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## An anatomy of external shocks in the Andean region

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# **An anatomy of external shocks in the Andean Region**

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## **Abstract**

This paper applies an agnostic structural vector autoregression (SVAR) approach to study the response of four Andean economies (Bolivia, Colombia, Ecuador, and Peru) to international shocks. More specifically, we look at the responses of these countries' gross domestic product, real exchange rate, fiscal and trade balances, and inflation to global demand, commodity price, monetary, and financial shocks. Our results confirm that the Andean region is highly exposed to changes in external conditions, and especially to global demand fluctuations associated with declines in commodity prices. However, despite the similarities that characterize these countries in terms of their income level or their export specialization, we find substantial heterogeneity in the effects of the shocks, which we attribute to differences in the shock-absorbing capacity of their macroeconomic frameworks. This result underlies the need to put in place external buffers to fully exploit the benefits of a greater presence in international markets, be it in the form of exchange rate flexibility, international reserves, or fiscal and monetary space to act countercyclically.

**Keywords:** International Shocks, World Demand, Commodities, Growth, Prices, Trade Balance, SVAR, Andean Region.

**JEL codes:** F40, F32, Q02, E31, E32.

## 1. Introduction

Latin America's resilience to the global financial crisis of 2008–09 was hailed by many observers as a historic achievement in the region's effort to shield itself from the effects of international shocks (De Gregorio, 2014; Ocampo, 2009). A few years later, however, several South American countries were coping with yet another imported shock—which served as a stark reminder of their remaining vulnerability to abrupt changes in external conditions—the end of the commodity supercycle (Roch, 2017). Given their reliance on exports of oil, gas, and metallic minerals, Andean nations were particularly affected by the collapse in the price of primary products. In fact, none of these countries has yet managed to return to the levels of economic growth that prevailed before the shock.

In spite of the shared vulnerabilities that have been exposed by the swing in commodity prices, a simple observation of the evolution of a few selected indicators in recent years suggests that the effect of the shock has been heterogeneous in the Andean subregion. For instance, using International Monetary Fund (IMF, 2019) data, while Ecuador's average economic growth between 2015 and 2018 is almost four points below that of 2010–13 (5.5% vs. 0.6%), Bolivia's gross domestic product (GDP) growth fell by less than 1% and that of Peru and Colombia by 2.8% and 3.2%, respectively. In contrast, the deterioration of Bolivia's current account was much larger than that of its peers in the subregion, having moved from an average surplus of 3.8% of GDP between 2010 and 2013 to an average deficit of 5.4% of GDP between 2015 and 2018, in contrast with that of Peru and Ecuador, which actually improved during this period. In turn, public finances deteriorated in all four countries, but the increase in net lending was much larger in Bolivia (8.7% of GDP per year on average in 2015–18 and 2010–13) than in Peru (3.6% of GDP), Ecuador (3.2% of GDP), and Colombia (1.4% of GDP).

This paper aims at shedding some new light on the anatomy of international shocks in Bolivia, Colombia, Ecuador, and Peru. To do so, we study the effects of these events on key macroeconomic variables by combining the exogeneity block approach of Zha (1999) with the novel methodology of sign and zero restrictions on structural vector autoregressions (SVARs) developed by Arias, Rubio-Ramírez, and Waggoner (2018). More specifically, we estimate the impact of shocks to global activity, commodity prices, the Federal Reserve's monetary policy, and international stock markets on the Andean

countries' GDP, inflation, real exchange rate (RER), international reserves, and the trade and fiscal results.

We thus contribute to the empirical literature on the cross-border transmission of international shocks. This field of research received new impetus following the outbreak of the global financial crisis in 2007–08 and the long unseen contagion effects it triggered in mature markets. Several papers have since been published on the impact of global aggregate demand shocks and financial and monetary shocks. The following are a few of the relevant contributions with a focus on advanced economies. Déés, Di Mauro, Pesaran, and Smith (2007) used a global vector autoregression (VAR) model and found that financial shocks are transmitted rapidly from the United States to the euro area, while changes in the Federal Reserve's monetary policy have a limited impact on Europe. Ehrmann, Fratzscher, and Rigobon (2011) also provided robust evidence on the economic significance of financial cross-market spillovers between the United States and the euro area. Chen, Filardo, He, and Zhu (2012) found that quantitative easing in the United States boosted asset prices globally, but had a limited cross-border impact on growth and inflation in advanced economies. Georgiadis and Jancokova (2017) used local projections to estimate the global output spillovers of monetary policy shocks in the United States and the euro area.

Various other contributions have focused on the propagation of commodity price shocks. Kilian, Rebucci, and Spatafora (2009), for instance, estimated the impact of shocks in the crude oil market on the external balances of importers and exporters of that commodity. They found that, for exporters, positive oil shocks are associated with the accumulation of net foreign assets, but that these effects are much larger when rooted in a global demand shock than on a supply shock. In turn, in the case of oil importers, they found that the negative impact of oil supply shocks on the current account is quickly offset by the reaction of the nonoil trade balance, while demand shocks have a more persistent effect. Rafiq, Sgro, and Apergis (2016) used a heterogeneous linear panel model to answer similar questions, and found that positive oil price shocks lead to a deterioration of the total trade balance of exporters, presumably as a result of an offsetting expenditure effect. In the case of importers, they found an asymmetric relationship between the price of oil and the total trade balance—although an increase in oil prices does not have a significant impact on the total trade balance, a decline in oil prices boosts nonoil imports, thus leading to a deterioration of the total trade balance.

Reflecting the lesser availability of high frequency data of good quality in developing countries, most of the literature on the cross-border propagation of international shocks has focused on advanced economies (Agenor, McDermott, and Prasad, 2000). In recent years, however, various relevant contributions have been published with a focus on this category of countries. Calderón and Fuentes (2011) provided a set of interesting stylized facts about the business cycles of emerging markets, and pointed out that terms-of-trade shocks are more profound in countries that are more commercially and financially integrated into the global economy. Allegret, Couharde, and Guillaumin (2012) used an SVAR model with block exogeneity to study the impact of oil price shocks, trade shocks, and financial and monetary shocks on East Asian countries. They found that the effects of external shocks on these economies was amplified over time, and that oil prices and trade shocks had a larger effect than financial and monetary shocks. Österholm and Zettelmeyer (2008) focused on Latin America, and found that external shocks (particularly global demand shocks and a tightening of financial conditions) explained more than 50% of the fluctuations in the region's economic growth.

The existing empirical literature, however, does not reach a consensus on the relevance of terms-of-trade movements as a determinant of business cycle fluctuations in developing countries. As predicted by the New Keynesian economic theory, Ben Zeev, Pappa, and Viccondoa (2017) found that terms-of-trade shocks have a major impact on Latin American economies, explaining on average 49% of their output cyclical fluctuations. By contrast, Schmitt-Grohé and Uribe (2018) found a much lesser weight of about 10% for terms of trade as a determinant of aggregate activity. Focusing more specifically on commodity price shocks, Fernández, González, and Rodríguez (2018) combined a structural model with SVAR estimations, concluding that commodity price shocks explained more than 40% of the variance of real output in the emerging market economies that they studied. In turn, Allegret et al. (2012) and Bonilla Bolaños (2014) emphasized the heterogeneous effects of commodity prices on real output for East Asian and Latin American countries, with contributions ranging between 4% and 60% for the former, and between 6% and 27% for the latter.

Regarding the role of global financial conditions for developing countries, Akıncı (2013) used a panel SVAR model to study the effects of the global risk-free interest rate, global financial risk, and country-specific sovereign spreads. Akıncı found that global risk shocks explain approximately 20% of the fluctuations of aggregate activity in emerging



markets and country spread shocks another 15%. These results are aligned with the work of Canova (2005), who estimated the impact of U.S. shocks with a country VAR, finding that the financial channel plays an important role in explaining macroeconomic fluctuations in Latin America. Allegret et al. (2012) and Bonilla Bolaños (2014) also provided evidence concerning the relevance of financial conditions as amplifiers of international shocks for developing economies.

This paper makes various contributions to the literature. First of all, we focus on a narrow subset of countries that has seldom been studied in isolation: the Andean subregion (Bolivia, Colombia, Ecuador, and Peru). At the same time, along the lines of Allegret et al. (2012), Bonilla Bolaños (2014), and Canova (2005), we take a broad approach regarding the types of shocks that we consider, analyzing the impact of changes in global economic activity, different types of commodity shocks, and financial and monetary shocks. This enables us to reach relevant conclusions about some of the specific vulnerabilities associated with the ways in which Andean countries have integrated into the global economy. Among the common factors that characterize the subregion are its income level, its reliance on commodity exports, and its trade openness.<sup>1</sup> By contrast, some of the factors that could contribute to explain the heterogeneous effects of international shocks on Andean nations are their foreign exchange regimes, and, more generally, their macroeconomic policy frameworks.<sup>2</sup>

A second contribution of this paper is methodological. As already mentioned, we apply the methodology recently developed by Arias et al. (2018). Compared with other methods, this agnostic SVAR approach with partial identification offers the advantage of

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<sup>1</sup> Using IMF (World Economic Outlook) data, in 2018 per capita gross domestic product was US\$3.682 in Bolivia, US\$6.316 in Ecuador, US\$6.684 in Colombia, and US\$7.002 in Colombia. In that same year, the sum of exports and imports represented 57% of GDP in Bolivia, 35% in Colombia, 47% in Ecuador, and 48% in Peru. Metallic minerals and hydrocarbons' participation in total exports is close to 77% in Bolivia, 60% in Colombia, 35% in Ecuador, and 69% in Peru.

