A Time-Varying Phillips Curve with Global Factors: A Bounded Random Walk Model*

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Abstract

This paper estimates a flexible Phillips curve with time-varying parameters and stochastic volatility for individual countries comprising quarterly dataset covering 34 countries covering the period 1994-2018. Besides the domestic output gap, the model incorporates oil price gap and global output gap which account for global determinants of inflation. The main findings are as follows: (i) Inflation persistence has declined in most countries pointing to credibility of monetary policy in anchoring inflation expectations around the implicit targets. These targets are relatively constant with a marginal downward trend in advanced economies (AEs) below official targets while they are high in emerging economies (EMEs) closer to the upper bound of target bands. (ii) Inflation volatility has declined across all countries but remained relatively high in EMEs and few AEs. (iii) Inflation dynamics are explained by the combination of domestic output gap, global output gap, and oil price gap. The effects of these variables are constant over time and across countries. Phillips curves are generally flat for the period under consideration, but statistically different from zero. The global demand seems to matter more in EMEs than in AEs. The results also point to dominant role played by oil prices as key factor behind inflation dynamics across countries and over time.

JEL classification: C11, C32, E31, F62
Kerwords: 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 as to whether the relationship between real economy and inflation has been altered and whether the Phillips curve is still valid. 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). The fear of deflation shared by many policymakers and central banks did not materialize. And the post-crisis recovery, especially in advanced economies (AEs) which recorded low unemployment, was not accompanied with rising in inflation. A view widely accepted is that the slope of the Phillips curve has flattened since the early 1990s, possibly owing to both improved conduct of monetary policy with a better anchoring of inflation expectations (see, Simon et al., 2013; Kiley et al., 2015; Coibion and Gorodnichenko, 2015; Jordà, Marti, et al., 2019), and a decline in inflation volatility.[1] This observation of flattening of the Phillips curve has interesting policy implications. It suggests the sacrifice ratio has increased, which means that monetary policy needs to be more aggressive to bring about a small change in inflation. This has rekindled interest about key drivers of national inflation. Two views emerge from the literature based on empirical evidence when attempting to explain this conundrum.

The first camp supports the notion that inflation is still largely explained by domestic factors. Proponents consider the credibility, achieved by many central banks in anchoring inflation expectations around the set target, as the main cause of flattening of the Phillips curve. In this environment, inflation expectations are well anchored at the central bank explicit target, which in turn stabilizes realized inflation in a way that renders it less responsive to demand pressure.

Theoretically, King and Wolman (1996) demonstrates how credible monetary policy authority is capable of stabilizing inflation, by anchoring expectations of agents around its objective. As agents form their expectations through learning, a gradual disinflation process results in slow learning, which in turn leads to adaptive inflation expectations. However, if the central bank shows a strong commitment disinflate quickly, agents will react accordingly as they believe that the central bank will achieve its objective. Hence expectations become anchored. This suggests a mild reaction of inflation to demand pressures, implying a flat Phillips curve. There is increasing empirical evidence linking the flattening of the Phillips curve to credible monetary policy especially for AEs, but also for some EMEs with inflation targeting (IT) policy framework.[2] This hypothesis is widely shared in policy circles as well as in academia. Many papers find no evidence that global factors explain largely inflation dynamics in recent two to three decades (see, Ihrig et al., 2010; Martınez-Garcıa and Wynne, 2013; Mikolajun and Lodge, 2016 and Bems et al., 2018). They think the flattening of the

[1]See for example Carlstrom and Fuerst, 2008; Ball and Mazumder, 2011; Simon et al., 2013; Blanchard et al., 2015; Gillitzer and Simon, 2018; Blanchard, 2016; Chan et al., 2016; Kabundi et al., 2019 on flattening the Phillips curve.

[2]See for example Ball (2006), Williams et al. (2006), Simon et al. (2013), Kiley et al. (2015), Jordà, Marti, et al. (2019).

Phillips curve reflects policy synchronicity in AEs and EMEs, embodied wide spread use of nominal anchor. Other factors include nonlinearity of the Phillips curve (see, Gagnon and Collins, 2019 and Hooper et al., 2020) and the composition of consumer price indices which comprises predominantly of noncyclical items (see, Stock and Watson, 2019).

The second camp highlights the role played by global factors in explaining the muted response of domestic inflation. The literature identifies several channels through which globalisation affects inflation dynamics in the last two decades. First, researchers point to the adoption of IT framework in many countries.[3] Second, rising trade integration affects domestic inflation via increase in exports and imports to GDP ratio which in turn drives up, on the one hand national income, and on the other hand, imports prices. Moreover, Gilchrist and Zakrajsek (2019) demonstrate how increased trade exposure significantly reduces the response of the US inflation to fluctuations in economic activity over time starting in the 1990s. Third, the expansion of EMEs, particularly China, contribute in various ways to recent development in countries' inflation. For example, Eickmeier and Kühnlenz (2018) show that China's demand and supply shocks affect significantly inflation in other countries. Direct channels operate via export and import prices, while indirect channels work through exposure to foreign competition and commodity prices. Furthermore, growing significance of EMEs in the world economy, coupled with rising in technology, lead to expansion of value chains to locations across borders with low cost of production. In this regard, Albuquerque and Baumann (2017) point to the essential role played by the global value chains in raising importance of the global output gap in determining domestic inflation. At the same time, there has been an increase supply of cheap labor from EMEs, which has exerted downward pressure on global wages. Fourth, one cannot undermine the role played by common shocks affecting economies simultaneously (e.g. oil or commodity prices) or spilling over from one or subset of countries to others (e.g. during the pandemic). For example, inflation volatility rose sharply among Latin American and Asian countries respectively during the Tequila and Asian crisis, which then spread globally especially in countries with weak economic fundamentals.

Forbes (2019) demonstrate empirically, using a Phillips curve with a set of global variables, that globalisation plays an increasingly more important role in explaining inflation dynamics. While domestic forces are still relevant in driving inflation, their roles have changed over time. For example, domestic slack remains important, but it has become less so over time, whereas the role played by global slack has increased. Interestingly, she concurs with the first camp regarding the essential role played by inflation expectations and lagged inflation, which reflect strong impact of policy.

Unlike Forbes (2019) who estimates panel regressions for a dataset comprising of 43 countries, this paper estimates the Phillips curve for individual countries from a dataset with a total

[3]See for example Gamber and Hung, 2001; Bean, 2006; Borio and Filardo, 2007; Albuquerque and Baumann, 2017; Eickmeier and Kühnlenz, 2018; Forbes, 2019; Gilchrist and Zakrajsek, 2019.

of 34 countries (23 AEs and 11 EMEs). Estimating the Phillips curve in this way enhances the understanding of inflation dynamics specific to each country as well as common features shared globally. Besides the time-variation in coefficients, some parameters are restricted in line with expectations. Specifically, the model constrains the inflation persistence (coefficient on lagged inflation) to be positive and less than one. This restriction allows inflation to follow a mean-reverting process in line with the data generating process. Like Kabundi et al. (2019), inflation persistence in this model is interpreted as a measure of the degree of central bank credibility. It implies that 0 means the central bank is fully credible and agents are forward looking, whereas 1 suggests complete lack of credibility and agents are backward looking. Coefficients on domestic output gap, global output gap, and oil price gap are restricted to be positive and less than one. Without this constraint, the estimation sometimes yields negative slope of the Phillips curve which is implausible. It is worth mentioning that the oil price and global out gap are estimated outside of the model. The intuition here is that each country is expected to face the same oil and global shocks. Estimating them in the model will yield different measures for each country, which is counter-intuitive.

