Borradores de ECONOMÍA

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Núm. 967
2016

BANCO DE LA REPÚBLICA COLOMBIA
Bogotá - Colombia - Bogotá - Colombia - Bogotá - Colombia - Bogotá - Colombia - Bogotá - Colombia - Bogotá - Colombia

Policy Responses to Commodity Price Fluctuations

Javier G. Gómez-Pineda*†

Abstract

The world economy has recently been hit by commodity price fluctuations, with first round effects on noncore inflation and second round effects on core inflation. The policy response to these fluctuations depends on the first and second round effects as well as on the strength of the central bank reaction to core inflation. The impulse responses and the historical error decomposition exercises show that the second round effects have followed two cycles, the first one before and after Lehman crisis; the second one, starting in 2010, have exerted particularly strong downward pressure on interest rates since 2015. The results are obtained with a global model of the largest five systemic economies plus one non systemic economy. In the model, latent variables are obtained with the multivariate Kalman filter and parameters are estimated with Bayesian methods.

JEL classification: E58; E37; E43; Q43

Keywords: Commodity prices; Oil price shocks; Second round effects; Inflation

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*October 14, 2016.

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1 Introduction

Commodity price fluctuations raise important questions for monetary policy. Should central banks react to CPI inflation adding variability to the economy? If central banks target core inflation, what is the effect on core inflation of commodity price fluctuations? What is the strength of the policy reaction to core inflation? What has been the record so far? The paper deals with the answers to the last three questions.

Among the papers dealing with the policy reaction to commodity price fluctuations two stand out. The first paper is De Gregorio (2012) where a feedback central bank rule is defined on CPI inflation to help tame the second round effects of commodity price fluctuations. Instead, we define the feedback rule on core inflation but incorporate the second round effects as a reduced-form effect of noncore inflation on core inflation. The reason is that a central bank reaction to noncore inflation adds variability to the economy; or in other words, inflation targeting is demand management, supply side shocks left aside. Our set up does not necessarily mean that central bank targets should be defined on core inflation. It only means that core inflation can help in the operation of monetary policy, by setting aside the supply shocks that sooner or later should fade away. De Gregorio also finds stronger second round effects of commodity food fluctuations, compared to the second round effect of oil price fluctuations. His results can be easily reconciled with ours, as we incorporate both oil and food commodity price fluctuations weighted by the shares of oil and food in the CPI.

The second paper is Gelos and Ustyugova (2012) where the share of food in the CPI is shown to explain the extent of the effect of noncore inflation on core inflation. Their result is compatible with our definition of noncore inflation and the share of food in the CPI in the countries considered in our study.

This paper has six sections including the introduction. Section 2 presents the transmission mechanisms from commodity price fluctuations to the policy response. It begins with the transmission from commodity prices to noncore inflation, continues with the transmission to core inflation and finally tackles the specification of the policy rule and the definition of the real interest rate. Section three presents the sources of the data. Section four describes the model estimation and calibration. Section five presents the results and finally section six concludes.

2 The Model

The model of the paper is a simple, however large, central bank gap model; it is a variant of the models in Gómez, Guillaume and Tanyeri (2015) (GGT) and Gómez and Julio (2016) (GT). The former paper, GGT, proposes a global model where the countries are arranged in six blocks, the blocks of the IMF

Global Projection Model (GPM). The later paper, GT, adds a model for Colombia so that the global model accounts for a consistent block of so called "rest of the world" variables.[1]

The model in this paper includes five systemic economies and one nonsystemic economy: the United States, Europe, Japan, China, the United Kingdom and Colombia. The setup of the model enables us to study the effects of developments in each of the systemic economies on the world economy, the systemic economies themselves and on the nonsystemic economy, Colombia. The relatively small number of economies account for 50 percent of world output.

The focus of this paper is on the transmission from commodity oil and food price fluctuations to country core inflation and the policy response. To this end, we add to the simple gap model a *commodity prices channel*. The channel has two strands. The first one is the effect of oil prices on country energy prices and from country energy prices to country CPI inflation. The second strand is the effect of commodity food prices on country food prices and from country food prices to CPI inflation.

