



Contents lists available at ScienceDirect

Journal of International Money and Finance

journal homepage: www.elsevier.com/locate/jimf

How large and persistent is the response of inflation to changes in retail energy prices? ☆

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ARTICLE INFO

Article history:

Available online 15 February 2023

JEL Classifications:

E30

E31

H23

Keywords:

Retail energy prices

Oil prices

Inflation

Local projections

Impulse responses

ABSTRACT

We estimate the dynamic effects of changes in retail energy prices on the consumer price level using a novel monthly database, covering 110 countries over 2000:M7 to 2016:M6. We find that (i) the price level responds positively to retail energy price shocks, with effects being, on average, modest and transitory. However, our results suggest significant heterogeneity across countries owing to differences in institutional factors. In particular, the response of the consumer price level to these shocks is relatively larger and more persistent in countries with less flexible labor markets, a lower energy intensity, a looser fiscal policy stance, and a less credible monetary policy. We also find evidence of non-linearity and asymmetry in the responses, with both positive and bigger energy price shocks leading to larger and more persistent effects on the consumer price level.

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1. Introduction

Russia's recent invasion of Ukraine led to significant pressures on global energy markets, aggravating a surge in oil and gas prices which was already underway starting in the second half of 2021.¹ As a result, oil and fuel product prices have risen to levels not seen for more than a decade. At the same time, both headline inflation (price of all goods and services) and core inflation (excluding food and energy) have recently been on the rise, reaching levels not seen in decades, and are currently above target in most advanced economies and several emerging and developing markets.²

☆ This paper has benefited from insightful comments and suggestions from the editor, and two anonymous referees. This research is part of a Macroeconomic Research in Low-Income Countries project (Project ID: 60925) supported by the UK's Foreign, Commonwealth and Development Office (FCDO). The views expressed in this paper are those of the authors and do not necessarily represent the views of the International Monetary Fund (IMF), FERDI, or FCDO.

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¹ The surge was already underway before the invasion as global supply in the energy market was tight after years of subdued investment and geopolitical uncertainty, and global demand was increasing as countries were recovering from the pandemic.

² The recent increases in inflation across countries are adding to pressures originating from pandemic-related factors, including supply chain disruptions, a shift in demand toward goods and away from services, aggregate stimulus policies, and labor market tightness.

These dynamics are also occurring at a time there is an increasing recognition of the need to enact policies to mitigate against climate change.³ The ongoing policy debate—on mitigating emissions of carbon dioxide and other greenhouse gases—are part of a concerted effort to combat global warming that has gained prominence in 2009 when the world's largest economies (G20) agreed to reduce emissions (Parry et al., 2014). These commitments have later been re-affirmed in 2012, and more recently, in the context of the 2015 Paris Climate Agreement. Nevertheless, commitments by countries have yet to translate into tangible steps to reduce emissions mostly due to concerns by policymakers about the potential adverse macroeconomic effects of increasing energy prices.

One challenge in particular is the potential impact of the resulting increase in energy prices on inflation, especially at the current juncture with both energy prices and inflation already soaring—and the risk of social unrest is already high. The perception that increases in energy prices lead to large and persistent inflationary impact is due to several major past episodes of high inflation, including during the mid to late 1970s, and more recently during the period that preceded the financial crisis and recession of 2008–09.

How do changes in retail energy price changes affect consumer price inflation? For simplicity, suppose that there is a one-time increase in the retail price of gasoline, while everything else is unchanged. Economic theory suggests that, since households consume gasoline, any increase in the price of this fuel would lead to a reduction in the purchasing power of households—with the magnitude of the impact being proportional to the share of gasoline consumption in the consumer basket of a typical household. This is referred to as the *direct* effect and is widely recognized as being larger in low-income countries and emerging markets, where energy constitutes a larger share of consumption (as high as 50 percent in some countries in Africa). While such effect should, at least in principle, be small and is expected to fade away due to consumers adjusting *downwards* their consumption in response to the price increase, estimates suggest that the demand by households for energy is, on average, relatively inelastic in the short-run. Hence, there is no reason to believe that *direct* effects are necessarily small and insignificant in the short run. In fact, in countries were switching to more energy efficient cars and other household equipment can be challenging due to issues related to affordability, direct effects are expected to be more persistent, possibly spilling over into the medium-term. The same argument applies to countries where the appropriate infrastructure is lacking, and the absence of adequate public transportation systems makes it challenging for households to decrease their consumption of the more expensive fuel or substitute away from driving energy inefficient cars for the purpose of commuting to work or school.

Another impact on inflation, referred to as the *indirect* effect, results from the fact that some energy products—such as diesel—are often used directly by industries as inputs in the production process of other (non-energy) goods and services. Similarly, the *indirect* effects on inflation can also be induced by the extent to which higher diesel or natural gas prices impact electricity prices faced by industries, thus affecting their cost of production. The indirect impact tends to be more worrisome for policymakers, especially in countries that are relatively more energy intensive. We can cast these two types of effects into two main channels of transmission of fuel price shocks, with the indirect effect exhibiting the impact of an aggregate supply shock, while the direct effect being akin to an aggregate demand shock. Recent empirical evidence suggests that while the former channel's quantitative importance remains an open issue (Kilian, 2008), there is a consensus in the literature that the latter channel dominates in practice. From this perspective, a key mechanism whereby fuel price shocks affect the economy is through a disruption in consumers' and firms' spending on goods and services other than energy (Kilian 2008; Hamilton 2008).² Even if both channels of transmission respond to increases in fuel prices—leading to shifts in both the aggregate supply and demand curves to the left—the expected net effect on inflation may likely be small and transitory.

Nevertheless, under certain conditions, the impact of energy price shocks on inflation can be significant and even persistent, when amplified by certain characteristics and factors in the economy. For instance, less flexible labor markets—for example, when the wage setting mechanism is centralized in the presence of powerful unions—an upward pressure on wages could well induce wage-price spiral effects that can magnify the effects of fuel price shocks. Another factor is the way in which monetary policy reacts to the domestic fuel price shocks—for example by accommodating or not accommodating such shocks—may potentially matter for how domestic inflation responds to them. For example, should the energy price shocks lead to a cycle of wage negotiations (e.g., in a centralized wage bargaining system), what ought to be a transitory energy supply side shock can become a demand side shock that may potentially de-anchor inflation expectations leading to sustained increases in the price levels. It is widely recognized that the ability of monetary policy to reduce inflationary pressures crucially depends on institutions that determine the ability of a central bank to navigate political headwinds and successfully establish *de facto* independence. Overall, improving our understanding of the inflationary effects of energy price increases is very relevant for the practice of policy.

2. Literature review

There are at least two shortcomings with much of the work that attempts to sort out the potential impact of fuel price shocks on inflation. The first is that much of the literature has focused on the price of crude oil as the variable of interest in studying the effects of fuel price shocks on macroeconomic variables (Chen, 2009; De Gregorio et al., 2007; Blanchard

³ The environmental, fiscal, and macroeconomic consequences of underpricing energy products are discussed at length in Clements et al. (2013) and Coady et al., 2017.

and Galí, 2007; Gelos and Ustyugova, 2017; Habermeier et al., 2009; and Choi et al., 2018). While undoubtedly relevant for analysis, shocks to the international price of crude oil are generally not very informative in answering the question at hand, mainly because crude oil is not consumed directly by consumers and is not used—at least not directly—as an input to production by firms outside of the refining industry.³ And while it is reasonable to assume that shocks to international crude oil prices are eventually transmitted one-to-one to retail domestic fuel prices, this is only true for a handful of countries where prices are fully liberalized.

