Takats (2020) find support for the significant role of the world output gap on inflation, Calza (2008), Ihrig et al. (2010), and Mikolajun and Lodge (2016) find no supporting evidence for the role of the global output gap in domestic inflation dynamics. One possible explanation for such a different impact of global economic slack could be the different relationship between the global output gap and headline and core inflation.

- *Global Supply Chain Pressure (GSCP):* Built by Benigno et al. (2022), the GSCP index measures supply chain disruptions according to the Baltic Dry Index (BDI), the Harpex index, air freight costs, and some components of the Purchasing Managers' Index (PMI), such as delivery time, backlogs, and purchased stocks. The principal component analysis is employed to extract a common component from these data. An increase in the standard deviation of the GSCP index implies more supply chain disruptions.
- *Nominal Effective Exchange Rate (NEER)*[5]*:* NEER is a measure of the value of a currency against a weighted average of several foreign currencies. An increase in NEER indicates an appreciation of the local currency against the weighted basket of currencies of its trading partners. While the literature tends to categorize the exchange rate as a global factor, it is not a "common" factor like other global variables included in the analysis, as domestic developments and policy choices have a significant bearing on the exchange rate. ΔNEER is the monthly year-on-year change. Table 1 reports the summary statistics for all variables used in the analysis, which show considerable heterogeneity across countries and over time. For example, as measured by the headline CPI, average inflation is 2.2 percent from 2002 to 2022, with a minimum of -4.3 percent and a maximum of 20.1 percent. Similarly, core inflation excluding food and energy is 1.9 percent on average, with a minimum of -4.2 percent and a maximum of 16.4 percent during the sample period. The domestic and global output gaps are, on average, 0, respectively. However, the domestic output gap has a larger variance than the global output gap, denoting that the deviations of the domestic output gap could be significantly spread out.

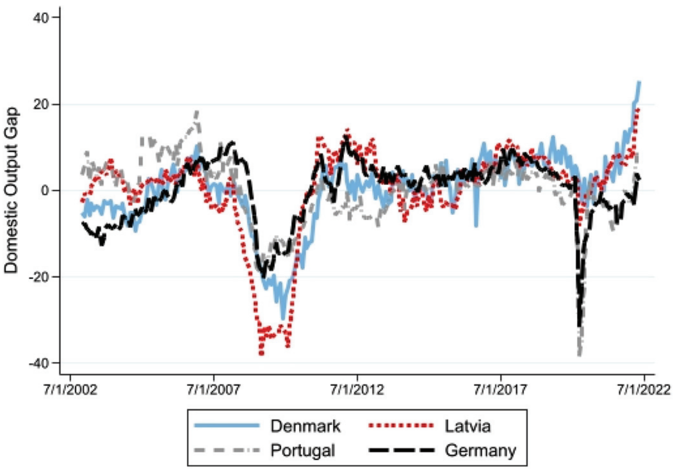
In Figure 1, we plot the series of domestic output gap for selected countries in our sample. While all series follow a similar pattern, countries such as Denmark and Latvia had a larger decline in the output gap during the GFC compared to Germany and Portugal.

[5]For robustness checks, we use the real effective exchange rate (REER) index and obtain similar results.

Table 1. Summary Statistics

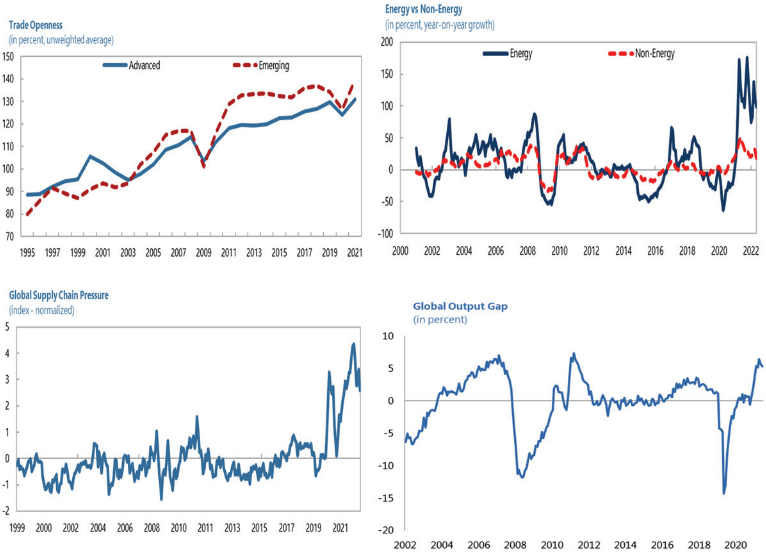
	Mean	Std. Dev.	Variance	Minimum	Maximum
Δ Headline Inflation (%)	2.219	2.397	5.744	–4.347	20.146
Δ Core Inflation (%)	1.916	1.935	3.745	–4.171	16.448
Domestic Output Gap (%)	0.000	4.479	20.058	–60.944	59.880
Global Output Gap (%)	0.000	4.193	17.577	–14.306	7.368
Δ NEER (%)	0.505	3.924	15.400	–23.982	23.049
Δ REER – ULC (%)	0.261	4.638	21.511	–22.911	29.101
Δ REER – CPI (%)	0.309	4.125	17.014	–21.670	24.525
Δ Energy Prices (%)	14.406	41.199	1697.386	–63.294	175.750
Δ Non-energy Prices (%)	6.701	16.459	270.884	–34.351	51.508
Δ Commodity Prices (%)	8.804	24.451	597.853	–42.122	71.643
GSCP (Normalized)	0.149	1.044	1.089	–1.523	4.351

Figure 1. Domestic Output Gap in Selected Countries



However, the COVID-19 pandemic led to a much sharper decline in the domestic output gap for the latter group, while the former group of countries has been producing above its potential output during the post-pandemic period. One of the main differences between these groups of countries is in the way lockdown measures were enacted during the pandemic period, as Denmark and Latvia have, on average, a smaller stringency index than Germany and Portugal (Hale et al. 2021).

Figure 2. Global Factors



Source: Haver Analytics, IMF, World Bank, OECD, Baumeister and Hamilton (2019), Benigno et al. (2022), and IMF staff calculations.

The three different exchange rate measures used in the analysis show similar values across different summary statistics, but the average NEER is slightly higher due to the absence of inflation adjustment. In addition, the variance of the REER based on unit labor costs (ULC) is larger, indicating significant differences in ULC among European countries. Regarding the year-on-year variation of energy and non-energy prices, we observe more frequent fluctuations in energy prices compared to non-energy, indicating a potentially significant role played by energy prices in explaining inflation dynamics in Europe (top-right panel of Figure 2). Although global supply chain pressures appear to have a stable profile before 2019, the global pandemic and the war in Ukraine have caused larger and more volatile supply chain disruptions (bottom-left panel of Figure 2).

Overall, with rapidly increasing globalization, we expect international factors to become more prominent determinants of domestic inflation dynamics over time. For instance, at the onset of the GFC in 2008, abrupt and sharp changes in global resource utilization, commodity prices, and trade openness contributed to deflationary pressures worldwide, albeit with varying degrees across countries and in terms of headline and core inflation rates. More recently, the COVID-19 pandemic has induced a sharp decline in headline and core measures of inflation across the world due to plunging energy prices and demand. However, it quickly rebounded with the strong pace of recovery and global supply chain disruptions. Our analysis aims to unveil such relationships and shed light on how they evolved over time.

4. Econometric Methodology and Results

The empirical analysis presented in this study is based on a threefold econometric strategy to ensure robustness and granular assessment. First, we implement the GDFM approach to disentangle the effect of common (global) and domestic (country-specific) factors on inflation and investigate the degree of synchronization of inflation dynamics across European countries. Second, we deepen the analysis by estimating an augmented Phillips-curve model of inflation with global variables in a panel setting. Third, we use the LP method to estimate the dynamic response of alternative measures of consumer price inflation to global and domestic shocks.

4.1 Generalized Dynamic Factor Model

The objective of the GDFM analysis is to decompose the variation of inflation in each country into the following components:

- *Variation Explained by Observable Global Components:* These include global factors that are observable to us (such as energy and non-energy prices) and likely to affect inflation across all countries in the sample.
- *Variation Explained by Observable Domestic Factors:* These include other observable country-specific factors that are likely to have a differential effect on inflation.
- *Variation Explained by Common Inflation Dynamics:* This is obtained by applying the GDFM to the portion of inflation that is not explained either by observable global or domestic factors. This element of the variance decomposition

captures the common co-movements of inflation across the countries by extracting $k \geq 1$ unobservable common shocks, which are weighted by some country-specific factor loadings, as explained in Forni et al. (2000; 2005).[6] That is, all countries face the same common shocks, but the way inflation reacts to these common shocks is country specific. Notice that these common shocks do not necessarily have an economic interpretation, so we refer to them as *common inflation dynamics*. The number of common shocks, k, is chosen using a data-driven information criterion, as explained below.

Early applications of dynamic factor models by Sargent and Sims (1977) and Stock and Watson (1989, 1991, 1993) suggest that a few latent factors can account for much of the dynamic behavior of economic aggregates.[7] The advantages of the DFM approach thereby include (i) a parsimonious representation of the data regarding unobservable common elements, which characterizes the degree of inflation co-movement and synchronization without making strong assumptions a priori (Mumtaz, Simonelli, and Surico 2011); (ii) a reduced-form solution to a standard dynamic stochastic general equilibrium (DSGE) model (Sargent 1989; Ha, Kose, and Ohnsorge 2019); and (iii) extraction of factors using non-parametric principal components, which prevents misspecification and deals with time-varying parameters and non-linearities (Miranda, Poncela, and Ruiz 2021).