In the following section we describe the model with a focus on the channels and equations that are relevant for the policy response to commodity price fluctuations. The remaining model equations are described in more detail in GGT.[2]

2.1 Commodity prices and transmission to country inflation

To formalize the first strand of the commodity price channel, let the price of oil $\hat{q}_t^{Oil}$ follow supply and demand factors

$$\hat{q}_t^{Oil} = \beta_1 \hat{q}_{t-1}^{Oil} + \beta_2 \hat{y}_t^{World} + \varepsilon_t^{\hat{q}^{Oil}}, \tag{1}$$

Supply is given by the error term $\varepsilon_t^{\hat{q}^{Oil}}$, a standard supply shock. Demand is given by the world output gap, $\hat{y}_t^{World}$. In equation (1), the price of oil is defined in real terms; defined as $q_t^{Oil} \equiv p_t^{Oil} - p_t^{US}$.

The latent price of oil follows

$$\bar{q}_t^{Oil} = \bar{q}_{t-1}^{Oil} + \frac{1}{4}\gamma_t^{q^{\,Oil} + \varepsilon_t^{\bar{q}^{Oil}}}, (2)$$

and

$$\gamma_t^{\bar{q}^{Oil}} = \beta_3 \gamma_{t-1}^{\bar{q}^{Oil}} + \varepsilon_t^{\gamma^{\bar{q}^{Oil}}}. \tag{3}$$

In the second strand, food commodity prices also follow supply $\varepsilon_t^{\hat{q}^{Food}}$ and demand $\hat{y}_t^{World}$ factors,

$$\hat{q}_t^{Food} = \beta_4 \hat{q}_{t-1}^{Food} + \beta_5 \hat{y}_t^{World} + \varepsilon_t^{\hat{q}^{Food}}. \tag{4}$$

[1]A central bank gap model is normally based on two transmission channels, an aggregate demand channel and an exchange rate channel. Besides these standard transmission channels in the small open economy, the models in GGT and GJ include three global transmission channels: a systemic risk channel, a foreign aggregate demand channel, and a foreign exchange rate channel.

[2]Among the remaining equations are the stochastic processes for latent prices, the UIP condition for bilateral real exchange rates and the identities for the nominal and real multilateral exchange rates.

Latent country energy and food prices follow processes similar to those of equations (2) and (3) for the price of oil.

The transmission from the price of oil to domestic energy prices $\hat{q}_t^e$ follows

$$\hat{q}_t^e = \nu_7 \hat{q}_{t-1}^e + \nu_8 \hat{q}_t^{Oil} + \nu_{12} \hat{q}_t + \varepsilon_t^{\hat{q}^e}, \tag{5}$$

while the transmission from food commodity prices to country food prices $\hat{q}_t^f$ is given by

$$\hat{q}_t^f = \nu_{13} \hat{q}_{t-1}^f + \nu_5 \hat{q}_t^{Food} + \nu_4 \hat{q}_t + \varepsilon_t^{\hat{q}^f}, \tag{6}$$

where $\hat{q}_t$ is the real multilateral exchange rate.

It bears emphasis that $\hat{q}_t^e$ and $\hat{q}_t^f$ in equations (5) and (6) are real prices at the country level while $\hat{q}_t^{Oil}$ and $\hat{q}_t^{Food}$ are real prices at the world level.

As for the effect of these relative prices on inflation, inflation in the energy, food, and overall CPI indexes are obtained with the identities

$$\pi_t^e \equiv \pi_t + 4(q_t^e - q_{t-1}^e), \tag{7}$$

$$\pi_t^f \equiv \pi_t + 4(q_t^f - q_{t-1}^f), \tag{8}$$

and

$$\pi_t \equiv \pi_t^c + \nu_f(q_t^f - q_{t-1}^f) + \nu_e(q_t^e - q_{t-1}^e), \tag{9}$$

where π_t is CPI inflation, π_t^c is core inflation, $q_t^e \equiv p_t^e - p_t$ is the country real price of energy, $q_t^f \equiv p_t^f - p_t$ is the country real price of food, and ν_f and ν_e are the weights of food and energy in the CPI.[3]

A measure of non core relative prices is built as an aggregate of domestic energy and food prices relative to the CPI. In deviation form, this aggregate is

$$\hat{q}_t^{NC} = \frac{\nu_e}{1-\nu_x} \hat{q}_t^e + \frac{\nu_f}{1-\nu_x} \hat{q}_t^f, \tag{10}$$

where $\nu_x = 1 - \nu_f - \nu_e$. The first difference of this relative price, a proxy of noncore inflation, is approximately equal to the deviation of CPI inflation from core inflation. It is used here to account for the second round effects of commodity price fluctuations on core inflation.