Furthermore, global crude oil price shocks are not the only major source of shocks to retail fuel prices across countries. Differences in fuel pricing policies, taxation, fluctuations in exchange rates, and other important domestic factors also matter and may distort analyses that focus solely on the effect of international crude oil price shocks. To reinforce the importance of domestic factors and country-specific shocks, the weather events of Hurricane Katrina in the Gulf Coast of the United States in 2005 provide a very good illustration, in the sense that they have shown that country-specific shocks—and even regional within-country shocks—can explain a large component of the fluctuations in domestic retail fuel prices that is not necessarily reflected (at least not meaningfully) in the dynamics of international crude oil prices. Therefore, from the perspective of households and firms, retail fuel prices—such as the retail price of fuel or diesel—are most relevant than measures of international crude oil prices, since they are ultimately the basis on which these agents make their economic decisions (Kilian, 2008). And while reliable high frequency data on retail fuel prices in advanced countries are readily available, the public availability of such data tend to be generally very acute across emerging, developing, and low-income countries. The lack of availability of a consistent dataset on high frequency retail domestic fuel prices worldwide, has often hindered empirical research on the macroeconomic impact of energy price shocks.

The second issue is that insufficient attention has been paid in the literature to the potential non-linearity in the effects of energy price shocks on inflation.⁴ For instance, there is no reason to expect a large increase in fuel prices to have a similar effect on inflation than an increase of a much smaller magnitude. This is because economic agents are unlikely to change their behavior in response to small fluctuations in fuel prices. Therefore, output and prices may respond differently to oil price shocks of different magnitudes (Hamilton 1996). This may have important implications for our understanding of the transmission mechanism of these shocks and for the debate about the appropriate policy response to them.

In this study, we use and update the large novel monthly dataset of domestic retail fuel prices compiled in Kpodar and Abdallah (2017), to estimate the effects of retail fuel price changes on inflation for different country groups. When devising country groups, we focus on country-specific factors—including the income level, energy intensity, labor market flexibility, and central bank credibility—as candidate features that can help explain the heterogeneity in the spillovers from retail domestic fuel price shocks to inflation across countries.

The empirical approach, detailed in the next section of the paper, relies on a multivariate model that accounts for the dynamic relations among the variables, and allows for non-linearity in the effects. Within this framework, we identify shocks to retail domestic fuel prices by relying on the common assumption (in the literature) that innovations to the domestic fuel price series—measured in local currency units—are predetermined with respect to macroeconomic variables. To the best of our knowledge, this study involves the first attempt to use the most comprehensive monthly data on retail domestic fuel prices across a broad set of 110 countries over 2000 to 2016—including advanced, emerging, and developing countries—to: (i) undertake a detailed and careful empirical analysis of their dynamic effects on inflation; and (ii) explain the heterogeneity in such effects across countries using country-specific factors such as energy intensity, labor market flexibility, fiscal stance, and monetary policy credibility. The main results of our study can be summarized as follows:

The dynamic response of inflation to a retail domestic fuel price shock is generally modest and transitory. For the full sample, the price level responds positively to retail energy price shocks, peaking at around 0.025 percent, twelve months after the shock, then gradually decreases and becomes insignificant over longer horizons. However, the responses vary significantly across country groups, with emerging and developing countries exhibiting a larger and persistent response, peaking at around 0.05 percent, 16 months after the shock. In comparison, the consumer price level in advanced countries exhibits a much smaller and more transitory response—with a peak of around 0.01 percent—5 times smaller than that of the other country group—that quickly dissipates few months after the shock.

Aside from the income level, other structural factors also help to explain the heterogeneity in the response of inflation to the shocks across countries. For example, the variation in the response of the price level to fuel price shocks across country groups can be explained by differences in the extent of labor market flexibility, energy intensity, the stance of fiscal policy, and monetary policy credibility. Specifically, our results suggest that larger responses of the price level to domestic retail fuel price shocks are exhibited by economies with less flexible wages, looser fiscal balance, less credible monetary policy, and higher energy intensity. Finally, there is also some evidence for asymmetry and non-linearity in the responses of the price level to energy prices shocks: the consumer price level to responds more (and in a more persistent way) to increases in retail energy prices and to energy price shocks of larger magnitude.

The rest of the paper is structured as follows. Section II lays out the empirical approach and presents the data along with some stylized facts. Section III presents and discusses the empirical results from the baseline model and attempts to explain the heterogeneity in the response of inflation to retail energy price shocks across country groups, focusing on the role of eco-

⁴ Existing studies mostly focused on the case of advanced countries.

conomic and institutional fundamentals. This section also presents the results from the non-linear model. Section IV summarizes the findings and concludes.

2.1. Empirical framework: Estimation and identification

Our aim is to estimate the dynamic responses of consumer price inflation to domestic retail fuel price shocks. Let y_t be the k -dimensional vector stochastic process for the endogenous variables. We postulate that y_t can be approximated by a vector autoregression of finite order p :

$$B_0 y_{it} = B_1 y_{it-1} + \dots + B_p y_{it-p} + u_{it} \tag{1a}$$

where u_{it} contains country-specific structural shocks—with their variance–covariance matrix being normalized to be the identity matrix. To allow estimation of the structural model in (1a), one first needs to derive its reduced-form representation. This simply involves expressing y_t as a function of its lagged values. A typical variation of (1a) allows for an intercept, a vector of conditioning exogenous variables and country fixed effects. For expository purposes, we abstract here from these, although we will account for them when we estimate the model. To derive the reduced-form representation, we pre-multiply both sides of the structural model representation in (1a) by

$$B_0^{-1} B_0 y_{it} = B_0^{-1} B_1 y_{it-1} + \dots + B_0^{-1} B_p y_{it-p} + B_0^{-1} u_{it}$$

The reduced-form counterpart of the structural model in (1a) can then be re-written as:

$$y_{it} = A_1 y_{it-1} + \dots + A_p y_{it-p} + \varepsilon_{it} \tag{1b}$$

The reduced-form error terms in (1b) are simply a transformed version of the structural errors in (1a), and the variance–covariance matrix in (1b) is:

$$\Sigma_\varepsilon = B_0^{-1} B_0^{-1'}$$

By using this multivariate specification, one could determine the response of inflation to energy price shocks conventionally as follows:

In a first step, estimate the reduced form representation in (1b);

Second, invert the resulting estimated coefficient to obtain the moving average coefficients—these essentially constitute the reduced-form impulse responses.

Third, impose sufficient identifying restrictions on B_0^{-1} to form the matrix of structural impulse responses, which contains the impulse responses of inflation to the identified domestic retail energy price shocks.