We use the same baseline GDFM specification for each country in the sample in the following form:

$$\pi_{c,t} = X^{g}_{c,t}\beta_c + X^{d}_{c,t}\gamma_c + \chi_{c,t} + \varepsilon_{c,t}, \tag{1}$$

where $X^{g}_{c,t}$ and $X^{d}_{c,t}$ are the observed global and domestic components, respectively; $\chi_{c,t} = \sum_{j=1}^{k} b_{c,j}(L)u_{j,t}$ is the unobserved

[6]The dynamic factor model approach has widely been used in the literature to assess global financial and business cycles (Menden and Proaño 2017; Cerutti, Claessens, and Rose 2019; Miranda-Agrippino and Rey 2020; Mumtaz and Musso 2021) and inflation developments (Mumtaz and Surico 2008; Ciccarelli and Mojon 2010; Neely and Rapach 2011; Ha, Kose, and Ohnsorge 2019; Szafranek 2021).

[7]There are several surveys of dynamic factor models, including Breitung and Eickmeier (2006), Stock and Watson (2006, 2011, 2016), Bai and Ng (2008), Lütkepohl (2014), and Bai and Wang (2016).

common dynamic component, L standing for the lag operator, and k the number of factors. The $b_{c,j}(L)$'s are the factor loadings, which are country specific and whose dynamic structure is otherwise unspecified; and $\{u_{1,t},\ldots,u_{k,t}\}$ are the *common shocks.* Finally, $\varepsilon_{c,t}$ is the idiosyncratic component, i.e., a zero-mean stationary process, independent of $\left(X^g_{c,t}, X^d_{c,t}, \chi_{c,t}\right)$ at all leads and lags. The vector of coefficients, (β_c, γ_c), represents the country-specific loadings for the observed global and domestic components. The observable global component includes the global output gap, energy and non-energy commodity prices, a measure of global supply chain pressure, and the NEER. The observable domestic component includes the domestic output gap. The unobservable common component, $\chi_{c,t}$, is allowed to have a causal dynamic structure as explained above (Forni et al. 2000). To obtain a consistent estimation of (β_c, γ_c), we further assume that $Cov\left(X^g_{c,t}, \chi_{c,t}\right) = Cov\left(X^d_{c,t}, \chi_{c,t}\right) = 0$. All observables in this equation are taken to have a mean equal to zero and a standard deviation equal to one. The vector of regressors, $\left(X^g_{c,t}, X^d_{c,t}\right)$, is a normalized version of the observable global and domestic factors. The constant term is thus omitted from the model. The covariance between $X^g_{c,t}\widehat{\beta}_c$ and $X^d_{c,t}\widehat{\gamma}_c$ is assigned to each one of these components proportionally to the total variance. For instance, if $Var\left(X^g_{c,t}\beta_c\right) = 5$, and $Var\left(X^d_{c,t}\gamma_c\right) = 1$, five-sixths of the covariance is assigned to the global components, and the remaining one-sixth is assigned to the domestic component (see Gibbons, Overman, and Pelkonen 2013). As explained above, the variance of $\pi_{c,t}$ is thus decomposed as follows: (i) variance explained by the observable global component, $Var\left(X^g_{c,t}\beta_c\right)$; (ii) variance explained by the observable domestic component, $Var\left(X^d_{c,t}\gamma_c\right)$; (iii) variance explained by the common inflation dynamics, $Var(\chi_{c,t})$; and (iv) idiosyncratic variation, $Var(\varepsilon_{c,t})$.

We first obtain an estimator of (β_c, γ_c), $\left(\widehat{\beta}_c, \widehat{\gamma}_c\right)$, via ordinary least square (OLS) regression of inflation on observable (global and domestic) factors. Upon the assumptions listed above, this estimator is consistent and asymptotically normal as $T \rightarrow \infty$. We then compute the percentage of the variance explained by the observable global components as $Var\left(X^g_{c,t}\widehat{\beta}_c\right) \cdot 100$ and the percentage of the variance explained by the observed domestic components as

$Var\left(X^d_{c,t}\widehat{\gamma_c}\right)\cdot 100$, where the covariance is distributed across the two components as explained above. Next, we construct

$$\pi_{c,t} - X^g_{c,t}\widehat{\beta_c} - X^d_{c,t}\widehat{\gamma_c} = \chi_{c,t} + \varepsilon_{c,t}, \tag{2}$$

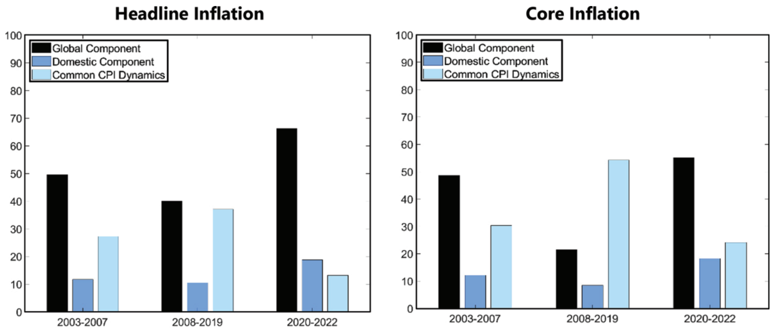
which represents the residuals from the OLS regression of each country's inflation rate onto the observed global and domestic components. To simplify notations, we have omitted from Equation (2) the estimation error that occurs from replacing (β_c, γ_c) with $\left(\widehat{\beta_c}, \widehat{\gamma_c}\right)$.[8] These residuals correspond to our dependent variable, $\pi_{c,t}$, from which the effect of the observable global and domestic components has been partialled out. Next, we apply to these residuals the GDFM as in Forni et al. (2000). The estimation of the unobservable common factor, based on the matrix of inflation rates from the 30 European countries, gives us the variance explained by the common inflation dynamics. Therefore, a crucial step in estimating the GDFM is determining the number of common factors in the model. There are various statistical approaches to determining the number of factors in the GDFM. In this paper, we determine the number of factors according to the information criterion proposed by Hallin and Liska (2007). We obtain $k^* = 3$ for headline CPI and $k^* = 4$ for core CPI, as the optimal number of factors. This is also confirmed by a graphical analysis of the dynamic eigenvalues averaged over the spectral frequencies (Appendix Figure A.1).[9]

The average variance explained by each one of the components over three separate periods is presented in Figure 3. The sample is split in this manner to separately consider the effects of the common components on inflation before and after the global financial crisis and before and after the pandemic. The share of variance explained by the different components changes substantially over the period

[8]Upon the stated assumptions, the OLS estimators of (β_c, γ_c) are consistent for $T \to \infty$, while the consistent estimation of $\chi_{c,t}$ requires both $n, T \to \infty$ (see Forni et al. 2000). The first-step estimation error is thus negligible when estimating the GDFM in the second step.

[9]The first six eigenvalues appear to diverge, while the others are relatively stable. Further analysis also reveals that the relative increase in the variance explained when increasing the common components from six to seven is less than 3 percent. As 5 percent is often the pre-assigned minimum to include an additional component, we conclude that the choice of six unobservable global factors is likely to be robust.

Figure 3. Average Share of Variance Explained



2003–22. In particular, the observable global component explains a larger share of the variance in the post-pandemic period, especially for headline inflation. Similarly, the share of variance explained by the country-specific component increases by about 10 percent for both headline and core inflation during the period 2020–22. The sharp increase in the percentage of variance explained by both the observable global and domestic factors goes along with a decrease in the variance explained by the common inflation dynamics. There are several potential explanations for this result. First, consumer price inflation in Europe was relatively stable during the pre-pandemic period, resulting in a high level of synchronization across countries, as shown by the large percentage of variance explained by the common dynamics before 2020. The COVID-19 pandemic, however, may have caused a permanent upward break in inflation dynamics, which may not be necessarily homogenous across countries and may have reduced the level of synchronization in inflation. Second, because of containment restrictions and supply disruptions during the pandemic, many economies remained below potential and consequently experienced an abrupt buildup of price pressures with the relaxation of lockdown measures.

Another interesting result that emerges from the GDFM is the heterogeneity across countries. We divide our sample into advanced economies and emerging markets. The former group includes the euro area (except for Latvia, Lithuania, Slovakia, and Slovenia), Norway, Sweden, Switzerland, and the United Kingdom, while the latter group includes most Eastern European countries. As it

Figure 4. Average Share of Variance Explained: Advanced Europe

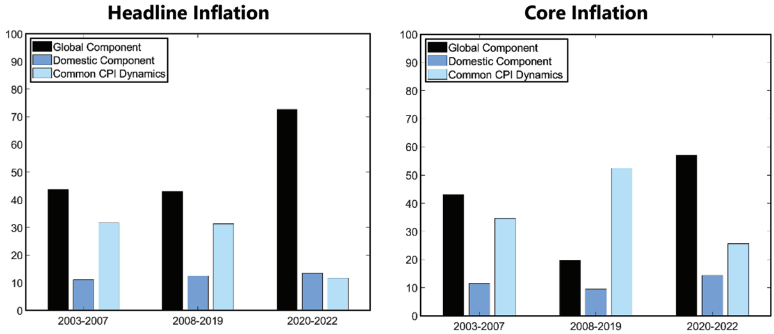
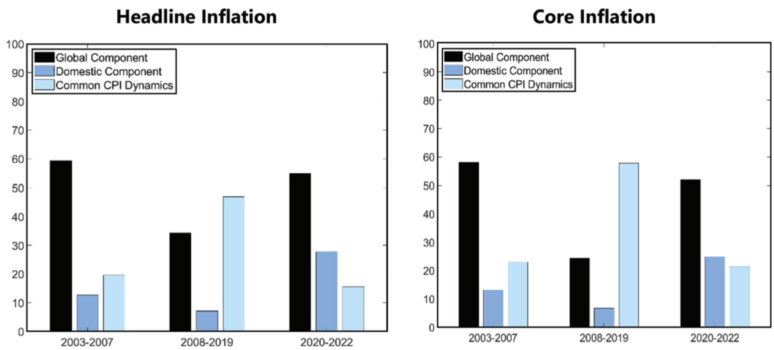


Figure 5. Average Share of Variance Explained: Emerging Europe



appears in Figure 4, the results for advanced economies are qualitatively different from the overall results. The relative importance of country-specific factors has increased, although not substantially, since the beginning of the COVID-19 pandemic (the variance explained by the domestic component increases by less than 1 percent for headline inflation and by less than 5 percent for core inflation). By contrast, global factors play a fundamental role, and the variance explained by co-movement in inflation in the advanced economies decreases substantially.