To make the second round effects of commodity prices on core inflation clear, we add our proxy of noncore inflation at the right hand side of the Phillips curve as follows:

$$\pi_t^c = (1-\nu_1)\pi_{t+1|t} + \nu_1 \pi_{t-1}^c + \nu_2 \hat{y}_t + \nu_3 \hat{q}_t^{RER} + 4\nu_{14}(\hat{q}_t^{NC} - \hat{q}_{t-1}^{NC}) + \varepsilon_t^{\pi^c}, \tag{11}$$

where $4(\hat{q}_t^{NC} - \hat{q}_{t-1}^{NC})$ is the first difference of noncore relative prices at an annual rate.

[3] Following Caravenciov et al (2013), an error term ε_t^{π} is added to equation (9) $\pi_t = \pi_t^x + \nu_f(q_t^f - q_{t-1}^f) + \nu_e(q_t^e - q_{t-1}^e) + \varepsilon_t^{\pi}$ to account for changes in ν_f and ν_e as the CPI basket changes over time. This error term is not economically meaningful; it merely ensures consistency in equation (9).

2.2 The policy rule

The nominal interest rates follows

$$i_t = \delta_1 i_{t-1} + (1-\delta_1)\left[\bar{r}_t + \pi^c_{t+1|t} + \delta_2(\pi^c_{t+5|t} - \bar{\pi}_{t+5|t}) + \delta_3 \hat{y}_t\right] + \varepsilon^i_t, \tag{12}$$

where π^c_t is core inflation or inflation excluding food and energy and $\bar{\pi}_t$ is the inflation target.

In policy rule (12), the central bank reacts to core inflation. It reacts to noncore inflation only indirectly as the Phillips curve incorporates the second round effects. The central bank does not operate with an eye on CPI inflation, instead it targets core inflation, including the second round effects, and enables energy and food relative prices adjust, as relative price changes should sooner or later fade away.

2.3 The real interest rate

It is important to devote at least a separate section to the definition of the real interest rate. The definition $r_t \equiv i_t - \pi_t$ uses contemporaneous overall inflation. But a definition that uses expected inflation may better suit forward looking consumption and investment decisions. In addition, a definition that uses core inflation is a more relevant measure of future inflation, as fluctuations in non core inflation should sooner or later fade away. Hence, we define the real interest rate as

$$r_t = i_t - \pi^c_{t+1|t}, \tag{13}$$

where, again, $\pi^c_{t+1|t}$ is expected core inflation.

A look at equation (13) reveals that, under the hypothetical assumption of no second round effects, commodity price fluctuations would have no effect on real interest rates.

3 The Data

Data are quarterly for the period 196Q1 − 2016Q2. The source of stock market data is Bloomberg Financial Services. Commodity price indexes are taken from the World Bank commodity price database. The source of policy interest rate data is country central banks. The sources of country GDP and consumer price data are the OECD database and the country statistics departments.

4 Model calibration and estimation

The model was calibrated taking into account a set of indicators such as impulse response functions, the evolution of latent variables, equation fit, error decompositions, and model forecasting performance. The calibrated parameters appear in Table 1. The backward-looking component of the output gap equations σ_2 was set at 0.7 mainly to help convergence in historical error decompositions. The interest rate smoothing parameter δ_3 was set at 0.5 as a compromise between model convergence and interest rate forecast performance. In general, most parameters were calibrated so as to obtain reasonable impulse responses and historical error decompositions.

The estimation dealt with those coefficient most relevant to the issues dealt with in the paper. The coefficients related to the first round effects are ν_5 and ν_8. The one related to the second round effects is ν_{14}. Finally, the coefficient related to the policy reaction function is δ_2 . The prior means where those found in the calibration of the model. Prior standard deviations were repeatedly reduced in a series of estimations seeking convergence in the likelihood function for each parameter.

The estimated parameters appear in Table 2. The estimation of parameters ν_5 and ν_{14} confirms the quality of the calibrated parameters as the difference between the prior and posterior means is below a tenth of the prior mean in most parameters. The estimation of parameters ν_7 and δ_2 shows that data bring useful information to the model as the differences between prior and posterior modes are large.