While such approach is standard, it presupposes that the data is generated by a Vector Autoregression (VAR) model—which is clearly only correct if the model coincides with the data generating process. Studies have argued that the dynamics of some basic models often follow VARMA representations that are often incompatible with VARs (Cooley and Dwyer, 1998). Consequently, and under such conditions, it follows that specifying a VAR may well introduce significant misspecification, with potentially serious implications for the estimation of—and inference from—impulse response functions, since misspecification errors are compounded with the forecast horizon (Jordà, 2005).⁵

To address this issue, we take an alternative approach to estimating the impulse responses by fitting the following linear projection for each equation in our multivariate model (Jordà 2005, 2009). The baseline specification, over different horizons ($h = 0, \dots, H$), is as follows:

$$y_{i,t+h} = G_0^h y_{it} + G_1^h y_{i,t-1} + \dots + G_h^h y_{i,t-p} + \beta^h EP_{it} + \gamma_i^h + f_i^h + \varepsilon_{i,t+h} \tag{2a}$$

where EP is the retail price of energy (gasoline)—measured in local currency, and y is a vector stochastic process containing the following variables: the nominal effective exchange rate (NEER), the consumer price index, and a measure of the short-term interest rate (the lending rate).⁶ We include country-fixed effects to control for unobserved heterogeneity across countries in the sample, and time fixed effects to capture common global shocks such as shifts in commodity prices or the global business cycle, among others. By construction, the slope β_p^h is interpreted as the response of a variable to changes in retail gasoline prices over horizon h . This approach is essentially akin to generating multi-step predictions using direct forecasting equations that are re-estimated for each forecast horizon. As discussed in Jordà (2005), this approach is robust to misspecification, since impulse responses are defined without a reference to the unknown data generating process—and even when the Wold decomposition does not exist (Koop et al., 1996; Potter, 2000; and Jordà, 2005). Another advantage of estimating impulse responses using the LP method—over those from VARs—is in the flexibility of dealing with non-linearities and state dependency (Ramey et al., 2018). Estimating impulse responses using local projections has been used extensively in the literature in recent years, including in studies related to the pass-through from international oil price shocks to retail fuel prices (Kpodar and

⁵ Misspecification problems are potentially even more relevant in the context of our study, since we use panel data consisting of a wide range of countries, which makes it more difficult to specify the estimation equations from the viewpoint of economic theory.

⁶ We use the local currency price of fuel rather than the dollar price to avoid dividing by an endogenous variable (Blanchard and Galí, 2007).

Abdallah, 2017), the effects of fiscal policy shocks (Auerbach and Gorodnichenko, 2013; Ramey et al., 2018), and the effects of exchange rate shocks (Caselli et al., 2019), among others. To investigate the potential heterogeneity in the effects, we modify the baseline specification in (2a) to allow them to vary according to country-level factors, including energy intensity, central bank credibility, and labor market flexibility, among others. The modified specification is as follows:

$$y_{i,t+h} = G_0^h y_{it} + G_1^h y_{i,t-1} + \dots + G_h^h y_{i,t-p} + \beta_1^h D_{it} EP_{it} + \beta_2^h (1 - D_{it}) EP_{it} + \gamma_t^h + f_i^h + \varepsilon_{i,t+h} \quad (2b)$$

where D_{it} is an indicator denoting these factors and is interacted with the shock variable. The indicator D_{it} is a binary variable equal to 1 if a factor is above or below a certain threshold (e.g., X^{th} percentile or mean) and 0 otherwise. We also ask whether the estimated effects vary according to the magnitude of the change in energy prices. To do so, we split the energy price growth variable into two variables—with one containing larger changes ΔEP_{it}^l and another containing smaller changes ΔEP_{it}^s —according to the following criteria:

$$\Delta EP_{it}^l = \begin{cases} \Delta EP_{i,t} | \Delta EP_{i,t} \geq \Delta \bar{EP}_{i,t} \\ 0 | \Delta EP_{i,t} < \Delta \bar{EP}_{i,t} \end{cases}$$

$$\Delta EP_{it}^s = \begin{cases} \Delta EP_{i,t} | \Delta EP_{i,t} < \Delta \bar{EP}_{i,t} \\ 0 | \Delta EP_{i,t} \geq \Delta \bar{EP}_{i,t} \end{cases}$$

The above criteria consider how the absolute value of the change in energy prices $|\Delta EP_{i,t}|$ compares to a certain threshold $\Delta \bar{EP}_{i,t}$ —here, it is set to be equal to 2 standard deviations for the change in energy prices across the sample (around 5 percent). Overall, compared to an estimation strategy whereby one would split the sample into two country groups based on some factors or characteristics, the joint estimation allowed by the LP framework also leads to gains in efficiency. While the local projection approach allows us to estimate the impulse responses of interest more accurately, it doesn't address the important issue of identifying the causal effects of domestic retail energy price shocks on inflation. Imposing identifying restrictions is needed for that purpose.

In the current context, strict exogeneity would not be required. A much weaker—and more defensible assumption—is that changes in domestic energy prices are predetermined with respect to domestic macroeconomic variables (Davis and Haltiwanger, 2001; Lee and Ni, 2002; Kilian, 2008; Blanchard and Galí, 2007). In other words, the retail price of energy is assumed to respond, with a delay, to changes in macroeconomic conditions—a standard assumption in the literature. The study by (Kilian and Vega, 2011) lends credence to such exclusion restrictions in monthly retail fuel price models—ruling out instantaneous feedback from domestic macroeconomic aggregates to retail energy prices. This helps to reinforce confidence in our identification strategy, especially that we also use data at the same frequency (Kilian, 2008).⁷ In practice, this is implemented by imposing a recursive identification strategy where domestic retail energy prices are ordered first. While the analysis in Jordà (2005) does not explicitly discuss the distinction between structural and reduced form impulse responses derived from local projections, the impulse responses in his study are obtained using similar identification (Jordà 2005, pp. 175).

Finally, in estimating the impulse responses, we include in each equation 12 lags of each endogenous variable. Prior to estimation, we transform all data to log first differences (except for the interest rate variable, which we first-difference only). We estimate each equation, for each horizon, by least squares techniques. Finally, for hypothesis testing, we use standard errors that are clustered at the country level and are robust to heteroscedasticity and autocorrelation. The standard errors are estimated while allowing for an arbitrary covariance structure between time periods (Bertrand, Duflo, and Mullainathan, 2004). This procedure can be generalized to an estimator of the variance covariance matrix which is consistent in the presence of any correlation pattern within countries over time. Here, we use a generalized White-like formula to compute the standard errors.⁸ Despite its generality, the approach does quite well, especially when the sample size is sufficiently large (Bertrand, Duflo, and Mullainathan, 2004).⁹ We report 90 percent confidence bands around the estimates.

2.2. Data and stylized facts

In this study, we extract from the database compiled in Kpodar and Abdallah (2017) monthly domestic retail fuel prices over the period 2000:1 to 2016:6 for a sample of 110 countries, of which 31 are high income countries, 42 are emerging countries and 37 are low-income countries.¹⁰ We use the retail gasoline price as the fuel price variable in all specifications, throughout our study. Using the retail diesel price produces similar results. The unbalanced panel data in this study contains around 12,600 observations—an order of magnitude greater than has been used in most studies on the macroeconomic

⁷ The assumption that changes in fuel prices are predetermined with respect to macroeconomic variables is typically inappropriate when working with annual data. The literature supports its use when working with high frequency data in general—and with monthly data, in particular (Kilian, 2008).

⁸ This is analogous to applying the Newey-West correction (Newey and West 1987) in the panel context where we allow for all lags to potentially be important.

⁹ This is implemented in a straightforward way by using the cluster command in STATA, and choosing entire countries (and not only country-time cells) as clusters.

effects of fuel price shocks to date. We group countries according to income levels and structural or institutional factors and estimate our effects according to such groupings. The remaining variables are obtained from the IMF's International Finance Statistics (IFS) database and Haver Analytics. Fig. 1 displays the evolution of monthly domestic retail fuel prices for three groups of countries since 2000. It shows the monthly U.S. dollar price of a liter of fuel. As the figure suggests, there is great heterogeneity across countries. Moreover, not only the distribution of these changes has not been uniform, but also their incidence has not always been common to all countries. For instance, retail fuel prices appear to display somewhat less variability in some emerging and low-income countries mainly reflecting a prevalence of regulated fuel prices. Finally, changes in retail energy prices appear to be correlated with inflation across countries in the sample (see Fig. 2).

