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Global inflation before and after the covid-19 pandemic: a panel data approach

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Abstract

The main objective of this article is to investigate the global inflation rate behavior before and after the Covid-19 pandemic and the beginning of Russia-Ukraine War, for a panel of 42 advanced and emerging market countries, representing all regions of the world. By making use the System GMM econometric methodology, our quarterly data ranges from 2016Q1 to 2023Q4, but will also divide the data in two subsamples, ranging from 2016Q1 to 2019Q4, and from 2020Q1 to 2023Q4. The estimated global inflation empirical models indicate that: i) for the whole period there is evidence of inflation inertia and significance for oil price; ii) GDP gap has an important role for the post-Covid-19/War period and for the sample of countries below average with positive coefficient; iii) there is partial evidence of exchange rate passthrough to inflation and only for the post Covid-19/War period, but the deflationary process caused by the exchange rate dynamics has not been enough to contribute to an effective global inflation control after 2020; iv) food and oil prices have positive and statistically significant impact in the post-Covid-19/War period and have similar effects for countries below and above GDP average; v) Global supply chain pressures helped to mitigate inflation, before the pandemic, but contributed significantly to the global inflation surge after the outbreak; vi) there is no evidence of exchange rate non-linearity.

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Global Inflation Before and After the Covid-19 Pandemic: A Panel Data Approach

1. Introduction

In 2008-09 the world was struck by a serious financial breakdown, the subprime mortgage crisis, which started in the US and spread throughout advanced and emerging economies. Data from the World Bank show that the Global GDP growth dropped from, respectively, 4.4% and 2.1%, in 2007 and 2008, to -1,3%, in 2009, recovering only in 2010, with a 4.4% average growth rate. To fight the financial crisis, interest rates were decreased, and a great amount of monetary expansion was put into place to help financial institutions in danger of failure and, therefore, putting at risk the global economy as a whole.

It took just about one decade for the world economy to be hit by another major event, the Covid-19 pandemic, followed by the Russia/Ukraine conflict. These crises generated some important exogenous shocks, which led to a considerable drop in the world's GDP, an initial deflationary process, followed by a sudden inflation surge, especially due to supply-chain bottlenecks caused by the sudden lockdown. According to IMF (2023), the global GDP growth dropped from 2.8%, in 2019, to -2.8%, in 2020. This economic downturn was more concentrated in advanced economies, with their GDP growth rate decreasing from 1.7% (2019) to -4.2% (2020), in comparison with emerging economies, from 3.6% (2019) to -1.8% (2020). As for the 2021/2022 recovery period, the World GDP growth rate reached 6.3%, in 2021, and 3.4%, in 2022), highlighting the performance related to emerging market countries, 6.9% (2021) and 4.0% (2022), compared to the advanced countries, 5.4% (2021) and 2.7% (2022).

As for the inflation rate, the pandemic lockdown led to an initial price decrease, as the average global inflation rate reduced from 2.2% (2019) to 1.9 (2020). This process was especially more intense in advanced countries, with inflation decreasing from 1.4% (2019) to 0.7% (2020), whilst emerging economies continued to mark an average inflation rate above 5.0% in 2019 and 2020. Supply-chain bottlenecks and the Russia/Ukraine conflict generated two other important economic shocks that affected inflation all over the planet, with the inflation rate averaging 8.3%, in 2022, and almost reaching a double-digit (9.85%) in emerging market economies (IMF, 2023).

This article aims to investigate the effects caused by the Covid-19 pandemic and the Russia/Ukraine War on global inflation. Our aim is not to detail an explanation of the world inflation throughout the past decades, but only to analyze how prices performed some years before and after the pandemic. The economic variables defined as potential determinants of global inflation are country-specific short-term interest rates, real effective exchange rate, output gap, terms of trade, and global variables, such as food prices, oil prices, and a global supply chain pressure index. To this end, this research makes use of System GMM econometric methodology for a panel of 42 advanced and emerging market countries, for the period ranging from 2016Q1 to 2023Q4. We also break the investigation into two periods: i) Pre-Covid-19 (2016Q1-2019Q4); ii) Post-Covid-19 (2020Q1-2023Q4).

Besides this introduction, this article has four more sections. Section 2 brings the literature related to the topic analyzed. Section 3 describes the data and econometric approach. Section 4 reports all empirical results, and the final section concludes.

2. Global Inflation and Covid-19 Pandemic: Literature Review

Inflation dynamics around the world has been a source of investigation among researchers and economists for a long time. For instance, at the beginning of the 2000s, Rogoff

(2003) documented that global inflation dropped from 30% to 4%, especially due to improved central bank institutions and actions, as well as greater awareness of politicians and economic agents that higher inflation could be the wrong instrument to deal with fiscal problems.

Some years later, Woodford (2007) expressed his concern regarding the ability of monetary authorities to control inflation in a globalized world due to the possibility of: i) liquidity premia being more related to global liquidity than to domestic liquidity supplied by the central bank; ii) real interest rates being more dependent on the investment = saving global balance than to domestic balance; iii) inflationary pressures being more linked to a "global slack", than to a country's output gap.