<sup>2</sup> Among the countries of the subregion, Ecuador is a dollarized economy with no separate legal tender, Bolivia has a fixed exchange rate regime, and both Colombia and Peru are floaters. As relatively large recipients of foreign direct investment and portfolio flows, these two last countries are more integrated into international financial markets than Bolivia and Ecuador. This broadly coincides with the orientation of economic policies during the past decades, which (until recently) has tended to be interventionist and state led in Bolivia and Ecuador, and market friendly in Colombia and Peru.

imposing restrictions only on the shocks that are being analyzed, rather than on the whole system. By abstaining from imposing unnecessary restrictions, this avoids introducing potential estimation biases, as is the case in the method of Uhlig (2005). Moreover, under this methodology the shocks are not affected by the ordering of the variables, a problematic feature of the recursive procedure (see Kilian and Lütkepohl, 2017). In addition, the methodology that is used in this paper produces independent draws from a joint distribution without the need for burn-in draws, and is more computationally efficient in terms of time, a property that has gained relevance in recent years (Aldrich, 2014; Aruoba and Fernández-Villaverde, 2015).

Our results confirm that the Andean region is highly exposed to the effects of external shocks, and especially to declines in commodity prices associated with fluctuations in global demand. However, we find substantial heterogeneity in the magnitude of the effects, with the Ecuadorean and Bolivian real economies more at risk than those of Colombia and Peru. We argue that this heterogeneity reflects differences in the macroeconomic frameworks of the countries in our sample and their varying degrees of shock-absorbing capacity. The main message that emerges from the paper, therefore, is the need to put in place external buffers in the Andean region to fully exploit the advantages of a greater participation in international markets, be it in the form of exchange rate flexibility, foreign exchange reserves, or fiscal and monetary space to act countercyclically.

The remainder of this paper is organized as follows. Section 2 describes the SVAR model with an international and a domestic block, our identification strategy, and the data that we use. Section 3 presents and discusses the results of our estimations on the impact of the various international shocks analyzed in this paper. More specifically, we conduct three exercises: (i) a preliminary estimation on the effects of each shock with no identifying restrictions; (ii) a second estimation with zero and sign restrictions, as described in section 2; (iii) a third estimation with identifying restrictions in which the shocks persist for at least four consecutive quarters. Section 4 complements the analysis on the economic relevance of the shocks under analysis with a historical decomposition of the demeaned GDP of the four countries included in our sample, and with a variance decomposition. Finally, section 5 briefly concludes.

## 2. The Agnostic Structural Vector Autoregression Approach

In this section, we present the SVAR model that we used to estimate the impact of international shocks on the Andean economies. Then, we describe the identification strategy for each shock. Also, we present the structure of the international and domestic blocks to apply Zha's (1999) methodology, and the sign and zero restriction algorithm of Arias et al. (2018). Finally, we describe the data and their sources.

### 2.1. The Structural Vector Autoregression Model

Consider the following SVAR:

$$y_t' A_0 = \sum_{i=1}^p y_{t-i}' A_i + c + \varepsilon_t'; \quad t = 1, \dots, T, \quad (1)$$

Where  $y_t$  is an  $nx1$  vector of endogenous variables,  $\varepsilon_t$  is an  $nx1$  vector of structural shocks,  $A_j$  is an  $nxn$  matrix of structural parameters for  $j = 0, \dots, p$  with  $A_0$  invertible,  $c$  is a  $1xn$  vector of deterministic parameters,  $p$  is the lag length, and  $T$  is the sample size. Conditional on past information and the initial conditions, the vector of structural shocks is assumed to be Gaussian with mean zero and covariance matrix  $I_n$  (the  $nxn$  identity matrix). Equation (1) can be written more compactly as:

$$y_t' A_0 = x_t' A_+ + \varepsilon_t', \quad (2)$$

where  $A_+ = [A_1' \ A_2' \ \dots \ A_p' \ c']$  and  $x_t' = [y_{t-1}' \ y_{t-2}' \ \dots \ y_{t-p}' \ 1]$ . The dimension of  $A_+$  is  $m \times n$ , where  $m = np + 1$  is the number of explanatory variables. The elements of  $A_0$  and  $A_+$  correspond to the structural parameters of the VAR system. Then, the reduced-form representation of equation (2) is given by:

$$y_t' = x_t' B + u_t, \quad (3)$$

where  $B = A_+ A_0^{-1}$ ,  $u_t = \varepsilon_t' A_0^{-1}$ , and  $E[u_t u_t'] = \Sigma = (A_0 A_0')^{-1}$ . The matrices  $B$  and  $\Sigma$  are the reduced-form parameters.

We are interested in understanding the response of the  $i$ th variable to the  $j$ th structural shock at a finite horizon  $h$ . In the VAR, that concept corresponds to the element in row  $i$  and column  $j$  of the impulse response function (IRF) obtained with the following matrix:

$$L_h(A_0, A_+) = (A_0^{-1} J' F^h J)' \quad (4)$$

$$F = \begin{bmatrix} A_1 A_0^{-1} & I_m \cdots & 0 \\ \vdots & \vdots \ddots & \vdots \\ A_{p-1} A_0^{-1} & 0 \dots & I_m \\ A_p A_0^{-1} & 0 \dots & 0 \end{bmatrix} \quad \text{and} \quad J = \begin{bmatrix} I_m \\ 0 \\ \vdots \\ 0 \end{bmatrix}$$

With this definition, we observe that the IRF and the structural shocks depend on  $A_0$  and  $A_+$ . It is well known that estimating the response to the shocks is impossible without imposing some identifying restrictions on the structural parameters, where these can be either linear or nonlinear (Rubio-Ramírez, Waggoner, and Zha, 2010). As we explain next, our identification imposes restrictions only on international shocks, implying that our SVAR model is partially identified.

## 2.2. The Identification

We imposed some restrictions on the international variables to estimate the effects of exogenous shocks associated with them on the Andean countries. By contrast, we did not impose restrictions on the domestic variables, to avoid making prior assumptions about the structure of the Andean economies that we studied, which could have affected our results. Table 1 summarizes the sign and zero restrictions that we imposed on our model. First, we explain the sign restriction on each international shock. Then, we present the zero restrictions. We normalized all shocks by imposing the positive sign restriction on the response of the same international variable.

**Table 1: Identification Restrictions**

Variable	Shock				
	FED Monetary Policy	Global Demand	Oil Price	Nonoil Price	Financial
Federal Reserve rate	Positive	0	0	0	Unrestricted
World demand	Unrestricted	Positive	Negative	Negative	Unrestricted
Oil price	Unrestricted	Positive	Positive	Unrestricted	Unrestricted
Nonoil price	Unrestricted	Positive	Unrestricted	Positive	Unrestricted
MXWO	Negative	Unrestricted	Unrestricted	Unrestricted	Positive

Note: FED = Federal Reserve; MXWO = Morgan Stanley's world stock market index.

Regarding the first shock, we only imposed one restriction: that an increase in the Federal Reserve's rates is negatively associated with asset prices, as measured by Morgan

Stanley's world stock market index (MXWO).<sup>3</sup> There is a rich empirical literature to sustain the notion that stock prices tend to fall as a result of monetary policy shocks (increase in the interest rate), and Galí (2014) offers a theoretical framework for this relationship.<sup>4</sup> We imposed no restrictions on the impact of monetary policy shocks on global activity and on commodity prices, both oil and nonoil.

Regarding the second shock, we imposed the restriction that an acceleration of global demand is positively associated with both oil and nonoil commodity prices, a relationship that is well documented in the literature (Chiaie, Ferrara, and Giannone, 2017; Kilian, 2009, 2014). In turn, we abstained from imposing a restriction on the association between global demand shocks and asset prices. Also along the lines of work by Kilian, we imposed a short-term negative relationship between commodity price shocks (both oil and nonoil) and global economic activity. Indeed, as argued in Kilian (2014), a rise in commodity prices tends to increase input costs for production and to reduce the demand for goods and services other than energy, thus negatively affecting real activity. We imposed no restrictions on the relationship between oil price shocks and either other commodity prices or financial asset prices.<sup>5</sup> In the same vein, we did not impose a restriction on the sign of the relationship between oil or other commodity shocks and the price of financial assets.

Our model imposed some zero restrictions on the impact of the global demand and the two commodity shocks on the monetary policy of the Federal Reserve. This is aligned with the results of Boivin and Giannoni (2008), who showed that global forces have a limited macroeconomic impact on the United States, and thus on the direction of its

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<sup>3</sup> The MXWO index measures the performance of liquidity, investability, and replicability of the large- and mid-cap stocks across 23 advanced economies that it allows. The countries included are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom, and the United States. This variable is part of the Morgan Stanley Capital International (MSCI) indexes. For more details see <https://www.msci.com/acwi>.

<sup>4</sup> See, for instance, Bernanke and Kuttner (2005), Galí and Gambetti (2015), Gürkaynak, Sack, and Swanson (2005), Patelis (1997), and Rigobon and Sack (2004).

<sup>5</sup> Various contributions have emphasized that global aggregate demand is a much more relevant and persistent determinant of oil prices than oil-specific supply shocks (see Antolín-Díaz and Rubio-Ramírez, 2018; Kilian, 2009, 2014). For this reason, we omitted oil supply to avoid overfitting our model.

monetary policies. Finally, we imposed no restrictions on the relationship between financial shocks and the Federal Reserve's rate.