In the case of emerging market economies, presented in Figure 5, the importance of domestic factors has increased since the pandemic, and their total share of variance has increased from about 7 to about 25 percent for both headline and core inflation. On the contrary, the variance explained by the global components represents a smaller share of the variance in inflation, and so do the common inflation dynamics. This seems consistent with the evidence that the output gap is larger on average for emerging economies since the pandemic, and that may have spurred higher inflation compared to other advanced European economies.

4.2 Panel Data Analysis

We deepen the analysis by estimating an augmented Phillips-curve model of inflation dynamics in a panel setting. We follow the literature and choose explanatory variables widely employed in the standard Phillips-curve model. For instance, Forbes (2019) and Busetti, Caivano, and Delle Monache (2021) show that lagged inflation, output gap, exchange rate, and commodity prices likely affect inflation in the standard Phillips-curve model. Given the focus of this paper on global factors and post-pandemic inflation, we augment the standard Phillips-curve model to account for the role of supply chain disruptions in post-pandemic inflation dynamics (Benigno et al. 2022; Hall, Tavlas, and Wang 2023). It should be noted, however, that the choice of the explanatory variables is partly constrained by the data at monthly frequency. We first estimate the standard Phillips-curve model and augment it with a measure of supply chain disruptions. More formally, we estimate the following specification:[10]

$$\pi_{c,t} = \beta_1 + \beta_2 \pi_{c,t-1} + \beta_3 Y^D_{c,t} + \beta_4 Y^W_t + \beta_5 \triangle neer_{c,t-1} + \beta_6 \triangle energy_t + \beta_7 \triangle nonenergy_t + \eta_c + \varepsilon_{c,t}, \quad (3)$$

where subscripts c and t denote country and time, respectively, and data are sampled at a monthly frequency. $\pi_{c,t}$ indicates monthly year-on-year inflation rate on a monthly basis as measured by the headline and core CPI following Kamber, Mohanty, and Morley (2020) and Busetti, Caivano, and Delle Monache (2021), who also

[10] The correlation diagnostics (Appendix Table A.8) indicate the absence of multicollinearity in our regressions.

consider year-on-year changes; $\pi_{c,t-1}$ is the first lag of inflation; Y_t^D and Y_t^W denote the domestic output gap and the global output gap, respectively; $neer_{c,t-1}$ is the nominal effective exchange rate, which is lagged to account for the delay in exchange rate pass-through to consumer prices; and $\Delta energy_t$ and $\Delta nonenergy_t$ are year-on-year growth rates of international energy and non-energy commodity prices, respectively.[11] η_c denotes the time-invariant country-specific effect, and $\varepsilon_{c,t}$ is the error term. We use a fixed-effect estimator with the Driscoll-Kraay standard errors, which helps address cross-sectional dependence and serial correlation over time. We are not overly concerned about the Nickell bias generated by estimating a dynamic panel data model with a fixed-effect estimator, as the time-series dimension is much larger than the number of countries (see Arellano 2003, pp. 85–87 for details, and Ha, Kose, and Ohnsorge 2021). We further augment the empirical model to explore the role of global supply chain disruptions. We therefore introduce a measure of global supply chain disruptions into the model following Benigno et al. (2022) and Hall, Kose, and Ohnsorge (2023):

$$\pi_{c,t} = \beta_1 + \beta_2\pi_{c,t-1} + \beta_3 Y_{c,t}^D + \beta_4 Y_t^W + \beta_5 \triangle neer_{c,t-1} + \beta_6 \triangle energy_t + \beta_7 \triangle nonenergy + \beta_8 GSCP_t + \eta_c + \varepsilon_{c,t}, \quad (4)$$

where $GSCP_t$ denotes global supply chain pressure, which is normalized and interpreted such that a zero implies that the index is at its average value, with negative values reflecting how many standard deviations the index is below this average value. As a result, we expect a higher value of global supply chain disruptions to exert upward pressure on headline and core measures of consumer price inflation.

The panel data analysis in Table 2 confirms the importance of inflation persistence and the domestic output gap. With all variables

[11] Time fixed effects are not included because the global output gap and energy prices, the two most significant global factors, should capture global elements changing each year common to all countries, consistent with Bems et al. (2018), Forbes (2019), and Jasova, Moessner, and Takats (2020).

Table 2. Baseline Estimates: Full Sample

	Headline Inflation		Core Inflation	
	Baseline	**+GSCP**	**Baseline**	**+GSCP**
Inflation_{t-1}	0.950***	0.950***	0.974***	0.975***
	(0.015)	(0.015)	(0.012)	(0.011)
Domestic Output Gap	0.004***	0.004***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
Global Output Gap	0.005	0.007	0.006**	0.008***
	(0.005)	(0.005)	(0.003)	(0.003)
ΔNEER_{t-1}	–0.021***	–0.020***	–0.014***	–0.012***
	(0.003)	(0.003)	(0.002)	(0.002)
ΔEnergy Prices	0.005***	0.004***	0.001**	0.001**
	(0.001)	(0.001)	(0.001)	(0.000)
ΔNon-energy Prices	0.002	0.002	0.001	0.001
	(0.002)	(0.002)	(0.001)	(0.001)
GSCP		0.0376		0.0498***
		(0.0288)		(0.0178)
Country FE	Yes	Yes	Yes	Yes
F-test: Global	28.91***	26.28***	28.81***	22.23***
Within R^2	0.9533	0.9536	0.9524	0.9530
Observations	7,020	7,020	7,020	7,020
Countries	30	30	30	30

Note: Driscoll-Kraay standard errors are reported in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. "F-test: Global" tests the joint significance of our global variables. A constant is included in all specifications but not shown in the table. The sample period spans from December 2002 to May 2022.

in the model correctly signed, we find that inflation persistence is a critical factor across all specifications and for different measures of inflation. A relatively large coefficient of lagged inflation corroborates the generally accepted fact that inflation in Europe was persistent prior to the pandemic (Batini and Laxton 2006; Ciccarelli and Osbat 2017). The coefficients on the domestic output gap—0.004 for headline and core inflation—are positive and statistically significant at the 1 percent level. These imply that a 1 percentage point increase in the domestic output gap is associated with an increase of 0.004 percentage point in both headline and core measures of consumer price inflation, broadly consistent with previous findings in the literature.

The global output gap has a statistically significant positive effect on core inflation but not on headline inflation. A 1 percentage point increase in the global output gap is associated with an increase of 0.005–0.008 percentage point in core inflation, everything else being equal. However, the global output gap affects domestic inflation not only through the pricing decision of determinants of inflation, such as the exchange rate and global commodity prices. Hence, as discussed in the data section, previous studies usually find mixed results on the relationship between the global output gap and domestic inflation, which varies according to period, country, and measurement used in the analysis.

International energy prices exhibit a high degree of positive correlation with inflation. A 1 percentage point year-on-year growth in energy prices is associated with a 0.004 and 0.001 percentage point increase in headline and core inflation, respectively. The non-energy prices are not statistically significant, suggesting that energy prices play a more significant role in shaping domestic inflation than non-energy commodity prices. We find support for a strong relationship between energy prices and inflation. Nevertheless, the impact of energy prices varies according to different measures of inflation. International energy prices have a direct effect on headline inflation, which includes energy components. Although there is no such direct effect on core inflation, which excludes energy and food prices, we still find evidence for an indirect effect on core inflation. While the share of energy prices in consumer prices indices across the EU has been around 10 percent, Ari et al. (2022) illustrate that energy items constituted approximately half of the annual consumer price index (CPI) inflation rates as of May 2022, during the peak of the energy crisis in Europe. They further argue that this disparity may be attributed to differences in wholesale markets, regulation, and policy measures. On the other hand, non-energy commodity prices do not have a statistically significant effect on headline and core inflation in Europe, where food does not account for a large share of the average consumption basket.

The global supply chain variable also has an inflationary effect. The GSCP variable measures comprehensive global supply chain disruption in which an increase in one standard deviation is associated with a 0.05 percentage point increase in core inflation. The F-test of the joint significance of the global variables continues to show a strong joint statistical significance on headline and core inflation, underscoring their vital role in shaping domestic inflation.[12] We notice that the values of the F-test in headline inflation are considerably higher than in core inflation. One possible explanation is that commodity prices directly affect headline inflation. However, when considering the individual statistical significance of global variables, core inflation receives a quantitatively and relatively similar impact from the state of the global economy compared to headline inflation, except for commodities. This increasing role of global factors in determining core inflation might signify the persistent impact of global economic conditions on domestic inflation.

The exchange rate, capturing both global and domestic developments as well as policy choices, has a statistically significant effect on inflation. For example, a 1 percentage point year-on-year growth in the exchange rate explains about 0.01–0.02 percentage point decrease in inflation. This variable is lagged to allow for the delay in pass-through into domestic prices, operating through cheaper foreign products and services imported into the country.

We also find that the impact of global variables varies according to income level, showing notable differences between advanced and emerging countries. We estimate the model separately for advanced and emerging market economies in Europe and obtain results, presented in Table 3, that are broadly in line with our baseline findings. One crucial difference is that the global output gap is statistically significant for core inflation in both advanced and emerging market economies, but its effects are larger in emerging markets than in advanced economies (the p-values for the test that the difference in the coefficients of global output gap between advanced economies and emerging markets is equal to zero are 0.113 and 0.097, for headline and core inflation, respectively).[13] Other global

[12]To show that the F-test of joint significance of our global variables is not driven mainly by energy and non-energy prices, we run Equation (4) without the commodity variables. The values of the F-test are 8.78*** and 13.96*** for headline and core inflation, respectively. This suggests that the commodity variables are not the main drivers of the F-test of joint significance of our global variables.

[13]This and the subsequent tests are performed by running a pooled regression in which the emerging market dummy is interacted with all the independent variables in the same model as the one reported in Table 3.