Ciccarelli & Mojon (2010) analyzed the case of 22 OECD economies, with quarterly data from 1960 to 2008, by estimating an Augmented Phillips Curve model to forecast global inflation. The authors showed a comovement of approximately 70% of the inflation variance in the countries analyzed. This was related to trend components and business cycle fluctuations and made domestic inflation a global phenomenon. They also found that domestic inflation rates usually revert to global inflation due to a strong error correction mechanism and that global inflation is much more than just commodity prices.

Eickmeier & Pijnenburg (2013) made use of a Phillips Curve to analyze global inflation from 1980 to 2007, through data related to 24 OECD countries. The authors found evidence that global inflation is affected by labor costs, import price inflation, international competition, and global interest rate. The pass-through of commodity and non-commodity import price changes to inflation is low but statistically significant.

Parker (2018) constructed a CPI dataset for 223 economies for the period ranging from 1980 to 2012 and showed a decrease in global inflation, mainly in advanced countries, with relative stability until the global financial crisis. Volatility was found in food and energy prices, which usually presented the highest average inflation in the past 30 years. The author also showed that global factors explain about 2/3 of inflation variance in high-income economies, but such an explanation declines considerably for lower-income economies.

Ha et al. (2019a) examined the synchronization case as a source of explanation for global inflation. According to the authors, since 2001, a common global factor has been responsible for explaining 22% of inflation variation across emerging and advanced countries. Such synchronization could be explained by common shocks, similarities in policy response actions, financial flows, and international trade connections, amongst others.

Ha et al. (2019b) examined the main factors influencing domestic and global inflation rates, for a group of 29 advanced and 26 emerging economies. For the period ranging from 1970 to 2017, they applied a FAVAR econometric methodology with three global variables (inflation, real output growth, and oil prices) and four country-specific variables (CPI inflation, output growth, nominal interest rates, and nominal effective exchange rates). They found that global inflation is largely influenced by global demand and oil price shocks (each of them contributing to 40% of the global inflation variation) and global shocks have been responsible for 25% of the variation in national inflation since the 1970s. However, domestic shocks have accounted for about 75% of domestic inflation variation, in emerging economies, which are more affected by global shocks when they don't follow an inflation-targeting regime, with open capital accounts and greater trade openness.

Ha et al. (2023) built a global database to analyze the role of synchronization in explaining inflation around the world and the inflation behavior during global recessions. They found that prices decreased sharply during recessions and continued to decrease even during the recovery period.

Even though the Covid-19 pandemic and the Russia/Ukraine War have been two recent major events, there is a considerable amount of research on several aspects of the consequences of the socks caused by them, particularly the pandemic. For instance, the impact of Covid-19 on unemployment has been examined by Gallant et al. (2020), Lee et al. (2021), Forsythe et al. (2022), Hall & Kudlyak (2022), Carrillo-Tudela et al. (2023), Guo et al. (2023), Lee et al. (2023), Leyva & Urrutia (2023), Pizzinelli & Shibata (2023), among others. Some other authors, such as Xu et al. (2021), Dong et al. (2021), Fujiwara (2022), Meyer et al. (2022), and Kim et al. (2022), have focused especially on the consumption changes that the pandemic crisis produced.

Bonam & Smădu (2021) examined the long-run impacts of major pandemics on European inflation, by using local projection methods and data from 1313 to 2018, covering 19 major pandemics. They showed a significant decrease in trend inflation for more than one decade after the outbreak, but the Covid-19 pandemic could have a different result due to: i) the quick response of fiscal and monetary authorities to accommodate the negative shocks in their economies, resulting in higher inflation; ii) the arrival of several vaccines, contributing to a quick recovery of the economy; iii) the possibility of some sectors to do their businesses from home or in another alternative way; iv) supply-side pressures and cost-push shocks.

Caporale et al. (2022) applied a fractional integration process to analyze the European inflation persistence case during the Coronavirus pandemic and the Russia-Ukraine conflict. Their econometric results showed a clear indication of an increase in inflation persistence in the period, suggesting that the shocks related to the two episodes are temporary, though long-lasting.

Reis (2022) aimed to analyze four hypotheses for why monetary authorities were unsuccessful in preventing the burst in inflation in 2021–22: i) misjudgment of the characteristics of perturbations; ii) misinterpretation that inflation expectations were anchored and that price increases were temporary; iii) belief that, due to credibility conquered in the past, the emphasis on real activity recovery would not lead to increase in inflation; iv) central banks tolerance of higher inflation. The author's final arguments were related to suggestions on lowering inflation rates, such as admitting future lower real activity levels, re-anchoring inflation expectations by increasing interest rates, and reassuring price stability as the main goal.

Schmitt-Grohé & Uribe (2022) explored the US inflation case, for the period 1900-2021, via estimation of a semi-structural model. The results predicted a 238 basis points growth in the permanent component of US inflation in the more than 60 years related to the postwar data (1955-2021), a period without any sudden inflation growth. When the focus was on the Covid-19 pandemic period (2019-2021), the same prediction showed an increase of 51 basis points, i.e., a considerable expansion in the permanent component of US inflation in the Covid-19 pandemic period.

