A Time-Varying Phillips Curve with Global Factors: Are Global Factors Important?*

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Abstract

Increased globalization and trade have integrated the world, but whether they are the underlying drivers of the flattening of the Phillips curve slope is not clear. This problem is further complicated since time-varying parameters are empirically important in most applications as the role of global factors may change over time. This paper investigates empirically the role played by global and domestic factors in driving dynamics in inflation using a panel data comprising of 23 advanced (AEs) and 11 emerging market economies (EMEs), from 1995Q1 to 2018Q1. The results indicate the predominance and increasing importance of global factors in explaining inflation dynamics, especially for EMEs. The Phillips curve is flat for both groups, but it is flatter in AEs. The results are consistent with the theoretical view that increased globalization and trade are underlying factors behind the flattening of the Phillips curve.

JEL classification: C11, C32, E31, F62

Keywords: trend inflation, global factors, non-linear state space model, multi-country

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1 Introduction

Recent development in inflation dynamics has raised questions about the validity of the Phillips curve across countries. In the aftermath of the Global Financial Crisis (GFC), many countries experienced a sharp decline in output with mild effects on inflation (see, Simon et al., 2013). This disconnect between output and inflation has resulted in a general consensus in the empirical literature that the slope of the Phillips curve has flattened since the early 1990s. Proponents of this view mainly attribute the flattening of the Phillips curve to better anchoring of inflation expectations (see, Simon et al., 2013; Kiley, 2015; Jordà et al., 2019; McLeay and Tenreyro, 2020), and a decline in inflation volatility.[1] However, Coibion and Gorodnichenko (2015) challenge this view and suggest that the Phillips curve is indeed empirically relevant once household inflation expectations are taken into account. In particular, Coibion and Gorodnichenko (2015) argue that the missing disinflation period after the GFC can be largely explained by household inflation expectations.

In light of recent development in inflation dynamics, this study aims to examine the empirical relevance of the Phillips curve relationship using a panel dataset that accurately represents the global economy. Our analysis employs a sophisticated empirical technique based on the "left fork of the road" Phillips-curve model, which accounts for domestic demand shocks, inflation inertia[2], and supply shocks. We use data from 34 countries, including 23 advanced economies (AEs) and 11 emerging market economies (EMEs), spanning the period from 1995Q1 to 2018Q1. The Phillips curve is estimated for each country and then aggregated into two groups, AEs and EMEs. Our methodology estimates a standard Phillips curve model, which incorporates both domestic and global variables. The domestic demand factor is represented by an individual country's output gap, while inflation inertia is captured by the lagged inflation gap. We also incorporate supply factors, such as oil prices and stochastic volatility, into the model. The global output gap is used to represent the global demand factor.

Our empirical findings provide evidence that global factors play a crucial role in shaping the inflation dynamics of countries. Specifically, our analysis reveals that global demand exerts a significant influence on inflation across all countries, particularly in emerging market economies. Moreover, our results indicate that oil prices are a key driver of inflation fluctuations both within and across countries over time. To illustrate, our decomposition analysis reveals that the

[1] See for example Carlstrom and Fuerst (2008); Ball and Mazumder (2011); Simon et al. (2013); Blanchard et al. (2015); Gillitzer and Simon (2015); Blanchard (2016); Chan et al. (2016); Kabundi et al. (2019) on flattening the Phillips curve.

[2] In this paper, inflation inertia and inflation persistence can be used interchangeably. Theoretical models refer to it as inflation inertia. Empirical models use inflation persistence. But they all associate with slow-moving inflation if inertia or persistence is high.

contribution of oil prices to the inflation gap in 16 out of the 34 countries examined increases more than double following the GFC. Overall, our study highlights the importance of considering both global and domestic factors when examining inflation dynamics and provides insights into the specific factors that are most influential in shaping inflation outcomes.

We also find evidence that the slope of the Phillips curve is flat in most countries. This is likely due to the decline in inflation volatility and the low inflation persistence experienced across all countries. Finally, we find inflation persistence is more pronounced in EMEs than AEs. We highlight that the low degree of inflation persistence can be possibly attributed to either the central bank's strong commitment to stabilizing inflation or other economic environment factors such as private sector behavior or changes in the role of inflation expectations. Finally, our results provide empirical support to the theoretical view of Wynne and Martínez-García (2010) that global factors dominate a country's inflation dynamics and that the flattening of the Phillips curve is possibly due to an increase in trade and globalization in the world.

Similar to Gillitzer and Simon (2015), Blanchard (2016), and Kabundi et al. (2019), the flexibility of the framework adopted here relaxes stringent restriction of constant parameters mostly used in the estimation of the Phillips curve. In particular, the model allows five parameters to vary over time: the slope of the Phillips curve, inflation persistence, the effect of oil price, the effect of global demand, and inflation volatility. This is done by extending the bivariate unobserved components model with time-varying parameters, proposed by Chan et al. (2016), to a multivariate setup. The time-varying slope of the Phillips curve allows us to reveal whether the Phillips curve has indeed flattened or not. The time-varying inflation inertia potentially captures the change in the conduct of monetary policy associated with the anchoring of inflation expectations. The time-varying effects of oil price and global demand allow us to check both whether global factors determine inflation dynamics and whether their role change over time. Finally, the stochastic volatility accounts for other shocks that are not explicitly included in the model, such as supply shocks, that could alter the relationship between domestic demand and inflation. Allowing for a heteroscedastic variance can capture the decline in inflation volatility observed in the 1990s, also known as the "great moderation" which can reflect "good luck" aspect of improved inflation dynamics, attributed to positive supply shocks (Kabundi et al., 2019).

Theoretically, Wynne and Martínez-García (2010) argue that the flattening of the Phillips curve across countries is largely attributed to globalization and international trade. Furthermore, they also find the important role of global factors in driving a country's inflation dynamics as trade openness increases. Similarly, Gilchrist and Zakrajsek (2019) demonstrate how increased trade exposure significantly reduces the response of US inflation to fluctuations in economic activity over time since the 1990s. Additionally, the expansion of EMEs, particularly China, can also contribute in various ways to altering inflation dynamics in many countries through its effects on commodity prices and terms of trade. For example, Eickmeier and Kühnlenz (2018) show that China's demand and supply shocks significantly affect inflation in other countries. China's inception in the WTO in early 2000s as the world manufacturer drove down the cost of production of manufactured products and attracted greater demand for commodities from China with a spillover in global inflation. Meier et al. (2020) show that during the January 2020 lockdown, China has shut factories and supply dropped. This increased the prices in the US, especially for the sectors with high exposure to intermediate goods imports from China. These findings are supported by other empirical studies, such as Ciccarelli and Mojon (2010) and Kabukçuoğlu and Martínez-García (2018). These studies find that the global inflation factor accounts for about 70 percent of the variance of inflation across 22 OCED countries. And the addition of a global inflation factor predictor significantly improves the forecasting accuracy of US inflation.

In addition to the literature examining the role played by the global factor in explaining dynamics in domestic inflation, other studies associate the flattening of the Phillips curve with the improved conduct of monetary policy where central banks in both AEs and EMEs have managed to anchor inflation expectations around central bank's target. For instance, King and Wolman (1996) illustrate how credible monetary policy is capable of stabilizing inflation by anchoring the expectations of agents. If the central bank is not fully committed to the disinflation process, agents' expectations will be formed gradually as they learn slowly about monetary policy. In this case, agents tend to rely on past inflation when they forecast future inflation outlooks. As a result, inflation expectations are not fully anchored towards the central bank target. However, if the central bank conveys a strong commitment to disinflation, agents will react accordingly as they believe the central bank will achieve its objective. This will, in turn, lead to expectations becoming well anchored at the official target (Schaling and Hoeberichts, 2010). Consequently, inflation will react mildly to demand pressures, which implies a flat Phillips curve. Mounting empirical evidence links the flattening of the Phillips curve to credible monetary policy, especially for AEs, but also for some EMEs, since the adoption of the inflation targeting (IT) policy framework.[3] However, it is worth noting that a central bank's commitment does not imply credibility. For instance, a strongly committed central bank can still lose its credibility if it consistently misses its inflation targets.

Our study is closely related to Borio and Filardo (2007) and Forbes (2019), where both studies demonstrate empirically, using an Open Economy New Keynesian Phillips curve framework,

[3] See for example Ball (2006), Williams (2006), Simon et al. (2013), Kiley (2015), Jordà et al. (2019), Gagnon and Collins (2019), Hooper et al. (2020), and Kabundi and Mlachila (2019).

that global factors play an increasingly more important role in explaining inflation dynamics. However, they note that domestic forces are still relevant in driving inflation, but these factors have become less important over time.