Table 3. Estimates by Country Groups

	Advanced		**Emerging**	
	Headline Inflation	**Core Inflation**	**Headline Inflation**	**Core Inflation**
Inflation_{t-1}	0.903***	0.938***	0.963***	0.981***
	(0.017)	(0.012)	(0.014)	(0.011)
Domestic Output Gap	0.003***	0.003***	0.005**	0.006***
	(0.001)	(0.001)	(0.002)	(0.002)
Global Output Gap	0.005	0.005**	0.016*	0.013**
	(0.004)	(0.002)	(0.008)	(0.006)
ΔNEER_{t-1}	–0.016***	–0.009***	–0.027***	–0.017***
	(0.003)	(0.002)	(0.003)	(0.003)
ΔEnergy Prices	0.005***	0.001***	0.004***	0.001
	(0.001)	(0.000)	(0.001)	(0.001)
ΔNon-energy Prices	0.001	–0.000	0.003	0.003*
	(0.001)	(0.001)	(0.003)	(0.002)
GSCP	0.021	0.031*	0.065	0.076***
	(0.026)	(0.016)	(0.040)	(0.026)
Country FE	Yes	Yes	Yes	Yes
F-test: Global	22.15***	8.48***	26.45***	19.15***
Within R^2	0.9198	0.8781	0.9697	0.9738
Observations	4,446	4,446	2,574	2,574
Countries	19	19	11	11

Note: Driscoll-Kraay standard errors are reported in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. "F-test: Global" tests the joint significance of our global variables. A constant is included in all specifications but not shown in the table. The sample period spans from December 2002 to May 2022.

variables also appear to have quantitatively more prominent effects on inflation in emerging markets than in advanced economies. At the 10 percent level of significance, the coefficients of NEER and GSCP are different between advanced economies and emerging markets for headline inflation. In contrast, the effects of NEER, GSCP, non-energy prices, and domestic output gaps differ for core inflation. Overall, these results and higher values of the F-test of the emerging economies than the advanced economies align with our stylized facts that countries with higher integration into global markets will likely sustain a larger effect of global factors on inflation dynamics.

We also focus on the impact of global factors during different periods, such as the post-global financial crisis and post-pandemic periods (Table 4).[14] So far, we run our econometric specifications for the entire period. However, the contribution of global factors could vary in different periods. Accordingly, we compare post-GFC and post-pandemic periods to analyze whether the contributions of explanatory variables have changed over time. To this end, we rely on the panel structural break test (Bai and Perron 1998) to empirically test the break dates in our data (see Appendix Table A.5). It should be noted that we have two post-pandemic-period regression results to observe the contemporaneous and delayed effects of the GSCP variable separately. We find considerable differences between post-GFC and post-pandemic periods in terms of the statistical significance of global variables. These results show that global factors have contributed to shaping domestic inflation, though domestic variables still play a significant role since the GFC. Post-pandemic inflation developments appear to be primarily driven by domestic factors, surges in commodity prices, and supply chain disruption. The persistence of inflation has become even more quantitatively significant in the post-pandemic period. Europe has been characterized by an increasing persistence in inflation and declining trend inflation before the COVID-19 pandemic due to primarily cyclical domestic and global factors (Ciccarelli and Osbat 2017). While global factors were the primary driver of inflation dynamics in Europe before the pandemic, domestic factors also made significant contribution. As in Abdih, Lin, and Paret (2018), the transition process tends to be longer, especially in the case of positive inflation shocks, due to persistence in pricing behavior. Moreover, we find that the more stringent government measures for containment during the COVID-19 pandemic, the higher the inflationary pressures on prices (Appendix Table A.6). A critical question in this context is whether global factors are negligible in the post-pandemic period, but the F-test of

[14]The number of post-pandemic-period observations appears small at first sight, but we use monthly data, amounting to 870 observations. Therefore, our F-test remains stable and has fewer noises than data at a quarterly or annual frequency. For robustness, we implement a quasi-likelihood-ratio (LR) test, identical to an F-test in large samples. The quasi-LR test confirms our F-test results (Appendix Table A.9).

Table 4. Estimates by Sub-periods

	Headline Inflation			Core Inflation		
	Post-GFC	**Post-pandemic GSCP**	**Post-pandemic $GSCP_{t-3}$**	**Post-GFC**	**Post-pandemic GSCP**	**Post-pandemic $GSCP_{t-3}$**
$Inflation_{t-1}$	0.898***	1.006***	0.999***	0.926***	0.998***	1.006***
	(0.010)	(0.031)	(0.029)	(0.010)	(0.051)	(0.046)
Domestic Output Gap	0.003	0.008***	0.009***	0.003**	0.007*	0.005
	(0.002)	(0.003)	(0.003)	(0.001)	(0.004)	(0.004)
Global Output Gap	0.003	0.032*	0.021	0.007***	0.034**	0.019
	(0.005)	(0.019)	(0.019)	(0.002)	(0.014)	(0.011)
$\Delta NEER_{t-1}$	–0.026***	–0.028*	–0.026	–0.013***	–0.026*	–0.030**
	(0.003)	(0.015)	(0.016)	(0.002)	(0.0135)	(0.014)
ΔEnergy Prices	0.005***			0.000		
	(0.001)			(0.000)		
ΔNon-energy Prices	0.004**			0.002***		
	(0.002)			(0.001)		
ΔCommodity Prices		0.005	0.005**		–0.002	0.001
		(0.004)	(0.002)		(0.002)	(0.002)
GSCP	–0.033	0.023		0.016	0.096**	
	(0.039)	(0.057)		(0.022)	(0.041)	
$GSCP_{t-3}$			0.089*			0.062**
			(0.047)			(0.028)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
F-test: Global	44.26***	13.46***	18.36***	28.79***	7.56***	8.65***
Within R^2	0.9248	0.9537	0.9545	0.8926	0.9078	0.9070
Observations	3,810	870	870	3,810	870	870
Countries	30	30	30	30	30	30

Note: Driscoll-Kraay standard errors are reported in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. "F-test: Global" tests the joint significance of our global variables. Due to multicollinearity issues between energy and non-energy prices in the post-pandemic period, we use a single index of commodity prices. A constant is included in all specifications but not shown in the table.

joint significance still rejects the null hypothesis that global factors do not have any joint effects on inflation rates.

4.3 Local Projection Method

We implement the LP method of Jordà (2005) to estimate the response of inflation to global and domestic shocks. The LP approach is found to be better suited to estimate dynamic responses and robust to non-linear model misspecification (Auerbach and Gorodnichenko 2013; Romer and Romer 2019). We estimated the following baseline specification with the LP method:

$$\pi_{c,t+h} - \pi_{c,t-1} = \beta_{c,h} + \vartheta_{c,h} Y^{D}_{c,t} + \Phi_h Y^{W}_{t} + \sum_{m=1}^{2} \delta_{c,t,m} \Delta neer_{c,t-m} + \theta_h \Delta energy_t + \psi_h \Delta nonenergy_t + \sigma_h GSCP_t + \sum_{l=1}^{2} \gamma'_{c,t,l} X_{c,t-l} + \varepsilon_{c,t+h}, \quad (5)$$

where h indicates the forecast horizons. $\pi_{c,t+h} - \pi_{c,t-1}$ is the dependent variable, which is the cumulative response of inflation from $t-1$ to $t+h$. The cumulative impulse response function (IRF) values are constructed from the estimated coefficients at each time horizon h. Thus, the coefficients reflect the step in the cumulative IRF at a forward time h and they can be interpreted as the accumulated response of inflation to an increase in one standard deviation in *GSCP*, for example. Given that the error terms could be serially correlated due to the successive leading of the dependent variable in the local projection method, we thus resort to the Driscoll-Kraay standard errors to address the serial correlation across time and cross-sectional dependence.[15] $X_{c,t}$ is a vector containing domestic and global output gap, energy and non-energy prices, inflation, and global supply chain pressure. $X_{c,t}$ and $neer_{t-2}$ are used as controls to cleanse the estimated coefficients from the dynamic effects of inflation and the effects of past changes in the domestic and global output gap, energy

[15] Olea and Plagborg-Moller (2021) argue that the lag augmentation corrects standard errors for serial correlation.

and non-energy prices, exchange rate, and global supply chain pressure. Thus, this vector and $neer_{t-2}$ are not used to construct the IRF, and lag-augmented local projection remains robust to highly persistent data and the estimation of IRs at long horizons.[16]