Di Giovanni et al. (2022) built a calibrated model to analyze the effects of the Coronavirus outbreak on European inflation and comparisons with other economies. The authors showed that the 2020-21 Euro Area inflation was much more influenced by foreign shocks and global supply chain bottlenecks than by domestic aggregate demand shocks. They also found that inflation and trade were affected by the substitution of consumption from services to goods and that inflation was higher in sectors with labor scarcity. Finally, they found that foreign trade reaction to GDP movements was weaker, compared to the 2008-09 global financial crisis.

Binici et al. (2022) used monthly data for a panel of 30 European countries, from 2002 to 2022, and showed that European consumer inflation continues to be driven by global factors, such as international energy and non-energy commodity prices, global supply chain pressures, and exchange rate. But country-specific aspects, such as monetary and fiscal policy coordination, grew in importance, during the coronavirus pandemic period, in explaining high inflation and its persistence in the region. Domestic factors also gained importance in explaining price pressures across European countries.

Long et al. (2022) made use of a panel data of 38 countries, from January/2020 to June/2021, to investigate the effects of the Coronavirus outbreak on the world's economy and whether actions taken by monetary authorities helped to mitigate the negative effects of the pandemic. They observed an increase in inflation and unemployment and that the actions taken by central banks were unable to alleviate the macroeconomic consequences of Covid-19.

Storm (2022) analyzed the main drivers related to inflation in times of Covid-19 and the War period and argued that such price surge was mainly related to supply-side problems, together with some incorrect past and current macroeconomic policy decisions. The author also observed that controlling this type of inflation needs much more than simply raising interest rates but using other instruments such as an energy price control strategy, price caps or targeted relief, and some intervention to overcome supply chain bottlenecks.

Harding et al. (2023) proposed a nonlinear Phillips curve able to capture the modest inflation decrease in inflation in the Great Recession period and the inflation increase in the post-Covid-19 period. The authors estimated the model for quarterly US data, from 1965Q1 to 2022Q1, considering important variables, such as real per capita GDP, consumption, investment, and federal funds rate, among others. Their results showed that high inflation pressures made the monetary authority deal with inflation-GDP trade-off more strongly.

Benigno & Eggertsson (2023a) also worked with a non-linear New Keynesian model to account for the 2020s inflation surge. Their findings showed that the increase in inflation and its persistence was neglected because economic agents assumed a "flat" Phillips Curve and continued to believe that the inflation shock was transitory, even after high inflation rates were in place.

Benigno et al. (2023b) investigated the dynamics of inflation and monetary policy stance in the Euro Area and argued that supply shocks were responsible for bottlenecks and an energy crisis at the beginning of 2021. They also said that contracting aggregate demand to lower the inflation rate would be costly, and a policy mix would be more desirable to bring the inflation rate back to its target in the medium to long term with a soft landing of the economy.

Gagliardone & Gertler (2023) built a New Keynesian model to examine the US inflation case, emphasizing oil price increases, due to the Russia/Ukraine War, a FED's delayed response to price pressures in 2021. Their findings showed that the combination of oil price shocks and "easy" monetary policy was crucial for the 2020s US inflation surge.

Maurya et al. (2023) used an event study-based approach related to CPI data for 60 economies, for the period ranging from January/2020 to June/2022, to investigate the impact on global inflation of the Russia-Ukraine War. They found that the conflict caused a surge in global inflation, with specific effects determined by geographical proximity and trading relations activity with the countries involved.

Ferrante et al. (2023) analyzed the inflationary effects of sectoral reallocation caused by the Covid-19 pandemic, which shifted consumption from services to goods. Their model showed that shocks related to demand reallocation explained a large proportion of the U.S. inflation hike after the pandemic.

3. Data, Empirical Specification and Econometric Approach

For the period ranging from 2016Q1 to 2023Q4 we analyze data for the following panel of 42 developed and developing countries: Australia, Austria, Belgium, Brazil, Canada, Chile, China, Colombia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, South Korea, Latvia, Lithuania, Luxemburg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russia, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, UK, and the USA.

There is a mixture of country-specific variables and global variables in our estimations:

- π_{it} = Consumer Inflation Rate (% year). Source: The World Bank.
- r_{it} = Short-term Interest Rate (% year). Source: OECD.
- $dreer_{it}$ = Real Effective Exchange Rate (first difference). Source: BIS.
- gdp_{it} = GDP Gap – HP Filtered (U.S. dollars, 2015). Source: OECD.
- dtt_{it} = Terms of Trade (index 2010=1; first difference). Source: The World Bank.
- $food_t$ = Food Prices (% change over previous period). Source: IMF.
- oil_t = Oil Prices (% change over previous period). Source: IMF.
- $GSCPI_t$ = Global Supply Chain Pressure Index Source: Benigno et al. (2022), FED New York.