### 2.3. The Two Blocks and the Estimation

The Andean economies that are the focus of this paper are open economies small enough to assume that they do not influence the behavior of the international variables included in our model. This assumption enabled us to apply Zha's method (1999) to estimate equation (1) in two blocks, which yielded similar results to the seemingly unrelated regression estimation (SURE) procedure. The first block contained the international variables (I) and the domestic block (D) included all our variables.

Formally, we estimated the following expression:

$$[y_{It} \quad y_{Dt}] \begin{bmatrix} A_0^I & A_0^{DI} \\ 0 & A_0^D \end{bmatrix} = \sum_{i=1}^p [y_{It-i} \quad y_{Dt-i}] \begin{bmatrix} A_i^I & A_i^{DI} \\ 0 & A_i^D \end{bmatrix} + c + \begin{bmatrix} \varepsilon'_{It} \\ \varepsilon'_{Dt} \end{bmatrix} \quad (5)$$

where the domestic variables  $y_{Dt}$  are not included in the international block, implying that country variables do not influence the estimation of the international parameters. On the contrary, the domestic equations depend on all variables included and their lags.

We implemented the algorithms presented in Arias et al. (2018) to estimate the structural parameters with two blocks and the identification strategy described above. More specifically:

- a) We used the algorithm 2 of Arias et al. (2018) to independently draw  $(A_0, A_+)$  for each block.
- b) If  $(A_0, A_+)$  satisfied the sign and zero restrictions, then its importance weight was set as established in algorithm 3 of Arias et al. (2018). If not, its importance weight was set to zero.
- c) We returned to step a) until the required number of iterations had been obtained.
- d) We resampled with replacement using the importance weights.

Arias et al. (2018) selected the uniform-normal-inverse-Wishart distribution  $UNIW(v, \Phi, \Psi, \Omega)$  because it easily gets independent draws of the prior and posterior densities and gets efficient algorithms to implement the sign and zero restrictions. We set  $v = m$ ,  $\Phi = I_{n \times n}$ ,  $\Psi = 0_{n \times n}$ , and  $\Omega^{-1} = 0_{n \times n}$  to obtain the prior density over the

parameterization. We made 10,000 independent draws satisfying the sign and zero restrictions, with 60% of the effective sample size on average for the four countries.

## **2.4. Data**

We estimated the SVAR model for each of the countries that we analyzed: Bolivia, Colombia, Ecuador, and Peru. Each model contained quarterly country data with the following variables: real GDP, consumer price index (CPI), international reserves, the ratio of overall fiscal balance to GDP, the ratio of trade balance to GDP, and the real exchange rate (RER). The international variables included the Federal Reserve's funds rate (monetary policy, MP), the global activity index of Kilian (2009—Global Demand), the West Texas Intermediate (WTI) price of petroleum, the World Bank's Non-fuel Commodities Index, and Morgan Stanley's stock market index for 23 developed countries (MXWO financial index).

We obtained the Andean country data from national institutions, primarily central banks and statistics institutes. The Federal Reserve's rate was downloaded from the Federal Reserve Bank of St. Louis' website, the Non-fuel index from the World Bank, and the WTI and financial index from Bloomberg. With the exceptions of the Federal Reserve rate, the overall fiscal balance, and the trade balance, we transformed all the variables to first difference of logarithm. Also, all variables were seasonally adjusted. The sample for each country is described in the appendix.

## **3. Results**

This section presents the results of our estimations. First, we carried out a preliminary SVAR without the identifying restrictions described in the previous section. We therefore assessed the effect of each international shock separately on the domestic variables of interest without considering the origin of the shock, an exercise similar to that conducted by Akinci (2013), Fernández, Schmitt-Grohé, and Uribe (2017), and Schmitt-Grohé & Uribe (2018). Second, we applied the methodology of Arias et al. (2018) and imposed the aforementioned sign and zero restrictions on the SVAR, which enabled us to estimate the structural response of each variable taking into consideration the origin of the international shocks. This is particularly important for commodity shocks, which the literature has found to be primarily rooted in global demand fluctuations (see Kilian 2009, 2014). Finally, we conducted a third estimation that restricted the analysis to persistent

shocks to the international variables that lasted for at least four quarters. For the three exercises that we conducted, shocks were defined as one negative standard deviation change in the international variables included in our specification, except to the Federal Reserve shock, which was defined as one positive standard deviation.

### **3.1. Preliminary Estimation: Shocks Without Sources**

Starting with the preliminary exercise, as shown in Table 2, a shock on global demand had a statistically significant simultaneous negative impact on Bolivia and Ecuador's GDP ( $-0.1\%$  and  $-0.2\%$ , respectively). However, this effect dissipated quickly, and lost its statistical significance one quarter after the shock. The impact of the global shock on GDP was weaker and not statistically significant in Colombia, and it appeared to be offset quickly (positive reactions in quarters one to three after the shock). A similar pattern was apparent in the case of Peru, where GDP fell one quarter after the global demand shock, but recovered subsequently ( $0.2\%$  after three quarters).

Colombia's RER reacted quickly to shocks on global demand, with a depreciation of almost 2% in the quarter of the shock, which may partly explain why its impact on real activity was quickly offset in that country. Peru's RER also depreciated mildly in the quarter of the shock, although this effect was not statistically significant and was offset by quarter 1. As opposed to Colombia and Peru, the two countries of our sample that have fixed exchange regimes, Bolivia and Ecuador, experienced a contemporaneous appreciation of the RER in the quarter of the shock on global demand ( $0.9\%$  and  $0.6\%$ , respectively), an effect that was partially offset in subsequent quarters.

As expected, the trade balance of the four countries that we analyzed reacted negatively to a global demand shock. However, this effect was more persistent in Bolivia than in the other three. In the same vein, the fiscal position of all four countries reacted negatively to global demand shocks, although the impact of the shock appeared to be more profound and persistent in Bolivia and Ecuador than in Colombia and Peru. In the two countries that have a fixed exchange rate regime, the impact of the global demand shock on international reserves was negative, an effect that was more persistent in Bolivia than in Ecuador. By contrast, the stock of international reserves did not fall in Colombia and Peru after the shock, but rather the opposite. Finally, the inflation rate seemed to be relatively unaffected by the shock on global demand, with moderate declines in the CPIs of Bolivia,



Colombia, and Peru two quarters after the shock, and no statistically significant effects in Ecuador.

**Table 2: Impulse Response of Global Demand Shock**

Variables	Periods after shock								
	0	1	2	3	4	8	12	16	20
World GDP	-16.8755*	-12.9393*	-7.6264*	-8.0873*	-8.3455*	-5.2671*	-3.5364*	-2.3986*	-1.6218*
<b>Bolivia</b>									
RER	0.8669*	-0.2205	-0.7116*	-0.256	-0.1076	-0.1786	-0.0708	-0.0791	-0.0815
Trade Balance	0.1611	-0.4048	-0.798*	-0.9832*	-1.2113*	-0.9503*	-0.5168	-0.287	-0.1484
Intl. Reserves	-0.3068*	-0.1778	-0.413*	-0.6589*	-0.8919*	-1.7482*	-2.144*	-2.1897*	-2.0754*
Fiscal Balance	-0.1063	0.5039	-0.8135*	-0.8551*	-0.6979*	-0.7277*	-0.4064	-0.215	-0.088
Inflation (CPI)	-0.0733	-0.0375	-0.1745*	-0.1194	-0.0686	-0.0314	-0.0418	-0.0407	-0.0419
GDP	-0.0996*	-0.1015	0.0802	0.0766	-0.0731	-0.0114	-0.0098	-0.0155	-0.0172
<b>Colombia</b>									
RER	-1.8911*	-0.2892	-0.2513	0.9717*	1.5566*	0.7989*	0.4938	0.3324	0.3095
Trade Balance	-0.0883*	-0.0642*	-0.0552	0.0308	0.1087	0.1795	0.1564	0.1449	0.1604
Intl. Reserves	0.0845*	0.1006*	-0.0007	0.099	0.0202	-0.3342	-0.4976	-0.5286	-0.4896
Fiscal Balance	0.4109*	-0.2587*	-0.1654	-0.2811*	-0.3084*	0.0291	0.2468	0.3263	0.2719
Inflation (CPI)	-0.0197	0.0024	-0.1124*	-0.0184	-0.0384	-0.1574*	-0.132*	-0.0824	-0.0832
GDP	-0.0369	0.0912*	0.1164*	0.1615*	0.072	0.214*	0.2445*	0.2001*	0.1516*
<b>Ecuador</b>									
RER	0.5705*	-0.1972	-0.1892	-0.241*	-0.063	-0.0544	0.0074	-0.0166	-0.0155
Trade Balance	-0.5006*	-0.0319	0.13	0.2613	-0.0872	-0.3145	-0.2564	-0.1722	-0.0887
Intl. Reserves	-0.0704*	-0.1991*	-0.0846	-0.0137	0.0024	-0.0426	-0.0971	-0.1076	-0.0995
Fiscal Balance	-1.2027*	-0.3377*	-0.5668*	-0.3329*	-0.2735	-0.2968	-0.0946	-0.013	0.0344
Inflation (CPI)	-0.0094	-0.0677	0.0495	-0.0258	-0.0499	-0.0002	-0.008	-0.0133	-0.0121
GDP	-0.1884*	-0.039	0.0076	0.0334	0.226*	0.1419*	0.1581*	0.1092*	0.0839*
<b>Peru</b>									
RER	-0.1002	0.2191*	-0.2387*	0.0984	0.1036	-0.1105	-0.0427	0.0098	-0.009
Trade Balance	-0.1737*	0.2223*	0.1541	0.0244	0.1003	0.0268	-0.2126*	-0.2901*	-0.2676*
Intl. Reserves	0.0347	0.4291*	0.4627*	0.6963*	0.8136*	1.5091*	2.0509*	2.1744*	2.0734*
Fiscal Balance	-0.0646	-0.1666*	-0.1773*	-0.0704	0.1201	0.29*	0.3047*	0.1307	0.0491
Inflation (CPI)	0.0171*	-0.067*	-0.0467*	-0.044	0.0076	0.0243	0.0501*	0.0426*	0.0337
GDP	0.0325	-0.0682	0.0577	0.1562*	0.0715	0.1592*	0.0564	0.0516	0.0428

Note: Values are the posterior median; the \* (asterisk) represents the statistical significance at 68 percent equal-tailed probability ( $H_0: \text{IRF}=0$ ). The posterior estimations are based on 10,000 independent draws. CPI = consumer price index; GDP = gross domestic product; RER = real exchange rate.