Table 1. Some Calibrated Parameters

$\nu_{2,US}$	0.100	$\nu_{3,US}$	0.027	$\nu_{4,US}$	-	$\delta_{3,US}$	0.516	β_1	0.500
$\nu_{2,EU}$	0.100	$\nu_{3,EU}$	0.056	$\nu_{4,EU}$	0.039	$\delta_{3,EU}$	0.509	β_2	3.000
$\nu_{2,JA}$	0.100	$\nu_{3,JA}$	0.024	$\nu_{4,JA}$	0.037	$\delta_{3,JA}$	0.576	β_4	0.700
$\nu_{2,CH}$	0.100	$\nu_{3,CH}$	0.068	$\nu_{4,CH}$	0.038	$\delta_{3,CH}$	0.570	β_5	0.500
$\nu_{2,UK}$	0.100	$\nu_{3,UK}$	0.035	$\nu_{4,UK}$	0.038	$\delta_{3,UK}$	0.516	δ_1	0.500
$\nu_{2,CO}$	0.100	$\nu_{3,CO}$	0.049	$\nu_{4,CO}$	0.040	$\delta_{3,CO}$	0.587		

Table 2. Estimated Parameters

Parameter	Prior mean	Posterior mean	Parameter	Prior mean	Posterior mean
$\nu_{5,US}$	0.020	0.019	$\nu_{14,US}$	0.020	0.028
$\nu_{5,EU}$	0.020	0.020	$\nu_{14,EU}$	0.020	0.020
$\nu_{5,JA}$	0.050	0.024	$\nu_{14,JA}$	0.035	0.035
$\nu_{5,CH}$	0.110	0.107	$\nu_{14,CH}$	0.045	0.044
$\nu_{5,UK}$	0.090	0.088	$\nu_{14,UK}$	0.030	0.029
$\nu_{5,CO}$	0.005	0.005	$\nu_{14,CO}$	0.030	0.030
$\nu_{8,US}$	0.250	0.427	$\delta_{2,US}$	1.600	1.748
$\nu_{8,EU}$	0.120	0.016	$\delta_{2,EU}$	1.600	0.745
$\nu_{8,JA}$	0.200	0.204	$\delta_{2,JA}$	1.600	1.596
$\nu_{8,CH}$	0.080	0.043	$\delta_{2,CH}$	1.600	1.952
$\nu_{8,UK}$	0.110	0.200	$\delta_{2,UK}$	1.600	1.601
$\nu_{8,CO}$	0.005	0.005	$\delta_{2,CO}$	1.600	0.665

5 Results

The results of the paper deal with the effect of commodity price fluctuations on core inflation and the policy response. The results are reported in impulse response functions and error decomposition exercises for the world economy, Figure 1, and for the country economies, Figures 2 to 5.

The response of core inflation to commodity price fluctuations depends on two factors, first, the transmission from commodity price fluctuations to country noncore inflation, that is, on the strength of the first round effects; second, the transmission from country noncore inflation to country core inflation, that is, the extent of the second round effects. In turn, the extent of the first round effects depend on three factors; first, the size of the shocks to oil and food commodity prices; second, the response of country energy and food prices to oil and food commodity price fluctuations; and third, on the share of energy and food in the CPI.

At the world level, a shock to the price of oil, with a standard deviation of 13.61 percent, rises core inflation by one tenth of one percent (Figure 1, Panel A). The rise in core inflation elicits a response slightly higher than a tenth of one percent in interest rates (Figure 2, Panel B). The rise in real interest rates causes a drop in output, of about the same order of magnitude (Figure 1, Panel C).

A shock to the commodity price of food, with a smaller standard deviation, 7.55 percent, causes responses in core inflation comparable to those of a shock to the price of oil because the share of food in the world CPI is larger. The share of food in the world CPI is 21.5 percent while the share of energy is 6.9 percent.[4]

The historical error decomposition exercises show that the second round effects of commodity price shocks on core inflation followed two cycles (Figure 1, Panel D). The first cycle took place during $2008 - 2009$. The upward phase of the first cycle was in 2008 when core inflation rose with commodity prices, the downward phase was in 2009 when core inflation dropped along with commodity prices. The second cycle covered the period $2010{-}2016$. The upward phase of the second cycle was during $2010 - 2011$, the downward phase, during $2012{-}2016$. Core inflation has dropped with commodity prices with particular strength since $2015{-}2016$ (Figure 1, Panel D).

Interest rates faced pressure from commodity prices according to the two aforementioned cycles (Figure 1, Panel E). In particular, central banks have faced strong pressure to lower interest rates since 2015.

World output also has a response to commodity price fluctuations of comparable magnitude, of about a tenth of one percent for a 10 percentage points change in commodity prices. The output gap responds to commodity price fluctuations through the monetary policy channels, that is, because interest rates respond to core inflation.