As in Ciccarelli & Mojon (2010), Eickmeier & Pijnenburg (2013), and Binici et al. (2022), we estimate a parsimonious Augmented Phillips Curve model represented by the following equation:

$$\pi_{it} = \beta_0 + \beta_1\pi_{it-1} + \beta_2 r_{it} + \beta_3 dreer_{it-1} + \beta_4 gdp_{it} + \beta_5 dtt_{it} + \beta_6 controls_t + u_{it} \quad (1)$$

The β_1 coefficient, related to the lagged inflation, captures the global inflation inertia (persistence). The interest rate (β_2) coefficient captures the Fisher Effect, meaning that the nominal interest rate must increase together with inflation increases to keep the real interest rate constant. The lagged exchange rate (β_3) coefficient describes the impact of delayed exchange rate movements on inflation. The purpose behind this approach is that exchange rate movements might affect prices, and therefore inflation, with some delay. The β_4 coefficient is related to each country's economic activity. As the Terms of Trade measure the country's relative price of exports to its import prices, the β_5 coefficient captures the exposure of global inflation to global trade. The β_6 coefficient is related to the control variables, which are three important global factors: oil prices, food prices, and the GSCPI. The latter is measured as standard deviations from the index's historical average.

The System GMM (two-step) robust estimation will be used as the econometric methodology. This methodology is chosen because it considers the time series and the cross-sectional dimensions of the data, and it is also able to deal with non-observable country-specific effects and possible endogeneity problems in the explanatory variables. However, the GMM System empirical methodology poses two important challenges. The first one is the presence of weak instruments and their connection with an asymptotical increase in the coefficients' variance, which might lead to biased coefficients in small samples. Arellano & Bond (1991), Arellano & Bover (1995), and Blundell & Bond (1998) deal with this problem of reducing the potential bias and inaccuracy related to the use of Difference GMM by developing a regression system in differences and levels. The authors argue that the lagged levels of the explanatory variables can be used as instruments for the regression in differences, and lagged differences of the explanatory variables can be used as instruments for the regression in levels. They are suitable instruments as it is assumed that the possible correlation between country-specific effects and the levels of the regressors tend to disappear when regressors are in differences.

Another empirical challenge is raised by Roodman (2009a, b), who draws attention to the symptoms caused by instrument proliferation in GMM estimations and argues that an excessive number of instruments, compared to the sample size, might lead to biased coefficients, invalidating some asymptotic results and specification tests. To deal with the instrument proliferation problem, the system GMM methodology used in this paper applies the "collapse" empirical strategy, which creates an instrument for each variable and lag distance (Roodman, 2009b).

However, we are working with a not-so-large sample size (42 countries), but with a large time dimension (32 quarters for the whole estimation model), which imposes some difficulty in restricting the number of instruments. The strategy is to estimate all models including time dummies as additional control variables (time effects), but not to use them as instruments. Therefore, our instrument set for the first-difference equation includes the lags of the explanatory variables (interest rate, real effective exchange rate - first difference, GDP Gap, terms of trade - first difference, food price, oil price, and GSCPI). As for the levels equation, our instrument set includes the lags of the explanatory variables, in first difference.

We will estimate four dynamic panel data inflation models: i) Model 1: Baseline Model, including inflation (dependent variable) and the following control variables: lagged inflation, interest rates, lagged real effective exchange rate (first difference), GDP Gap, and terms of trade (first difference); ii) Model 2: adds food prices to the Baseline Model 1; iii) Model 3: adds oil prices to the Baseline Model 1; iv) Model 4: adds the GSCPI Index to the Baseline Model 1. We will also include a dummy to differentiate emerging/less developed countries (dummy = 1) and advanced economies (dummy = 0). As a benchmark, we will first estimate the four models for the whole period (2016Q1 - 2023Q4) and report the results in Table 2. After that, we will estimate the same four models but break the analysis into two periods (Pre-Covid-19: from 2016Q1 to 2019Q4 and Post-Covid-19: from 2020Q1 to 2023Q4). These results will be reported in Table 3.

The descriptive statistics reported in Table 1 show an increase in the average CPI inflation when the periods before and after the Covid-19 outbreak are compared. This is in line with the results of Schmitt-Grohé & Uribe (2022) for the US case, who found that the permanent component of US inflation grew during the Covid-19 pandemic period. On the other hand, Bonam & Smădu (2021) reported a different finding but argued that the Covid-19 pandemic could be different as several measures were taken to ease the negative shocks, businesses were performed in several alternative ways, vaccines were quickly made available, and several supply bottlenecks. All these prevented inflation from decreasing abruptly, as in the case of other pandemics.

The maximum inflation rates detected before and after the pandemic were in Brazil and Hungary, respectively, while the minimum rates were found in Romania (before) and Greece (after). Table 1 also shows that the average global interest rate increased from 1.64%, before the pandemic, to 2.42% afterward, despite the recession detected by the average GDP Gap, which dived into negative territory, after the crisis. Recession was stronger in India (min = -17.83), while a boom happened in Ireland (max. = 11.35). The maximum short-term interest rate was found in Brazil (Pre-Covid-19) and Russia (post-Covid-19). As for the prices for the global economy, it is clear that mean values are much higher after 2020 for food and global supply chain prices and quite similar for oil prices comparing the two periods but with higher standard deviation in the post-Covid-19 period (Table 1).