As shown in Table 3, primary commodity price shocks had the strongest and more persistent effects on activity in Ecuador, where GDP fell on average by 0.3% during four consecutive quarters (Q0 to Q3), a result that is statistically significant.<sup>6</sup> The negative effect of commodity price shocks on GDP was both weaker and less persistent in Bolivia and Peru, while no negative impact was found in the case of Colombia. This may be due to the fact that Colombia experienced the largest simultaneous depreciation of the RER

<sup>6</sup> Primary commodity shocks refer to shocks to the price of the main commodity exported by each country, in the case of Colombia and Ecuador, hydrocarbons, in the case of Bolivia, natural gas, and in the case of Peru, metallic minerals.

as a result of commodity shocks (−2.2%), which may have helped to cushion their impact on activity. Once again, as opposed to what was observed in the two countries in our sample with floating exchange rates, in the quarter of the shock the RER tended to appreciate in the countries that have fixed exchange rate regimes, an effect that was particularly apparent in the case of Ecuador.

**Table 3: Impulse Response of Primary Commodity Shock**

Variables	Periods after shock								
	0	1	2	3	4	8	12	16	20
Fuel price	-13.8034*	-2.7379*	0.831	2.5896*	0.5083	0.0097	-0.0084	0	0
<b>Bolivia</b>									
RER	0.4579	-0.3332	-0.755*	-0.9231*	-0.2663	-0.0862	0.0822	0.0882	0.0615
Trade Balance	-0.0986	0.128	0.7765*	1.2062*	1.4048*	1.2274*	0.5713	0.107	-0.1105
Intl. Reserves	-0.0722	-0.0272	0.3053	0.4083	0.5175	1.4021*	1.8993*	1.7639*	1.2402*
Fiscal Balance	0.7231	-0.0552	0.947*	-0.0673	0.7913	0.5833*	0.3946	0.0215	-0.1012
Inflation (CPI)	0.139	-0.0726	-0.0318	-0.0065	0.043	0.058	0.0468	0.0217	0.0061
GDP	-0.055	-0.0383	-0.1833*	0.0905	0.1032*	0.0309	0.0275	0.0248	0.016
<b>Colombia</b>									
RER	-2.2006*	-0.135	-0.4723	0.6219*	-0.3897	0.1551	0.1259	0.0279	-0.0551
Trade Balance	-0.0901*	-0.1744*	-0.2971*	-0.3747*	-0.3962*	-0.2702*	-0.0846	-0.1175	-0.1717*
Intl. Reserves	0.1531*	0.2462*	0.36*	0.5854*	0.642*	0.6329*	0.462*	0.3422*	0.3719*
Fiscal Balance	0.224	-0.4201*	-0.1758	0.1576	0.1062	-0.1656	-0.4556*	-0.3097*	-0.1488
Inflation (CPI)	-0.0323*	-0.0724*	-0.1211*	-0.0431	-0.0009	0.1317*	0.0135	-0.0154	0.0326
GDP	0.0477	0.0328	0.1653*	0.066	0.0622	-0.0537	-0.0651	0.0013	0.0093
<b>Ecuador</b>									
RER	0.841*	0.064	0.0323	-0.4193*	-0.3396*	-0.0579	-0.0214	-0.0154	-0.0097
Trade Balance	-1.059*	-0.4989*	-0.2289	0.3465*	0.2018	-0.207	-0.0538	-0.0129	-0.0133
Intl. Reserves	-0.1561*	-0.3774*	-0.4067*	-0.2623*	-0.1746*	-0.0635	-0.0506	-0.0435	-0.0312
Fiscal Balance	-1.5539*	-0.8829*	-0.7781*	-0.8737*	-0.5384*	-0.3224	-0.0501	-0.0262	-0.0162
Inflation (CPI)	-0.0546	-0.0657	-0.0638	-0.1744*	-0.1067*	-0.068*	-0.0215	-0.0129	-0.0109
GDP	-0.1613*	-0.3189*	-0.33*	-0.324*	-0.0596	-0.012	-0.0146	-0.0035	-0.0016
<b>Peru</b>									
RER	-0.4565*	0.7177*	0.1696	0.2878	0.0787	-0.3095*	-0.0348	0.0574	-0.0292
Trade Balance	-0.2751*	-0.0147	-0.0316	-0.0843	-0.2044	0.2426	-0.0952	-0.173	-0.0937
Intl. Reserves	-0.0485	0.5232*	0.5826*	0.736*	0.7677*	0.2225	0.637	0.861*	0.5778
Fiscal Balance	-0.0848	-0.4768*	-0.7282*	-0.961*	-0.8049*	-0.0644	0.1399	-0.0452	-0.0413
Inflation (CPI)	0.0177*	0.0181	0.0084	0	0.1204*	-0.0298	0.0061	0.0334	0.0027
GDP	-0.0152	-0.1033*	-0.0174	0.2267*	0.0373	0.0162	0.0816	0.0276	-0.0068

Note: Values are the posterior median; the \* (asterisk) represents the statistical significance at 68 percent equal-tailed probability ( $H_0: \text{IRF}=0$ ). The posterior estimations are based on 10,000 independent draws. CPI = consumer price index; GDP = gross domestic product; RER = real exchange rate.

The fiscal impact of the oil price shock was also more profound and persistent in Ecuador than in the other Andean nations: the overall balance exhibited a statistically significant deterioration of 1.6% during the quarter of the shock, which continued to be statistically significant with a declining intensity for the four quarters that followed. Although less markedly, Peru's fiscal balance also deteriorated from Q1 to Q4 following a decline in the price of minerals, while the fiscal impact of the oil shock on Colombia was both milder

and shorter lived. In contrast, the negative impact of primary commodity price shocks on the trade balance was larger in Colombia (statistically significant declines from Q0 to Q8) than in its regional peers, followed by Ecuador and Peru. Interestingly, the trade balance improved in Bolivia after the shock. Commodity price shocks resulted in lower inflation in Colombia and Ecuador, with the opposite result found in Peru.

**Table 4: Impulse Response of Other Commodities Shock**

Variables	Periods after shock								
	0	1	2	3	4	8	12	16	20
Non fuel price	-4.7003*	-1.5967*	-0.1729	0.9823*	0.5462*	-0.0489	-0.0001	0.0001	0
<b>Bolivia</b>									
RER	1.5633*	-0.1467	0.013	-0.7448*	-0.2588	-0.1106	-0.0734	-0.0935	-0.0701
Trade Balance	-0.6031*	-1.0153*	-0.9367*	-0.5786	-0.608	-0.6174*	-0.2142	-0.0494	0.1156
Intl. Reserves	-0.4441*	-0.4822*	-0.8695*	-0.7396*	-1.1387*	-1.7964*	-1.8123*	-1.6945*	-1.4099*
Fiscal Balance	-2.159*	0.2607	-1.6199*	-0.6726*	0.0969	-0.5436*	-0.0755	0.0041	0.092
Inflation (CPI)	0.1603*	-0.3085*	-0.3243*	-0.2733*	-0.0697	-0.0995*	-0.0428	-0.0439*	-0.0301
GDP	0.0153	-0.131*	-0.1388*	0.2243*	0.0006	-0.0426	-0.0273	-0.0313*	-0.0242*
<b>Colombia</b>									
RER	-0.2185	-0.6273*	-0.6246*	0.6416*	0.4373	-0.104	-0.0544	0.0498	-0.0222
Trade Balance	-0.0252	-0.1021*	-0.1534*	-0.1669*	-0.1542*	-0.191*	-0.0968*	-0.0449	-0.0533
Intl. Reserves	0.0713*	0.0912*	0.139*	0.264*	0.331*	0.3233*	0.3066*	0.2014*	0.1544
Fiscal Balance	-0.325*	0.1001	-0.1584	-0.033	-0.1992	-0.0501	-0.1855*	-0.2024*	-0.1217*
Inflation (CPI)	-0.0024	-0.0895*	-0.129*	-0.0918*	-0.0865*	0.048	0.0289	0.0101	0.0119
GDP	-0.0049	-0.1324*	0.0716	-0.028	0.0486	0.0248	-0.0323	-0.0267	-0.0077
<b>Ecuador</b>									
RER	0.7695*	0.2361*	-0.1123	-0.289*	-0.2551*	-0.0764	-0.0035	0.0025	0.0023
Trade Balance	-0.9067*	-0.77*	-0.4254*	0.245	0.3026*	-0.1158	-0.0038	-0.0122	-0.0033
Intl. Reserves	-0.1278*	-0.2831*	-0.4309*	-0.2199*	-0.1861*	-0.0179	0.0149	0	-0.0072
Fiscal Balance	-1.2066*	-0.7651*	-0.5589*	-0.5792*	-0.3001	-0.1932	0.0407	0.0244	0.003
Inflation (CPI)	-0.0346	-0.1077*	-0.0599	-0.1118*	-0.0967*	-0.0343	-0.0011	0.0016	-0.0006
GDP	-0.1379*	-0.2721*	-0.2008*	-0.3442*	-0.0819	0.0152	0.0228	0.0016	-0.0014
<b>Peru</b>									
RER	-0.3767*	0.125	-0.2791*	0.2473*	0.1836	-0.1049	-0.0501	-0.008	0.0245
Trade Balance	-0.1178*	0.0329	-0.2227	-0.1784	-0.2931*	0.157	0.1192	0.0082	-0.0223
Intl. Reserves	-0.3002*	0.0064	-0.0119	0.1714	0.1262	-0.3802	-0.365	-0.149	-0.1265
Fiscal Balance	-0.0025	-0.2175*	-0.3495*	-0.5822*	-0.5265*	-0.1937	0.0834	0.0584	-0.024
Inflation (CPI)	0.0083	0.0358*	-0.0109	-0.0524	0.0083	-0.02	-0.0134	0.0043	-0.0037
GDP	0.0028	0.0474	0.004	0.1392*	-0.0652	-0.0382	0.0202	0.024	-0.0168