Empirically, our paper contributes to the existing literature on the role of global factors affecting inflation dynamics in three folds. First, we investigate the role of global factors on a large panel set of countries' inflation dynamics. In contrast, many previous studies have only examined the role of global factors on US inflation and a narrow set of countries' inflation. The key advantage of our study is that we can elicit insight into whether global factors are important for explaining both AEs and EMEs inflation dynamics. Second, it is well established in Cogley et al. (2010) that the inflation gap persistence has changed over time. Therefore, within our proposed framework, we allow for time variation in the parameters, which enables us to directly assess a country's key driver of inflation dynamics over time. On the contrary, the studies by Borio and Filardo (2007) and Forbes (2019) both implement a time-invariant framework. Forbes (2019) does investigate the role of global factors on a country's inflation dynamics over time, but she divides her sample into two sub-samples which is subject to an arbitrary identification of a structural break. The time-varying parameter approach circumvents this limitation. We explicitly model a country's inflation gap and output gap endogenously, whereas, in Borio and Filardo (2007) and Forbes (2019) treat the output gap as an exogenous variable in their New Keynesian Phillips curve model. Finally, we extend the bivariate unobserved components model with time-varying parameters of Chan et al. (2016) to a multivariate framework in the estimation of the Phillips curve.

The rest of the paper is organised as follows. Section 2 outlines the empirical model. Section 3 presents and discusses the empirical results. Finally, section 4 concludes.

2 Model Specification

We start from the model of Chan et al. (2016); given by equations (1) to (4) below. This framework relaxes stringent constant-parameter estimation used in traditional Phillips-curve model. In so doing, the model becomes more flexible such that it can accommodate structural change in the relationship between inflation and its determinants. In addition, stochastic volatility captures heteroscedastic variance and provides a better estimation of parameters. Starting with a bivariate unobserved component Phillips curve, we have:

$$\pi_{i,t} - \tau^{\pi}_{i,t} = \rho_{i,t}(\pi_{i,t-1} - \tau^{\pi}_{i,t-1}) + \alpha_{i,t}(y_{i,t} - \tau^{y}_{i,t}) + \epsilon^{\pi}_{i,t}, \quad \epsilon^{\pi}_{i,t} \sim \mathcal{N}(0,\ e^{h_t}) \tag{1}$$

$$y_{i,t} - \tau^{y}_{i,t} = \varphi_{i,1}(y_{i,t-1} - \tau^{y}_{i,t-1}) + \varphi_{i,2}(y_{i,t-2} - \tau^{y}_{i,t-2}) + \epsilon^{y}_{i,t}, \quad \epsilon^{y}_{i,t} \sim \mathcal{N}(0,\ \sigma^2_y) \tag{2}$$

$$\tau^{\pi}_{i,t} = \tau^{\pi}_{i,t-1} + \epsilon^{\tau\pi}_{i,t}, \quad \epsilon^{\tau\pi}_{i,t} \sim \mathcal{N}(0,\ \sigma^2_{\tau\pi}) \tag{3}$$

$$\tau^{y}_{i,t} = \tau^{y}_{i,t-1} + \epsilon^{\tau y}_{i,t}, \quad \epsilon^{\tau y}_{i,t} \sim \mathcal{N}(0,\ \sigma^2_{\tau y}) \tag{4}$$

where i denotes country i, $i = 1, \ldots, N$. At time t, $\pi_{i,t}$ is inflation of country i and $y_{i,t}$ is output growth of country i, $\tau^{\pi}_{i,t}$ and $\tau^{y}_{i,t}$ are their trends. These trends are unobserved latent states which can be interpreted as long-run equilibrium levels of inflation and output, also known as trend inflation and trend output. $\pi_{i,t} - \tau^{\pi}_{i,t}$ is the inflation gap, $y_{i,t} - \tau^{y}_{i,t}$ is the domestic output growth gap. $\epsilon^{\pi}_{i,t}$ is the error term with stochastic volatility defined as:

$$h_{i,t} = h_{i,t-1} + \epsilon^{h}_{i,t}, \quad \epsilon^{h}_{t} \sim \mathcal{N}(0,\ \sigma^2_{i,h}) \tag{5}$$

$\rho_{i,t}$ is inflation persistence or inertia. When expectations are well anchored, inflation is less persistent (i.e. $\rho_{i,t} \approx 0$). Conversely, when expectations are adaptive, inflation tends to exhibit high persistence (i.e. $\rho_{i,t} \approx 1$). $\alpha_{i,t}$ is the slope of the Phillips curve. $\rho_{i,t}$ and $\alpha_{i,t}$ are allowed to vary over time:

$$\rho_{i,t} = \rho_{i,t-1} + \epsilon^{\rho}_{i,t}, \quad \epsilon^{\rho}_{i,t} \sim \mathcal{N}(0,\ \sigma^2_{i,\rho}) \tag{6}$$

$$\alpha_{i,t} = \alpha_{i,t-1} + \epsilon^{\alpha}_{i,t}, \quad \epsilon^{\alpha}_{i,t} \sim \mathcal{N}(0,\ \sigma^2_{i,\alpha}) \tag{7}$$

In order to provide additional information regarding inflation, global output gap and the oil price are also included in our model. With these two additional variables, equation (1) becomes a multivariate unobserved component that can be written as:

$$\pi_{i,t} - \tau^{\pi}_{i,t} = \rho_{i,t}(\pi_{i,t} - \tau^{\pi}_{i,t}) + \alpha_{i,t}(y_{i,t} - \tau^{y}_{i,t}) + \beta_{i,t}\tilde{g}_t + \gamma_{i,t}\tilde{d}_t + \epsilon^{\pi}_{i,t} \tag{8}$$

where $\tilde{g}_t$ is the global output gap, $\tilde{d}_t$ is the oil price gap, $\beta_{i,t}$ and $\gamma_{i,t}$ are time-varying parameters:

$$\beta_{i,t} = \beta_{i,t-1} + \epsilon^{\beta}_{i,t}, \quad \epsilon^{\beta}_{i,t} \sim \mathcal{N}(0,\ \sigma^2_{i,\beta}) \tag{9}$$

$$\gamma_{i,t} = \gamma_{i,t-1} + \epsilon^{\gamma}_{i,t}, \quad \epsilon^{\gamma}_{i,t} \sim \mathcal{N}(0,\ \sigma^2_{i,\gamma}) \tag{10}$$

Note that each country faces the same global demand and oil price shock. It, therefore, makes sense to estimate them outside of the model, otherwise, these shocks will be specific to each country, which is counter-intuitive. Thus, $\tilde{g}_t$ and $\tilde{d}_t$ are estimated using different filtering techniques. The baseline model uses the filtering approach developed by Grant and Chan (2017).

To assess a country's monetary policy credibility and the slope of the Phillips curve, we constrained specific parameters in our proposed model specification within a certain interval according to economic theory. Specifically, we restrict the inflation persistence parameter (the coefficient on lagged inflation) to be positive and less than one. This restriction allows us to assess the degree of central bank credibility. For instance, a value of 0 could suggest that the central bank is fully credible and agents are forward-looking. In contrast, a value of 1 suggests a complete lack of credibility and agents are fully backward-looking. Furthermore, we also restrict the parameters on the domestic output gap, global output gap, and oil price gap to be positive and less than one. This ensures that a positive domestic or global output gap shock leads to higher inflation, which is consistent with economic theory. These restrictions are imposed following Chan et al. (2016), who employ a bounded random walk process. More specifically, the error terms ϵ_t^ρ, ϵ_t^α, ϵ_t^β, and ϵ_t^γ are assumed to follow a truncated normal distribution:

$$\epsilon_{i,t}^\rho \sim \mathcal{TN}(-\rho_{i,t}, 1-\rho_{i,t}, 0,\ \sigma_{i,\rho}^2) \tag{11}$$

$$\epsilon_{i,t}^\alpha \sim \mathcal{TN}(-\alpha_{i,t}, 1-\alpha_{i,t}, 0,\ \sigma_{i,\alpha}^2) \tag{12}$$

$$\epsilon_{i,t}^\beta \sim \mathcal{TN}(-\beta_{i,t}, 1-\beta_{i,t}, 0,\ \sigma_{i,\beta}^2) \tag{13}$$

$$\epsilon_{i,t}^\gamma \sim \mathcal{TN}(-\gamma_{i,t}, 1-\gamma_{i,t}, 0,\ \sigma_{i,\gamma}^2) \tag{14}$$

where $\mathcal{TN}$ denotes the truncated normal distribution. All coefficients, bounded and unbounded, are estimated by Bayesian method using Markov chain Monte Carlo (MCMC) algorithm. The priors are in Appendix A and for further details of estimation, we refer our readers to Chan et al. (2016).

3 Empirical Results

3.1 Overview and Data Description

In this section, we present empirical results from the multivariate unobserved components model with two global factors. In particular, we aggregate individual country results into AEs and EMEs. First, we discuss the role played by global factors in explaining inflation dynamics for AEs and EMEs. Second, we focus on the domestic factors.