Table 1: Descriptive Statistics

	Pre-Covid-19/War (2016Q1-2019Q4)				Post-Covid-19/War (2020Q1-2023Q4)			
	Mean	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**
Inflation (% year)	1.96	1.6	-2.93	9.47	4.92	4.45	-2.21	25.10
Interest Rate (% year)	1.64	2.92	-0.9	14.25	2.42	3.40	-0.79	20.0
Exchange Rate (1st diff)	0.06	1.37	-6.26	7.93	0.10	2.23	-17.83	13.75
GDP Gap	0.78	1.49	-7.08	5.31	-0.78	3.91	-27.21	11.35
Terms of Trade (1st diff)	0.07	2.53	-15.25	14.41	0.17	4.70	-33.57	33.55
Food Prices	0.77	4.64	-8.27	10.8	9.17	14.32	-12.83	31.41
Oil Prices	4.16	12.53	-26.79	25.34	3.76	22.45	-48.05	50.56
GSCPI	0.09	0.37	-0.64	0.66	1.50	1.58	-1.14	4.35

Notes: i) Pre Covid: sample = 672; Pos Covid: sample = 672.; ii) REER increases = appreciation
Mean, Std. Dev., Min., Max for the GDP Gap series must be multiplied by 1000.

4. Empirical Results

Even though our main aim is to examine global inflation before and after the Covid-19 pandemic, and consider the Russia/Ukraine conflict, we will start our investigation by analyzing the system GMM panel estimation results for the whole period, ranging from 2016Q1 to 2023Q4. Table 2 shows that the lagged inflation coefficient is positive and statistically significant in 3 out of the 4 estimated models, meaning that if we disregard the effects related to the Coronavirus pandemic and the beginning of the Russia/Ukraine War, there is an indication of inflation inertia (persistence) for the whole period analyzed. On the other hand, the interest rate coefficient is not statistically significant (with a change in sign) in any estimation, showing no evidence of the Fisher Effect, i.e., indicating that nominal interest rates seem not to increase together with global inflation increases to keep the global real interest rate constant.

Changes in the real exchange rate have an expected negative sign only in Model 2 (with food prices) and Model 4 (with GSCPI), indicating that an increase in the exchange rate is associated with a currency appreciation process, which is normally deflationary, and vice-versa. However, there is no statistical significance in any estimation performed when the whole period is analyzed.

As for the GDP output gap coefficient, it is positive in all estimated equations, as expected, but statistically significant only in the second model, when we control for food prices. This reflects the importance of this global factor in the inflation determination.

Table 2: Global Inflation Model - System GMM - Whole Period (2016Q1 - 2023Q4)
Dependent Variable: Consumer Inflation Rate

Variables	Model 1	Model 2	Model 3	Model 4
Inflation$_{t-1}$	**1.145 [0.000]**	**0.973 [0.000]**	**1.029 [0.001]**	1.065 [0.139]
Interest Rate	-0.345 [0.280]	-0.103 [0.158]	0.101 [0.814]	0.141 [0.788]
Exchange Rate$_{t-1}$ (1st diff.)	0.050 [0.506]	-0.025 [0.276]	0.036 [0.799]	-0.133 [0.401]
GDP Gap	0.003 [0.975]	**0.100 [0.000]**	0.140 [0.358]	0.112 [0.658]
Terms of Trade (1st diff)	-0.019 [0.769]	0.013 [0.521]	-0.001 [0.980]	-0.050 [0.610]
Food Prices		**0.058 [0.000]**		
Oil Prices			0.008 [0.432]	
GSCPI				0.225 [0.486]
Dummy Emerging Markets	11.328 [0.422]	-1.361 [0.384]	-269.76 [0.381]	12.129 [0.368]
Autocorrelation AR(2) [Prob]	[0.425]	[0.382]	[0.302]	[0.972]
Hansen [Prob]	[1.000]	[1.000]	[1.000]	[1.000]

Notes: P-values in brackets; REER increases = appreciation; All estimated models include time dummies and use Stata's collapse command to deal with instrument proliferation.

The coefficients related to oil prices, and global supply chain pressures are positive, but not statistically significant. Changes in the terms of trade coefficient show no significance in any estimation either. The estimated parameters for the dummy variable for emerging and less developing countries show no statistical significance for the entire period analyzed, meaning that there is no difference in the inflation behavior of emerging and advanced economies.

As for diagnostic tests, the autocorrelation results indicate no second-order autocorrelation, and the Hansen overidentification tests suggest that the set of instruments is valid for all estimated models (Table 2).

When we break our sample into two periods to analyze the dynamics of inflation before and after the Covid-19/War some interesting results appear. Table 3 shows that the lagged inflation coefficient is positive, with statistical significance, in all estimated models, before and after the Coronavirus pandemic and the Russia/Ukraine War. This finding shows that, at least concerning inflation inertia, the two major crises had no relevant impact, as the coefficients' magnitude were quite similar before and after. However, this is different from the results reported by Caporale et al. (2022), for the European case, which showed an indication of inflation persistence growth in the period after the crises. Binici et al. (2022) also reported statistically significant inflation persistence in their post-pandemic longer lags estimation for the European case.