Note: Values are the posterior median; the \* (asterisk) represents the statistical significance at 68 percent equal-tailed probability ( $H_0: \text{IRF}=0$ ). The posterior estimations are based on 10,000 independent draws. CPI = consumer price index; GDP = gross domestic product; RER = real exchange rate.

Ecuador was, once again, the Andean nation most affected by declines in the price of other commodities, with GDP contractions in the quarter of the shock and in the three quarters that followed. Bolivia and Colombia's GDP also exhibited contractions, albeit less intense and persistent, while real activity in Peru seemed to be relatively unaffected by other commodity price shocks (see Table 4). As was the case with the other shocks, declines in other commodity prices led to depreciations in the RER of Colombia and Peru

in the short term, an effect that was partially offset after one year. By contrast, Bolivia and Ecuador experienced a contemporaneous appreciation in the quarter of the shock. The persistent fall in international reserves experienced by countries with a fixed exchange rate regime (Bolivia and Ecuador) after the shock also contrasts with the increase in reserves observed in Colombia. The impact of other commodity price shocks on the fiscal and trade balances was negative in all four countries, while its effect on inflation was larger in Bolivia and Ecuador than in Colombia and Peru.

**Table 5: Impulse Response of Federal Reserve Shock**

Variables	Periods after shock								
	0	1	2	3	4	8	12	16	20
FED rate	0.2725*	0.3319*	0.4414*	0.4669*	0.4961*	0.3941*	0.205*	0.062	-0.0082
<b>Bolivia</b>									
RER	-0.3986*	0.2995*	-0.1206	0.1607	0.1964	0.6792*	0.478*	0.3334	0.2202
Trade Balance	-0.1942	0.3324	0.6607*	1.0078*	1.2927*	1.5595	0.8316	0.1312	-0.2346
Intl. Reserves	0.1447*	-0.077	0.0653	-0.0499	0.0718	1.0516	2.041	2.4822	2.3752
Fiscal Balance	0.4202	-0.6682	0.4486	0.135	0.1699	0.5682	0.2476	-0.0619	-0.227
Inflation (CPI)	-0.0473	0.0581	0.2949*	0.4616*	0.6108*	0.5032*	0.3022*	0.1713	0.0868
GDP	0.0076	0.0232	0.176*	0.1236*	0.1856*	0.1463*	0.1069*	0.0868	0.0707
<b>Colombia</b>									
RER	-0.6279	0.1557	0.4308	0.5403	-0.0385	-0.2395	-0.1185	-0.0325	-0.0402
Trade Balance	-0.0156	-0.086*	-0.1237*	-0.159	-0.1721	-0.2295	-0.1681	-0.0985	-0.069
Intl. Reserves	0.0074	-0.0155	0.0337	0.0902	0.1803	0.4657	0.5624	0.454	0.2909
Fiscal Balance	-0.2679*	0.0325	0.1857	0.2087	0.0306	-0.223	-0.508	-0.4937	-0.3392
Inflation (CPI)	0.0099	0.0216	0.0244	0.0915*	0.0943*	0.1384*	0.1066	0.0621	0.0368
GDP	0.0753*	-0.1224*	-0.1268*	-0.2074*	-0.2595*	-0.3118*	-0.2641*	-0.1669	-0.0844
<b>Ecuador</b>									
RER	-0.0984	0.2824*	0.0387	0.1167	0.3222	0.3667*	0.2255	-0.0273	0.0126
Trade Balance	-0.2326*	-0.005	0.6229*	1.1745*	1.3382*	0.7445*	0.5169*	0.2765	-0.0546
Intl. Reserves	-0.0321	-0.0499	0.002	0.1006	0.3101*	0.2707	0.4424*	0.412*	0.3301*
Fiscal Balance	0.036	-0.0707	0.0605	0.3617	0.258	-0.7914	-1.0742*	-0.7217	-0.3966
Inflation (CPI)	-0.0666*	-0.0367	0.1413*	0.2477*	0.2621*	0.1686*	0.074	0.03	0.0169
GDP	0.0026	0.0657	-0.0347	0.0017	-0.0385	-0.37*	-0.2794*	-0.1952*	-0.0666
<b>Peru</b>									
RER	0.2295*	-0.2681*	0.1395	-0.0746	0.0064	0.035	-0.0975	-0.0767	0.0038
Trade Balance	0.1379*	-0.0625	-0.1894*	-0.2581*	-0.3669*	-0.07	0.2023	0.1678	0.0837
Intl. Reserves	0.1129*	0.0109	0.3038*	0.2016	0.1173	-0.3909	-0.9217*	-0.9536*	-0.7737
Fiscal Balance	-0.0201	0.0379	-0.05	-0.0443	-0.096	-0.4223	-0.2697	0.0217	0.0375
Inflation (CPI)	-0.0189*	0.0202	0.0372*	0.0891*	0.0756*	0.0107	-0.0176	-0.0207	-0.0193
GDP	0.0112	0.0253	0.0304	-0.0484	-0.0259	-0.1773*	-0.0317	0.0035	-0.0114

Note: Values are the posterior median; the \* (asterisk) represents the statistical significance at 68 percent equal-tailed probability ( $H_0: \text{IRF}=0$ ). The posterior estimations are based on 10,000 independent draws. CPI = consumer price index; FED = Federal Reserve; GDP = gross domestic product; RER = real exchange rate.

Moving on to the monetary and fiscal variables, the results exhibited in Table 5 suggest that shocks to the Federal Reserve's rate had a moderate impact on the region. Colombia is the Andean country that was more affected by an increase in the Federal Reserve's rate,

with persistent declines in GDP that were statistically significant several quarters after the shock. This may reflect the fact that Colombia is more financially integrated than its subregional peers and, therefore, more exposed to a tightening of global funding conditions. By contrast, the impact of the Federal Reserve rate shock on real activity was not statistically significant in Ecuador and Peru, and, counterintuitively, it was positive in the case of Bolivia.

Changes in the Federal Reserve's monetary policies appeared to have a mild effect on Andean countries' real exchange rates, with minor depreciations in the cases of Bolivia and Peru between the two first quarters (Q0 and Q1), and appreciations in Ecuador and Colombia (not statistically significant in the latter case) one quarter after the shock. A rise in the Federal Reserve's policy rate improved the trade balances of Bolivia and Ecuador two quarters after the shock, an effect that appeared to be persistent over time, while the opposite was found for Colombia and Peru. The Federal Reserve rate shock did not have statistically significant effects on fiscal balances in Bolivia, Colombia, and Ecuador, and only in Peru and Bolivia did we find a statistically significant, short-lived positive impact on the stock of international reserves. Finally, an increase in the Federal Reserve's rate appeared to be associated with a rise in the inflation rates of all four countries.

Table 6 shows the reaction to a fall in developed countries' stock markets, as measured by the MXWO index. The impact of this shock on real activity was more intense and persistent in Ecuador than in its subregional peers, a result that is somewhat counterintuitive given that, a priori, together with Bolivia it is the country in our sample that is less financially integrated with the rest of the world. Colombia and Peru appeared to respond to stock price shocks with a contemporaneous devaluation of the RER, an effect that was more intense in the Colombian case. Once again, in the two countries with fixed exchange rate regimes, Bolivia and Ecuador, the RER tended to appreciate in the quarter of the shock, an effect that was partially offset subsequently.

The negative impact of developed countries' stock market shocks on the trade balance was more intense in Bolivia and more persistent in Colombia, in spite of the aforementioned contemporaneous impact of the shock on the RER in Colombia. Although there was a negative simultaneous impact of the shock on the trade balance of both Ecuador and Peru, this effect seemed to dissipate quickly. Interestingly, developed country stock prices shocks appear to have had negative fiscal implications for Bolivia

and Ecuador, but not for Colombia and Peru. Finally, in all four cases inflation tended to fall after the shock, while its impact on international reserves was heterogeneous, with an increase in Colombia and a fall in the other three cases.