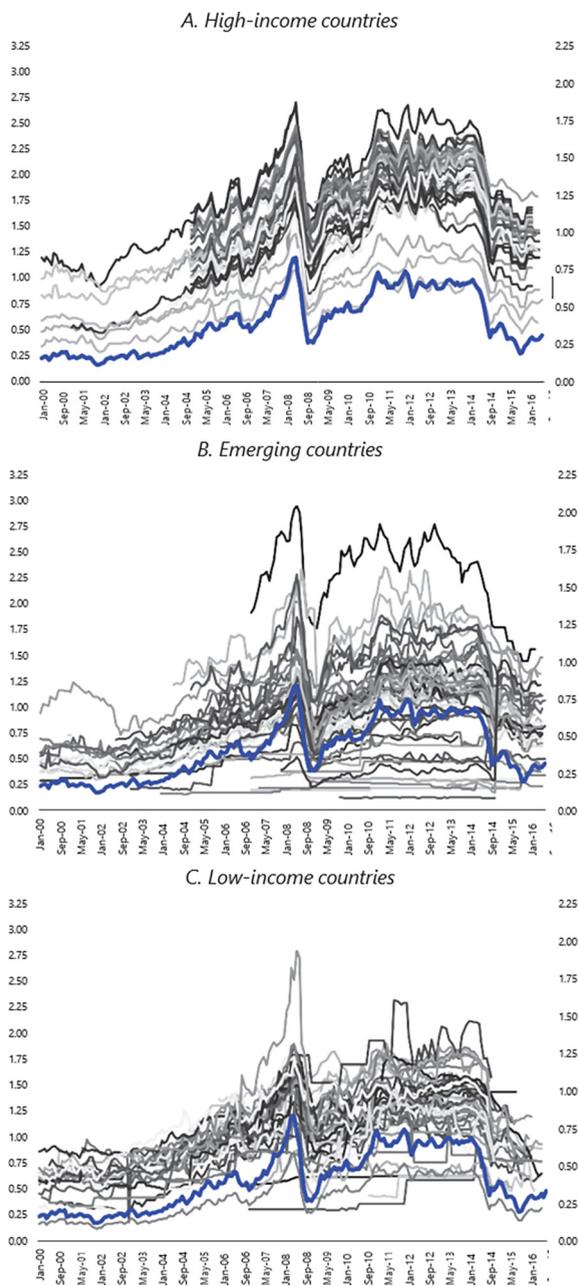


Fig. 1. Monthly Retail Energy Prices (USD per liter) Source: Kpodar and Abdallah (2017). Note: Retail fuel prices (USD per liter, left axis). The solid blue line corresponds to the international crude oil price (USD per liter, right axis). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)



Fig. 2. Changes in Retail Energy Prices and Inflation (Average, 2000–2016) Source: IMF staff calculations. Note: The scatter plot contains data for 110 countries, for which data on both headline CPI inflation and fuel prices were available.

3. Empirical findings

3.1. Baseline estimates

As discussed earlier, our impulse response functions to the energy price shocks are estimated using local linear projections. The responses are accumulated (so that they indicate the impact on the price level) and are shown for up to a 24-month horizon. The 90 percent confidence intervals (shaded area) are also shown around the estimate. The size of the shock is normalized so that it raises the energy price of energy by 1 percent on impact in all specifications, for comparability.

We first estimate the effects using a measure of core (non-energy) inflation, which we carefully compile to be comparable across countries. However, the lack of data restricted the sample to 77 countries (out of the original sample of 110 countries in this study)—and to a smaller time period in many of these countries.¹⁰ The impact on the price level (not shown)—when using this measure of inflation as the variable of interest—is positive and significant, suggesting that indirect and second round effects due to increases in energy price shocks are prevalent in the data (at least in the case of these 77 countries). Nevertheless, using this measure has obvious shortcomings due to the smaller coverage across countries, which we weigh against the advantage of estimating effects using 33 additional countries and over longer periods—which may be crucial to help improve our understanding of the effects being investigated in this study. For this reason, we will use headline inflation as the variable of interest for the remainder of our analysis.

Fig. 3 presents the results for the full sample of countries. As shown, the retail price of energy increases on impact by 1 percent, with the increase being persistent, remaining positive and significant over longer horizons. More specifically, it gradually decreases, reaching around 0.4 percent 12 months following the shock—after which it stays at around 0.3–0.4 percent 24 months after the shock. The price level responds positively to retail energy price shocks. The response is transitory peaking at around 0.025 percent, twelve months after the shock, then gradually decreases and becomes insignificant over longer horizons. Overall, this result suggests that the spillovers from energy price shocks to the consumer price level are, on average, somewhat modest and do not generally lead to permanent effects. This is consistent with empirical evidence suggesting that unpredictable changes in energy prices have historically been followed by a one-time adjustment in the price level, resulting in a blip in the inflation rate rather than sustained increase in the price level (Kilian and Lewis 2011). However, the findings for the full sample of countries can potentially mask a significant heterogeneity in the magnitude and the persistence of the effects of such shocks across countries.

Fig. 4 displays the (accumulated) impulse response functions of domestic inflation for two main country groups. As shown, the consumer price level in emerging and developing countries exhibits a larger and more persistent response peaking at around 0.05 percent, 16 months after the shock. In comparison, the consumer price level in advanced countries exhibits a much smaller and more transitory response—with a peak of around 0.01 percent—5 times smaller than that of the other country group—that quickly dissipates few months after the shock. The relatively large and persistent response for

¹⁰ Data on CPI excluding energy was compiled for 77 countries using various sources, including the IFS, IMF STA, Haver, and CEIC databases. For a number of countries, this variable was not readily available, and was imputed using information on the weights of energy in the CPI basket.

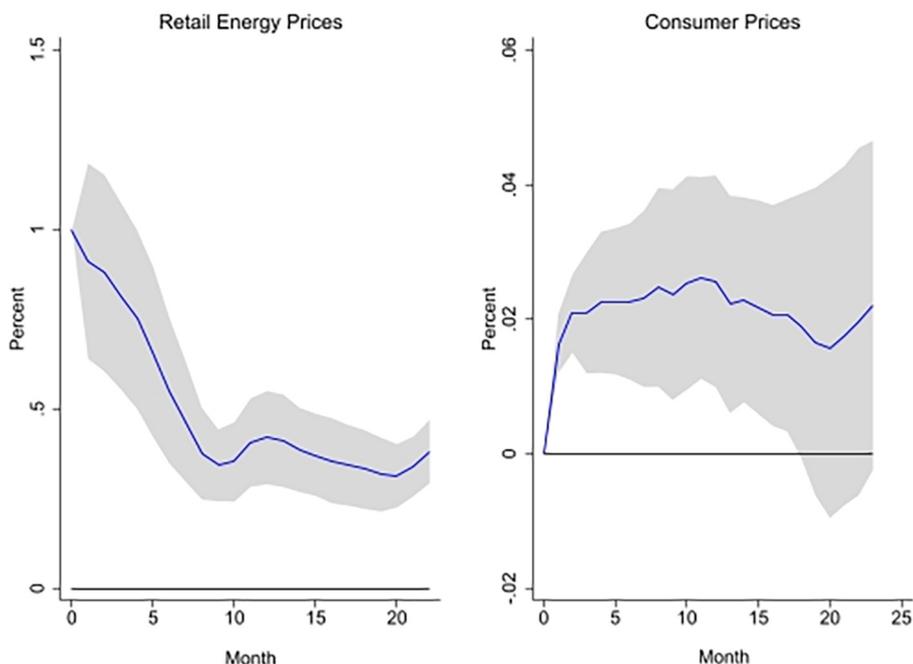


Fig. 3. Dynamic Responses of the Levels of Retail Price of Energy and Consumer Prices (All countries, 1 percent shock) Note: The estimate (solid line) and the 90 percent confidence intervals (shaded area) are shown.