We use a dataset that consists of quarterly series from 34 countries, 23 advanced economies

(AEs)[4] and 11 emerging market economies (EMEs)[5], observed from 1995Q1 to 2018Q1. The choice of countries and the sample size is based on data availability. The series included are the headline consumer price index (CPI) representing domestic headline inflation, real gross domestic product (GDP) which reflects domestic demand, oil price is used as a proxy of a supply shock, and global GDP proxies global demand.[6] The oil price is taken from the World Bank Commodity Price Data, domestic GDPs are obtained from Haver Analytics, and the global GDP is from the St. Louis Federal Reserve Bank's database, FRED. The CPI, real GDP, and global GDP series are transformed into quarter-on-quarter difference of natural logarithms times 400, while oil price is transformed into natural logarithms. Note that the global output gap, obtained using the global GDP, and the detrended oil price inflation is constructed outside of the model using the filtering technique developed by Grant and Chan (2017).[7] As mentioned above, it is appropriate to estimate the global output trend and oil price trend outside the model, given that each country faces the same global demand and supply shock. However, countries react differently to common shocks depending on the degree of trade openness or importance to global trade. Conversely, deriving them from the model will yield different global output trends and oil price trends for each country, which is counter-intuitive.

3.2 The role of global factors

We first show the estimates of global factors, and then report their roles in explaining inflation.

3.2.1 Estimates of global factors

Figure 1 presents the estimated global output trend and oil price trend, their gaps, and corresponding 68% credible intervals. The global output gap captures the economic cycle in the global economy. In particular, it illustrates recessionary episodes, namely, the East Asian crisis of 1997-1998, the 2000-2001 dotcom crisis, the global financial crisis of 2007-2008, and the

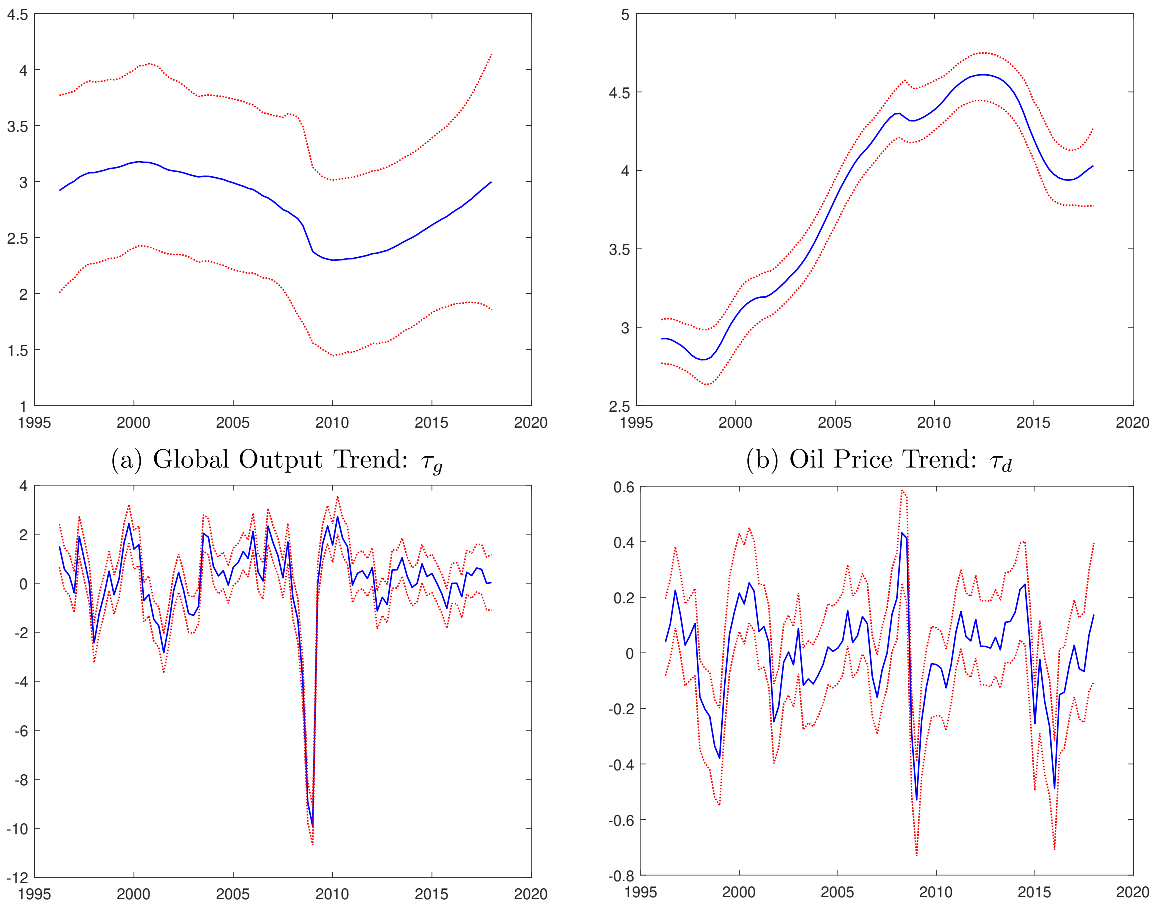
[4] Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Israel, Italy, Latvia, Lithuania, Netherlands, Portugal, Slovakia, South Korea, Spain, Sweden, Switzerland, UK, USA.

[5] Bolivia, Brazil, China, Hungary, Indonesia, Mexico, Philippines, Russia, South Africa, Thailand, Turkey.

[6] Alternatively, import prices could be used to represent supply shocks. Unfortunately, this series is not available for many countries. Importantly, substituting oil prices with import prices yields similar results.

[7] Importantly, the results remain unchanged when using other filtering techniques such as the unobserved component with stochastic volatility (UCSV) of Watson(1986); the Hodrick and Prescott(1997) (henceforth HP filter), and the AR(4) filter of Hamilton (2018). Note that the Grant and Chan (2017) is flexible enough that it does not impose a constant smoothing parameter of 1600 like the HP filter and it does not suffer from the end-point issue, which is common in many filters. See Grant and Chan(2017), Hamilton(2018) for more details on the weaknesses of the HP filter. For interested readers, we provide the estimate of global factors using the HP filter in Appendix D.

sovereign crisis in Europe in 2012. It then stabilizes around zero. The global output trend depicts a growth rate of 3 percent before the GFC, then drifted down to 2.3 percent before reverting back to its pre-crisis growth of 3 percent in 2018. The oil price gap captures relatively well instances where the oil price deviates from its long-term trend. Specifically, the upward movement in oil prices before the GFC was driven by high global demand, particularly in emerging market economies, what was termed the commodity super-cycle. This demand pressure is exemplified by a steep rise in its trend starting in the late 1990s, then plateaus during and after the GFC. The cyclical component of oil prices turned negative, then recovered gradually before dropping again in 2014 as a response to a positive supply shock in the oil market triggered by high shale production, particularly in the US. This pushed down oil prices.



(a) Global Output Trend: τ_g

(b) Oil Price Trend: τ_d

(c) Global Output Gap: $\tilde{g}_t$

(d) Oil Price Gap: $\tilde{d}_t$

Figure 1: **Estimates of global factors:** The solid blue line is the posterior median, while the dotted red lines are 16% and 84% quantiles. Y-axis is the percentage change. For global output, we use quarter-on-quarter difference of natural logarithms times 400. For oil price, we use natural logarithms.

3.2.2 Parameters on global factors

Global demand Figure 2 reports parameters on the global and domestic output gap. The left and right panels depict parameters on the global and domestic output gap, respectively.

In Figure 2, the upper panel is for all countries, the middle panel is for AEs, and the lower panel is for EMEs. We find the parameter on the global output gap (left panel) is higher across all countries than the parameter on the domestic output gap (right panel). This suggests that global demand plays a more significant role in explaining inflation across all countries than domestic demand.[8] This finding is consistent with Borio and Filardo (2007) and Forbes (2019), who argue that global demand matters more than domestic demand in explaining dynamics in inflation in both AEs and EMEs. These results have important monetary policy implications. They suggest that monetary policy authorities should closely monitor the global economy when they decide about the inflation outlook. Interestingly, some central banks have already started incorporating the global economic outlook in their decision-making process. In its statement of October 30, 2019, the Federal Reserve Bank clearly stated that its decision to lower the federal funds rate was informed by the combination of weak global economy and muted inflationary pressure. Many central banks partly associated the recent rise in domestic inflation with aggressive fiscal policy deployed in AEs.

When comparing the role of global demand in AEs and EMEs, the results indicate that global demand affects inflation more in EMEs than AEs. However, we do note that the uncertainty bands associated with these estimated global demand parameters are large, which could undermine the statistical significance of the observed difference between the impact of global demand on inflation in AEs and EMEs. In order to provide a more nuanced understanding of the factors driving inflation dynamics in each country, we conduct a decomposition analysis in Table 5 of Appendix C. This analysis reports the relative contributions of lagged inflation, domestic output gap, global output gap, and oil prices, to the inflation gap of each country, both in the pre- and post-GFC periods. We find the contribution of global demand has increased in 9 countries. And out of 23 AEs, the results show the contribution of global demand after GFC has increased in 2 countries only. Whereas, in EMEs, 7 of 11 countries exhibit a rise in inflation triggered by global demand shocks. This finding supports the argument that highlights the tendency of inflation to react more to global demand in EMEs than in AEs. This is not surprising, given that most multinational firms are likely to set up different intermediate input processing plants across various EMEs in order to benefit from a low cost of labor (Hanson et al., 2005). There-

[8] We also estimated a version of our model specification where the parameters are unrestricted. We report the results in Appendix E of the paper and find a similar conclusion that global demand, compared to its domestic counterpart, plays an important role in explaining inflation dynamics across countries.

fore, any shift in global demand for the production of goods will likely increase trade, which will subsequently push up inflation in both EMEs and AEs. Thus, our results are consistent with the theoretical findings of Wynne and Martínez-García (2010), in that increased globalization and trade enhance the role of global factors in explaining the behavior of inflation in individual countries. Another explanation pertaining to the difference in response is that inflation is more volatile in EMEs than AEs, and hence it generally responds more to all shocks.