The current paper contributes to the existing literature by attempting to answer the following questions. Are the coefficients changing over time? Does the global output gap, in addition to the domestic output and oil price gap, explain inflation dynamics? Of the four variables included in the model, which one matters the most for domestic inflation? The results can be summarized as follows.

There is evidence of changing nature of inflation volatility, which has declined across all countries but remained relatively high in EMEs and several AEs. Inflation volatility tends to rise in crisis periods compared with tranquil times. The implicit target is relatively constant in many countries at levels consistent with the set objectives, but closer to the upper bound of the target band for most of EMEs. Consistent with the literature, the results show that Phillips curves are generally flat for the period under consideration, but different from zero. They seem to be more flat in AEs than in EMEs. The global demand seems to matter more than the domestic demand in all countries, except for South Africa. The impact is constant throughout the sample and across countries. And the global demand seems to matter more in EMEs than in AEs. Finally, the results point to the dominant role played by oil prices as a key factor behind inflation dynamics across countries and over time. The coefficient on oil price gap is on average 6 times more than that of domestic output gap and 4 times more than the global output gap.

The remainder of the paper is organized as follows. Section 2 describes the specification of a time-varying Phillips curve with a bounded random walk process. Section 3 discusses the data, their transformation and empirical results. Section 4 concludes.

2 Model Specification

We start from the bivariate unobserved components model in chan2016bounded:

$$\pi_{i,t} - \tau^{\pi}_{i,t} = \rho_{i,t}(\pi_{i,t-1} - \tau^{\pi}_{i,t-1}) + \alpha_{i,t}(y_{i,t} - \tau^{y}_{i,t}) + \epsilon^{\pi}_{i,t} \tag{1}$$
$$y_{i,t} - \tau^{y}_{i,t} = \varphi_{i,1}(y_{i,t-1} - \tau^{y}_{i,t-1}) + \varphi_{i,2}(y_{i,t-2} - \tau^{y}_{i,t-2}) + \epsilon^{y}_{i,t} \tag{2}$$
$$\tau^{\pi}_{i,t} = \tau^{\pi}_{i,t-1} + \epsilon^{\tau\pi}_{i,t}, \quad \epsilon^{\tau\pi}_{i,t} \sim \mathcal{N}(0,\ \sigma^2_{\tau\pi}) \tag{3}$$
$$\tau^{y}_{i,t} = \tau^{y}_{i,t-1} + \epsilon^{\tau y}_{i,t}, \quad \epsilon^{\tau y}_{i,t} \sim \mathcal{N}(0,\ \sigma^2_{\tau y}) \tag{4}$$

where i denotes country i, $i = 1, \ldots, N$. At time t, $\pi_{i,t}$ is the inflation of country i and $y_{i,t}$ is the output 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 level 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 gap. $\epsilon^{\pi}_{i,t}$ is the error term with a 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 the inflation persistence. When expectations are well anchored, inflation is less persistent. Conversely, when expectations are adaptive, inflation tends to exhibit high persistence. $\alpha_{i,t}$ is the slope of the Phillips curve. $\rho_{i,t}$ and $\alpha_{i,t}$ are allowed to vary over time expressed by:

$$\rho_{i,t} = \rho_{i,t-1} + \epsilon^{\rho}_{i,t}, \quad \epsilon^{\rho}_{i,t} \sim \mathcal{N}(0,\ \sigma^2_{i,\rho}) \tag{6}$$
$$\alpha_{i,t} = \alpha_{i,t-1} + \epsilon^{\alpha}_{i,t}, \quad \epsilon^{\alpha}_{i,t} \sim \mathcal{N}(0,\ \sigma^2_{i,\alpha}) \tag{7}$$

The current model specification departs from Chan et al. (2016) and Kabundi et al. (2019), in that, it includes explicitly supply factor like Blanchard et al. (2015). And it includes the global output gap in addition to oil price. With these two additional variables, the first equation in (1) becomes:

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

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).

Matheson and Stavrev (2013), Blanchard et al. (2015), and Chan et al. (2016) constrain some parameters in line with theory. Failing to do that yields coefficients that can hardly be interpreted. For example, the inflation persistent, $\rho_{i,t}$, is restricted to be positive and strictly less than one to ensure stationarity. Similarly, inflation reacts positively to domestic and global demand pressures, and positive oil price shock. Thus, the slope of the Phillips and coefficients on global output and oil price gap are constrained to be positive and less than one. 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:

$$\epsilon_{i,t}^{\rho} \sim \mathcal{TN}(-\rho_{i,t}, 1-\rho_{i,t}, 0,\ \sigma_{i,\rho}^2) \tag{11}$$
$$\epsilon_{i,t}^{\alpha} \sim \mathcal{TN}(-\alpha_{i,t}, 1-\alpha_{i,t}, 0,\ \sigma_{\alpha}^2) \tag{12}$$
$$\epsilon_{i,t}^{\beta} \sim \mathcal{TN}(-\beta_{i,t}, 1-\beta_{i,t}, 0,\ \sigma_{i,\beta}^2) \tag{13}$$
$$\epsilon_{i,t}^{\gamma} \sim \mathcal{TN}(-\gamma_{i,t}, 1-\gamma_{i,t}, 0,\ \sigma_{i,\gamma}^2) \tag{14}$$

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 Data

The dataset comprises 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 are based on data availability. The series included are the consumer price index (CPI) representing domestic inflation, the real gross domestic product (GDP) which reflects domestic demand, oil price is which used as proxy of supply shock, and global GDP as a proxy of global demand.[6] 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 series are transformed into quarter-on-quarter difference of natural logarithms times 400. Note that the global output gap, obtained using the global GDP, and the detrended oil price inflation are constructed outside of the model using the filtering technique developed by Grant and

[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 price with import price yields similar results.

Chan (2017).[7] As mentioned above, it is appropriate to estimate the global output trend and oil price trend outsied the model, given that each country faces the same global demand and supply shock. Conversely, deriving them from the model will yield different global output trend and oil price trend for each country, which is counter-intuitive.