Regarding the country economies, the response of core inflation to oil price fluctuations is stronger in the United States, where the country price of energy reacts strongly to the commodity price of oil and the share of food in the CPI is small (Figure 2). In turn, the policy response to food price fluctuations is stronger in Japan, China and Colombia, with a large share of food in the CPI, as well as in the United

[4] These are country shares weighted by the share of the countries in world GDP, where world GDP is measured as the GDP of the systemic five economies.

Kingdom, with a large response to food to commodity food prices (Figure 2).

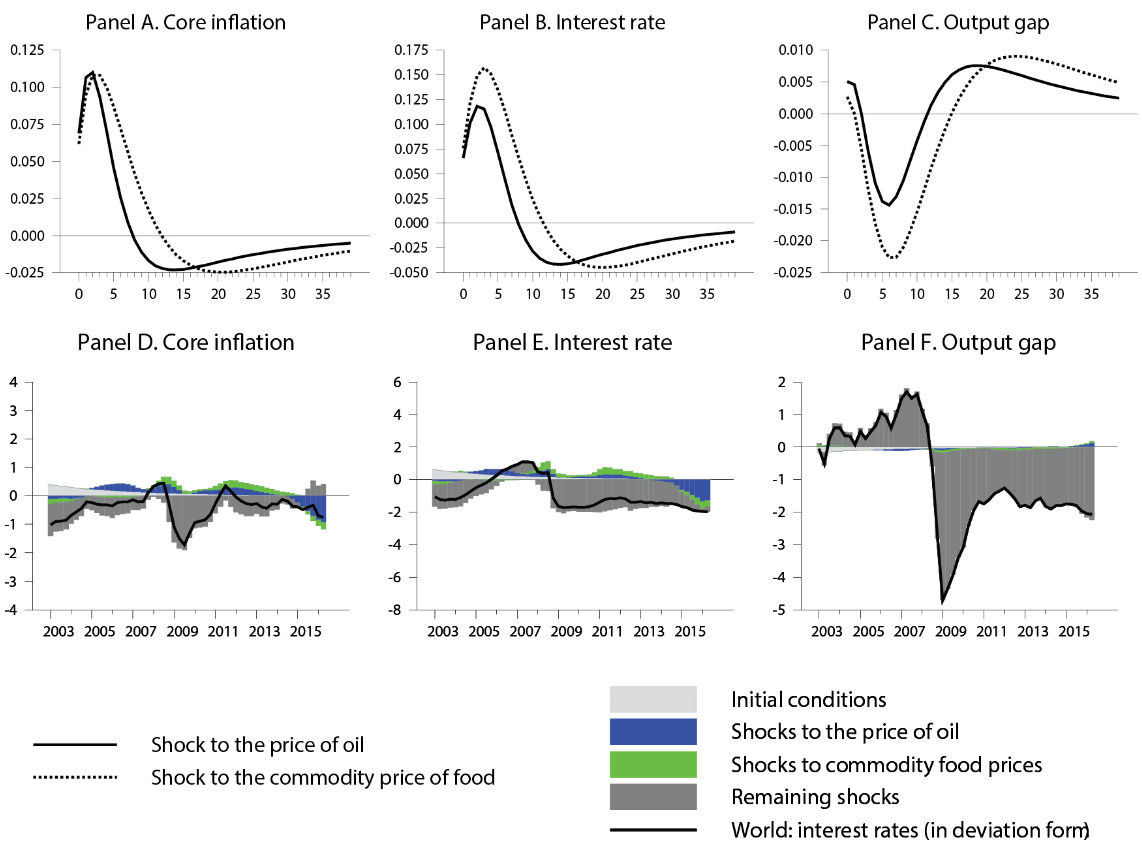
The historical error decomposition exercises display the two cycles of effects of commodity price fluctuations on core inflation across countries. Commodity price shocks tend to decrease core inflation since 2015 in all countries (Figure 4).

The policy response to commodity price fluctuations depends on the factors that affect core inflation as well as on the strength of the policy reaction. Given that the estimated policy response to core inflation was similar across countries, the policy response tends to follow the response of core inflation (Figure 3).

The historical error decomposition exercises show that commodity price fluctuations have exerted important pressure on interest rate policy, according to the two cycles of expansion and contraction, the pressure to lower interest rates has been particularly strong since 2015 (Figure 5).