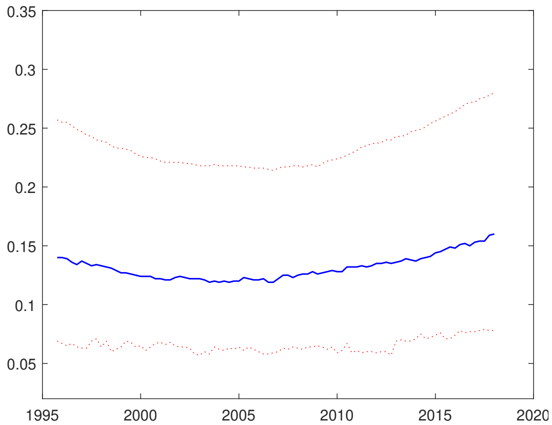
Oil price Figure 3 reports parameters on the oil price gap, for all countries, AEs, and EMEs, respectively. The results show evidence of constant coefficients over time (see Forbes, 2019). Two observations emerge from these results.

First, the impact of oil price prevails more in AEs than in EMEs (Figure 3). This is consistent with Jordà and Nechio (2018) and the downturn in inflation observed in 2014 in most AEs, triggered by a negative oil price shock. Additionally, in Table 5 of Appendix C, we find that, subsequent to the GFC, the contribution of oil prices to the inflation gap has exhibited a notable increase in 16 of the 34 countries examined. It is, therefore, reasonable to conclude that oil prices play a crucial role as determinant of inflation dynamics across countries.

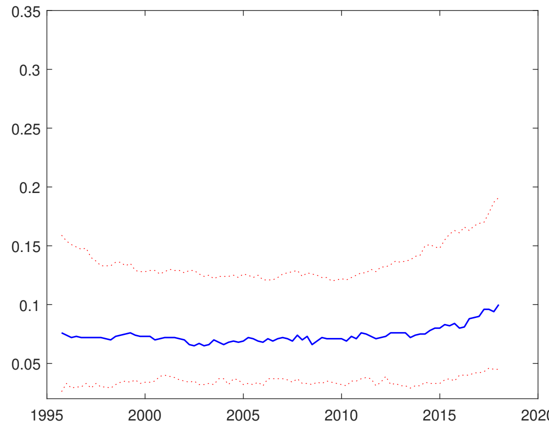
A potential caveat of our study is the omission of the exchange rate factor from our empirical framework. According to Taylor (2000), there is a positive relationship between exchange rate fluctuations and inflation. In particular, Calvo and Reinhart (2000) provides empirical evidence that exchange rate pass-through, which refers to the degree to which exchange rate fluctuations affect domestic prices, tends to be more substantial in EMEs than in AEs. This is also verified in an empirical study by Choudhri and Hakura (2006). Therefore, the omission of the exchange rate factor in the empirical model could be overstating the role of global demand on inflation dynamics in EMEs. However, Ca'Zorzi et al. (2007) document mixed evidence supporting exchange rate pass-through in EMEs. Specifically, their study reveals that the degree of exchange rate pass-through in low inflation EMEs, such as Asian economies, is relatively insignificant.

3.3 The role of Domestic factors

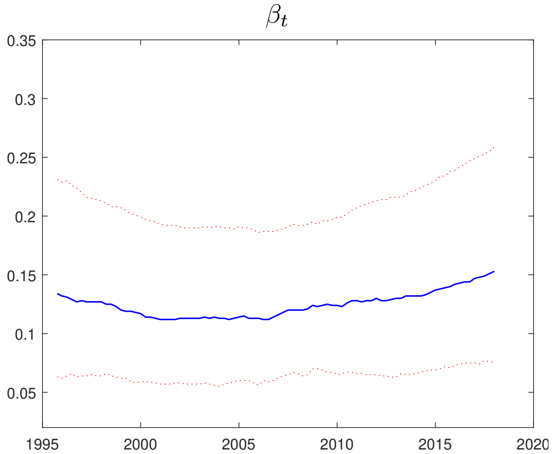
The slope of the Phillips curve α_t In Figure 2, the right panel reports the coefficient of the domestic output gap for all countries, AEs, and EMEs, respectively. There is little evidence of time variation. This is in line with Blanchard et al. (2015), Chan et al. (2016), and Kabundi et al. (2019). From a longer sample size, there is evidence of a changing slope of the Phillips curve in the 1970s and the 1980s, which captures inflationary episodes of the 1970s and disinflationary episodes of the 1980s exemplified by the great moderation period (Chan



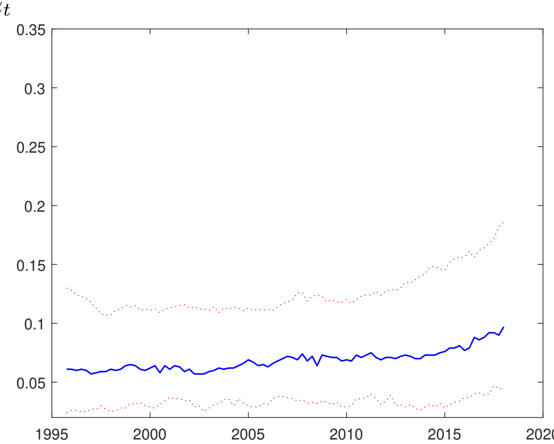
(a) All countries: Parameter on global demand: β_t



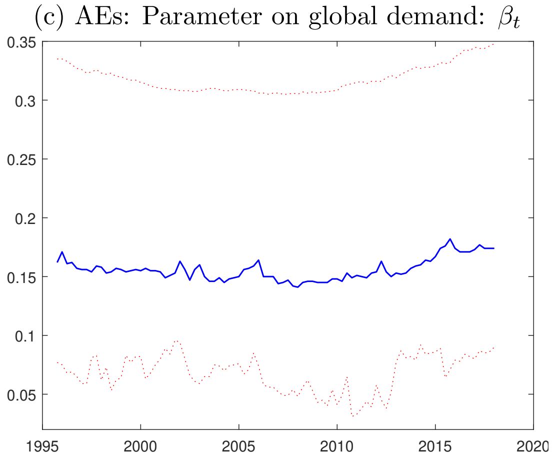
(b) All countries: Parameter on domestic demand: α_t



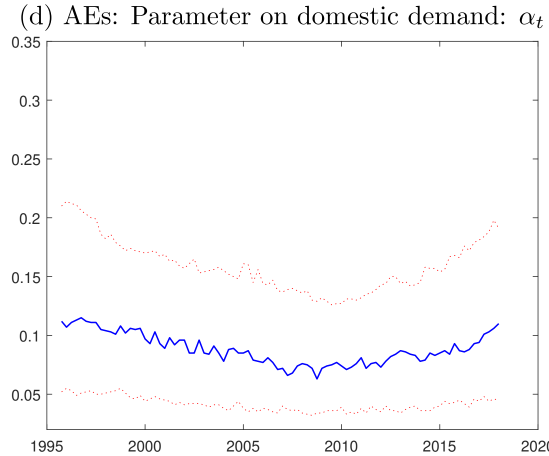
(c) AEs: Parameter on global demand: β_t



(d) AEs: Parameter on domestic demand: α_t

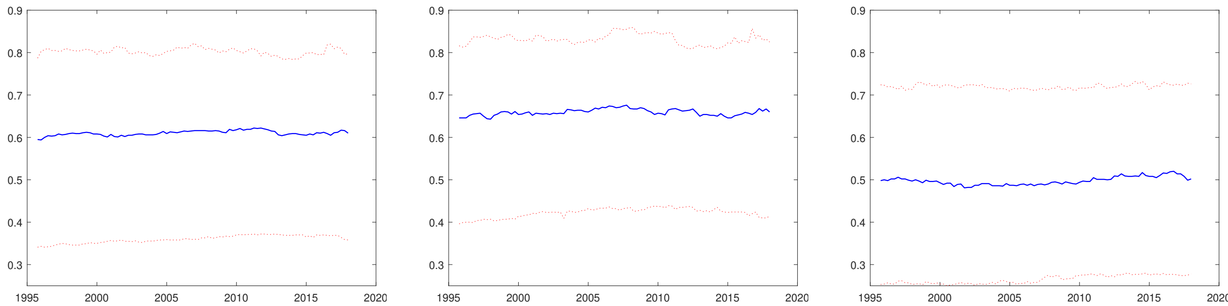


(e) EMEs: Parameter on global demand: β_t



(f) EMEs: Parameter on domestic demand: α_t

Figure 2: **Parameter on the global output gap β_t and the domestic output gap α_t:** The solid blue line is the posterior median, while the dotted red lines are 16% and 84% quantiles. Note the reported plots are the average estimated global output gap parameters across the 34 countries.