3.2 Global output gap and oil price gap

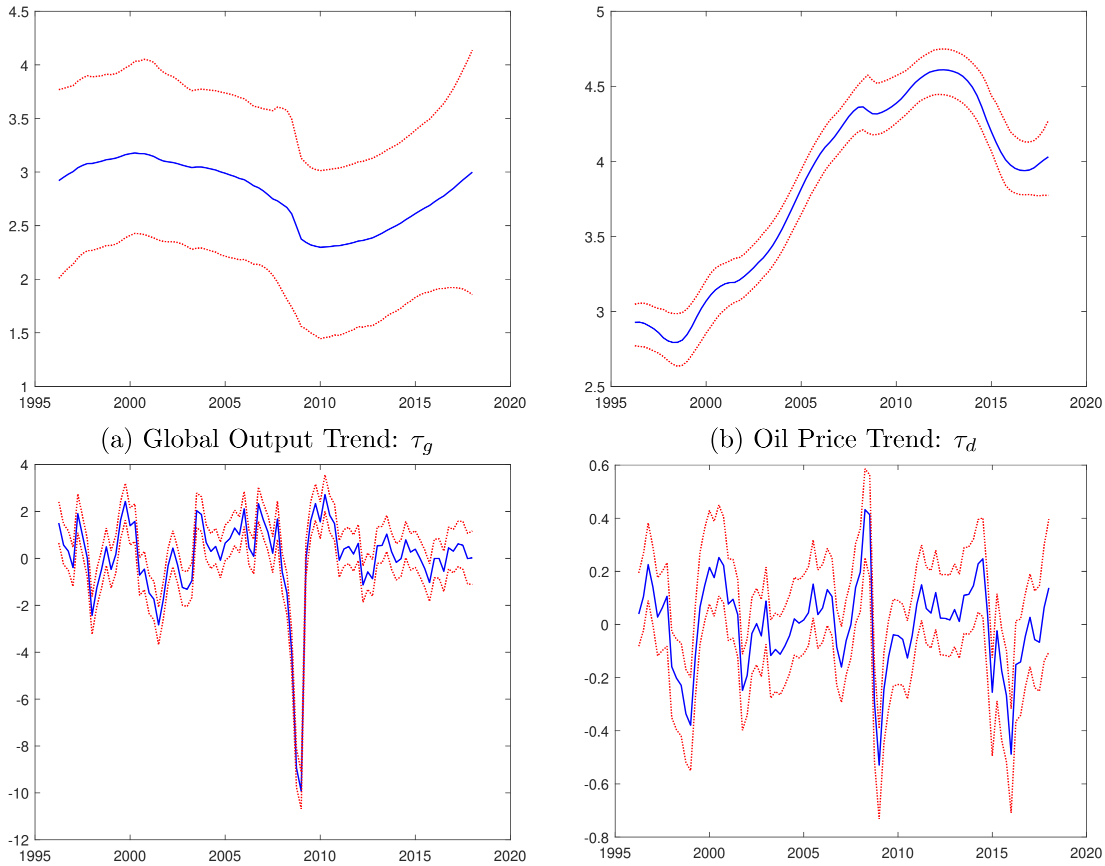
Figure 1 presents the estimated global output trend and oil price trend, their gaps, and corresponding 84% credible intervals. The global output gap captures economic cycle in the global economy. In particular, it illustrates recessionary episodes, namely, the East Asian crisis of 1997-1998, the 2000-2001 dotcom crisis, the global financial crisis of 2007-2008, and the 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 price before the GFC was driven by high global demand, particularly in emerging market economies. 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 price turned negative, then recovered gradually before dropping again in 2014, as a response to positive supply shock in oil market. This pushed down the trend in oil price.

3.3 Full Sample Results

The full sample results indicate that inflation dynamics are explained by lagged inflation, domestic output gap, global output gap, and oil price gap. Unlike Forbes (2019) who combines all countries together in a panel, interesting dynamics emerge when the Phillips curve is estimated for each country. In general, global output gap and oil price gap have larger coefficients than the domestic output gap. It is interesting to note that of the two external factors, oil price matters more. These results support the finding in the literature of a flat Phillips curve globally (see, Carlstrom and Fuerst, 2008; Ball and Mazumder, 2011; Matheson and Stavrev, 2013; Blanchard et al., 2015; Blanchard, 2016; Chan et al., 2016 and Kaihatsu and Nakajima, 2018). The coefficients on domestic output gap and global output gap are consistent with the full-sample results of Forbes (2019), whereas we have low inflation persistence and high coefficient on the oil price gap.

Next, we provide the details of the results. They are grouped into 5 broad categories,

[7] Importantly, the results remain unchanged when using other filtering techniques such as the unobserved component with stochastic volatility (UCSV) of Beveridge and Nelson, 1981; Watson, 1986; the Hodrick and Prescott, 1997; Hodrick and Prescott, 1997 (henceforth HP), 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 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.



(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: **Global Output Gap and Oil Price Gap:** The solid blue line is the posterior mean, while the dotted red lines are 16% and 84% quantiles.

notably, the implicit inflation target, inflation volatility, inflation persistence, estimated coefficients on other explanatory variables, and inflation gap decomposition.

3.3.1 Implicit inflation target

The implicit inflation target, which is agents' beliefs about the central bank target, is represented by the mean of long-term trend inflation, i.e. $\frac{1}{T}\sum_{t=1}^{T}\tau_t^{\pi}$. Consistent with central banks objectives, on average, implicit targets are around 2 percent for AEs and above 4 percent for most of EMEs (see Table 1). Specifically, 20 percent of countries have their average implicit targets above the official target band or point target. Figure 2 shows implicit inflation target of all countries. Notice a marginal decline in the trends especially for European countries following GFC, the European sovereign crisis, and the marked drop in commodity prices of 2014. In particular, the constructed target portrays a gradual decline

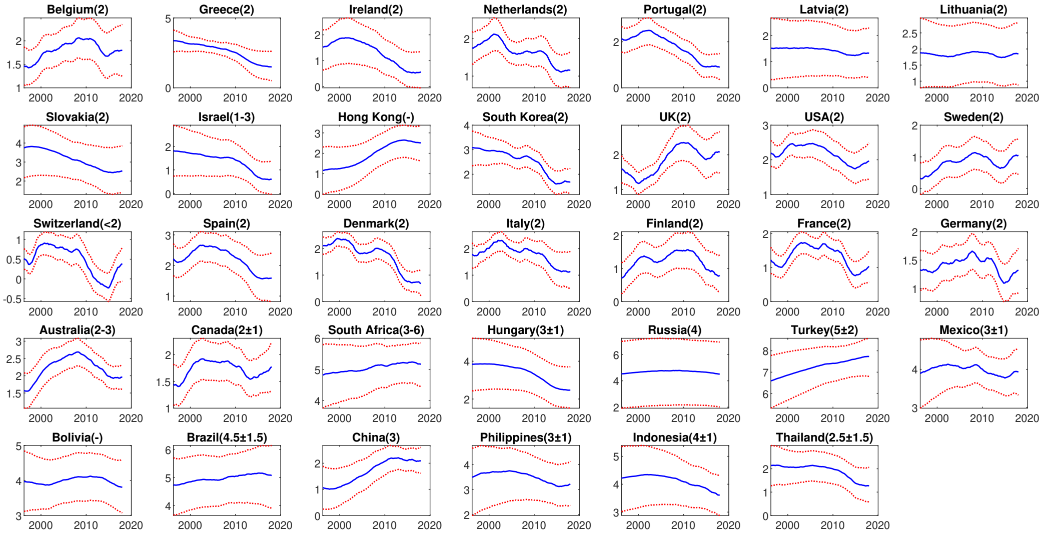


Figure 2: **Posterior estimates for trend inflation τ^{π}.** The title of each sub-figure is the country name, followed by the official inflation targets (point target or target bands). For Hong Kong and Bolivia, we do not find the official inflation targets, so we use "-". The solid blue lines are the means, the dotted red lines are 16% and 84% quantiles.