**Table 6: Impulse Response of Developed Country Stock Prices Shock**

Variables	Periods after shock								
	0	1	2	3	4	8	12	16	20
MXWO	-5.8271*	-2.5385*	0.1539	0.6304	0.1531	-0.0053	-0.0003	0	0
<b>Bolivia</b>									
RER	2.0721*	-0.5114*	-0.6888*	-0.3294	-0.1622	-0.0984	-0.1116	-0.0362	-0.0386
Trade Balance	-1.2268*	-1.1867*	-1.357*	-1.1197*	-0.4192	0.2892	0.0478	0.2744	0.1437
Intl. Reserves	-0.3905*	-0.4686*	-0.7806*	-0.8863*	-1.0833*	-1.1703	-1.008	-0.5843	-0.2197
Fiscal Balance	-1.7802*	0.31	-1.1215*	-1.1299*	0.2495	-0.0069	0.1382	0.1699	0.1279
Inflation (CPI)	0.3086*	0.1339	0.1653	-0.0901	-0.1748	-0.0236	0.0034	-0.011	0.009
GDP	0.0053	-0.2056*	-0.1041	0.0748	-0.2107*	-0.0338	-0.0374	-0.0068	-0.0062
<b>Colombia</b>									
RER	-3.5942*	-0.323	-1.1604*	-0.1781	-0.4827	0.0069	-0.0619	-0.0946	-0.1338
Trade Balance	-0.1398*	-0.187*	-0.2434*	-0.3158*	-0.302*	-0.2806*	-0.1582	-0.143	-0.1743
Intl. Reserves	0.1842*	0.2162*	0.2982*	0.4984*	0.6609*	0.6622*	0.5606*	0.4313*	0.4329*
Fiscal Balance	0.5288*	0.2968*	0.2009	0.5063*	0.0756	-0.1898	-0.4128*	-0.2813*	-0.2058
Inflation (CPI)	-0.0637*	0.0067	-0.0254	0.0602	0.0033	0.0719	0.0258	0.0131	0.022
GDP	0.076	-0.0853*	0.0899	-0.0973	-0.0406	-0.0307	-0.0391	-0.0336	-0.018
<b>Ecuador</b>									
RER	0.7714*	-0.3611*	-0.1687	-0.0693	0.0152	-0.0712	0.0865	-0.0008	-0.0037
Trade Balance	-0.6024*	-0.0309	0.459*	0.3397	-0.168	-0.1956	-0.2951	-0.1605	-0.1067
Intl. Reserves	-0.1144*	-0.1334*	-0.1954*	0.1226	0.1711	-0.0123	-0.0363	-0.0932	-0.0853
Fiscal Balance	-1.3613*	-0.3847*	-0.5698*	-0.8642*	-1.0056*	-0.3804	-0.4498*	-0.2883	-0.2543
Inflation (CPI)	0.0247	0.0925*	0.1502*	-0.0676	-0.0601	0.0204	-0.0186	-0.0178	-0.0228
GDP	-0.2426*	-0.1836*	-0.1667*	-0.1294	0.1071	-0.0809	0.0192	-0.0327	-0.0137
<b>Peru</b>									
RER	-0.2892*	0.2855*	0.0943	0.0437	-0.1722	-0.1524	0.0105	0.083	-0.0058
Trade Balance	-0.0998*	0.2583*	0.5345*	0.7643*	0.6895*	0.1376	-0.2504*	-0.197	-0.0203
Intl. Reserves	-0.431*	-0.1222	-0.3826*	-0.5276*	-0.4084*	0.4634	0.9076*	0.6964*	0.4126
Fiscal Balance	0.0656	-0.1589	-0.2908*	-0.1832	0.0254	0.4772*	0.2524*	-0.1057	-0.1178
Inflation (CPI)	0.0027	0.0202	-0.0524*	-0.0485	-0.0213	0.0432	0.0302	0.0144	0.0034
GDP	-0.024	-0.1407*	-0.0127	0.1771*	0.1016	0.2188*	0.0061	-0.0543	0.0079

Note: Values are the posterior median; the \* (asterisk) represents the statistical significance at 68 percent equal-tailed probability ( $H_0: \text{IRF} = 0$ ). The posterior estimations are based on 10,000 independent draws. CPI = consumer price index; GDP = gross domestic product; MXWO = Morgan Stanley's world stock market index; RER = real exchange rate.

### 3.2. Agnostic Approach: Shocks With Sources

In this second exercise we applied the identifying sign and zero restrictions described in section 2 to estimate the structural impact of each shock, assigning the effects to the international variable that originated the movements of the domestic variables of interest.<sup>7</sup>

<sup>7</sup> We included only the shock of the Ecuador model because it had a larger sample than the others, but the measure of the shocks was similar in all models.

As can be seen in Table 7, Ecuador was, by far, the Andean country most affected by global demand shocks, which were followed by four consecutive quarters of declining GDP (0.7% cumulatively), an effect that was both larger and more persistent than that estimated in the previous exercise (0.2% in Q1). By contrast, Bolivia's GDP only fell by 0.1% in Q1, while no statistically significant effects were found on real activity in the cases of Colombia and Peru. As in the previous exercise, the real exchange rate tended to appreciate in the fixed exchange rate regimes, Bolivia and Ecuador, while the opposite was found in the case of Colombia and Peru, with floating exchange rates (although the effect was not statistically significant in either of these last two countries). In parallel, international reserves fell in Bolivia and Ecuador (accumulated effect of 1.7% and 0.7%, respectively, in the year of the shock) , while no statistically significant effects were found for Colombia and Peru.

**Table 7: Impulse Response of Global Demand Shock with Agnostic Approach**

Variables	Periods after shock								
	0	1	2	3	4	8	12	16	20
World GDP	-8.0676*	-6.6495*	-2.8603*	-1.7675	-2.1852	-1.1733	-1.0567	-0.8095	-0.5721
<b>Bolivia</b>									
RER	0.4001*	-0.0853	-0.2638	-0.1086	-0.153	-0.1061	-0.0462	0.0301	-0.0568
Trade Balance	-0.4369*	-0.1383	-0.6379	-0.2694	0.284	0.3446	-0.2665	0.2328	-0.0317
Intl. Reserves	0.0053	-0.3816*	-0.5864*	-0.6917*	-0.4166	-0.5465	-0.4573	-0.2775	-0.2367
Fiscal Balance	-0.0314	-0.8199*	-0.398	-0.968*	0.3745	0.1479	-0.2193	0.212	0.0132
Inflation (CPI)	0.0503	-0.0245	-0.2322*	-0.0838	-0.0367	-0.0318	-0.0232	-0.0256	-0.0022
GDP	0.0234	-0.1327*	-0.0966	0.1274	0.0625	0.0412	-0.0023	-0.0034	-0.0019
<b>Colombia</b>									
RER	-0.2948	-0.2966	-0.5414	-0.415	-0.2353	0.1613	0.1492	-0.0931	-0.0738
Trade Balance	-0.0322	-0.0881*	-0.1808*	-0.1998*	-0.1369	-0.0612	-0.017	-0.0512	-0.0619
Intl. Reserves	0.0403	0.0937	0.0804	0.1863	0.2273*	0.2463	0.1967	0.1941	0.2278
Fiscal Balance	0.0109	-0.1244	-0.0873	0.1545	0.2472	-0.1735	-0.1162	0.0122	-0.0166
Inflation (CPI)	-0.0046	0.0017	-0.0275	0.0072	0.0632*	0.0145	-0.0004	0.0085	0.0223
GDP	0.0008	0.0261	0.0304	0.0861	-0.008	-0.1055	-0.0236	0.0139	0.0002
<b>Ecuador</b>									
RER	0.3987*	0.0311	0.0036	-0.3137*	-0.3724*	-0.0242	-0.0499	-0.0563	-0.0424
Trade Balance	-0.2814*	-0.237	-0.3416*	0.0722	0.2829	-0.1141	-0.1039	-0.0554	-0.0535
Intl. Reserves	-0.0298	-0.1736*	-0.3079*	-0.2245*	-0.1362	-0.0586	-0.0486	-0.0683	-0.0676
Fiscal Balance	-0.9463*	-0.2744*	-0.3158*	-0.4957*	0.0645	-0.1874	-0.0898	-0.064	-0.0429
Inflation (CPI)	-0.0107	-0.0469	-0.0887	-0.1543*	-0.0652	-0.0821	-0.0357	-0.0259	-0.0299
GDP	-0.0949*	-0.2091*	-0.1547*	-0.2677*	-0.1015	0.0142	-0.0367	-0.0289	-0.0179
<b>Peru</b>									
RER	-0.0093	0.2449	-0.127	0.1617	0.0878	-0.1037	-0.1218	0.0213	0.0767
Trade Balance	-0.0505	0.1075	0.3063*	0.1801	0.0445	0.0472	0.0032	-0.1279	-0.0687
Intl. Reserves	-0.016	0.1637	-0.1318	0.1812	0.3276	0.4664*	0.5773	0.6345	0.5496
Fiscal Balance	-0.052*	-0.0335	-0.1821	-0.1324	-0.1157	-0.006	0.168	0.0331	-0.0772
Inflation (CPI)	0.0057	-0.0191	-0.0298	-0.0637*	-0.05	0.0583	0.0346	0.0102	0.0157
GDP	0.0186	0.0326	0.0925	0.172	0.233*	0.1365	0.0141	0.011	0.0365

Note: Values are the posterior median; the \* (asterisk) represents the statistical significance at 68 percent equal-tailed probability ( $H_0: \text{IRF}=0$ ). The posterior estimations are based on 10,000 independent draws. CPI = consumer price index; GDP = gross domestic product; RER = real exchange rate.