(a) All countries: γ_t (b) AEs: γ_t (c) EMEs: γ_t

Figure 3: **Parameter on the oil price gap γ_t:** The solid blue line is the posterior median, while the dotted red lines are 16% and 84% quantiles. Note the reported plots are the average estimated oil price gap parameters across the 34 countries.

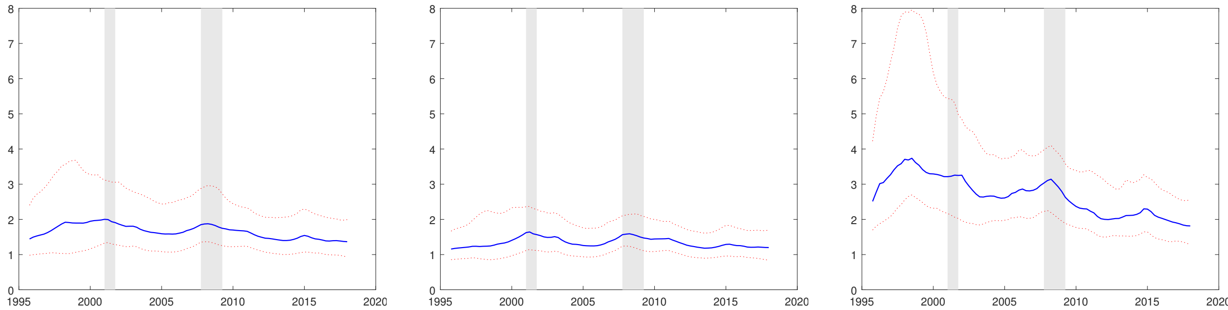
et al., 2016). In general, empirical studies depict a flat Phillips curve throughout the 1990s and thereafter. Actually, if there is any recent change, the results point to a marginal steepness of the slope that captures the upward trend in global inflation. The intuitive implication is that, in times of high inflation, firms' pricing decisions are likely to exhibit a greater degree of sensitivity to prevailing macroeconomic conditions, thereby resulting in increased price flexibility and, consequently, a more pronounced slope of the Phillips curve. A recent marginal rise in the slope of the Phillips observed in the US is also documented by Gilchrist and Zakrajsek (2019). Another pattern which emerges from the results is that inflation reacts more to domestic demand in EMEs than in AEs. For instance, the posterior estimates regarding the impact of domestic demand on inflation in AEs exhibit a consistently lower average value, below 0.1, whereas the corresponding estimates in EMEs are centered around 0.1.

Decline in inflation volatility Figure 4 reports the standard deviation of inflation. The results reveal a substantial decline in inflation volatility across countries. This could be attributed to a good policy, reflecting stable inflation dynamics, which in most cases coincide with the adoption of IT policy. Besides, the literature also explains this drop by "good luck" induced by a global common positive shock, such as the great moderation, affecting simultaneously inflation volatility in all countries. This global decline in inflation volatility could reflect the great moderation periods associated with a decrease in shock affecting the global economy compared to those witnessed in the 1970s and 1980s. It is evident from Figure 4 that inflation volatility has declined in both AEs and EMEs, albeit with different magnitudes. In general, volatility in AEs, which has recently been closer to one, is lower than the levels attained in EMEs. Also, inflation volatility in AEs exhibits two big jumps in 2000 and 2009, which coincide with the slowdown in global economic activity. While for EMEs, inflation volatility started at 2.5, then rose to 3.5 before declining persistently throughout the remaining sample period to 2.

Low inflation persistence Figure 5 reports the inflation persistence or inertia. A noticeable difference is observed in the inflation persistence between AEs and EMEs. In Table 4, we report the average value over time of inflation persistence for each country. The lowest persistence is found in Canada, followed by Germany, Switzerland, USA, Australia, France, Denmark, the Netherlands, and South Korea. Note that these countries have implicitly or explicitly adopted the inflation-targeting regime in the mid-1990s. Even though Switzerland has not explicitly adopted the IT policy, it does have a nominal anchor of maintaining inflation below 2 percent. Our results are consistent with the empirical findings of Cogley et al. (2010) and Beechey and Österholm (2018), where they find evidence of low inflation persistence in the US. AEs with high persistence include Finland, Hong Kong, Italy, Ireland, Slovakia, Sweden, Lithuania, and Latvia. It is not surprising that Hong Kong, which has a fixed exchange rate monetary policy, is the only AE with extremely high persistence. Similarly, EMEs portray a high degree of inflation persistence at the beginning of the sample; however, it steadily declines throughout the sample from about 0.7 in 1995 to 0.4 in 2018.

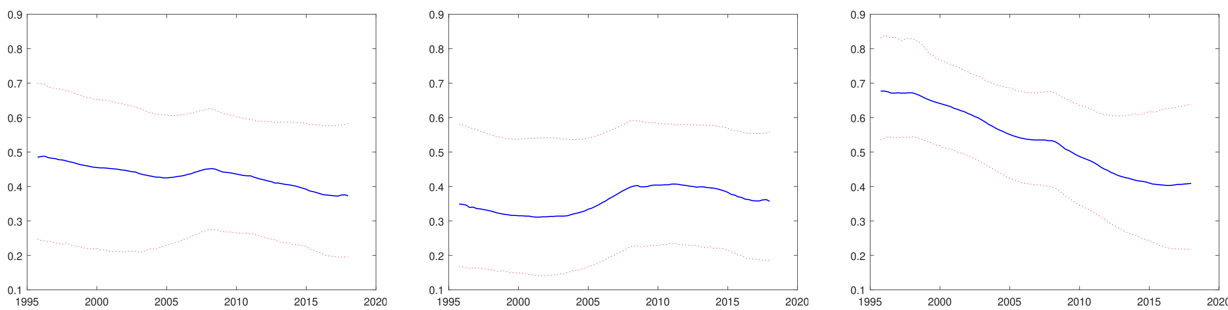
The low degree of inflation persistence exhibited in the majority of AEs and EMEs could be attributed to either a stronger commitment by the central bank to stabilizing inflation or other economic environment factors such as private sector behavior or changes in the role of inflation expectations. Notably, the observed low inflation persistence could be attributed to an improved anchoring of inflation expectations, which is indicative of a more forward-looking outlook on the part of economic agents in these countries (see Cogley and Sargent, 2005; Stock and Watson, 2007; Carlstrom and Fuerst, 2008; Ball and Mazumder, 2011; Matheson and Stavrev, 2013; Blanchard et al., 2015; Gillitzer and Simon, 2015; Chan et al., 2016; Kabundi et al., 2019). Nonetheless, given that our empirical framework is limited in its scope and does not account for expectations, a comprehensive structural analysis, such as the dynamic stochastic general equilibrium (DSGE) approach implemented in the work of Cogley et al. (2010), is necessary to disentangle the root cause of the low inflation persistence across AEs and EMEs, and to establish whether monetary policy indeed constitutes a significant driver of the reduction in inflation persistence across these countries. We leave this avenue for further investigation in future research.[9]

[9] We thank the referee for pointing us in this direction.



(a) All countries: $\exp(h_t/2)$ (b) AEs: $\exp(h_t/2)$ (c) EMEs: $\exp(h_t/2)$

Figure 4: **Inflation standard deviation** $\exp(h_t/2)$**:** The solid blue line is the posterior median, while the dotted red lines are 16% and 84% quantiles. The shaded regions are the NBER recession dates. Note the reported plots are the average estimated standard deviations across the 34 countries.



(a) All countries: ρ_t (b) AEs: ρ_t (c) EMEs: ρ_t

Figure 5: **Inflation persistence** ρ_t**:** The solid blue line is the posterior median, while the dotted red lines are 16% and 84% quantiles. Note the reported plots are the average estimated persistence parameters across the 34 countries.

4 Conclusion

This paper utilizes a state-of-the-art multivariate unobserved components model on a panel dataset comprising 34 countries, 23 advanced economies (AEs) and 11 emerging market economies (EMEs) to investigate the role played by global or domestic factors in explaining dynamics in domestic inflation. The results provide evidence that global factors are key and increasingly important determinants behind the movement in domestic inflation, even though domestic variables do not play a negligible role. Furthermore, it examines the possibility of flattening the Phillips curve over time. The results support the finding in the literature of a flat Phillips curve across countries, especially for AEs. These findings are in line with the theory, as proposed by Wynne and Martínez-García (2010), that increased globalization and trade are the underlying drivers of the flattening of the Phillips curve slope.