in Belgium, Ireland, Netherlands, Denmark, Italy, Finland, France, and Germany. These countries seem to have reached a new regime of inflation below the target, hovering about one percent. Other AEs such as Australia and Canada exhibit a similar pattern with a stable trend inflation around the official target of 2 percent. Sweden and Switzerland registered extremely low implicit target, below one percent, dropping even further into negative for Switzerland amid deflationary pressure as a response to the appreciation of the currency. It is interesting to note a low implicit target for Switzerland even though it does not follow an IT regime. South Korea exhibits persistent decline in trend inflation from 3 percent to 2 percent. Conversely, inflation in the UK trended upward for prolonged periods with many instances where inflation bridges the official target. Consequently, the implicit target moves from one percent in the beginning of the sample to 2 percent and settled there until the end of the sample. Similarly, Hong Kong, which is not an inflation-targeter, has experienced an uptick in its implicit target from 1.1 percent to 2.4 percent. Finally, China and Thailand are the only EMEs with low implicit target at levels that are comparable with AEs. While the implicit target is trending up in China, it has been relatively stable in Thailand with a marginal decline from 2.2 to 1.3 percent.

3.3.2 Inflation volatility

Figure 3 presents stochastic volatility. Notice that changing nature inflation volatility over time and across countries. Interesting patterns emerge from these figures. First, there is a substantial decline in inflation volatility across countries. This can 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 a "good luck" induced by a global common shock affecting simultaneously inflation volatility in all countries. This global decline in inflation volatility also reflects the great moderation periods associated with a decrease in shock affecting the global economy. It is evident from Figure 3 that volatility has declined in both AEs and EMs albeit with different magnitudes. In general, volatility in AEs, which has recently been closer to zero, is lower than the levels attained in EMEs. Notice that Hong Kong is the only AE with considerably high inflation volatility, resulting from its fixed exchange rate regime. Starting initially at extremely low levels, volatility in Switzerland picks up in 2001 and remained elevated until 2011, then reverts to its pre-2001 levels. Like Hong Kong, Switzerland follows a fixed-exchange rate policy.

Even though most EMEs have witnessed a downward trend in volatility, it remains high especially in Turkey and Bolivia. Importantly, expect for Bolivia, most EMEs adopted the IT framework in the early 2000s. Even though Turkey follows an IT regime with a free-floating currency, the country has intervened several times to support its currency from depreciating, thus introducing volatility in inflation. As a result of active monetary policy, inflation trended downward from double digit (see Figure 5, 50% in 1995 in Turkey and 20% in 1996 in Mexico) to a single digit. Since the adoption of IT, these countries managed to stabilize inflation which hovering at the upper bound of the official target band. For example, Mexico achieved price stability around four percent in 2003 while inflation has been stable around eight percent in Turkey since 2004.

With few exceptions, volatility in general tends to rise in crisis periods. Specifically, it increased during the Asian crisis, in EMEs and especially Asian countries, the dotcom crisis of 2001 in few AEs (Australia, Canada, France, Germany, Italy, Sweden, Switzerland, UK, US), the GFC shared globally, and the European sovereign crisis in Europe. In addition, idiosyncratic events generate remarkable spark in volatility in countries affected, notably currency crises in Mexico in 1995, depreciation of domestic currency in 2001 in South African and 2005 in Indonesia. Similarly, volatility in Italy has been on a rise since the GFC trigged by political and financial turmoil. Most countries exhibit initial high inflation volatility prior to the change in monetary policy (Australia, Bolivia, Canada, Italy, South Africa, Sweden, Switzerland, and UK). Interestingly, Blanchard et al. (2015) and Kaihatsu and Nakajima (2018) obtained the same results respectively for the AEs, the US and Japan.

3.3.3 Inflation persistence

Table 2 presents the average inflation persistence together with its credible intervals. A noticeable difference is observed in the inflation persistence between AEs and EMEs. Most advanced economies exhibit a small persistence which literature attributes to a better anchoring of inflation expectations, suggesting that agents in these countries have become more forward looking. In other words, inflation process is no longer adaptive (see Cogley and Sargent, 2005; Stock and Watson, 2007; Carlstrom and Fuerst, 2008; Ball and Mazumder,

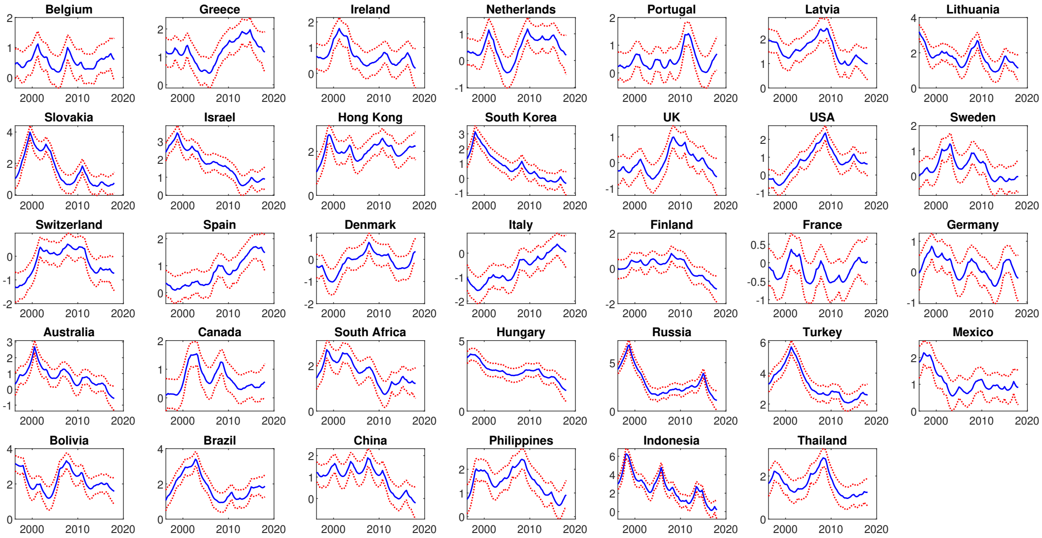


Figure 3: **Stochastic volatility** h_t**.** The solid blue line is the posterior mean, while the dotted red lines are 16% and 84% quantiles.