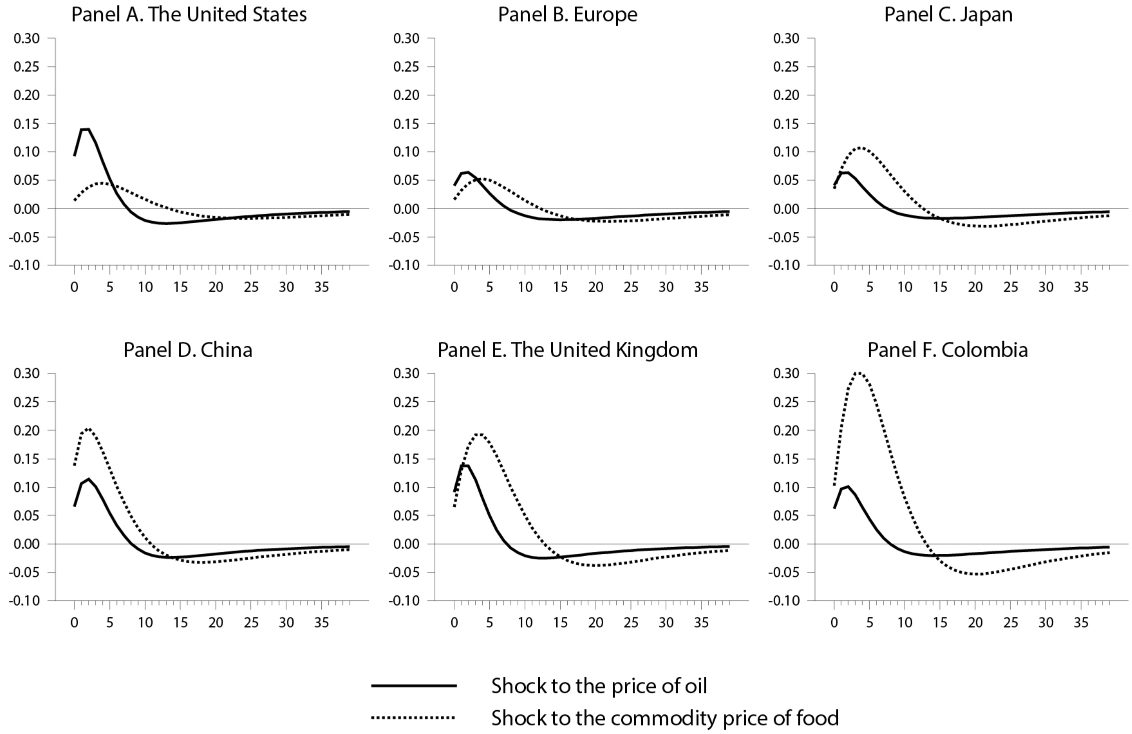
Graph 1. World core inflation, interest rate and output gap

Impulse response functions are to a one standard deviation shock; historical error decompositions in percentage points



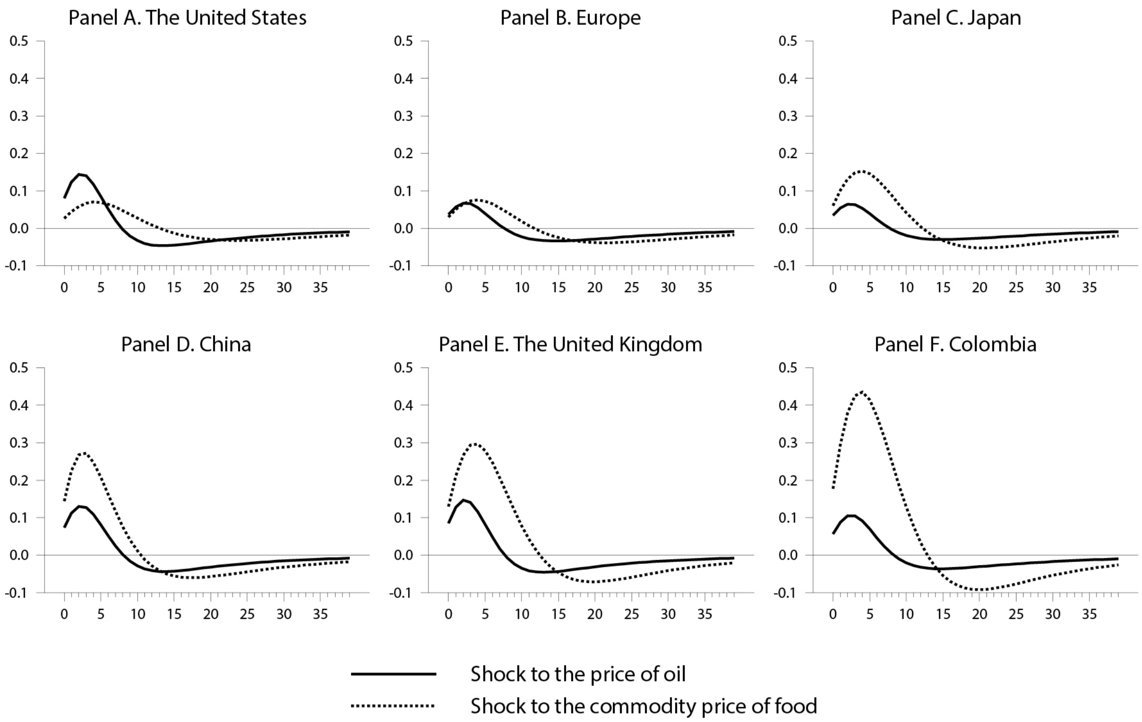
Graph 2. Response of core inflation to fluctuations in commodity prices