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A Priors

$$
\begin{aligned}
\varphi_1 &\sim \mathcal{N}(0,\ 10) \\
\varphi_2 &\sim \mathcal{N}(0,\ 10) \\
\tau_1^{\pi} &\sim \mathcal{N}(3,\ 10) \\
\tau_1^{y} &\sim \mathcal{N}(5,\ 10) \\
h_1 &\sim \mathcal{N}(0,\ 1) \\
\rho_1 &\sim \mathcal{N}(0,\ 10) \\
\alpha_1 &\sim \mathcal{N}(0,\ 10) \\
\beta_1 &\sim \mathcal{N}(0,\ 10) \\
\gamma_1 &\sim \mathcal{N}(0,\ 10) \\
\sigma^2_{\tau\pi} &\sim \mathcal{IG}(10,\ 0.18) \\
\sigma^2_{\tau y} &\sim \mathcal{IG}(10,\ 0.09) \\
\sigma^2_{y} &\sim \mathcal{IG}(10,\ 4.5) \\
\sigma^2_{h} &\sim \mathcal{IG}(10,\ 0.9) \\
\sigma^2_{\rho} &\sim \mathcal{IG}(10,\ 0.018) \\
\sigma^2_{\alpha} &\sim \mathcal{IG}(10,\ 0.009) \\
\sigma^2_{\beta} &\sim \mathcal{IG}(10,\ 0.009) \\
\sigma^2_{\gamma} &\sim \mathcal{IG}(10,\ 0.009)
\end{aligned}
$$

B Estimates of coefficients

Table 1: Coefficient on domestic output gap α

Countries	posterior mean over time	16% quantile	84% quantile
Belgium	0.150	0.046	0.250
Greece	0.042	0.016	0.069
Ireland	0.035	0.020	0.043
Netherlands	0.045	0.016	0.072
Portugal	0.078	0.030	0.124
Latvia	0.101	0.037	0.165
Lithuania	0.105	0.034	0.174
Slovakia	0.091	0.031	0.151
Israel	0.114	0.035	0.197
Hong Kong	0.096	0.032	0.163
South Korea	0.112	0.045	0.178
UK	0.098	0.036	0.162
USA	0.103	0.036	0.173
Sweden	0.108	0.038	0.178
Switzerland	0.125	0.048	0.201
Spain	0.119	0.039	0.201
Denmark	0.074	0.034	0.117
Italy	0.080	0.027	0.132
Finland	0.093	0.033	0.151
France	0.092	0.032	0.150
Germany	0.043	0.013	0.074
Australia	0.100	0.073	0.138
Canada	0.142	0.052	0.232
South Africa	0.133	0.048	0.210
Hungary	0.153	0.053	0.255
Russia	0.107	0.036	0.180
Turkey	0.110	0.042	0.177
Mexico	0.060	0.024	0.098
Bolivia	0.121	0.040	0.203
Brazil	0.107	0.042	0.174
China	0.167	0.061	0.274
Philippines	0.068	0.031	0.103
Indonesia	0.212	0.069	0.360
Thailand	0.031	0.013	0.044

Table 2: Coefficient on global output gap β

countries	posterior mean over time	16% quantile	84% quantile
Belgium	0.161	0.056	0.267
Greece	0.113	0.035	0.192
Ireland	0.162	0.075	0.245
Netherlands	0.066	0.020	0.112
Portugal	0.176	0.067	0.284
Latvia	0.169	0.046	0.298
Lithuania	0.151	0.043	0.266
Slovakia	0.171	0.056	0.286
Israel	0.169	0.051	0.290
Hong Kong	0.205	0.058	0.354
South Korea	0.120	0.033	0.208
UK	0.122	0.040	0.205
USA	0.210	0.077	0.343
Sweden	0.174	0.049	0.297
Switzerland	0.123	0.041	0.206
Spain	0.203	0.080	0.323
Denmark	0.125	0.043	0.210
Italy	0.094	0.030	0.156
Finland	0.152	0.052	0.254
France	0.117	0.040	0.195
Germany	0.136	0.044	0.230
Australia	0.138	0.055	0.219
Canada	0.179	0.061	0.298
South Africa	0.120	0.042	0.200
Hungary	0.221	0.063	0.385
Russia	0.160	0.052	0.259
Turkey	0.249	0.078	0.425
Mexico	0.068	0.025	0.112
Bolivia	0.337	0.126	0.542
Brazil	0.166	0.053	0.287
China	0.337	0.170	0.499
Philippines	0.187	0.060	0.319
Indonesia	0.254	0.088	0.421
Thailand	0.322	0.122	0.517

Table 3: Coefficient on oil price gap γ

countries	posterior mean over time	16% quantile	84% quantile
Belgium	0.613	0.314	0.871
Greece	0.556	0.251	0.849
Ireland	0.602	0.306	0.876
Netherlands	0.581	0.296	0.844
Portugal	0.502	0.164	0.835
Latvia	0.484	0.167	0.810
Lithuania	0.528	0.207	0.844
Slovakia	0.738	0.469	0.901
Israel	0.545	0.240	0.837
Hong Kong	0.560	0.252	0.860
South Korea	0.590	0.260	0.879
UK	0.570	0.261	0.861
USA	0.698	0.510	0.906
Sweden	0.476	0.168	0.787
Switzerland	0.718	0.502	0.924
Spain	0.589	0.293	0.866
Denmark	0.596	0.303	0.869
Italy	0.628	0.349	0.884
Finland	0.680	0.408	0.916
France	0.708	0.499	0.910
Germany	0.739	0.534	0.915
Australia	0.657	0.401	0.872
Canada	0.527	0.144	0.837
South Africa	0.477	0.154	0.795
Hungary	0.474	0.169	0.791
Russia	0.477	0.141	0.834
Turkey	0.534	0.310	0.702
Mexico	0.533	0.214	0.839
Bolivia	0.513	0.175	0.845
Brazil	0.393	0.109	0.699
China	0.490	0.164	0.836
Philippines	0.463	0.109	0.811
Indonesia	0.532	0.220	0.831
Thailand	0.598	0.189	0.880

Table 4: Inflation persistence ρ

countries	posterior mean over time	16% quantile	84% quantile
Belgium	0.303	0.156	0.447
Greece	0.399	0.217	0.577
Ireland	0.577	0.381	0.777
Netherlands	0.268	0.105	0.429
Portugal	0.441	0.257	0.623
Latvia	0.714	0.576	0.855
Lithuania	0.639	0.492	0.790
Slovakia	0.586	0.405	0.769
Israel	0.552	0.386	0.718
Hong Kong	0.487	0.321	0.649
South Korea	0.282	0.112	0.450
UK	0.372	0.218	0.528
USA	0.209	0.072	0.346
Sweden	0.486	0.316	0.656
Switzerland	0.207	0.072	0.342
Spain	0.300	0.135	0.462
Denmark	0.252	0.095	0.407
Italy	0.543	0.372	0.716
Finland	0.489	0.317	0.659
France	0.235	0.091	0.379
Germany	0.160	0.054	0.266
Australia	0.229	0.091	0.366
Canada	0.159	0.052	0.265
South Africa	0.559	0.388	0.732
Hungary	0.483	0.308	0.656
Russia	0.734	0.604	0.865
Turkey	0.518	0.390	0.644
Mexico	0.501	0.342	0.657
Bolivia	0.433	0.269	0.597
Brazil	0.650	0.508	0.796
China	0.479	0.335	0.622
Philippines	0.623	0.451	0.801
Indonesia	0.497	0.330	0.660
Thailand	0.479	0.311	0.646

C Inflation Gap Decomposition

Table 5: Inflation Gap Decomposition

	Country		lagged inflation	domestic output	global output	oil price	Other
North	USA	pre GFC	0.223	0.085	0.223	0.086	0.945
		post GFC	0.178	**0.098**	0.181	0.062	0.976
America	Canada	pre GFC	0.110	0.211	0.175	0.077	0.945
		post GFC	**0.136**	0.123	0.100	**0.094**	0.996
Latin	Bolivia	pre GFC	0.623	0.155	0.179	0.036	1.059
		post GFC	0.376	0.085	0.076	0.021	1.006
America	Mexico	pre GFC	0.890	0.044	0.018	0.020	0.812
		post GFC	0.374	**0.046**	**0.032**	**0.054**	1.070
	Brazil	pre GFC	0.569	0.160	0.049	0.020	1.107
		post GFC	**0.775**	0.098	0.033	**0.024**	1.151
Europe	UK	pre GFC	0.232	0.096	0.166	0.135	1.011
		post GFC	**0.572**	0.057	0.076	0.070	1.020
	Belgium	pre GFC	0.124	0.175	0.139	0.088	0.763
		post GFC	**0.464**	0.153	0.070	0.056	0.567
	Greece	pre GFC	0.426	0.099	0.124	0.063	1.114
		post GFC	**0.479**	0.066	0.031	0.035	0.730
	Italy	pre GFC	0.505	0.202	0.169	0.171	1.051
		post GFC	**0.691**	0.140	0.066	0.090	1.007
	Spain	pre GFC	0.252	0.282	0.161	0.065	0.883
		post GFC	**0.341**	0.132	0.088	0.049	1.114
	Sweden	pre GFC	0.480	0.177	0.159	0.070	1.298
		post GFC	**0.562**	0.122	0.080	0.053	0.995
	Switzerland	pre GFC	0.142	0.269	0.199	0.157	0.953
		post GFC	**0.222**	0.256	0.140	0.109	0.776
	Denmark	pre GFC	0.159	0.255	0.176	0.089	0.951
		post GFC	**0.276**	0.187	0.118	**0.144**	1.145
	Finland	pre GFC	0.363	0.328	0.199	0.080	1.202
		post GFC	**0.588**	0.238	0.106	**0.105**	0.968
	Germany	pre GFC	0.133	0.101	0.149	0.094	1.017
		post GFC	**0.167**	0.086	0.127	**0.124**	0.935