2011; Matheson and Stavrev, 2013; Blanchard et al., 2015; Gillitzer and Simon, 2018; Chan et al., 2016; Kabundi et al., 2019). 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. AEs with high persistent include Italy, Ireland, Slovakia, Lithuania, and Latvia. Agents are somewhat backward looking in Sweden, Hong Kong, and Finland. It is not surprising that Hong Kong, which has a fixed exchange rate monetary policy, is the only AE with extremely high persistence.

In stark contrast, EMEs portray high persistence which suggests that expectation formation is more adaptive in these countries. Brazil, Philippines, Russia, and South Africa have the highest persistence of above 0.5, whereas it lies between 0.4 and 0.5 for the rest of EMEs.

Average values mask interesting dynamics on the evolution of inflation persistence. Next, we show the details of time variation in AEs, followed by EMEs.

The time variation in AEs shows different pictures. One group experienced a downward in inflation persistence, while another group experienced an upward. The group experiencing a downward in inflation persistence includes Hong Kong, Israel, Latvia, and Lithuania. In particular, inflation persistence in Hong Kong moves from 0.73 in 1995 to 0.27 in 2018 (see Figure 4). The adaptive behavior of agents in the 1990s was mainly due to the persistently high inflation between 1995 and 1997, averaging 6 percent followed by a prolonged period of negative inflation which lasted about 5 years. Since 2005, monetary policy authority has managed to stabilize inflation around 2 percent (see Figure 5). Similar pattern in persistence is observed in Israel, however, the decline is less steep, moving from 0.78 to 0.39. High persistence at the beginning of the sample can be associated with high inflation that prevailed before the adoption of the IT regime in 1997. Latvia and Lithuania exhibit the similar pattern of inflation persistent which is consistent with the dynamics in inflation in these countries. Inflation persistence is high and constant until the GFC, then decreases slowly reaching 0.5 in 2018, suggesting that inflation is still somewhat adaptive. They started with high inflation of 20 and 29 percent, respectively. This period was followed by a rapid disinflation process, which brought inflation down to 1.49 percent in Latvia and around zero in Lithuania. However, inflation surged again after a temporary period of low inflation, attaining 19 percent in 2003 for Latvia and 13 percent in 2007 for Lithuania. Thereafter inflation plummeted and stabilized in both countries around the implicit target until the end of the sample.

The group experiencing an upward in inflation persistence includes Belgium, Finland, and the UK. The marginal increase in Belgium is associated with the deflationary process in the Europe in 2012, whereas high level attained in Finland and the UK is attributed to prolonged periods of tolerance of inflation above the target by central banks.

With regard to EMEs, Figure 4 divide 11 EMEs into three groups. The first group experienced a marked drop in inflation persistence. It includes China, Hungary, Mexico, Thailand, and Turkey, moving from 0.9 to 0.22, which suggests a drastic change in agents' beliefs from backward looking to forward looking. Bolivia and South Africa depict inflation persistent respectively at 0.5 and 0.6 which remains relatively constant, then decreases after the GFC to 0.27 and 0.37, respectively. These results reflect lengthy episodes, where inflation has stayed above its long-term trend. More specifically, they support the finding of Kabundi et al. (2019), who point out that the change observed in inflation persistence in South Africa can be attributed to a combination of good policy and good luck. With regard to good policy, they argue that the central bank becomes more active in combating inflation. With regard to good luck, they argue that negative oil price shock brings inflation down.

The second group experienced a noticeable upward in inflation persistence. It includes Brazil and Russia, from 0.57 to 0.77 and 0.50 to 0.74, respectively. It is worth noting that in contrast to Brazil, inflation persistence for Russia has been trending down after reaching its peak (0.83) in 2008Q3. The two countries have tolerated prolonged periods of deviation of inflation from its long-term trend. The third group is Philippines, who has a stable inflation persistence of 0.6.

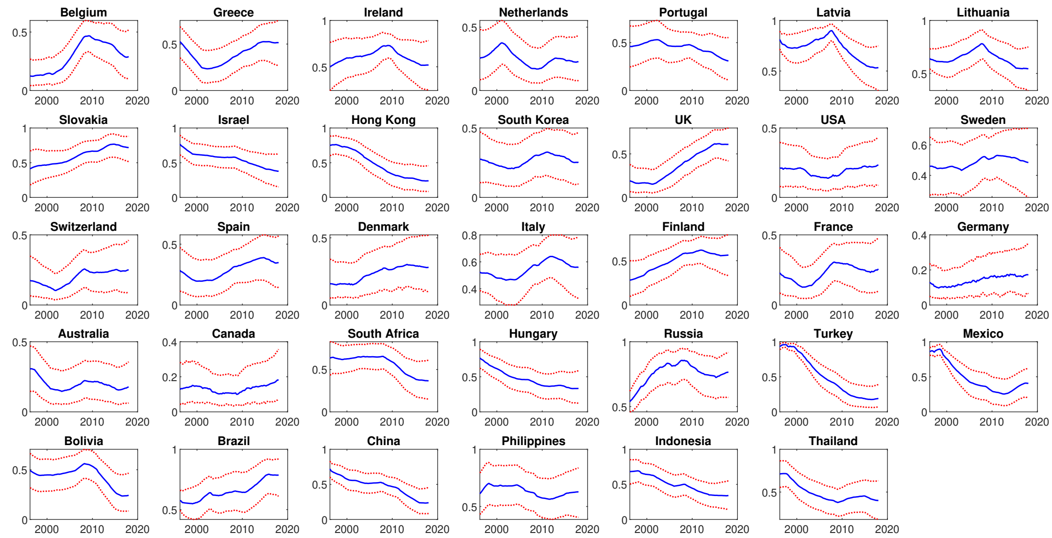


Figure 4: **Inflation persistence ρ_t.** The solid blue line is the posterior mean, while the dotted red lines are 16% and 84% quantiles.

3.3.4 Estimates of coefficients on explanatory variables

This section contains the results of parameters of explanatory variables, namely, the domestic output gap, the global output gap, and the oil price gap. As discussed in the model, these parameters are restricted be positive in line with expectations.

With regard to the coefficients on the domestic output gap (that is, α_t), Table 3 reports the average value over time and Figure 7 reports the time variation aspect. On average, Table 3 reports the mean of α_t over time. The slope of the Phillips curve varies from 0.031 (Thailand) to 0.212 (Indonesia). The small value shows that inflation is muted to domestic output gap. A pattern which emerges from the results is that inflation tend to react more to domestic demand in EMEs than in AEs. Figure 7 plots the time varying slope of Phillips curve. We do not observe evident time variation in it. It is quite flat from 1995 to 2018. This is consistent with Blanchard et al. (2015) and Chan et al. (2016), Kabundi et al. They use longer sample and find evidence of changing slope of the Phillips curve in the 1970s and the 1980s. But the slope has remained unchanged since early 1990s. Actually, if there is any recent change, the results point to a marginal steepness of the slope recently in most AEs like Belgium, Slovakia, South Korea, Switzerland, and the US. The recent marginal rise in the slope of the Phillips observed in the US is also documented by Gilchrist and Zakrajsek (2019).