Response to a one standard deviation shock



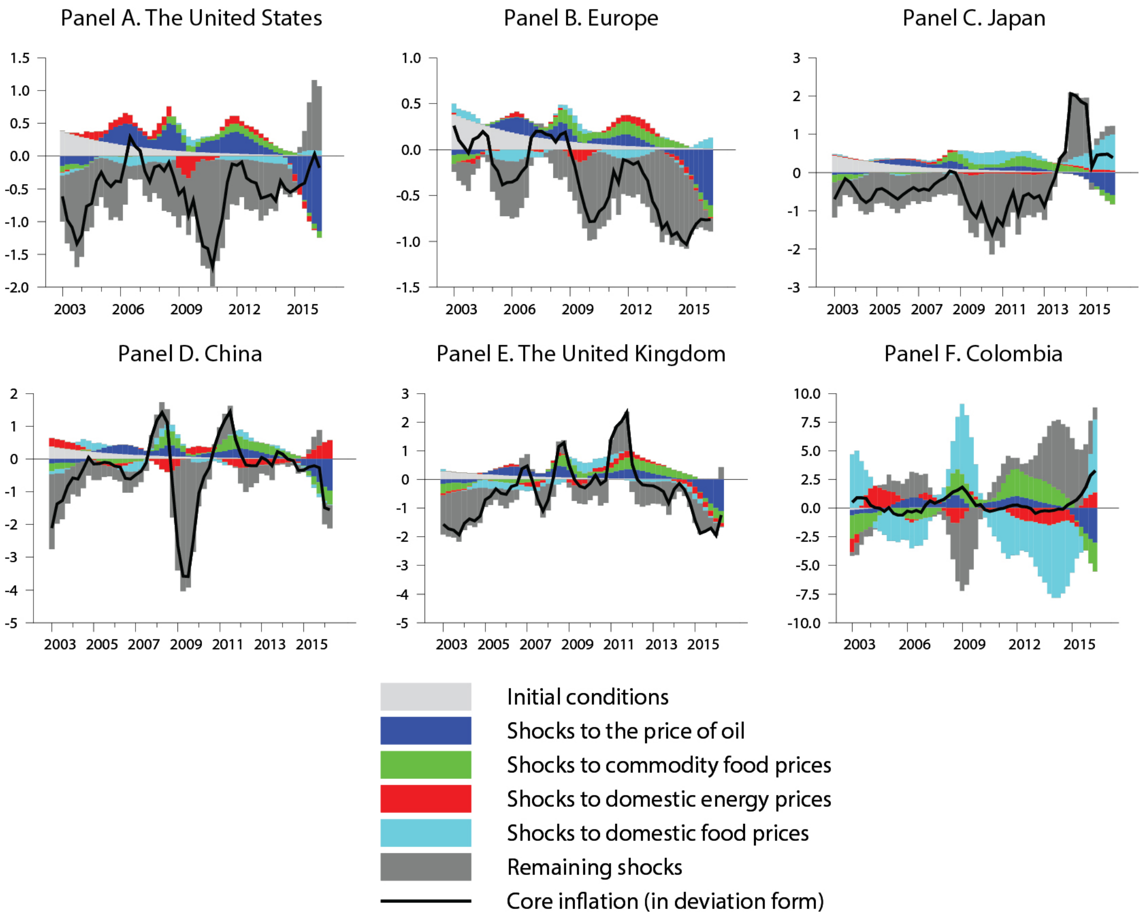
Graph 3. Policy response to commodity price fluctuations