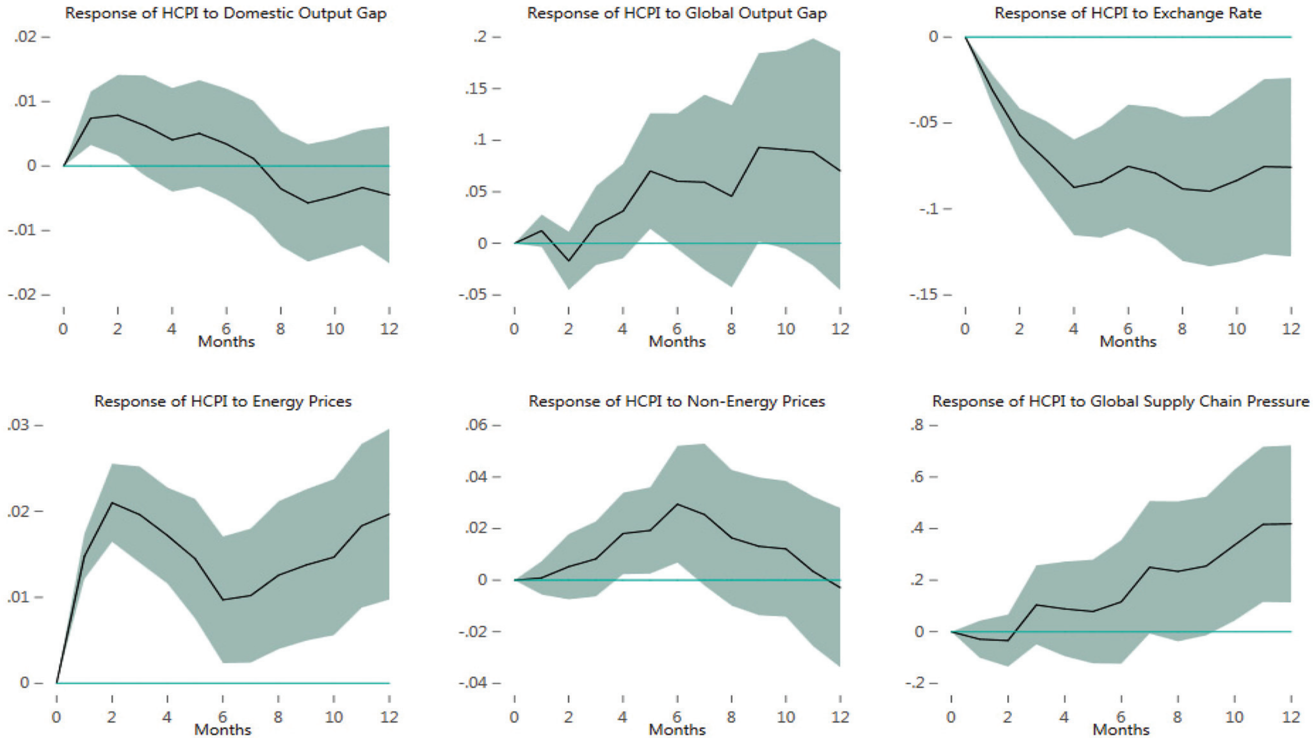
We use the LP method to examine the shocks in the post-GFC and the post-pandemic periods on the future path of inflation. Figures 6, 7, 8, and 9 report the estimated IRFs with 90 percent confidence intervals, and the discussion that follows is based on quantitative results drawn from these figures. First, we examine the post-pandemic domestic and global output gap. The domestic factor has developed into a more critical determinant in the post-pandemic period. The domestic output gap is quantitatively more significant, and the inflation responds sharply to the domestic factor in the post-pandemic period. Consistent with our fixed-effect regression estimates, the domestic output gap has grown to be a driving factor shaping domestic inflation. Moreover, they are likely to be persistent over time in the post-pandemic period.

The global output gap is quantitatively more significant than the domestic output gap in the post-pandemic period at the beginning of the future path. Inflation also responds sharply to the global output gap. Nevertheless, the domestic output gap is more persistent, and its effects last longer than the global output gap. This would imply that the impact of the domestic output gap in the post-pandemic period could be more considerable at the later stage of the future path of inflation. Accordingly, the domestic output gap being one of the driving factors in the post-pandemic period hints at monitoring domestic economic activities, consistent with Oinonen and Paloviita (2014), who argue that the domestic output gap has played a more decisive role since 2012 in steepening the Phillips curve in the euro zone. In addition, it possibly captures all the policy effects in the wake of the COVID-19 pandemic, such as fiscal and monetary policies.

Second, global factors—the global output gap, commodity prices, exchange rate, and global supply chain pressures—in the post-GFC period are likely to exert upward pressure on headline and core

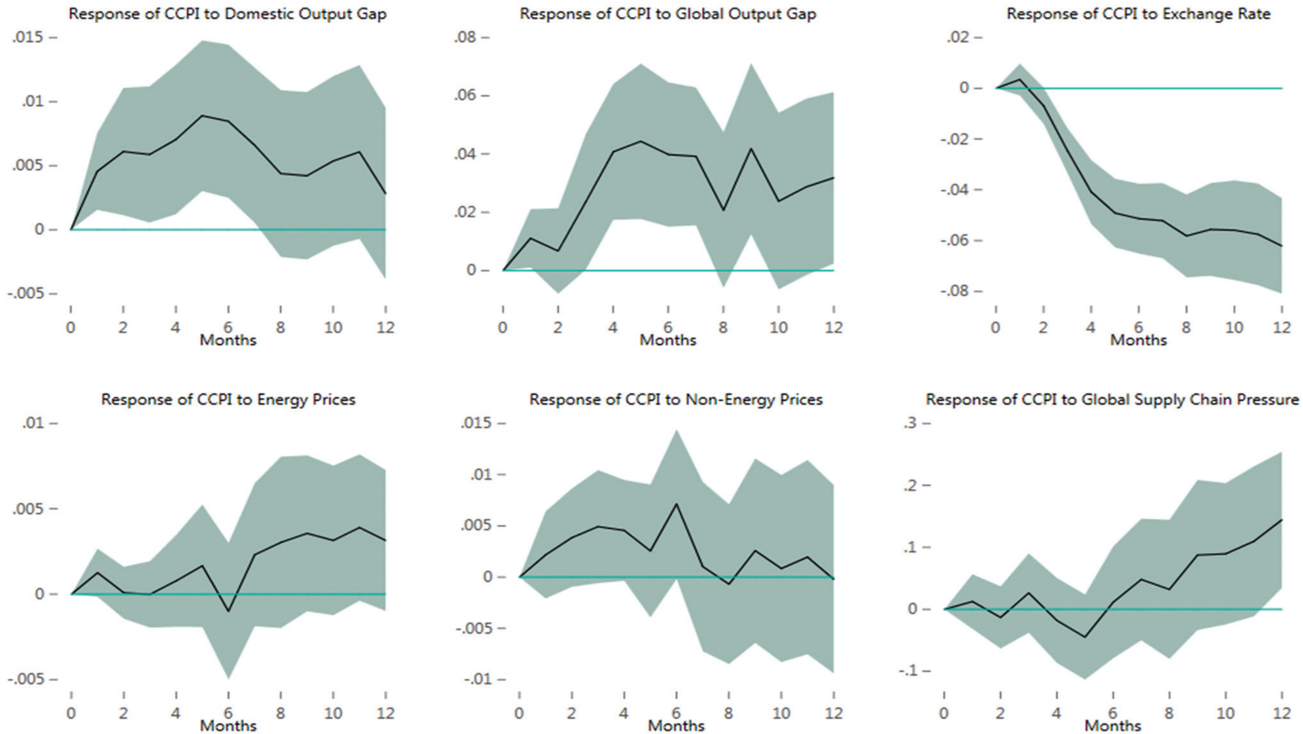
[16]Results are broadly similar when longer lags are employed in the LP method.

Figure 6. Augmented Phillips-Curve Estimates, Post-GFC: Headline Inflation



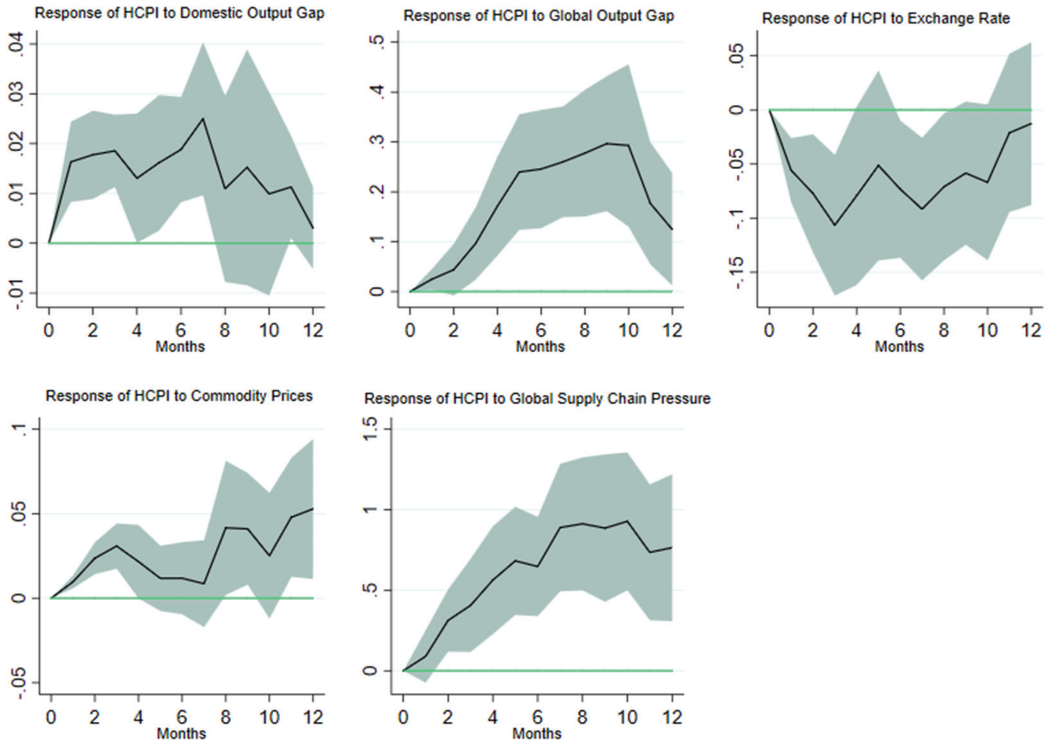
Note: Cumulative responses of headline inflation, with Driscoll-Kraay standard errors and 90 percent confidence interval.