Global demand shocks also had significant negative fiscal effects in Bolivia and Ecuador for about four consecutive quarters. In Peru, however, the negative fiscal impact of the shock was small and statistically significant only in the quarter of the shock, while no statistically significant effects were found in Colombia. In turn, the trade balances of Bolivia, Colombia, and Ecuador were negatively affected by global demand shocks (0.4%, 0.5%, and 0.6% of GDP in the first year, respectively), a result that was not found in Peru, where the trade balance actually improved two quarters after the shock. Finally, global demand shocks appeared to have a relatively subdued impact on the inflation rates of the Andean countries after one year, with minor deflationary effects on Bolivia, Ecuador, and Peru (0.2% in Q2, 0.2% in Q3, and 0.1% in Q3, respectively).

In this second exercise, primary commodity price shocks turned out to have had a minor impact on real activity (Table 8), a result that contrasts with that of the unrestricted estimations presented above. Only in Ecuador did we find a negative statistically significant impact of primary commodity price shocks on GDP in Q1 (0.1%). In other periods and in the rest of the countries included in our sample, the effect of the shock on real activity was also negative, but not statistically significant. What is the reason behind the divergent results found in the preliminary unrestricted estimation and those of this second exercise? Once we imposed the identifying restrictions, primary commodity shocks referred specifically to shocks that were not rooted in fluctuations in the other international variables included in the model. This implied that we were then capturing primarily the effects of commodity shocks rooted in exogenous disturbances affecting supply in major oil-producing countries, while the impact of commodity price shocks associated with fluctuations in global economic activity was captured by global demand shocks. As already mentioned, that commodity demand shocks are more relevant than other types of commodity shocks is a well-established conclusion of the empirical literature on this subject, which probably explains the modest impacts found in this second estimation.



**Table 8: Impulse Response of Primary Commodity Shock with Agnostic Approach**

Variables	Periods after shock								
	0	1	2	3	4	8	12	16	20
Fuel price	-2.9464*	-0.79	-0.1233	0.7297	1.028	0.2304	0.1274	0.0725	0.0503
<b>Bolivia</b>									
RER	0.0268	0.0097	-0.1162	-0.1567	0.0574	-0.1971	-0.0096	-0.028	0.0102
Trade Balance	-0.1883	0.1824	0.5918	0.4202	0.1855	-0.3488	0.2453	-0.0277	-0.0299
Intl. Reserves	-0.0562	0.135	0.5275	0.573	0.6285*	0.2595	0.155	0.0686	0.0304
Fiscal Balance	0.4189	-0.111	0.8992	0.2011	0.5619	-0.4749	0.198	-0.0557	-0.0208
Inflation (CPI)	0.0422	-0.0597	-0.0588	-0.0686	0.0582	-0.0242	-0.0397	0.0122	0.0012
GDP	-0.013	0.0185	-0.0776	0.0445	0.0269	0.0345	0.0101	0.0092	-0.0003
<b>Colombia</b>									
RER	-0.2161	-0.4483*	-0.3166	0.3404	0.2375	0.1132	0.186	-0.0346	-0.0016
Trade Balance	-0.0177	-0.074*	-0.1019*	-0.1527*	-0.1536*	0.031	0.0244	-0.0381	-0.0257
Intl. Reserves	0.029	0.1167*	0.1721*	0.15*	0.1514*	0.1638	0.0581	0.0329	0.047
Fiscal Balance	-0.1083	-0.2174	-0.0617	0.148	-0.1971	-0.259	-0.0878	0.0832	-0.0158
Inflation (CPI)	0.0101	0.0138	0.0368	-0.0444	0.0306	0.0615	-0.0108	0.0005	0.008
GDP	-0.0116	0.0038	0.0814	-0.0663	-0.0246	-0.0145	0.0238	0.0334	0.01
<b>Ecuador</b>									
RER	0.1092	0.0345	-0.054	-0.0175	-0.0221	0.1077	0.1145	0.1009	0.0796
Trade Balance	-0.2013*	-0.3981*	-0.2346*	-0.0422	0.2529	0.1305	0.1917	0.1002	0.0663
Intl. Reserves	-0.0428*	-0.1258*	-0.1852*	-0.072	-0.1152	0.1038	0.2086	0.1968	0.1633
Fiscal Balance	-0.0006	-0.0503	0.2033	-0.172	0.0177	0.1412	0.1384	0.0714	0.0561
Inflation (CPI)	-0.0294*	-0.0301	-0.1202*	-0.0404	0.0376	0.0319	0.0805	0.0681	0.0546
GDP	-0.0214	-0.1292*	-0.0649	-0.1106	-0.0839	0.097	0.0421	0.0481	0.0377
<b>Peru</b>									
RER	0.0088	0.2267	0.3187	-0.1756	-0.0761	-0.0985	-0.0354	0.0074	-0.0187
Trade Balance	-0.0593	0.0928	0.0668	0.3553*	0.0728	0.3265*	0.0651	-0.0135	0.063
Intl. Reserves	-0.0086	-0.0632	-0.0331	-0.3019*	0.0459	0.0191	0.1803	0.3542	0.4982
Fiscal Balance	0.0079	0.0629	0.1573	-0.1829	-0.1783	0.0764	0.1456	0.0086	0.02
Inflation (CPI)	-0.0049	0.0144	-0.017	-0.0409	-0.0028	-0.0315	-0.0189	0.0144	0.0117
GDP	-0.0062	-0.0595	-0.0404	0.1386	0.0618	0.0418	0.0665	0.1055	0.1239

Note: Values are the posterior median; the \* (asterisk) represents the statistical significance at 68 percent equal-tailed probability ( $H_0: IRF=0$ ). The posterior estimations are based on 10,000 independent draws. CPI = consumer price index; GDP = gross domestic product; RER = real exchange rate.

Probably for this same reason, we also failed to find statistically significant effects on most of the other domestic variables of interest, which confirmed that once we imposed the identifying restrictions, the impact of commodity price shocks faded away. Nonetheless, it is worth mentioning that this type of shock did have a statistically significant negative impact on the trade balances of Colombia (0.5 percentage points of GDP cumulatively from Q1 to Q4) and Ecuador (0.8 percentage points of GDP cumulatively from Q0 to Q2), where the shock also reduced the stock of international reserves.

Table 9 reveals that the shock on the price of other commodities also failed to have a statistically significant impact on any of the four countries considered in this paper. Once again, the difference between this result and that found in the preliminary estimation is

probably due to the fact that fluctuations in global demand shocks are at the origin of the shocks on the price of other commodities that were originally captured.

**Table 9: Impulse Response of Other Commodities Shock with Agnostic Approach**

Variables	Periods after shock								
	0	1	2	3	4	8	12	16	20
Non fuel price	-1.0565*	-0.4595	-0.3342	0.73*	0.6721*	0.1413	0.049	0.046	0.0328
<b>Bolivia</b>									
RER	0.1986	-0.2447	-0.0326	-0.2286	0.1104	0.0088	0.0699	0.0338	0.0174
Trade Balance	-0.5087*	-0.3313	0.0412	0.1001	0.0231	-0.5598	-0.1393	-0.0307	-0.253
Intl. Reserves	-0.1405*	-0.1592	0.0082	0.1687	0.2476	0.1695	0.1846	0.2609	0.1704
Fiscal Balance	-0.6041	-0.3036	-0.1609	0.0358	0.7023	-0.4698	-0.0221	0.0548	-0.1397
Inflation (CPI)	0.0274	-0.162*	-0.0803	-0.2076*	0.0311	0.0714	0.0067	0.0177	0.0182
GDP	-0.0515	-0.0268	-0.0555	0.0551	-0.06	0.0076	-0.0175	-0.0013	-0.0033
<b>Colombia</b>									
RER	0.329	-0.334	0.0027	0.4812	0.2756	0.2304	-0.0313	-0.0491	0.0238
Trade Balance	0.0198	0.0133	0.0135	-0.0551	-0.081	0.0936	0.0419	-0.0035	0.0118
Intl. Reserves	-0.0254	0.0016	0.0641	0.0235	0.0185	-0.0172	-0.0757	-0.0698	-0.0649
Fiscal Balance	-0.1375	-0.0269	-0.0075	-0.0976	-0.23	-0.1949	0.0568	0.0964	-0.0011
Inflation (CPI)	0.0266*	-0.0116	0	-0.0451	-5E-04	0.0209	-0.0238	-0.0033	-0.002
GDP	-0.0532	-0.0571	0.0285	-0.1596*	-0.043	0.011	0.0463	0.0234	0.0063
<b>Ecuador</b>									
RER	0.0234	0.0353	0.0142	0.1541	0.0769	0.1758*	0.1546*	0.1363*	0.0975
Trade Balance	-0.0155	-0.1051	-0.024	0.0613	0.226	0.1532	0.2594*	0.1115	0.0562
Intl. Reserves	0.007	0.0796	0.0358	0.0727	0.0454	0.2535*	0.3141*	0.2808*	0.2215
Fiscal Balance	0.2606	0.0102	0.1754	0.0365	-0.014	0.0802	0.1517	0.0545	0.0375
Inflation (CPI)	0.0043	-0.0116	0.0062	0.0687	0.0495	0.1126*	0.1288*	0.091*	0.0699
GDP	0.0155	-0.0072	-0.0105	-0.0733	-0.014	0.0945	0.0647	0.0695*	0.0492
<b>Peru</b>									
RER	-0.0188	-0.0575	0.0133	0.0194	-0.139	0.0424	-0.0222	0.038	0.0607
Trade Balance	0.022	0.2218*	0.0482	0.0396	-0.157	0.1955	-0.0034	-0.0374	0.0664
Intl. Reserves	-0.0857	-0.2291	-0.0464	-0.069	-0.028	-0.2676	-0.3416	-0.3149	-0.3646
Fiscal Balance	0.0088	-0.0316	0.1193	-0.1474	-0.197	0.002	0.1481	-0.0682	-0.0828
Inflation (CPI)	-0.0092*	0.0342*	0.023	-0.0464	0.0127	-0.0095	-0.0208	-0.0184	-0.0132
GDP	-0.0072	0.0209	-0.086	0.1976*	0.0327	-0.0967	-0.107	0.0003	0.0335

Note: Values are the posterior median; the \* (asterisk) represents the statistical significance at 68 percent equal-tailed probability ( $H_0: \text{IRF}=0$ ). The posterior estimations are based on 10,000 independent draws. CPI = consumer price index; GDP = gross domestic product; RER = real exchange rate.