A coefficient that kept the same behavior from the previous estimations is the one related to the interest rate (Table 3), with only one statistical significance in the pre-Covid-19 estimations, and a sign change before and after the crises. The coefficient related to terms of trade continues to have no statistical significance in any model estimated.

Regarding the specific estimations related to the Pre-Covid-19/War period (2016Q1-2019Q4), the third model, with oil prices as the control variable, is the one with the most significant coefficients, including oil prices. In fact, the importance found in oil supply shocks is in line with Ha et al. (2019b), for the pre-pandemic period. The dummy variable for emerging market economies also came out as statistically significant, with a positive sign, providing some evidence that inflation rates were higher for this country group before the crises.

The results related to the post-Covid-19/War period (2020Q2-2023Q4) are more interesting as many more coefficients show statistical significance, besides the lagged inflation rate. The exchange rate passthrough is statistically significant, with a negative sign, in the second and third models related to the period after the Coronavirus Outbreak/War. This is an expected outcome once an increase (decrease) in the exchange rate indicates an appreciation (depreciation) process, which is normally deflationary (inflationary). However, this expected negative sign has not been enough to contribute to an effective inflation control after 2020.

What is interesting is that this exchange rate significance in Models 2 and 3 comes together with the statistical significance and positive signs found in the output gap coefficients, and in the food and oil prices coefficients, which are related to cost-push shocks. Therefore, there is strong evidence that global inflation has been influenced by economic activity and these two important global factors altogether. The specific effects of each of these variables these prices are depicted in the following paragraphs.

This GDP Gap result, which is found in 3 out of 4 estimated models for the Post-Covid-19/War period, is in line with Caporale et al. (2022) for the European case, who also found a statistically significant output gap in their post-pandemic longer lags estimations. As for the passthrough of food and oil price changes to inflation seems to be specifically important in explaining the recent global inflation surge, as well as the global supply chain pressure index.

The oil price variable is the only one that kept its coefficient positive and statistically significant before and after the Covid-19/War crisis. However, as mentioned previously, in the post-pandemic period oil supply shocks come together with a significant exchange rate passthrough and economic activity. Gagliardone & Gertler (2023) reported that a combination of oil price shocks and dovish monetary policy was decisive for 2020s inflation surge in the USA. As for the food price coefficient, its significance in the post-pandemic period might be related to the impact of food prices due to supply chain bottlenecks after the Covid-19/War period.

The GSCPI estimated parameter is also statistically significant in the post-Covid-19/War period, meaning that global supply pressures became inflationary after the outbreak, reflecting a shift in the impact of supply costs, due to supply chain bottlenecks, after the Covid-19/War period (Table 3).

These outcomes are in line with Binici et al. (2022), who worked with a local projection method to estimate how inflation responded to global and domestic shocks in the post-pandemic period. They found that global factors (global output gap, commodity prices, exchange rate, and global supply chain pressures) could lead to a higher inflation rate, with long-lasting effects.

The coefficient related to the dummy variable for emerging and less developing economies was not statistically significant in the post-pandemic period, showing no evidence that these countries have faced lower inflation rates, compared to advanced countries, after the crises (Table 3).

As previously, the autocorrelation results (probability) indicate no second-order autocorrelation for all estimated models and the Hansen (probability) overidentification tests suggest that the set of instruments is valid for all estimated models.

Table 3: Global Inflation Model - System GMM (Pre and Post-Covid-19)
Dependent Variable: Consumer Inflation Rate

	Pre-Covid-19/War (2016Q1-2019Q4)				**Post-Covid-19/War (2020Q2-2023Q4)**			
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Inflation$_{t-1}$	**0.957 [0.000]**	**0.844 [0.000]**	**0.937 [0.000]**	**0.843 [0.000]**	**0.836 [0.000]**	**0.803 [0.051]**	**0.918 [0.000]**	**0.819 [0.000]**
Interest Rate	-0.313 [0.361]	-0.227 [0.242]	**-0.416 [0.009]**	-0.161 [0.223]	0.017 [0.936]	0.136 [0.557]	0.204 [0.441]	0.184 [0.335]
Exchange Rate$_{t-1}$ (1st diff.)	-0.002 [0.974]	-0.002 [0.964]	-0.011 [0.813]	-0.002 [0.955]	-0.008 [0.897]	**-0.085 [0.000]**	**-0.093 [0.070]**	-0.005 [0.940]
GDP Gap	0.046 [0.568]	0.088 [0.534]	0.066 [0.420]	8.00E-02 [0.180]	0.104 [0.152]	**0.000 [0.039]**	**0.143 [0.000]**	**0.150 [0.009]**
Terms of Trade (1st diff)	1.80E-02 [0.647]	0.016 [0.454]	0.025 [0.454]	1.50E-02 [0.542]	0.008 [0.861]	0.000 [0.316]	0.004 [0.910]	0.031 [0.355]
Food Prices		-0.005 [0.872]				**0.049 [0.056]**		
Oil Prices			**0.028 [0.000]**				**0.009 [0.006]**	
GSCPI				-0.232 [0.329]				**0.224 [0.052]**
Dummy Emerging Markets	2.823 [0.406]	1.774 [0.738]	**3.731 [0.031]**	1.677 [0.329]	0.729 [0.684]	-36.72 [0.376]	-0.755 [0.683]	-0.585 [0.700]
Autocorr. [Prob]	[0.119]	[0.055]	[0.100]	[0.021]	[0.022]	[0.251]	[0.102]	[0.039]
Hansen [Prob]	[0.972]	[0.997]	[1.000]	[1.000]	[0.999]	[1.000]	[1.000]	[1.000]

Notes: P-values in brackets; REER increases = appreciation; All estimated models include time dummies and use Stata's collapse command to deal with instrument proliferation.