With regard to the coefficients on the global output gap (that is, β_t), Table 4 reports the average value over time and Figure 8 reports the time variation aspect. Similar to the domestic demand, on average inflation in EMEs is more responsive to global demand than in AEs (Table 4). The coefficient varies from 0.337 (China) to 0.066 (Netherlands). Figure

7 plots the time varying β_t. Notice the general picture portrayed is that this coefficient decreases slightly until the GFC, then increases marginally until the end of the sample.[8] For example, the coefficient increases respectively from 0.19 to 0.24 for the US. This finding is comparable with Forbes (2019), who shows that the response of inflation to global demand factors increased recently. It reflects the effects of globalisation associated with increasing trade integration which started in early 1990s have intensified lately. Thus, synchronization in inflation across countries is partly a global demand phenomenon. In addition, positive credibility intervals imply that the effects are not negligible, which rules out the notion that domestic inflation is only explained by domestic impact as proposed by Ihrig et al. (2010), Martınez-Garcıa and Wynne (2013), Eickmeier and Pijnenburg (2013), Mikolajun and Lodge (2016), Bems et al. (2018), and Hooper et al. (2020). Consistent with Borio and Filardo (2007) and Forbes (2019), the results indicate that global demand matters more than domestic demand in explaining dynamics in inflation in both AEs and EMEs.[9] This finding has important monetary policy implications. It suggests that monetary policy authority should monitor closely the global economy when they make decisions. 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 economic and muted inflationary pressure.

With regard to the coefficients on the oil price gap (that is, γ_t), Table 5 reports the average value over time and Figure 9 reports the time variation aspect. On average, Table 5 reports the role played by supply shock over time. A few interesting observations can be highlighted. First, oil price gap seems to explain more dynamics in inflation than demand factors. The coefficients vary between 0.393 (Brazil) and 0.739 (Germany), compared with the maximum of 0.212 and 0.337 for domestic and global demand, respectively. Simon et al. (2013) find similar magnitudes using import prices. Second and consistent with Jordà and Nechio (2018), the impact of oil price seems to prevail more in AEs than in EMEs. This is consistent with the observation of downturn in inflation in 2014 in most AEs, which is in line with the oil price shock during the same period. Recall that implicit targets for the same countries fell as a result. Third, in line with the literature, the coefficient is constant over time during this period (see Forbes, 2019).

Results in Table 6 show coefficients of AR(2) process for each country's output gap. Notice that most AEs show high persistence in output gap, with the sum of coefficient ranging between 0.5 and 0.7. Spain depicts the highest persistence of the output gap of 0.926, which is closer to a random walk process. These results indicate that expansionary and contractionary periods are longer in AEs compared with EMEs. South Africa is the only

[8] In general, there is 0.5 rise in slope of global output gap from 2008 to 2018.

[9] Except for South Africa where the domestic demand exhibits a higher coefficient and Switzerland where the two demand factors yield coefficients of the same magnitude. Notice that Thailand depicts a constant coefficient on global demand, whereas South Africa is the only country with a decreasing slope of global demand.

EME country with high persistence (0.617).

3.3.5 Inflation Gap Decomposition

In Table 7, we briefly show the result of inflation gap decomposition. In our model, we have five components: lagged inflation $\left(\rho_t(\pi_{t-1} - \tau^{\pi}_{t-1})\right)$, domestic output $\left(\alpha_t(y_t - \tau^{y}_{t})\right)$, global output $(\beta_t \tilde{g}_t)$, oil price $(\gamma_t \tilde{d}_t)$ and the error. The number represents the contribution of a component to the inflation gap $(\pi_t - \tau^{\pi}_t)$.

The contribution of lagged inflation has increased in 17 out of 34 countries after the GFC. An interesting finding is that in the 17 countries, 16 countries are AEs. Even if most advanced economies exhibit a small inflation persistence, the lagged inflation is still important to explain the dynamics of inflation. The contribution of domestic output has increased in 13 countries out of 34 countries after the GFC. And out of 23 AEs, only in 6 countries, the contribution of domestic output has increased after GFC. Compared with 7 countries out of 11 EMEs, this supports the finding in 3.3.4 that inflation tend to react more to domestic demand in EMEs than in AEs. The contribution of global output has increased in 9 countries. And out of 23 AEs, only in 2 countries, the contribution of domestic output has increased after GFC. Compared with 7 countries out of 11 EMEs, this supports the finding in 3.3.4 that inflation tend to react more to global demand in EMEs than in AEs. And the contribution of oil price has increased in 20 out of 34 countries after the GFC, supporting an important role played by oil prices. By comparing the magnitude of contribution, we find further evidence that the impact of oil price prevails more in AEs than in EMEs.

4 Conclusion

This paper estimates the Phillips for individual countries from a dataset with a total of 34 countries (23 AEs and 11 EMEs). Besides the domestic output gap, the model incorporates global output gap and oil price gap which account for global determinants of inflation. We allow for time-variation in coefficients and parameters are restricted in line with expectations. The results can be summarized as follows.

There is evidence of changing nature of inflation volatility, which has declined across all countries but remained relatively high in EMEs and several AEs. Inflation volatility tends to rise in crisis periods compared with tranquil times. Inflation persistence has declined in most AEs countries. The estimates of trend inflation are relatively constant in many countries. The levels are consistent with the official targets, but closer to the upper bound of the target band for most of EMEs. Consistent with the literature, the results show that Phillips curves are generally flat for the period under consideration, but different from zero. They seem to be more flat in AEs than in EMEs with a marginal uptick towards the end of the sample. The global demand seems to matter more in EMEs than in AEs. Finally, the results point to the dominant role played by oil prices as a key factor behind inflation dynamics across countries and over time. The coefficient on oil price gap is on average 6 times more than that of domestic output gap and 4 times more than the global output gap.

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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 Supplementary material: Tables

Table 1: Mean of Trend Inflation over time

countries	posterior mean over time	16% quantile	84% quantile
Belgium	1.787	1.376	2.198
Greece	2.592	1.943	3.248
Ireland	1.303	0.605	1.988
Netherlands	1.645	1.256	2.033
Portugal	1.781	1.282	2.278
Latvia	1.427	0.411	2.441
Lithuania	1.839	0.893	2.785
Slovakia	3.074	1.921	4.220
Israel	1.390	0.592	2.183
Hong Kong	1.841	0.943	2.766
South Korea	2.509	2.017	3.002
UK	1.782	1.355	2.209
USA	2.172	1.782	2.563
Sweden	0.794	0.303	1.285
Switzerland	0.467	0.144	0.790
Spain	2.202	1.647	2.759
Denmark	1.727	1.388	2.064
Italy	1.777	1.339	2.228
Finland	1.225	0.734	1.721
France	1.309	0.979	1.639
Germany	1.387	1.075	1.699
Australia	2.196	1.794	2.597
Canada	1.713	1.349	2.077
South Africa	5.018	4.260	5.786
Hungary	3.349	2.157	4.548
Russia	4.585	2.118	7.112
Turkey	7.171	6.237	8.128
Mexico	3.971	3.391	4.559
Bolivia	3.990	3.283	4.696
Brazil	4.867	3.902	5.842
China	1.659	1.075	2.243
Philippines	3.526	2.543	4.506
Indonesia	4.079	3.175	4.993
Thailand	1.936	1.267	2.606