Response to a one standard deviation shock



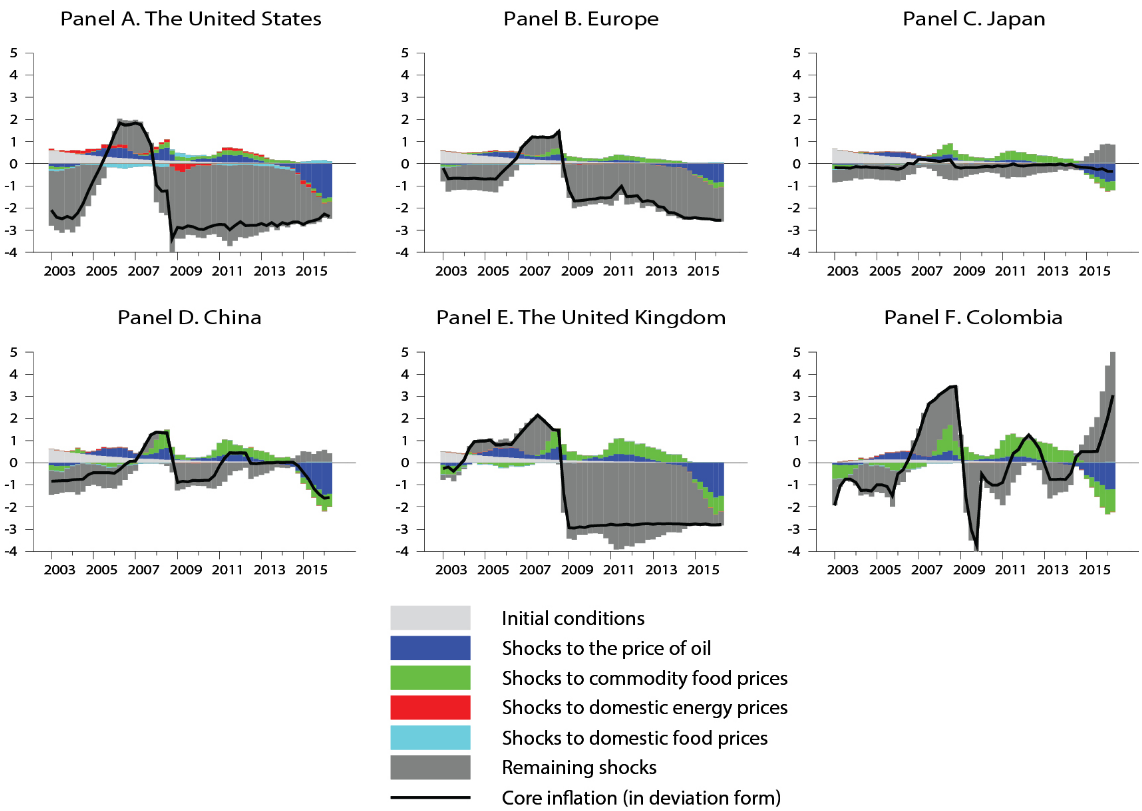
Graph 4. Country core inflation rates

Historical error decompositions; contributions in percentage points



Graph 5. Country interest rates

Historical error decompositions; contributions in percentage points



6 Conclusions

The policy response to commodity price fluctuations depends on three factors: the extent of the first round effects, the extent of the second round effects and the strength of the policy response to the second round effects. In turn, the extent of the first round effects depends on three factors: the size of the shocks to oil and food commodity prices, the extent of the effect of commodity price fluctuations on country energy and food prices and the share of energy and food in the CPI.

Shocks to oil prices have effects on core inflation at the world level that are comparable to those of commodity food prices because oil price shocks have a larger variance while food price inflation have a larger share in the CPI.

The second round effects of commodity price shocks on core inflation followed two cycles. The first cycle corresponds to the peak and trough in commodity prices in 2008 and 2009 before and after Lehman bankruptcy. The second cycle started in 2010 and has exerted strong downward pressure on core inflation particularly since 2015.

The policy response to commodity price fluctuations has followed the effect of commodity price fluctuations on core inflation, given the set up of the model. The cycles in commodity prices have exerted pressure on policy interest rates, including particularly strong downward pressure since 2015.

A limitation of the paper is that the response to commodity price fluctuations may depend on the effect of commodity prices on the terms of trade. The systemic economies included in the model are currently oil importers while the non systemic economy is a oil exporter. We leave this topic for future research.

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