Table 6: *Continued* Inflation Gap Decomposition

	Country		lagged inflation	domestic output	global output	oil price	Other
	Slovakia	pre GFC	0.522	0.144	0.065	0.025	0.964
		post GFC	**0.662**	0.069	0.048	**0.047**	1.037
	France	pre GFC	0.189	0.156	0.121	0.164	0.945
		post GFC	**0.246**	**0.172**	0.098	0.126	0.972
	Ireland	pre GFC	0.522	0.060	0.103	0.048	0.937
		post GFC	**0.616**	**0.111**	0.095	**0.069**	1.309
	Portugal	pre GFC	0.511	0.121	0.141	0.070	1.158
		post GFC	0.412	**0.134**	**0.143**	0.049	1.106
	Lithuania	pre GFC	0.738	0.116	0.068	0.022	1.068
		post GFC	0.715	**0.129**	0.040	**0.035**	1.063
	Hungry	pre GFC	0.603	0.057	0.032	0.009	0.579
		post GFC	0.439	0.057	**0.057**	**0.018**	0.826
	Latvia	pre GFC	0.752	0.164	0.050	0.012	0.801
		post GFC	0.716	0.128	0.038	**0.021**	0.991
	Netherlands	pre GFC	0.308	0.077	0.067	0.083	0.988
		post GFC	0.184	0.042	0.032	0.063	0.960
Asia	Indonesia	pre GFC	0.640	0.097	0.044	0.014	0.870
		post GFC	0.369	**0.244**	**0.110**	**0.051**	0.968
	Philippines	pre GFC	0.585	0.079	0.054	0.032	0.939
		post GFC	0.552	**0.106**	**0.077**	**0.040**	0.947
	China	pre GFC	0.589	0.089	0.175	0.035	1.095
		post GFC	0.477	**0.234**	**0.180**	**0.046**	0.825
	Hong Kong	pre GFC	0.756	0.080	0.051	0.021	0.914
		post GFC	0.244	0.074	0.049	**0.039**	1.012
	Thailand	pre GFC	0.690	0.065	0.202	0.036	1.090
		post GFC	0.440	0.050	0.113	0.035	0.980
	South Korea	pre GFC	0.200	0.181	0.074	0.048	1.122
		post GFC	**0.263**	**0.214**	0.067	**0.120**	0.900

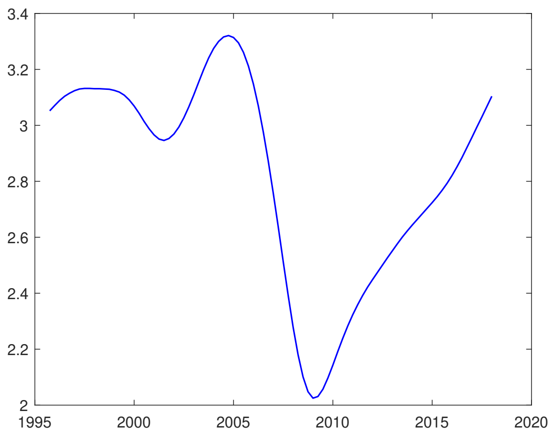
Table 7: *Continued* Inflation Gap Decomposition

	Country		lagged inflation	domestic output	global output	oil price	Other
Other	Australia	pre GFC	0.177	0.048	0.133	0.085	0.986
		post GFC	**0.191**	0.046	0.092	0.079	1.033
	Israel	pre GFC	0.548	0.117	0.055	0.028	1.247
		post GFC	0.449	0.112	**0.063**	**0.041**	1.029
	Russia	pre GFC	0.837	0.057	0.015	0.004	0.645
		post GFC	0.824	**0.068**	**0.031**	**0.016**	1.175
	Turkey	pre GFC	0.842	0.025	0.010	0.001	0.491
		post GFC	0.219	**0.148**	**0.063**	**0.020**	1.011
	South Africa	pre GFC	0.701	0.090	0.053	0.019	1.269
		post GFC	0.497	**0.112**	0.053	**0.037**	1.022

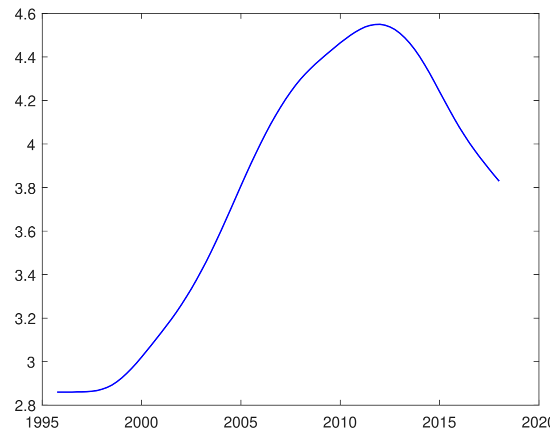
Note that the increasing contribution is indicated in Bold.

D Other filtering techniques

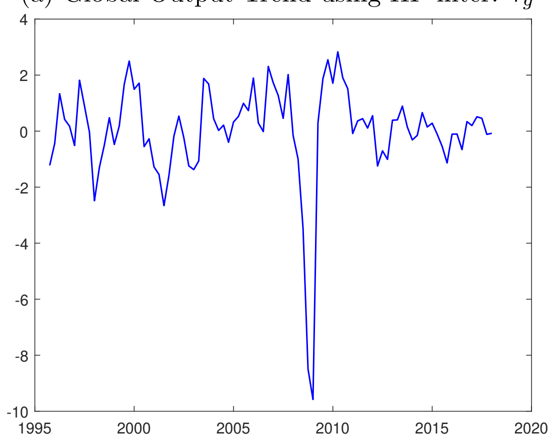
This section reports the estimate of global output trend and oil price trend using the HP filter of Hodrick and Prescott(1997).



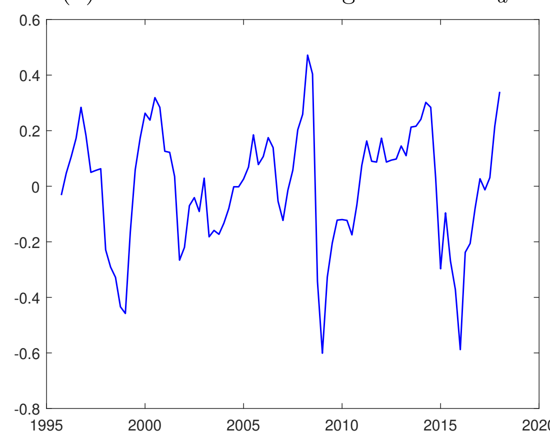
(a) Global Output Trend using HP filter: τ_g



(b) Oil Price Trend using HP filter: τ_d



(c) Global Output Gap using HP filter: τ_g



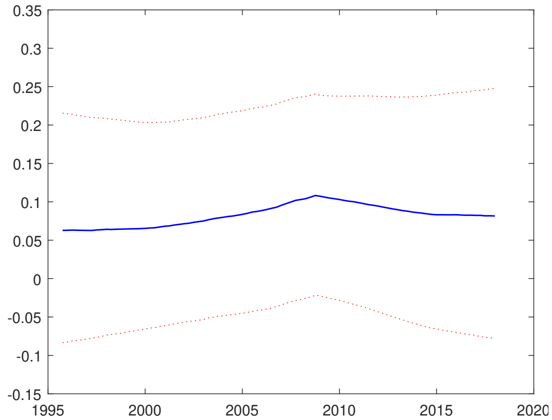
(d) Oil Price Gap using HP filter: τ_d

Figure 6: **Estimates of global output trend and oil price trend using the HP filter:** For global output, we use quarter-on-quarter difference of natural logarithms times 400. For oil prices, we use natural logarithms.

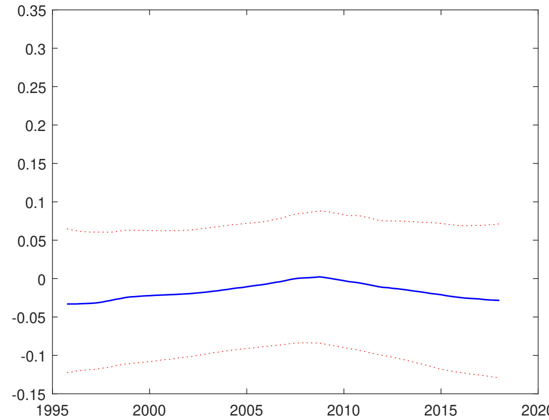
E Robustness Check

In this appendix, as summarized in the main paper, we provide additional results that provide a robustness check on our main model specification (used in the main paper). In the main paper, we restrict some of the parameters. In this appendix, the parameters are unrestricted. Figure 7 reports parameters on the global and domestic output gap. The left and right panels depict parameters on the global and domestic output gap, respectively. Figure 8 reports parameters on the oil price gap, for all countries, AEs, and EMEs, respectively. Figure 9 reports the standard deviation of inflation. Finally, figure 10 reports the inflation persistence or inertia.