We also performed some robustness checks to evaluate the previous results reported in Tables 2 and 3. In the first test, we used time demeaned fixed effects to re-estimate the Global Inflation Model for the whole period and control for some unobserved heterogeneity. The new outcomes were in line with the dynamic GMM estimation, depicted in Table 2, indicating that the lagged inflation, GDP Gap, and the three price control variables (oil prices, food prices and GSCPI) were statistically significant with positive estimated coefficients. However, due to space limitations, we decided not to report the results, which are available upon request.

To capture a better understanding of global inflation under different economic conditions, we performed a second robustness check, also related to a re-estimation of the Global Inflation Model (whole sample). The strategy consisted of breaking the sample on the GDP average of 109.95 and estimating two regressions: i) Below the GDP Average, with a subsample of 28 countries; ii) Above the GDP Average, with a subsample of 14 countries (China, Estonia, Hungary, Iceland, India, Indonesia, Ireland, Israel, Poland, Romania, South Korea, Lithuania, New Zealand, Slovenia).

Table A1 in the Appendix reports these results and brings similarities and differences when compared to the results depicted in Table 2. Regarding resemblances, the inflation inertia coefficient is still positive and statistically significant and there is still no evidence for the Fisher Effect, once the interest rate coefficient is not significant in 7 out of 8 estimations. Despite the lack of significance, it is important to emphasize the difference in the interest rate coefficient sign for countries below the GDP average (predominantly negative) and countries above GDP average (positive).

As for the lagged exchange rate coefficients, they show a sign shift, from mostly positive for countries below the GDP average to mostly negative for countries above the GDP average. Nevertheless, most of the coefficients are not statistically significant. Regarding the GDP output gap coefficients, they are all positive but statistically significant only for economies below GDP average and only one model for countries above GDP average. Therefore, we can infer that the lack of significance found in economic activity in Table 2 is much more related to countries that were exhibiting an economic growth rate above average.

Finally, it is important to bear in mind that, as mentioned previously, we are working with a limited sample size (42 countries), and dividing the sample into two parts makes it even more limited. Therefore, these results should be read with some caution.

In a third robustness check, we re-estimated the Global Inflation Model, depicted in Table 3, with the subsamples pre-Covid-19/War (2016Q1-2019Q4) and post-Covid-19 (2020Q1-2023Q4), but incorporating non-linearities in the real exchange rate. We labeled the new variables Exchange Rate$^{(+)}$ for positive values (currency appreciation) and Exchange Rate$^{(-)}$ for negative values (currency depreciation). Table A2 in the Appendix reports these results. Statistical significance is found in only 2 out of 16 possible cases. Therefore, it is fair to say that due to the lack of statistical significance of the positive and negative changes in the real effective exchange rate, there is no evidence of non-linearity in the exchange rate for the inflation models.

5. Concluding Remarks

This article aimed to examine the global inflation behavior for a panel of 42 advanced and emerging market countries and the period ranging from 2016Q1 - 2023Q4. An essential feature of the research was to include countries from all regions of the world and to analyze global inflation before and after the Covid-19 and Russia-Ukraine Conflict.

The main estimation results showed evidence of inflation persistence for the entire period as well as for the periods before and after the pandemic outbreak. This was an expected result as inertia in price is usually present even in low inflation economies. On the other hand, an unexpected result was related to the Fisher Effect, which wasn’t detected in any estimation performed, neither for the whole sample nor for the subsamples.

Changes in the real effective exchange rate coefficient came out with an expected negative sign only after the Covid-19/War, indicating a significant exchange rate passthrough to inflation only for this period. However, the deflationary process caused by the exchange rate dynamics was not enough to contribute to an effective inflation control after 2020.

As for the global factors, food and oil prices seem to be specifically important in explaining the recent inflation surge. The same applies to global supply chain pressures, which were deflationary before the pandemic but became inflationary after the outbreak, reflecting considerable increases in supply costs after the Covid-19/War period. In addition, it seems that emerging and less developing countries have been facing lower inflation rates after the Covid-19 period, which is a very unusual result.

It is important to emphasize that this is still an ongoing research process trying to contribute to the discussion on the economic impacts of the coronavirus pandemic and the Russia/Ukraine conflict. It is a continuing process because the total effects of the pandemic, even though it is not considered as such anymore, have yet to be completed. As for the war, it is far from being over, with economic and social consequences hard to be effectively measured.