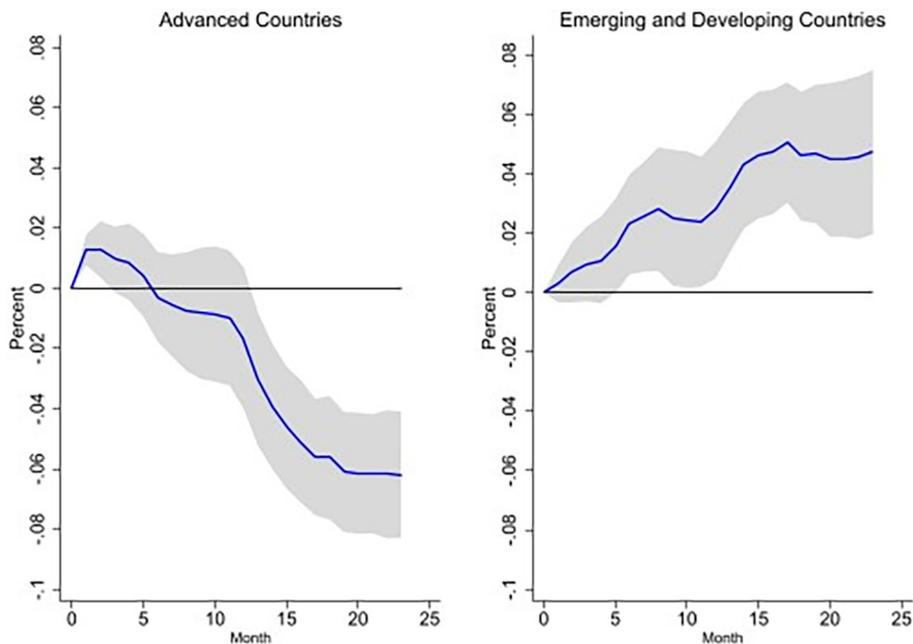


Fig. 4. Dynamic Responses of the Consumer Price Level (By Income group, 1 Percent Energy Price Shock) Note: The estimate (solid line) and the 90 percent confidence intervals (shaded area) are shown.

the emerging economies group—which is predominated by fast growing emerging economies in Developing Asia—is consistent with the evidence in Cunado and Perez de Garcia (2005) who also finds a sizeable inflationary impact of oil price shocks in this sample of countries.

3.2. Explaining the cross-country heterogeneity in the responses

There are several potential explanations behind the pattern of differentiated responses of inflation to fuel price shocks across country groups. On the one hand, economies that have a relatively high energy intensity—compared to other country groups—are expected to experience larger movements in domestic inflation due to fuel price shocks. This is the case of emerging and low-income countries, for which the responses of domestic inflation were estimated to be, on average, higher than that of the low energy intensive high-income economies. On the other hand, the persistence in the inflationary effects of retail fuel price shocks in emerging economies is suggestive of possible second-round effects. Such effects may come largely because of rising inflation expectations following the incidence of shocks in this group of countries. This is because, for example, forward-looking workers and employers may build higher inflation into future wages and prices. In this sense, labor market rigidities, such as the rigidity of wages, can play an important role here through the wage spiral channel.

The smaller and more transitory response of inflation in advanced economies may potentially reflect relatively more credible monetary policies. The importance of the role of monetary policy for containing inflationary pressures associated with energy price shocks has been well highlighted in the literature (Bernanke et al., 1997; Blanchard and Galí, 2007). For instance, to the extent that the public views the central bank's policy response as sufficiently credible, fuel price changes should not be associated with sustained effects in inflation. Hence, the response of inflation expectations to energy prices can be very important for monetary policy. The consensus is that a central bank with perfect credibility should target core inflation (excluding volatile commodity prices such as the price of

fuel). Nevertheless, if energy prices have excessive impact on inflationary expectations, larger monetary policy responses to energy price changes may be warranted (Cavallo, 2008; Harris et al., 2009). But assuming that there is a generally high degree of central bank credibility, there is no reason for such expectations to develop.

In the current environment, major central banks have already responded to inflationary pressures by raising interest rates. However, the exact amount of policy tightening required to lower inflation without inducing a recession is difficult to ascertain. Beyond the initial level of inflation, inflation expectations, and labor market and price rigidities, another important factor that has proven to be crucial in lowering the cost of disinflation in past episodes is the stance of fiscal policy. From this perspective, the role of fiscal policy in supporting the tightening of the overall macroeconomic policy stance is without doubt key—with the importance for changes in fiscal policy to be budget-neutral (at a minimum), with any additional transfers offset elsewhere.

Hence, we carefully explore the role of these four structural and institutional factors—energy intensity, flexibility of labor markets, the fiscal stance, and monetary policy credibility—in helping to explain the observed differences in the size and the persistence of the estimated effects of energy price shocks on the domestic price level across different country groups.¹¹ To do so, we classify countries according to these factors as follows:

Energy intensity. We use data on the share of energy in the economy from the OECD library, over 2000–14. We classify a country as *more energy intensive* if its net inland quantity of energy consumed relative to total real output produced falls above the median of the cross-country distribution. Otherwise, it is classified as *less energy intensive*.

Labor market flexibility. We use data on the extent to which wages are flexibly determined, including on the centralization of collective bargaining in the wage setting process. Data are from the 2014 *Global Competitiveness Report* published by the World Economic Forum (WEF). We classify a country as having relatively *more flexible labor markets* if the score on this indicator falls above the median of the cross-country distribution. Otherwise, it is classified as having relatively *less flexible labor markets*.

The fiscal stance: We use data on the change in primary net lending/borrowing by country from the International Monetary Fund's Fiscal Monitor Database (median over 2000–14). We then classify a country as having a relatively *looser fiscal policy stance* if the change in its primary net lending/borrowing (median over the sample period) falls below the median of the cross-country distribution. Otherwise, it is classified as having relatively *tighter fiscal policy stance*.

Monetary policy credibility. We use the Central Bank Autonomy index developed in Dincer and Eichengreen (2014). The index measures the degree of independence and transparency of a central bank—including its ability to select the objectives of monetary policy and its policy instruments. These dimensions are important for establishing and strengthening policy credibility. We consider a country to have a *more credible monetary policy* if its score on this indicator falls above the median of the cross-country distribution. Otherwise, it is classified as having a *less credible monetary policy*.