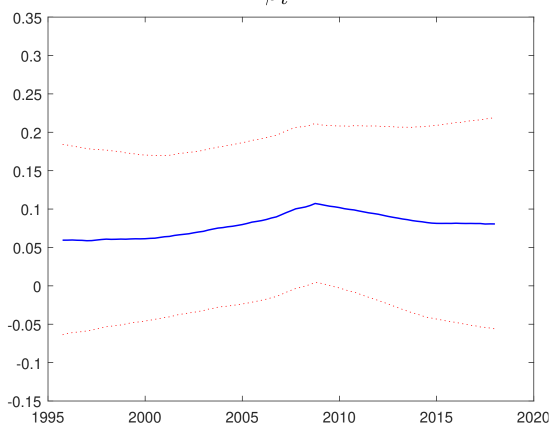
From Figure 7, we can see that the posterior estimates of the global demand parameter are always higher than their domestic counterpart. Therefore, our main finding in the paper is robust and global factors play a crucial role in shaping the inflation dynamics across countries. However, the credibility of our findings based on the unrestricted model is limited by the wide uncertainty bands associated with the estimated parameters. Conversely, the outcomes obtained from our proposed model specification offer greater reliability as the parameter estimates are statistically significant and conform to the prevailing literature.



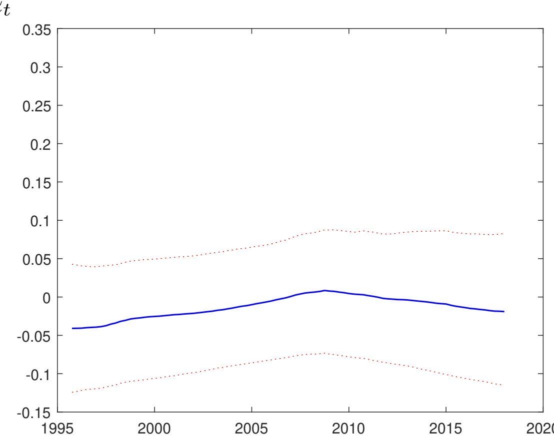
(a) All countries: Parameter on global demand: β_t



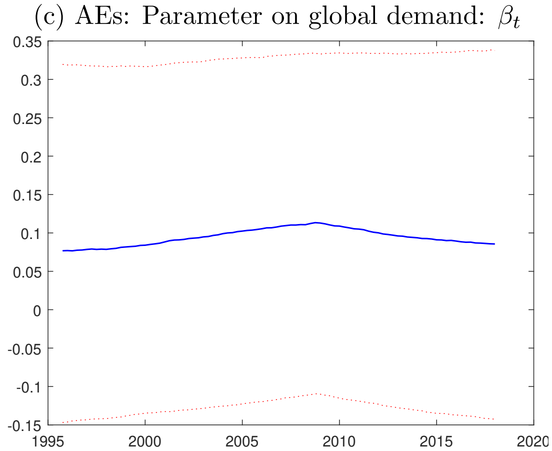
(b) All countries: Parameter on domestic demand: α_t



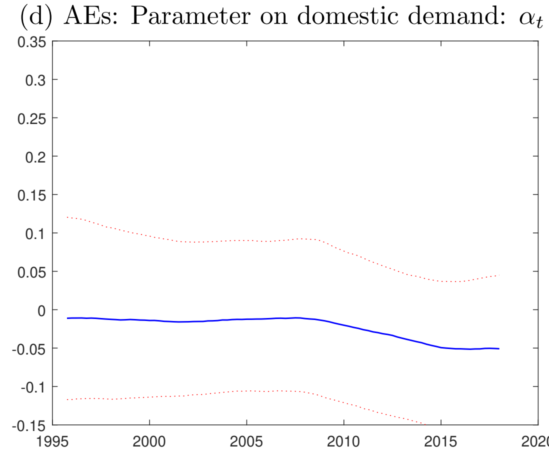
(c) AEs: Parameter on global demand: β_t



(d) AEs: Parameter on domestic demand: α_t

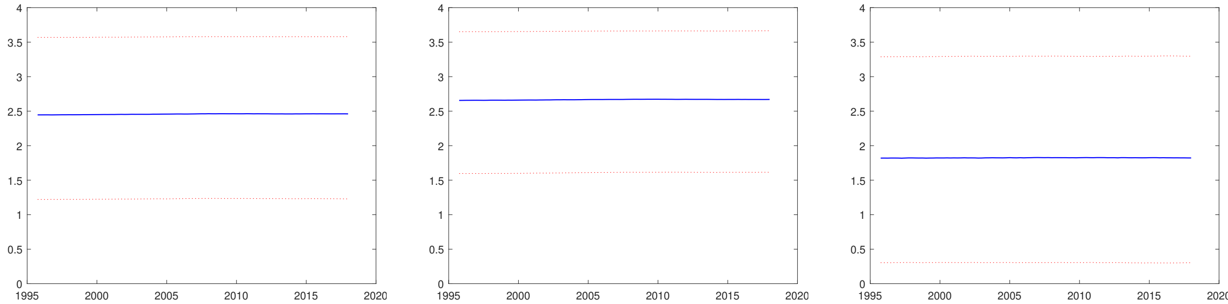


(e) EMEs: Parameter on global demand: β_t



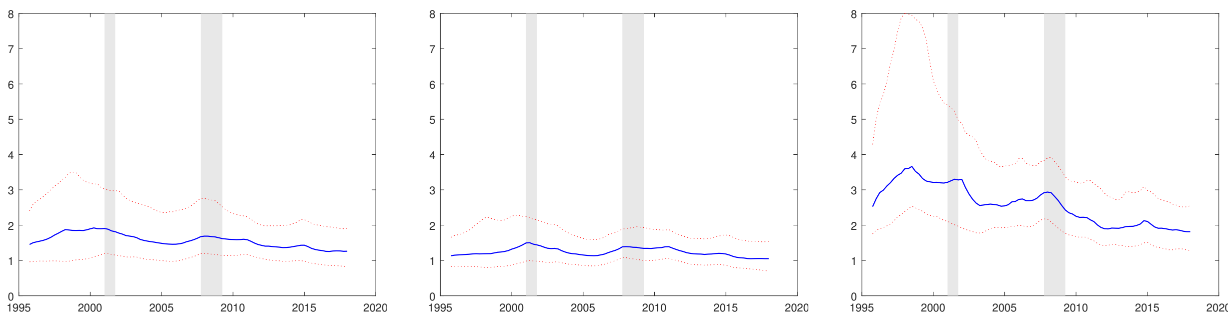
(f) EMEs: Parameter on domestic demand: α_t

Figure 7: **(Unrestricted) Parameter on the global output gap β_t and the domestic output gap α_t:** The solid blue line is the posterior median, while the dotted red lines are 16% and 84% quantiles. Note the reported plots are the average estimated global output gap parameters across the 34 countries.



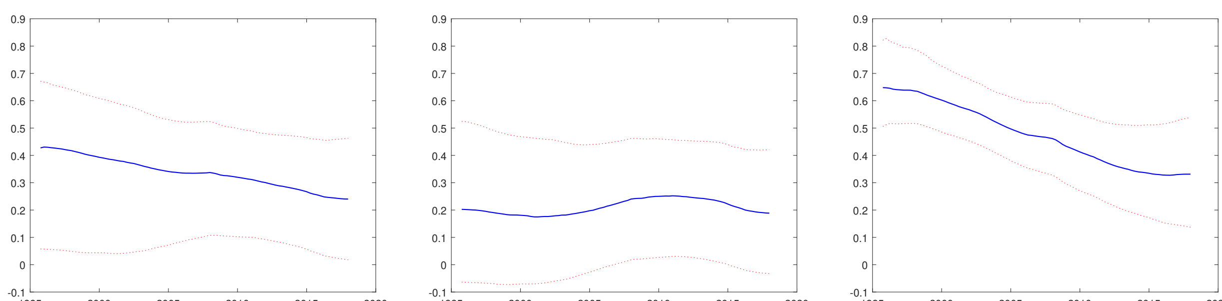
(a) All countries: γ_t (b) AEs: γ_t (c) EMEs: γ_t

Figure 8: **(Unrestricted) Parameter on the oil price gap γ_t:** The solid blue line is the posterior median, while the dotted red lines are 16% and 84% quantiles. Note the reported plots are the average estimated oil price gap parameters across the 34 countries.



(a) All countries: $\exp(h_t/2)$ (b) AEs: $\exp(h_t/2)$ (c) EMEs: $\exp(h_t/2)$

Figure 9: **(Unrestricted) Inflation standard deviation $\exp(h_t/2)$:** The solid blue line is the posterior median, while the dotted red lines are 16% and 84% quantiles. The shaded regions are the NBER recession dates. Note the reported plots are the average estimated standard deviations across the 34 countries.



(a) All countries: ρ_t (b) AEs: ρ_t (c) EMEs: ρ_t

Figure 10: **(Unrestricted) Inflation persistence ρ_t:** The solid blue line is the posterior median, while the dotted red lines are 16% and 84% quantiles. Note the reported plots are the average estimated persistence parameters across the 34 countries.