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Appendix

Table A1: Global Inflation Model - System GMM - Whole Period (Sample Adjusted to GDP Average) Dependent Variable: Consumer Inflation Rate

	Countries Below GDP Average				Countries Above GDP Average			
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Inflation$_{t-1}$	**0.707 [0.000]**	**0.954 [0.000]**	**1.029 [0.000]**	**0.95 [0.000]**	**0.816 [0.000]**	**0.891 [0.000]**	**0.847 [0.000]**	**0.839 [0.000]**
Interest Rate	0.107 [0.444]	-0.084 [0.329]	**-0.284 [0.001]**	-0.126 [0.297]	0.227 [0.122]	0.005 [0.973]	0.138 [0.369]	0.147 [0.340]
Exchange Rate$_{t-1}$ (1st diff.)	-0.0009 [0.980]	0.014 [0.486]	**0.059 [0.063]**	0.063 [0.260]	-0.028 [0.747]	**-0.121 [0.056]**	-0.08 [0.130]	-0.064 [0.236]
GDP Gap	**0.021 [0.003]**	**0.080 [0.000]**	**0.098 [0.000]**	**0.110 [0.002]**	0.086 [0.125]	**0.086 [0.083]**	0.082 [0.159]	0.068 [0.238]
Terms of Trade (1st diff)	0.021 [0.328]	0.001 [0.902]	-0.017 [0.518]	0.000 [0.999]	-0.001 [0.967]	-0.010 [0.662]	-0.001 [0.949]	-0.011 [0.383]
Food Prices		**0.057 [0.000]**				**0.131 [0.000]**		
Oil Prices			**0.017 [0.000]**				0.001 [0.821]	
GSCPI				**0.381 [0.000]**				**0.469 [0.001]**
Dummy Emerging Markets	-0.298 [0.915]	-0.62 [0.526]	0.989 [0.432]	-0.547 [0.871]	-1.728 [0.173]	-1.169 [0.256]	-1.412 [0.219]	**-1.848 [0.024]**
Autocorrelation AR(2) [Prob]	[0.077]	[0.099]	[0.129]	[0.189]	[0.579]	[0.099]	[0.057]	[0.240]
Hansen [Prob]	[1.000]	[1.000]	[1.000]	[1.000]	[1.000]	[1.000]	[1.000]	[1.000]

Notes: P-values in brackets; REER increases = appreciation; All estimated models include time dummies and use Stata's collapse command to deal with instrument proliferation.

Table A2: Global Inflation Model - System GMM
(With Exchange Rate Nonlinearity)
Dependent Variable: Consumer Inflation Rate

	Pre Covid-19 (2016Q1-2019Q4)				Post Covid-19 (2020Q2-2023Q4)			
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Inflation$_{t-1}$	**0.987 [0.000]**	**0.87 [0.000]**	**0.868 [0.000]**	**0.759 [0.000]**	**0.954 [0.000]**	**0.915 [0.051]**	**0.914 [0.000]**	**0.894 [0.000]**
Interest Rate	-0.251 [0.231]	-0.259 [0.183]	**-0.271 [0.098]**	-0.067 [0.682]	**-0.341 [0.000]**	0.11 [0.550]	0.158 [0.669]	0.018 [0.930]
Exchange Rate$^{(+)}$ (1st diff.)	0.068 [0.599]	0.112 [0.964]	0.12 [0.430]	0.038 [0.774]	**0.251 [0.039]**	-0.092 [0.532]	-0.091 [0.583]	-0.019 [0.900]
Exchange Rate$^{(-)}$ (1st diff.)	-0.171 [0.121]	**-0.282 [0.023]**	-0.097 [0.470]	-0.164 [0.232]	-0.053 [0.610]	0.185 [0.473]	0.221 [0.417]	0.187 [0.395]
GDP Gap	0.027 [0.730]	0.059 [0.740]	0.060 [0.698]	0.079 [0.542]	**0.219 [0.000]**	0.047 [0.310]	**0.132 [0.000]**	**0.121 [0.009]**
Terms of Trade (1st diff)	1.90E-02 [0.596]	0.025 [0.598]	0.006 [0.698]	0.033 [0.258]	-0.004 [0.919]	0.022 [0.673]	0.004 [0.917]	0.016 [0.681]
Food Prices		-0.01 [0.846]				**0.041 [0.009]**		
Oil Prices			**0.017 [0.023]**				**0.01 [0.012]**	
GSCPI				-0.326 [0.336]				**0.233 [0.018]**
Dummy Emerging Markets	3.567 [0.832]	**6.539 [0.093]**	2.517 [0.134]	0.975 [0.391]	**2.704 [0.016]**	-0.218 [0.991]	1.522 [0.788]	-0.57 [0.559]
Autocorr. [Prob]	[0.297]	[0.162]	[0.168]	[0.137]	[0.205]	[0.180]	[0.157]	[0.020]
Hansen [Prob]	[1.000]	[1.000]	[1.000]	[1.000]	[0.998]	[1.000]	[1.000]	[1.000]

Notes: P-values in brackets; REER increases = appreciation; All estimated models include time dummies and use Stata's collapse command to deal with instrument proliferation.