Figs. 5a–5d present the effects of a 1 percent retail energy price shock on the domestic consumer price level for the different country groups. The results suggest that these fundamentals or structural factors matter a great deal in explaining the differences in the responses of the consumer price level to retail energy price shocks across countries. First, as expected, we find that the response is more significant in the country group classified as more energy intensive (Fig. 5a). The price level rises gradually in response to the shock, reaching a peak of 0.028 percent in this group, and lasting for up to 17 months after the shock. While the response of the price level in the other country group is roughly similar, based on the peak estimate, it is much less persistent. In fact, the response is short-lived, lasting only up to 5 months, after which it becomes small and sta-

¹¹ These factors have been found to be important in the literature in explaining the extent to which fuel price shocks affect inflation (Blanchard and Galí, 2007; Gelos and Ustyugova, 2017).

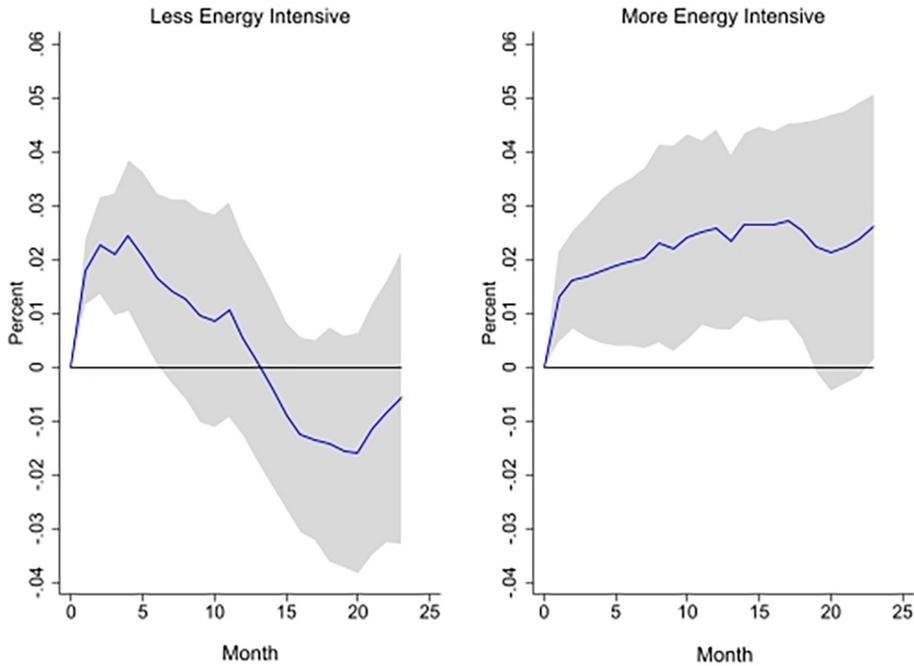


Fig. 5a. Dynamic Responses of the Consumer Price Level Note: The estimate (solid line) and the 90 percent confidence intervals (shaded area) are shown.

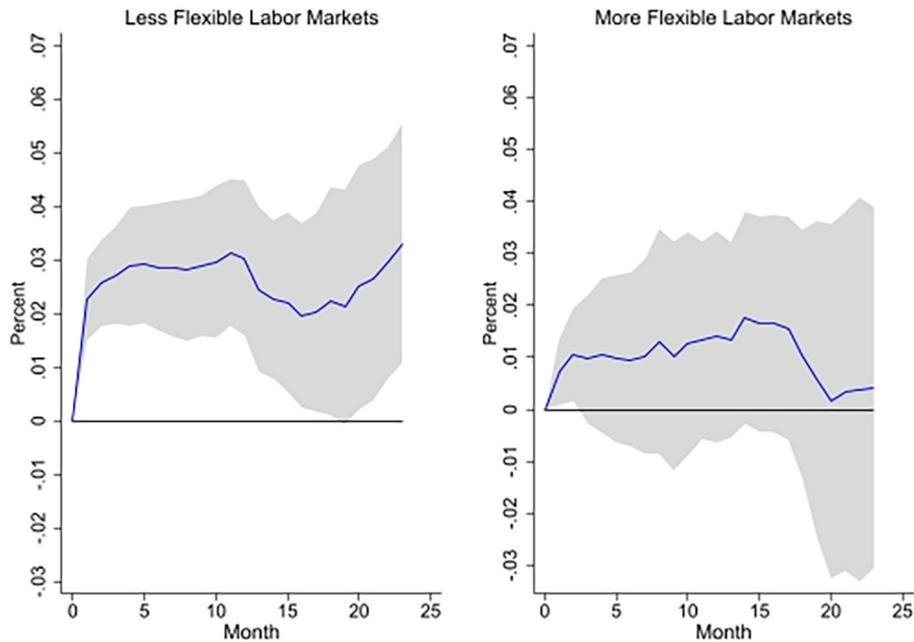


Fig. 5b. Dynamic Responses of the Consumer Price Level Note: The estimate (solid line) and the 90 percent confidence intervals (shaded area) are shown.

tistically insignificant. Gregorio et al. (2007) also finds that, in a group of advanced countries, the spillover from fuel price shocks on domestic inflation depends on the level of energy intensity.

Fig. 5b shows that the estimated response of the consumer price level is also significantly larger in the group classified as having *less flexible labor markets*. The peak response of inflation (0.03 percent) for this group is around twice higher than that of the group characterized by *more flexible labor markets* (0.016 percent). The effects are also notably more persistent for the former group, with the effects lasting up to 24 months after the shock, compared to around only 2 months for the group of countries with more flexible markets. This could potentially imply the prevalence of sizable wage spiral effects in this group

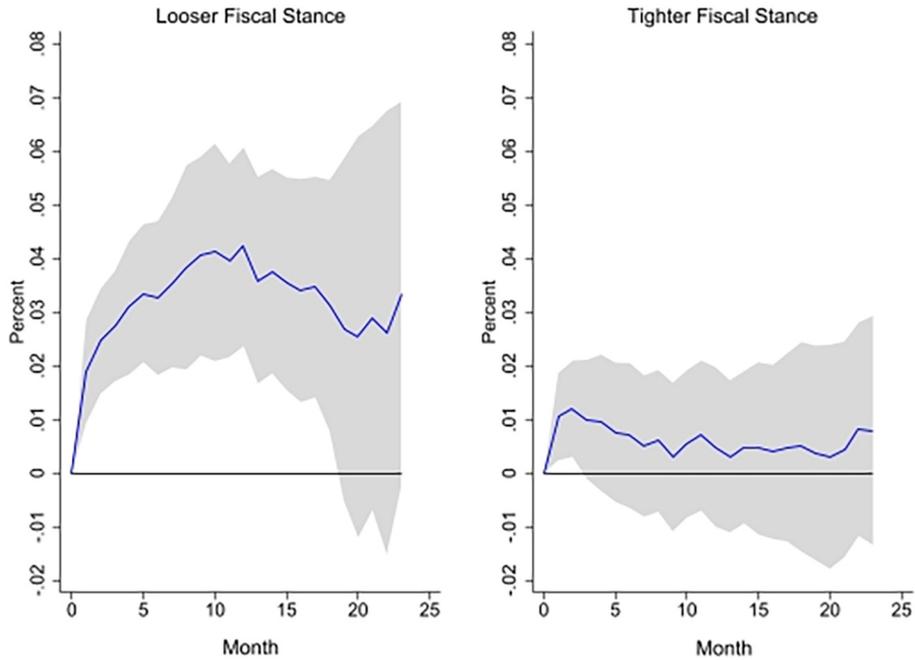


Fig. 5c. Dynamic Responses of the Consumer Price Level Note: The estimate (solid line) and the 90 percent confidence intervals (shaded area) are shown.