Table 2: Inflation persistence

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

Table 3: Coefficient on domestic output gap

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 4: Coefficient on global output gap

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 5: Coefficient on oil price gap

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 6: Autoregressive coefficients

countries	AR(1)			AR(2)		
	mean	16% quantile	84% quantile	median	16% quantile	84% quantile
Belgium	0.686	0.588	0.784	-0.161	-0.259	-0.063
Greece	0.193	0.102	0.282	0.435	0.346	0.525
Ireland	-0.114	-0.208	-0.020	0.100	0.007	0.193
Netherlands	0.377	0.278	0.476	0.188	0.088	0.287
Portugal	0.311	0.213	0.407	0.275	0.178	0.373
Latvia	0.302	0.210	0.392	0.356	0.265	0.447
Lithuania	0.202	0.108	0.297	0.212	0.119	0.305
Slovakia	-0.104	-0.200	-0.009	0.060	-0.034	0.154
Israel	0.210	0.113	0.308	0.163	0.070	0.256
Hong Kong	0.241	0.145	0.338	0.212	0.116	0.308
South Korea	0.366	0.268	0.464	0.003	-0.092	0.099
UK	0.605	0.504	0.706	0.070	-0.030	0.170
USA	0.318	0.217	0.419	0.211	0.111	0.312
Sweden	0.293	0.196	0.390	0.153	0.056	0.252
Switzerland	0.491	0.392	0.590	0.039	-0.059	0.138
Spain	0.837	0.736	0.939	0.089	-0.013	0.190
Denmark	0.042	-0.058	0.141	0.118	0.019	0.219
Italy	0.540	0.440	0.640	0.056	-0.043	0.155
Finland	0.245	0.145	0.344	0.118	0.021	0.213
France	0.526	0.424	0.629	0.141	0.039	0.243
Germany	0.343	0.246	0.440	0.035	-0.062	0.132
Australia	-0.121	-0.218	-0.023	0.078	-0.020	0.175
Canada	0.522	0.422	0.622	-0.088	-0.188	0.012
South Africa	0.514	0.410	0.618	0.102	-0.001	0.205
Hungary	0.085	0.000	0.351	0.008	0.000	0.000
Russia	0.541	0.445	0.638	-0.042	-0.144	0.060
Turkey	0.017	-0.080	0.114	0.121	0.029	0.214
Mexico	0.476	0.385	0.567	-0.100	-0.178	-0.021
Bolivia	-0.169	-0.266	-0.073	-0.167	-0.263	-0.070
Brazil	0.247	0.150	0.344	-0.012	-0.107	0.083
China	0.178	0.075	0.283	0.106	0.008	0.204
Philippines	0.065	-0.035	0.163	0.058	-0.040	0.154
Indonesia	0.515	0.417	0.613	-0.017	-0.114	0.080
Thailand	-0.007	-0.105	0.091	0.114	0.020	0.207

Table 7: 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 7: 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
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

Table 7: Inflation Gap Decomposition

	Country		lagged inflation	domestic output	global output	oil price	Other
	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
End							

Note that the increasing contribution is indicated in Bold.

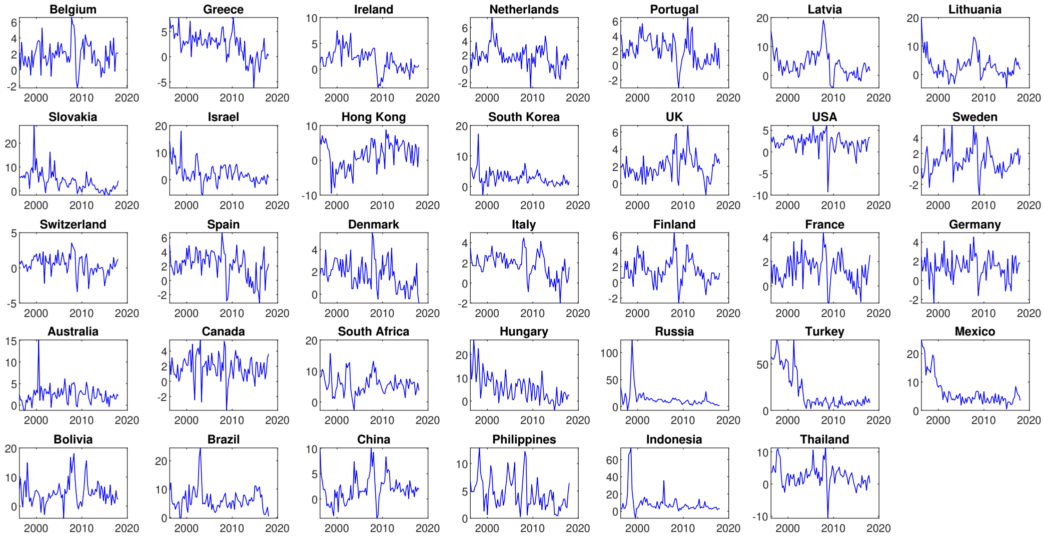

Figure 5: **Inflation π.**

C Supplementary material: Figures

Figure 5 plots the inflation data that we use in the model. Figure 6 plots posterior estimates for trend output τ^y. Figure 7 plots coefficient on domestic output gap α_t. Figure 8 plots coefficient on global output gap β_t. Figure 8 plots coefficient on oil price gap γ_t.

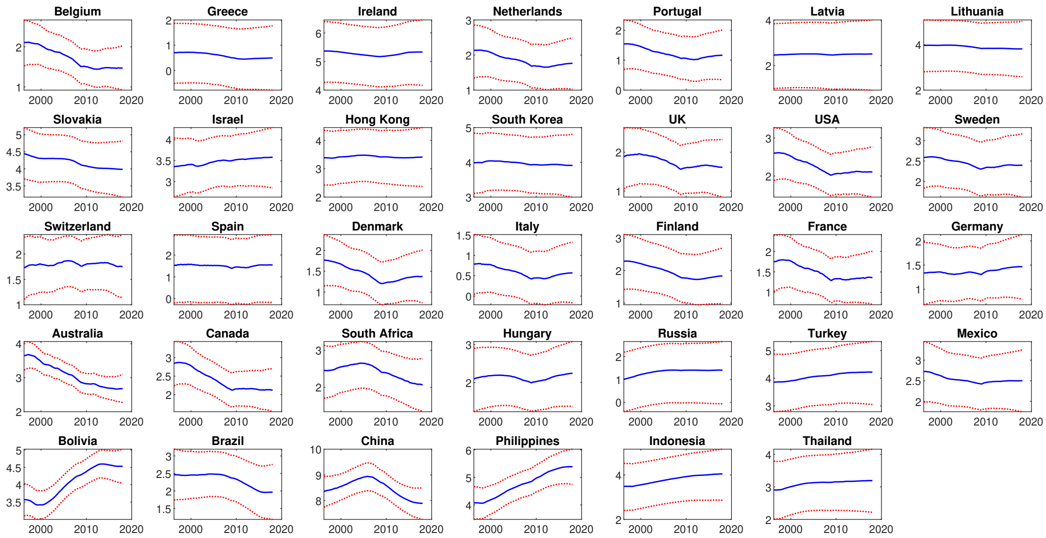

Figure 6: **Posterior estimates for trend output τ^y.** The solid blue line is the posterior mean, while the dotted red lines are 16% and 84% quantiles.