Figure 7. Augmented Phillips-Curve Estimates, Post-GFC: Core Inflation



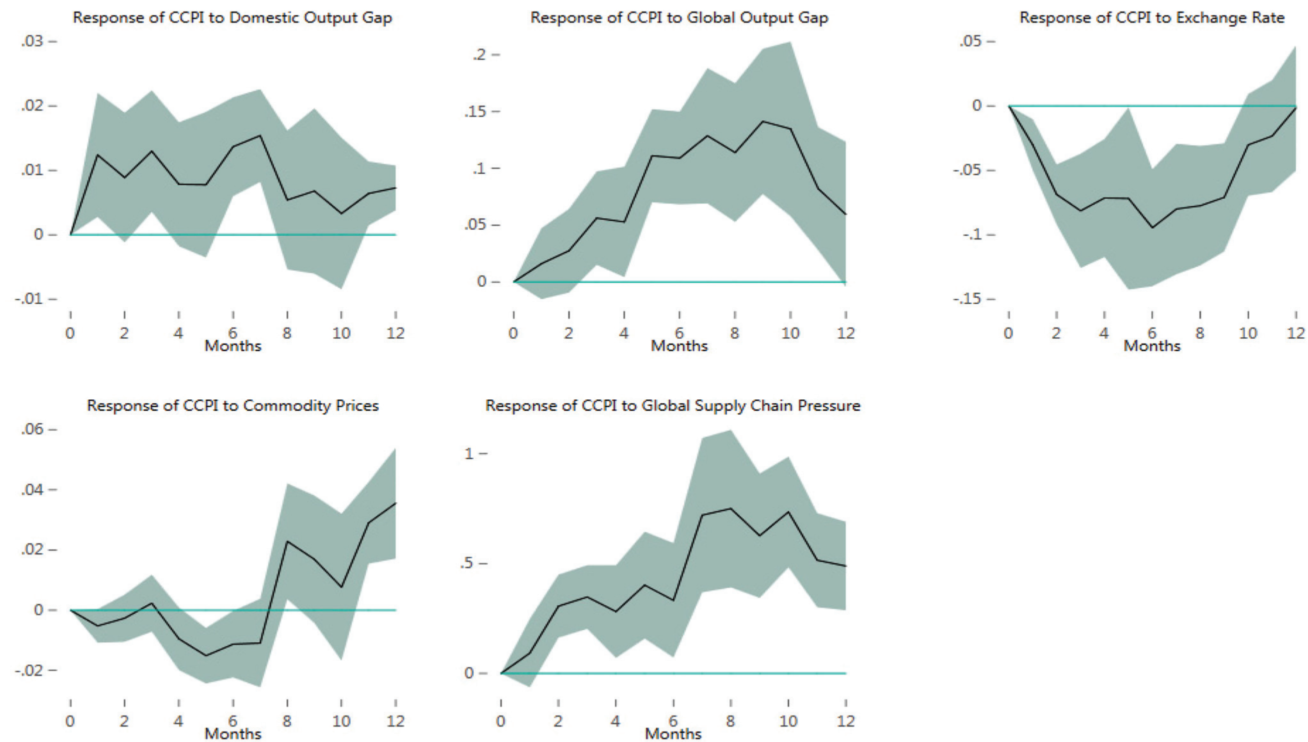
Note: Cumulative responses of headline inflation, with Driscoll-Kraay standard errors and 90 percent confidence interval.

Figure 8. Augmented Phillips-Curve Estimates, Post-Pandemic: Headline Inflation



Note: Cumulative responses of headline inflation, with Driscoll-Kraay standard errors and 90 percent confidence interval.

Figure 9. Augmented Phillips-Curve Estimates, Post-Pandemic: Core Inflation



Note: Cumulative responses of headline inflation, with Driscoll-Kraay standard errors and 90 percent confidence interval.

inflation, and their effects could be long-lasting. Moreover, the long-lasting effects of these global variables on core inflation draw the attention of monetary authorities to consider external factors when implementing monetary policy. In contrast, energy prices have relatively short-lived effects on inflation, and their effects quickly disappear at the end of two months in headline inflation in post-GFC headline inflation. Likewise, their effects have negligible effects on core inflation and are short-lived. On the exchange rate, its effects are relatively muted in core inflation for one to two months, also statistically insignificant, denoting a slower pass-through into prices in the post-GFC.

Considering variables other than output gap measures is crucial when comparing domestic and global factors. For instance, the response of inflation to the exchange rate in the post-pandemic period is slightly more considerable but less persistent than in the post-GFC period. Furthermore, the novelty of this paper is the integration of the impact of global supply chain pressure on inflation. We show that the global supply chain pressure exerts upward pressure on inflation with a delay of one month in the post-pandemic period. Our results align with Benigno et al. (2022), who show that recent inflationary pressures are closely associated with global supply chain pressures in the euro zone. This is because the global supply chain disruption would increase the costs of production, which could be passed on to consumers. Again, global supply chain pressure is quantitatively more considerable in the post-pandemic period than in the post-GFC period, but it is less persistent.

Overall, inflation has become more responsive to both domestic and global factors in the post-pandemic period. The more significant responsiveness of inflation to domestic and global factors indicates that a slight change in underlying domestic and global economic activities could influence the price levels quickly. When the shocks become persistent, they could affect the general trend in inflation. Given that central banks focus more on trend inflation than short-term volatility, both demand-pull and cost-push inflation from domestic and global factors during the post-pandemic period hint at the need for stronger monetary policy tightening to bring inflation under control. This is particularly critical in view of the increasing persistence in inflation dynamics we observed after the pandemic.

5. Robustness Checks

We use two alternative measures of the REER, inflation forecasts and a different lag structure of our variables of interest, to confirm the robustness of our baseline results. First, we rely on the REER constructed based on CPI and unit labor cost (ULC) to test whether these variables change our baseline results (Table 5). The choice of the exchange rate variable between the NEER and the REER may influence inflation dynamics differently due to the inclusion of euro zone countries in our panel. These robustness checks, however, show that there is no qualitative difference when we use the REER compared to our baseline results, including the NEER.

Second, we include inflation forecasts, which have become standard practice in the literature to control forward-looking price behavior along with past inflation (Albuquerque and Baumann 2017; Jordà and Nechio 2018; Mcleay and Tenreyro 2020). Although we cannot directly observe firms' inflation forecasts, it can be useful to rely on consensus professional forecasts. This can be especially beneficial for large firms when making economic decisions. However, small firms may not see much benefit from this type of aggregate information, as noted by Maćkowiak and Wiederholt (2009). We use a one-year-ahead inflation forecast in the model and obtain broadly similar results, which show that inflation expectations are still relevant after the pandemic (see Table 6). Notably, the effect of inflation forecast is larger in the post-pandemic period, implying a growing role of domestic factors. However, the null hypothesis that the difference between the coefficients of inflation forecast in the two periods is equal to zero cannot be rejected at standard statistical levels (for headline inflation, the difference is equal to 0.0849, and the jackknife test statistic is equal to 1.102; for core inflation, the difference is equal to 0.0702, and the jackknife test statistic is equal to 1.082; both test statistics lead to a lack of rejection of the null hypothesis at the 10 percent level assuming asymptotic normality of the resulting estimator).[17] Nonetheless, the persistence of inflation is still

[17]We performed the test of the null hypothesis that the difference between the coefficients in the two models is equal to zero using a clustered jackknife at the country level (see, e.g., Hansen 2022). Using clustered bootstrap leads to comparable results.

Table 5. Augmented Phillips-Curve Estimates: Alternative REER Measures

	Headline Inflation		Core Inflation	
	REER–CPI	**REER–ULC**	**REER–CPI**	**REER–ULC**
Inflation_{t-1}	0.963***	0.951***	0.985***	0.973***
	(0.015)	(0.018)	(0.011)	(0.013)
Domestic Output Gap	0.004***	0.003***	0.004***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Global Output Gap	0.006	0.008	0.008***	0.009***
	(0.005)	(0.005)	(0.003)	(0.003)
$\Delta\text{REER\_CPI}_{t-1}$	–0.018***		–0.012***	
	(0.003)		(0.002)	
$\Delta\text{NEER\_ULC}_{t-1}$		–0.007***		–0.004***
		(0.002)		(0.001)
ΔEnergy Prices	0.004***	0.004***	0.001**	0.001**
	(0.001)	(0.001)	(0.000)	(0.000)
ΔNon-energy Prices	0.002	0.001	0.001	0.001
	(0.002)	(0.002)	(0.001)	(0.001)
GSCP	0.036	0.038	0.049***	0.046***
	(0.028)	(0.028)	(0.017)	(0.017)
Country FE	Yes	Yes	Yes	Yes
F-test: Global	25.34***	23.97***	17.65***	8.92***
Within R^2	0.9534	0.9456	0.9529	0.9372
Observations	7,020	5,850	7,020	5,850
Countries	30	25	30	25

qualitatively and quantitatively substantial despite the inclusion of the inflation forecast.

Third, we employ a different lag structure for commodity prices, exchange rates, and global supply chain pressures in the post-pandemic period. For instance, exchange rate movements might take longer to feed through core inflation. Likewise, commodity prices would take longer to feed through core inflation, though they feed faster through headline inflation. Therefore, we aim to investigate various lag structures to observe the changing dynamics of these variables. First, we follow the literature on the optimal number of exchange rate pass-through on inflation. Gopinath, Itskhoki, and Rigobon (2010) argue that most of the pass-through takes place in the first two quarters and levels off soon after at the aggregate level, and we report the results in the first column in Appendix Table A.7.

Table 6. Augmented Phillips-Curve Estimates: Inflation Forecasts

	Headline Inflation		Core Inflation	
	Post-GFC	**Post-pandemic**	**Post-GFC**	**Post-pandemic**
Inflation_{t-1}	0.882***	0.988***	0.908***	0.975***
	(0.011)	(0.031)	(0.010)	(0.065)
$\text{Inflation Forecast}_{t+12}$	0.0941***	0.0179**	0.083***	0.153*
	(0.025)	(0.065)	(0.013)	(0.079)
Domestic Output Gap	0.0020	0.006**	0.003**	0.006*
	(0.002)	(0.003)	(0.001)	(0.003)
Global Output Gap	0.0018	0.031*	0.004**	0.031**
	(0.005)	(0.018)	(0.002)	(0.012)
ΔNEER_{t-1}	–0.025***	–0.025*	–0.012***	–0.021
	(0.003)	(0.014)	(0.002)	(0.013)
ΔEnergy Prices	0.004***		–0.000	
	(0.001)		(0.000)	
ΔNon-energy Prices	0.004**		0.002**	
	(0.002)		(0.001)	
ΔCommodity Prices		0.005		–0.002
		(0.004)		(0.002)
GSCP	–0.021	0.004	0.022	0.073*
	(0.037)	(0.057)	(0.020)	(0.037)
Country FE	Yes	Yes	Yes	Yes
F-test: Global	37.22***	11.49***	17.85***	6.65***
Within R^2	0.9282	0.9565	0.8986	0.9183
Observations	3,556	812	3,556	812
Countries	28	28	28	28

Note: Driscoll-Kraay standard errors are reported in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Due to multicollinearity issues between energy and non-energy prices in the post-pandemic period, we use a single index of commodity prices. A constant is included in all specifications but not shown in the table.