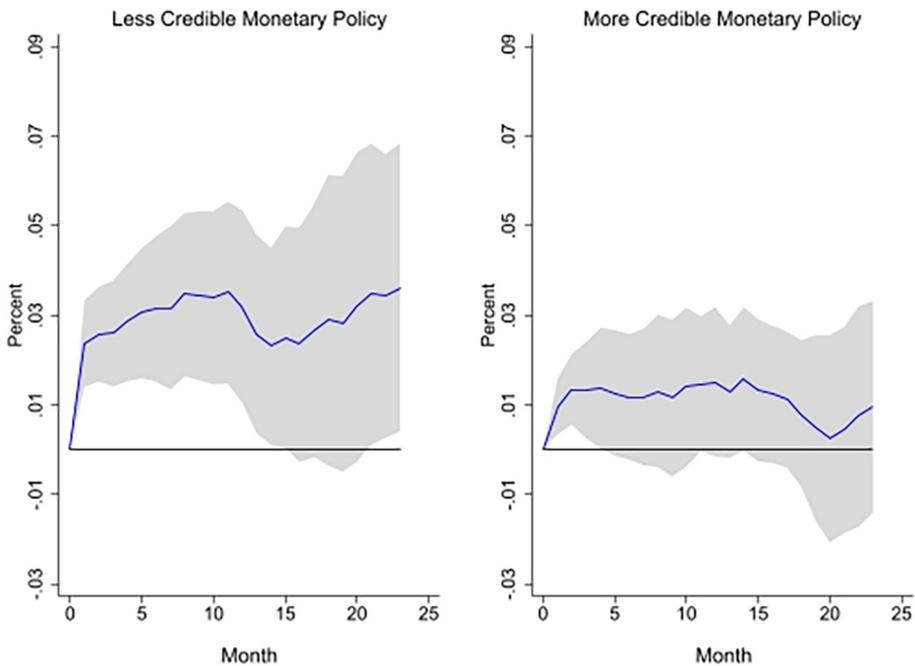


Fig. 5d. Dynamic Responses of the Consumer Price Level Note: The estimate (solid line) and the 90 percent confidence intervals (shaded area) are shown.

of countries. The analysis in [Blanchard and Galí \(2007\)](#) suggests that the presence of some rigidity in the adjustment of labor markets to the shocks is a necessary ingredient to generate significant fluctuations in measures of inflation and output. Our finding is in contrast with the results in [Gelos and Ustyugova \(2017\)](#) who found that, in a group of 31 advanced and 61 emerging and developing countries over 2001–10, the inflationary impact of global fuel price increases does not appear to be significantly affected by labor market factors.

Our findings also suggest that countries with a relatively looser fiscal policy stance exhibit a larger (peak response of 0.042 percent) and more persistent impact of energy price shocks on the consumer price level, with the effects lasting up to 18 months after the shock (Fig. 5c). On the other hand, countries with a relatively tighter fiscal policy stance exhibit somewhat smaller effects (peak response of 0.012 percent). The effects are also short-lived for this group, lasting only up to 2 months, after which they become small and statistically insignificant (Fig. 5c). This result highlights the importance of fiscal policy in supporting monetary policy in the fight against the inflationary impact of energy price shocks. One way for this

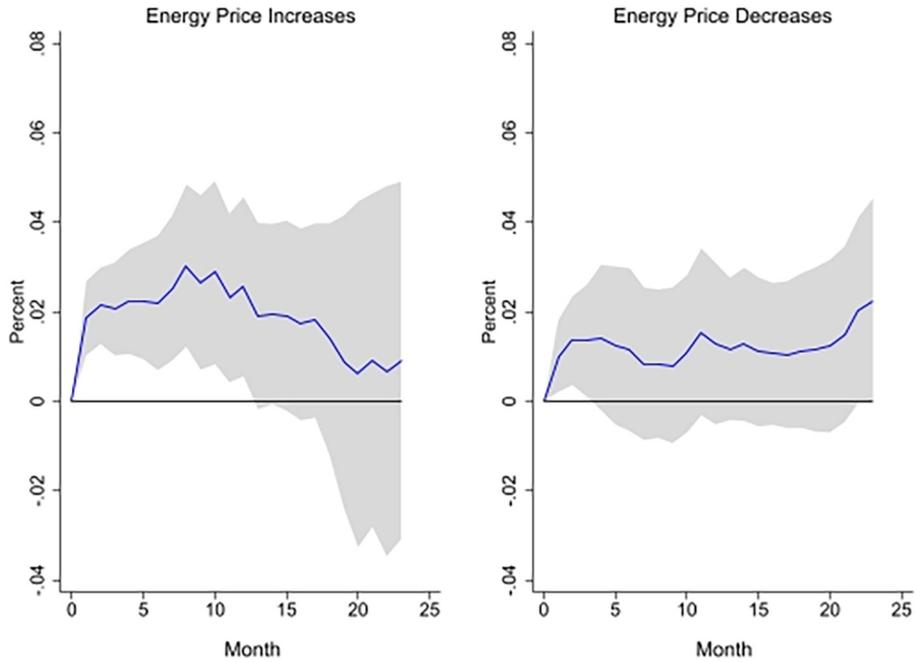


Fig. 6. Dynamic Responses of the Consumer Price Level Note: The estimate (solid line) and the 90 percent confidence intervals (shaded area) are shown.

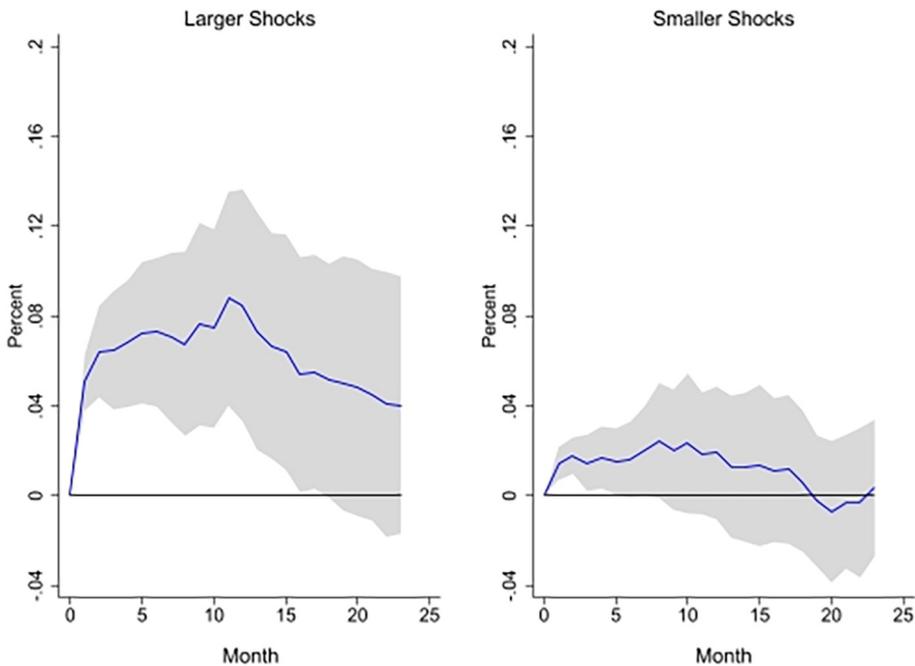


Fig. 7. Dynamic Responses of the Consumer Price Level Note: The estimate (solid line) and the 90 percent confidence intervals (shaded area) are shown.