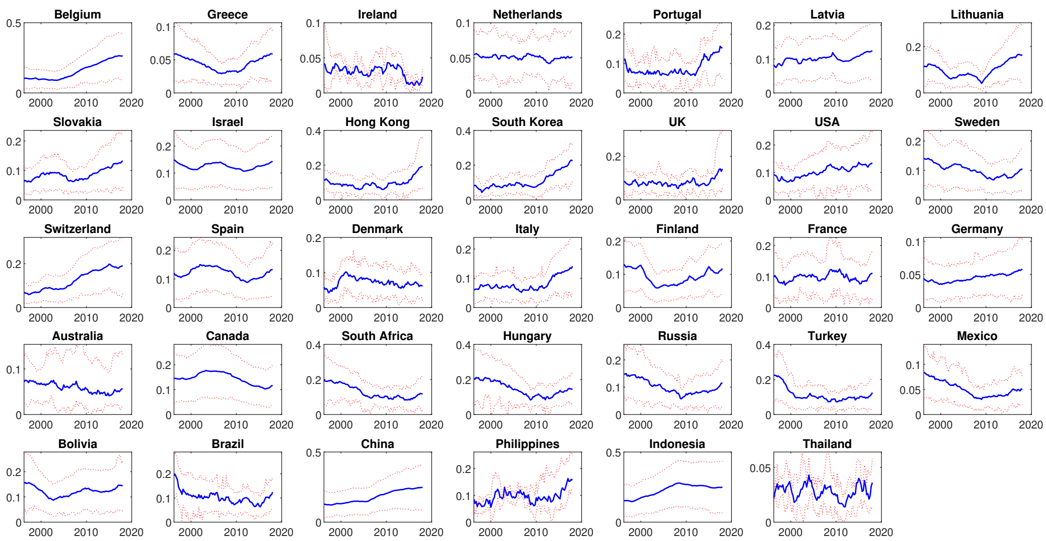

Figure 7: **Coefficient on domestic output gap α_t.** The solid blue line is the posterior mean, while the dotted red lines are 16% and 84% quantiles.

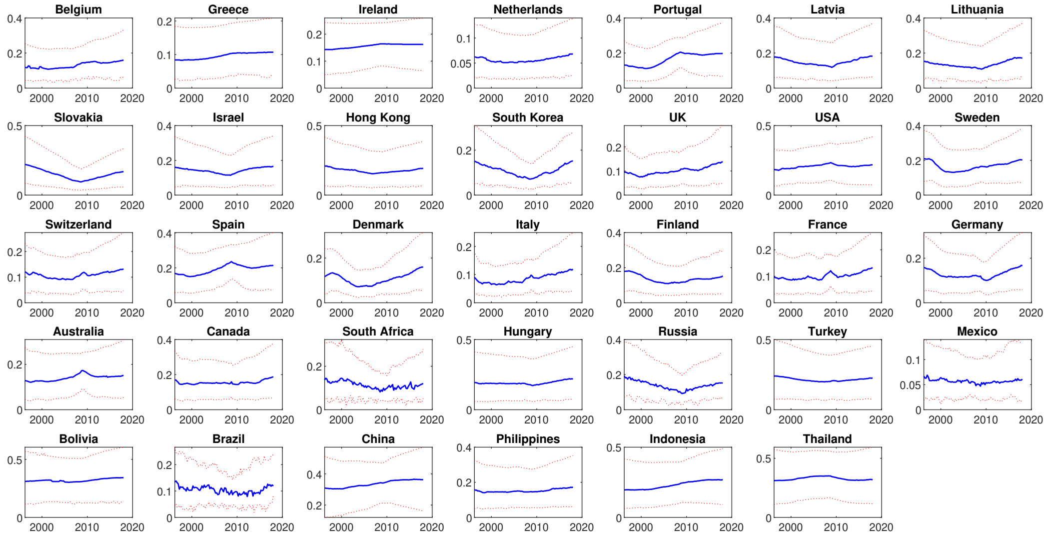

Figure 8: **Coefficient on global output gap β_t.** The solid blue line is the posterior mean, while the dotted red lines are 16% and 84% quantiles.

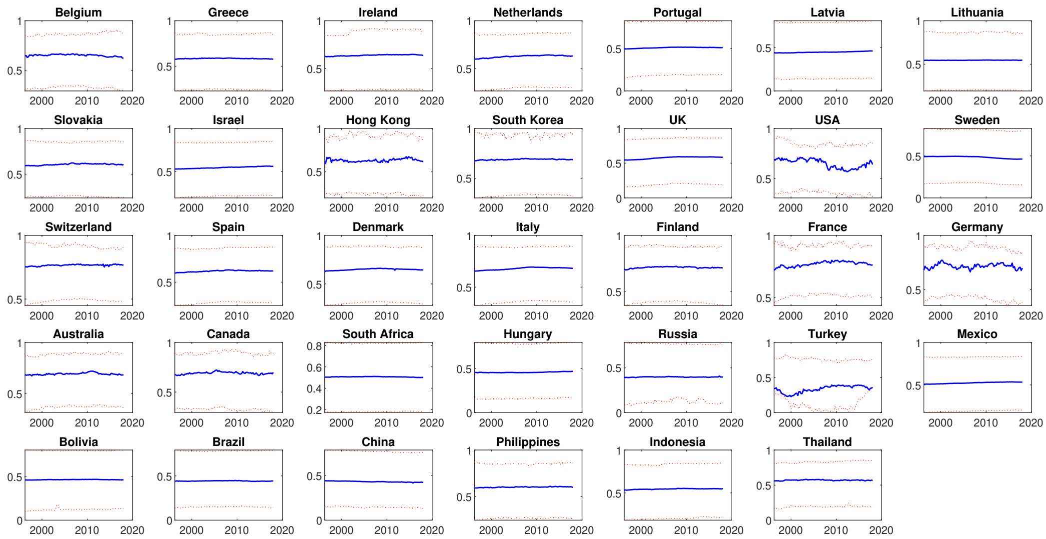

Figure 9: **Coefficient on oil price gap γ_t.** The solid blue line is the posterior mean, while the dotted red lines are 16% and 84% quantiles.