Second, given that exchange rate pass-through takes place in the first two quarters (six months in our case), we also consider commodity prices and supply chain disruptions for six months to capture the delayed impact of it, which is reported in the second column in Appendix Table A.7. Third, to ensure that the optimal number of commodity prices and supply chain disruptions are correct in addition to exchange rate pass-through, we resort to the Bayesian information criterion (BIC) and find that four lags are the optimal number of lags in our case (third column in Appendix Table A.7).

The results show that there is indeed a lagged impact of exchange rates, commodity prices, and global supply chain pressures on core inflation with varying degrees of statistical significance. The delayed effects of the variables would continue to affect inflation in the longer term. Exchange rate appreciation tends to exert downward pressure, mostly with the first lag, while commodity prices and supply chain disruptions affect inflation with significant delays. Given that the first lag of exchange rates is always significant, we could maintain therefore our baseline specifications with the first lag of exchange rate.

6. Conclusion

The current inflationary wave poses substantial challenges worldwide. The origins of this surge are multifaceted, attributed to diverse sources, including pandemic-induced policy responses fueling demand, COVID-19-related supply constraints, and heightened geopolitical tensions caused by the conflict in Ukraine.

This study contributes to the ongoing debate by disentangling the confluence of contributing factors to the post-pandemic rise in inflation. Throughout this analysis, it emerges that global factors persist as pivotal drivers of inflation dynamics across Europe, yet post-pandemic domestic influences, notably monetary and fiscal responses to the crisis, have taken on a more prominent role. Our empirical findings confirm the significance of both global and domestic forces in shaping inflation dynamics. Primarily, our research unveils the sustained and substantial explanatory power of global factors, which has remained consistent over time, accounting for approximately 40 percent of headline and 20 percent of core inflation variance. Notably, the pandemic has witnessed a heightened prominence of country-specific factors, with domestic influences explaining an additional 10 percentage points of inflation variance post-COVID-19.

Further heterogeneity in inflation dynamics is evident within advanced and emerging market economies. For instance, Denmark's headline inflation variance attributed to domestic factors surged from about 15 percent to about 60 percent during the pandemic, mirroring a similar trend in Latvia from about 15 percent to over

65 percent. While before the pandemic, common inflation dynamics predominated in explaining variance among advanced economies, the post-pandemic landscape saw an augmented role for both global and domestic factors in these economies. In contrast, emerging market economies maintained the ascendancy of global factors in driving inflation, with domestic influences gaining even greater significance in the post-pandemic phase.

To strengthen the robustness of our analysis, we extend our examination of inflation dynamics with panel data models, corroborating our initial findings. Across varied specifications and inflation measures, inflation persistence emerges as a consistently significant factor. While the domestic output gap influences both headline and core inflation, the global output gap exhibits a comparatively greater impact on core inflation. Additional global factors, encompassing international energy and non-energy commodity prices, alongside global supply chain pressures and exchange rates reflecting both global and domestic elements, exert substantial effects on European inflation. These results, robust to a battery of sensitivity checks, delineate marked differences between advanced and emerging market economies, underscoring global factors' greater sway in developing countries. However, domestic influences have gained paramount importance across all countries in driving inflation dynamics in the post-pandemic period.

The implications of our inflation analysis reverberate notably in the realm of optimal monetary policy conduct, not only within Europe but also transcending its boundaries. While a mixture of exogenous factors contributes to the inflation surge, attributing blame solely to global factors would be misleading. Although pandemic-induced disruptions and geopolitical tensions indeed triggered recent inflation surges, our investigation highlights a waning significance of joint global factors post-pandemic. In other words, domestic developments have emerged as decisive drivers characterized by heightened persistence. The evolution of aggregate demand domestically and internationally now holds greater significance in recalibrating monetary policy stance to tame inflation.

However, our findings are limited by the absence of a COVID-19 fiscal stimulus measure, potentially affecting demand positively. To address this deficiency, a model with a quarterly fiscal stimulus measure should be developed. Also, exploring the continuing role of domestic factors in post-pandemic normalcy is important, given the ongoing debate on global factors' impact on inflation.

Appendix

Table A.1. List of Countries

Advanced Europe	**Emerging Europe**
Austria	Bulgaria
Belgium	Croatia
Cyprus	Czech Republic
Denmark	Estonia
Finland	Hungary
France	Latvia
Germany	Lithuania
Greece	Poland
Ireland	Romania
Italy	Slovak Republic
Luxembourg	Slovenia
Malta	
Netherlands	
Norway	
Portugal	
Spain	
Sweden	
Switzerland	
United Kingdom	

Table A.2. Data Sources

Variable	Source	Variable Description
Headline Inflation	Eurostat and IMF	Year-on-year headline inflation rate (%)
Core Inflation	Eurostat, OECD, and CEIC	Year-on-year core inflation rate (%)
Domestic Output Gap	Eurostat, OECD, and IMF	Percentage deviation from the trend of log of monthly domestic industrial production index (%). The Hamilton filter (2018) is employed.
Global Output Gap	Baumeister and Hamilton (2019)	Percentage deviations from the trend of the log of monthly global industrial production index (%). The Hamilton filter (2018) is employed. The global industrial production index measures the weighted industrial production of the OECD and six emerging markets (Brazil, China, India, Indonesia, Russian Federation, and South Africa).
Nominal and Real Effective Exchange Rate	IMF	Year-on-year nominal and real effective exchange rate growth (%)
Energy Prices	IMF	Year-on-year energy price growth rate (%)
Non-energy Prices	IMF and World Bank	Year-on-year non-energy prices growth rate (%)
Commodity Price Index	IMF	Year-on-year commodity price growth rate (%)
Global Supply Chain Pressure Index	Benigno et al. (2022)	Principal component analysis is employed to extract a common component from PMI and transportation costs. This index is normalized.
Inflation Forecast	Consensus Economics	Survey-based one-year-ahead inflation forecast (%)

Table A.3. Panel Unit-Root Test

	Lag (1) C	Lag (1) C + T	Lag (2) C	Lag (2) C + T
Headline $\pi_{c,t}$	–9.635***	–8.638***	–8.613***	–7.514***
Core $\pi_{c,t}$	–7.448***	–7.587***	–7.079***	–6.508***
$Y^d_{c,t}$	–25.861***	–25.952***	–24.489***	–24.001***
ΔNEER$_{c,t}$	–15.294***	–13.508***	–13.458***	–11.475***
ΔREER$_{c,t}$ CPI	–12.541***	–10.649***	–11.510***	–9.559***
ΔREER$_{c,t}$ ULC	–10.422***	–8.615***	–11.047***	–9.354***
$\pi^e_{c,t}$	–7.157***	–6.079***	–6.556***	–5.299***

Note: Pesaran (2007) t-test for unit roots in heterogeneous panels with cross-section dependence. C and T denote constant and trend, respectively. Z[t-bar] is reported.

Table A.4. Time-Series Unit-Root Test

	Drift	Trend
Y^W_t	–2.606***	–2.615
GSCP$_t$	–2.719***	–3.783**
ΔEnergy Prices$_t$	–3.715***	–3.745**
ΔNon-energy Prices$_t$	–3.695***	–3.709**
ΔCommodity Prices$_t$	–3.397***	–3.385*

Note: The augmented Dickey-Fuller (1979, ADF) test is used. The t-statistic is reported. One lag is used based on the Akaike information criterion.

Table A.5. Structural Break Test at Unknown Break Dates

Bai and Perron (1998) Critical Values				
Headline	**Test Statistic**	**1% Critical Value**	**5% Critical Value**	**10% Critical Value**
Estimated Break Points: June 2008 and June 2019				
SupW(τ)	28.43***	3.12	2.71	2.52
Estimated Break Points: June 2008 and May 2019				
Core SupW(τ)	19.28***	3.12	2.71	2.52

Note: Null hypothesis of no break(s) against two breaks. This test checks for structural breaks in time series and panel data models using multiple tests. It identifies the T1, T2, . . . , and Ts breakpoints and determines if a model with accurate break dates has a smaller sum of squared residuals (SSR) than one with incorrect break dates. The panel structural break test uses an algorithm from Bai and Perron (2003) to find the break dates and select the smallest SSR. Our sample division into post-GFC and post-pandemic is close to the panel structural break test results.

Table A.6. Impact of the COVID-19-Related Government Response to Inflation

	Headline Inflation		Core Inflation	
	IV	**DK**	**IV**	**DK**
ln Government Response$_{t-1}$	0.1087*** (0.019)	0.1024** (0.038)	0.017 (0.015)	0.007 (0.030)
Country FE	Yes	Yes	Yes	Yes
Control	Yes	Yes	Yes	Yes
Countries	30	30	30	30
Obs.	822	822	822	822

Note: IV indicates the instrumental-variable estimator to explicitly account for the lagged inflation, whereas DK denotes the Driscoll-Kraay standard errors. Robust standard errors are included in parentheses for the IV estimator. ***p > 0.01, **p < 0.05, *p < 0.1. The COVID-19 government response stringency index is taken from https://data.humdata.org/dataset/oxford-covid-19-government-response-tracker?force_layout=desktop (see Hale et al. 2021). The estimations begin from January 2020 and onward.