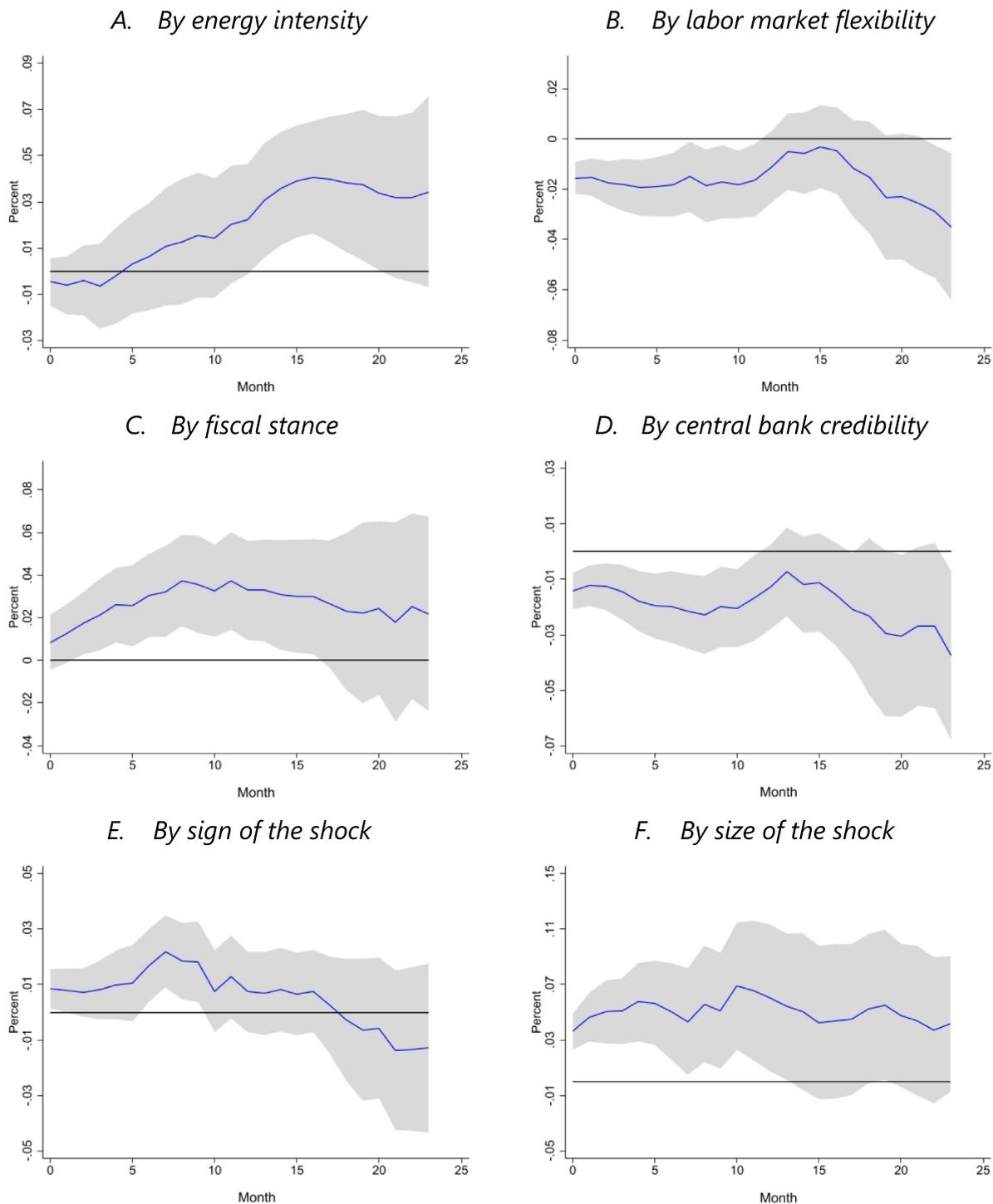


Fig. 8. Differences in the Impulse Responses of the Consumer Price Level to the Shocks Note: The estimate (solid line) and the 90 percent confidence intervals (shaded area) are shown.

to be achieved is perhaps through public wage policy, by helping to avert a wage-price spiral—especially in countries where the public sector is large enough to affect the wage setting mechanism in the economy.

The response of the consumer price level is also larger, more persistent and more significant in the group characterized by a less credible monetary policy—with a peak response of 0.035 percent and effects lasting for up to 24 months after the shock. In contrast, the response of the price level among the group of countries characterized by more credible monetary

policy regimes is smaller (peak response of around 0.012) and more transitory lasting only up to 3 months, after which it becomes statistically insignificant. (Fig. 5d). This result highlights the important role of monetary policy in the transmission of energy price shocks to domestic inflation.

In particular, a more credible monetary policy, with a commitment to maintaining a low and stable rate of inflation—including through the widespread adoption of inflation targets—is, as expected, successful in anchoring long-run inflation expectations and securing a low-inflation environment in the face of energy price shocks.

We also investigate potential non-linearities and asymmetries in the response of inflation—and consequently the price level—to energy price shocks. First, the magnitude of the shock potentially matters because, for example, expectations about inflation are more likely to be affected and may be more prone to get de-anchored when the changes in energy prices are larger. Second, there is no reason to expect, a priori, that increases and decreases in energy prices have similar effects on the price level.

Figs. 6 and 7 presents the results. We find that energy price increases tend to have larger and more significant impact than energy price decreases on the price level (Fig. 6). We also find that larger energy price shocks tend to lead, on average, to larger and more persistent effects on the price level (Fig. 7).

In particular, the effects of larger energy price shocks on the price level last up to 16 months after the shock, with a peak response of around 0.09 percent. In contrast, the effects of smaller shocks are smaller—peaking at around 0.02 percent—and much more transitory, lasting only up to 5 months after the shock. These findings suggest that central banks may need to act more vigilant in addressing the impact of large increases in energy prices. Finally, for each case (Figs. 5a-7), we test whether the differences (between groups) in the responses of the price level to the shocks are statistically significant. Fig. 8 present the findings, which suggest that the differences in the impulse responses are statistically significant—albeit the evidence is weaker in the case of the results according to the sign of the shock (Fig. 8, panel E).

4. Conclusion

This paper estimates the dynamic responses of the domestic consumer price level to energy price shocks. Unlike most other studies on the relationship between energy price changes and inflation, we use a rich novel dataset on monthly retail domestic energy prices for a large set of high income, emerging and low-income countries over 2000–16. We find that, on average, the effects of energy price changes are somewhat modest and transitory. However, the effects tend to vary considerably across countries. We attempt to explain this heterogeneity in the effects across countries and find that the impact of changes in energy prices on the consumer price level depends on key economic and structural factors.

In particular, the impact can be larger and more persistent in countries characterized by higher energy intensity, lesser labor market flexibility, looser fiscal policy stance, and lower monetary policy credibility. We also find evidence of non-linearity and asymmetry in the responses, with both positive energy price shocks and energy price shocks of larger magnitudes leading to larger and more persistent effects on the consumer price level. Our results may have direct implications for how central bank ought to react to the current energy price shocks. More specifically, different central banks may face different trade-offs in their response to an energy price shock of a given magnitude—with some central banks needing to react more aggressive to avert the inflationary impact of such shocks, depending on the set of structural and institutional factors that characterize their economies.

Data availability

Data will be made available on request.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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