Table A.7. Augmented Phillips-Curve Estimates, Post-pandemic: Different Lags

	6 Lags.(NEER)	6 Lags.(NEER, Commodity, GSCP)	4 Lags.(NEER, Commodity, GSCP)
Inflation_{t-1}	1.007***	0.970***	0.979***
	(0.049)	(0.047)	(0.045)
Domestic Output Gap	0.007*	0.006	0.006
	(0.004)	(0.004)	(0.004)
Global Output Gap	0.033**	0.000	0.018
	(0.013)	(0.013)	(0.011)
ΔNEER_{t-1}	–0.024*	–0.020*	–0.021**
	(0.013)	(0.011)	(0.010)
ΔNEER_{t-2}	–0.020	–0.019	–0.010
	(0.015)	(0.012)	(0.015)
ΔNEER_{t-3}	0.008	0.011	0.007
	(0.015)	(0.020)	(0.021)
ΔNEER_{t-4}	0.037*	0.036	0.009
	(0.022)	(0.024)	(0.018)
ΔNEER_{t-5}	–0.028	–0.043*	
	(0.026)	(0.024)	
ΔNEER_{t-6}	0.007	0.015	
	(0.020)	(0.017)	
ΔCommodity Prices	–0.002		
	(0.002)		
$\Delta\text{Commodity Prices}_{t-1}$		0.003	0.001
		(0.002)	(0.002)
$\Delta\text{Commodity Prices}_{t-2}$		–0.001	–0.001
		(0.004)	(0.004)
$\Delta\text{Commodity Prices}_{t-3}$		–0.010**	–0.012**
		(0.005)	(0.005)
$\Delta\text{Commodity Prices}_{t-4}$		0.011*	0.015***
		(0.006)	(0.003)
$\Delta\text{Commodity Prices}_{t-5}$		–0.001	
		(0.005)	
$\Delta\text{Commodity Prices}_{t-6}$		0.003	
		(0.003)	
GSCP	0.090**		
	(0.038)		
GSCP_{t-1}		0.050	0.091
		(0.078)	(0.095)
GSCP_{t-2}		–0.079	–0.107
		(0.077)	(0.092)
GSCP_{t-3}		0.003	–0.020
		(0.045)	(0.045)
GSCP_{t-4}		0.050	0.081
		(0.077)	(0.053)
GSCP_{t-5}		–0.074	
		(0.059)	
GSCP_{t-6}		0.125**	
		(0.047)	
Country FE	Yes	Yes	Yes
F-test: Global	11.27***	39.90***	18.29***
Within R^2	0.9085	0.9165	0.9147
Observations	870	870	870
Countries	30	30	30

Note: Driscoll-Kraay standard errors are reported in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. The post-pandemic periods are estimated from January 2020 to May 2022. A constant is included in all specifications but not shown in the table. Due to multicollinearity issues between energy and non-energy prices, we employ the commodity price index in the post-pandemic period. The dependent variable is core inflation.

Table A.8. Collinearity Diagnostics

Variable	VIF	SQRT VIF	Tolerance	Condition Index
$Y_{c,t}^{D}$	1.60	1.26	0.6263	1.000
Y_{t}^{W}	1.80	1.34	0.5555	1.3818
$\pi_{c,t}^{e}$	1.09	1.05	0.9150	1.5605
$\Delta \text{NEER}_{c,t}$	1.07	1.03	0.9384	3.4102
ΔEnergy Prices_t	2.87	1.70	0.3479	1.7025
ΔNon-energy Prices_t	2.48	1.57	0.4033	2.2387
GSCP_t	1.50	1.23	0.6657	2.6951
Mean VIF	1.77	Condition Number		3.4102

Note: Collinearity diagnostics measures VIF, sqrt VIF, tolerance, and condition index. The mean variance of inflation factor (VIF) is 1.77, indicating the absence of multicollinearity in our regressions. The condition number is an index of the global instability of our regression coefficients. If the condition number is larger than 10, it denotes the instability of the regression coefficients.

Table A.9. Quasi-Likelihood-Ratio (LR) Test

	Without Global Factors	With Global Factors
Quasi-LR χ^2	130.59***	67.27***

Note: "With Global Factors" column estimates the following equation from January 2020 to May 2022: $\pi_{c,t} = \beta_1 + \beta_2 \pi_{c,t-1} + \beta_3 Y_{c,t}^{D} + \beta_4 Y_t^{W} + \beta_5 neer_{c,t-1} + \beta_6 commodity_t + \beta_7 GSCP_t + \eta_c + \varepsilon_{c,t}$. "Without Global Factors" column estimates the same equation but excludes global factors. The quasi-LR test compares the fit of one model (with global factors) to the fit of the other (without global factors). The quasi-LR test is equivalent to an F-test in large samples. ***p < 0.001, **p < 0.05, *p < 0.1.

Figure A.1. Dynamic Eigenvalues (averaged over frequencies)

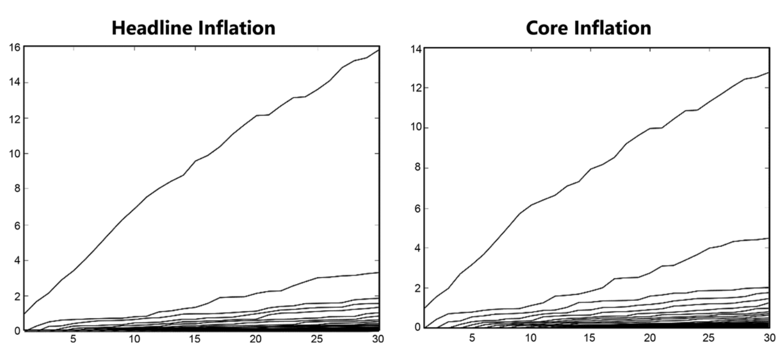


Figure A.2. Share of Headline Inflation Variance

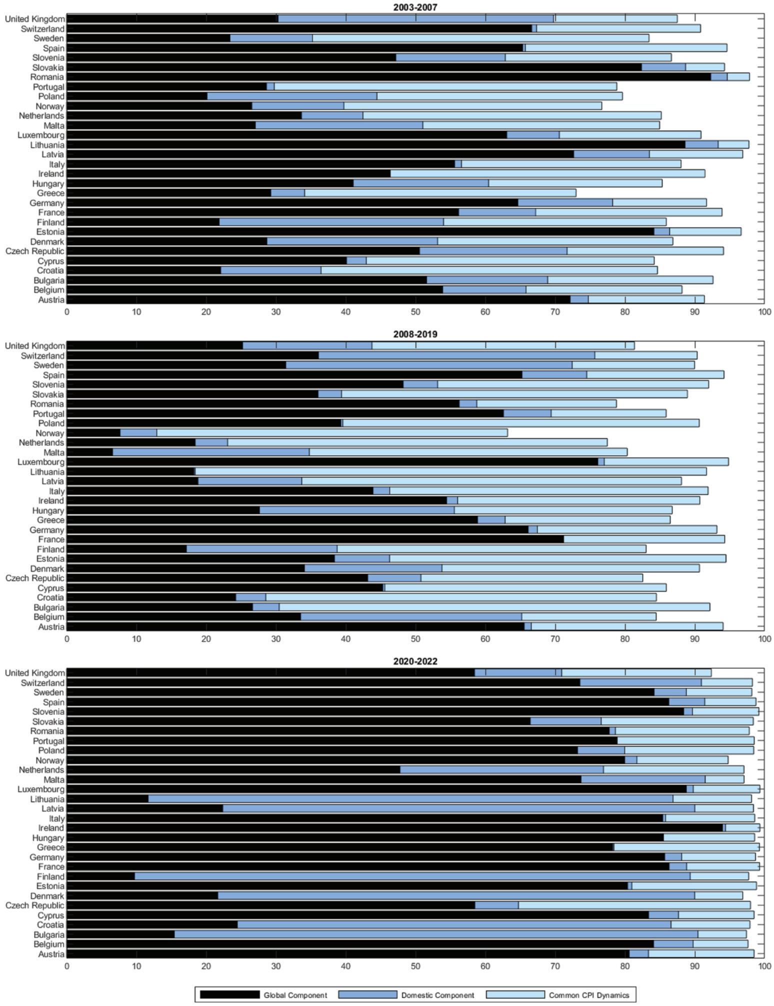
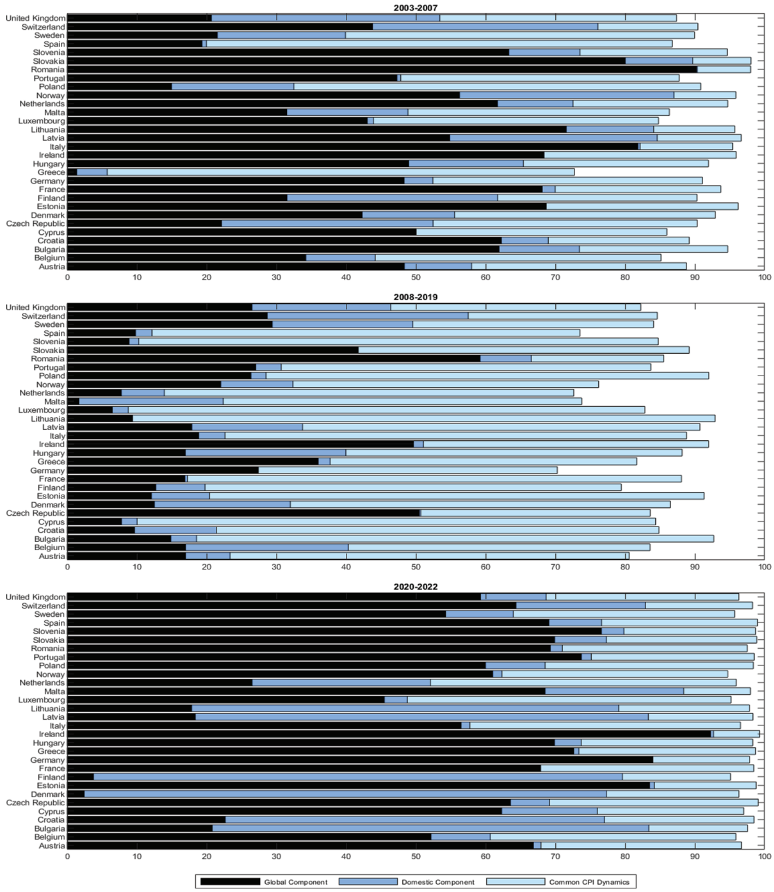


Figure A.3. Share of Core Inflation Variance



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