Interestingly, we failed to find a statistically significant effect for monetary and global stock market shocks on the macroeconomic variables of interest of the two countries in our sample that are, a priori, more financially integrated in the world economy: Colombia and Peru (Tables 10 and 11). Instead, shocks to the Federal Reserve's interest rate appear to have had a negative impact on Ecuador's GDP (statistically significant declines in Q0 and Q2) and on its trade balance in Q0. International monetary shocks led to a reduction in Bolivia's stock of international reserves, a result that is also found for the global stock market shock. We also found a statistically significant contemporaneous contraction of GDP in the stock market shock for Ecuador, but not for the other countries in our sample.

**Table 10: Impulse Response of Federal Reserve Shock with Agnostic Approach**

Variables	Periods after shock								
	0	1	2	3	4	8	12	16	20
FED rate	0.0645*	0.0548	0.099*	0.1089	0.1167	0.0785	0.022	-0.0035	-0.006
<b>Bolivia</b>									
RER	0.1988	-0.1952	-0.2287	0.017	-0.1178	0.0802	0.0821	0.1038	-0.0069
Trade Balance	-0.2134	-0.1507	-0.4861	-0.2626	0.3317	0.2687	-0.4396	0.1801	-0.0412
Intl. Reserves	-0.0509	-0.2863*	-0.4454*	-0.3208	-0.1947	0.1566	0.4291	0.6202	0.6424
Fiscal Balance	-0.5047	-0.2398	-0.6241	-0.3143	0.1495	0.368	-0.2129	0.1771	-0.0736
Inflation (CPI)	0.0115	-0.012	-0.1416	-0.0367	-0.0319	0.0328	0.0632	0.0225	0.024
GDP	-0.018	-0.0817	-0.0023	-0.0023	0.0673	0.0279	0.0098	0.0065	0.0147
<b>Colombia</b>									
RER	-0.7149	-0.1312	-0.2845	-0.0544	-0.0155	0.0518	0.1158	-0.0501	-0.0314
Trade Balance	-0.0437	-0.0617	-0.088	-0.0988	-0.0408	-0.0543	-0.0158	-0.0367	-0.0504
Intl. Reserves	0.0465	0.0455	0.0545	0.1166	0.1575	0.1976	0.1999	0.1927	0.2011
Fiscal Balance	-0.0599	0.0634	0.0915	0.1812	0.0568	0.0445	-0.0488	-0.0013	-0.0153
Inflation (CPI)	-0.004	0.0301	0.0094	0.0302	0.024	0.0128	0.0098	0.008	0.0175
GDP	0.0519	0.0078	0.0252	-0.0386	-0.0397	-0.0532	-0.0337	0.011	0.0104
<b>Ecuador</b>									
RER	0.1878	-0.0529	0.0386	-0.0745	-0.1678	0.1046	0.0791	0.0374	0.0153
Trade Balance	-0.2153*	-0.0259	0.0183	0.2508	0.4503	0.168	0.05	-0.0012	-0.0234
Intl. Reserves	-0.0288	-0.0779	-0.1303	-0.0364	0.0629	0.2078	0.2231	0.1321	0.059
Fiscal Balance	-0.4748	-0.0395	-0.1052	-0.1187	0.1378	0.0067	-0.018	-0.0338	-0.0274
Inflation (CPI)	-0.0246	-0.0255	-0.0035	-0.0305	0.0356	0.0462	0.0602	0.0411	0.0136
GDP	-0.0499*	-0.0539	-0.0965*	-0.1305	-0.0395	0.0723	0.0302	0.0151	0.0065
<b>Peru</b>									
RER	-0.0359	0.0587	0.176	0.0734	0.084	-0.1472	-0.0706	0.0756	0.0189
Trade Balance	-0.0206	0.0609	0.0831	0.0749	0.0479	0.0281	-0.0231	-0.0647	-0.0028
Intl. Reserves	-0.033	0.0279	0.0263	0.0112	0.0819	0.2359	0.3285	0.3103	0.2685
Fiscal Balance	-0.0295	-0.0486	-0.1018	-0.0754	-0.0366	0.0787	0.0659	-0.0398	-0.0099
Inflation (CPI)	0.002	-0.0211	-0.0415	-0.0176	0.0234	0.029	-0.0023	0.0062	0.0165
GDP	0.0014	-0.0036	0.0795	0.1037	0.091	0.065	0.016	0.0111	0.0139

Note: Values are the posterior median; the \* (asterisk) represents the statistical significance at 68 percent equal-tailed probability ( $H_0: IRF=0$ ). The posterior estimations are based on 10,000 independent draws. CPI = consumer price index; FED = Federal Reserve; GDP = gross domestic product; RER = real exchange rate.

**Table 11: Impulse Response of Developed Country Stock Prices Shock with Agnostic Approach**

Variables	Periods after shock								
	0	1	2	3	4	8	12	16	20
MXWO	-1.5218*	-0.5215	0.2003	0.2608	-0.0234	0.1388	0.0664	0.0237	0.0088
<b>Bolivia</b>									
RER	0.278	-0.1664	-0.1737	-0.1135	-0.2675	-0.0724	-0.079	0.0031	-0.0531
Trade Balance	-0.2486	-0.195	-0.6283*	-0.2987	0.1574	0.4849	-0.2468	0.2137	0.0435
Intl. Reserves	-0.039	-0.3242*	-0.4986*	-0.5496	-0.5056	-0.6616	-0.6958	-0.5785	-0.4927
Fiscal Balance	-0.4404	-0.4416	-0.5548	-0.5916	0.0326	0.2025	-0.2128	0.1905	0.0459
Inflation (CPI)	0.0327	0.0033	-0.1109	-0.0523	-0.12	-0.0758	-0.016	-0.0328	-0.0129
GDP	-0.0204	-0.0489	-0.0151	-0.0186	0.0168	0.0061	-0.0113	-0.0117	-0.0042
<b>Colombia</b>									
RER	-0.533	-0.1336	-0.3901	-0.2242	-0.2412	0.062	0.0853	-0.0523	-0.0233
Trade Balance	-0.0366	-0.0579	-0.0923	-0.0904	-0.0406	-0.0246	-0.0071	-0.0133	-0.0107
Intl. Reserves	0.0412	0.0375	0.0469	0.0736	0.0905	0.0423	0.021	0.026	0.0416
Fiscal Balance	-0.0305	-0.0236	0.022	0.1944	0.0878	-0.1039	-0.0558	-0.0102	-0.013
Inflation (CPI)	-0.0051	0.0202	0.0113	0.0251	0.0219	-0.0014	0	0.0004	0.0036
GDP	0.0302	0.0298	0.0564	0.03	0.025	-0.011	-0.0113	-0.0034	-0.0093
<b>Ecuador</b>									
RER	0.2163	-0.096	-0.0101	-0.1766	-0.2166	-0.1132	-0.0948	-0.0806	-0.0529
Trade Balance	-0.1362	-0.1151	-0.2247	-0.1645	-0.1137	-0.1742	-0.1281	-0.0468	-0.0291
Intl. Reserves	-0.0254	-0.0852	-0.1935	-0.1417	-0.1536	-0.2165	-0.2048	-0.16	-0.0989
Fiscal Balance	-0.426	-0.1256	-0.2004	-0.2723	-0.1906	-0.1402	-0.0699	-0.0344	-0.0191
Inflation (CPI)	-0.0042	-0.0068	-0.0525	-0.1328	-0.0742	-0.1012	-0.078	-0.0523	-0.0357
GDP	-0.0503*	-0.0933	-0.09	-0.1037	-0.0679	-0.0416	-0.0471	-0.0394	-0.0226
<b>Peru</b>									
RER	-0.0561	-0.0872	0.0857	0.0536	0.0419	-0.0752	-0.0523	-0.0138	-0.0073
Trade Balance	-0.019	0.0929	0.0746	0.107	0.0992	0.0715	0.0544	-0.005	-0.0076
Intl. Reserves	-0.0499	-0.0319	0.0169	-0.0285	-0.0281	0.1919	0.3513	0.4716	0.5463
Fiscal Balance	-0.0351	-0.1509	-0.1332	-0.0894	-0.0245	0.0276	0.0722	0.047	0.013
Inflation (CPI)	0.0027	-0.0031	-0.0424	-0.0407	-0.0115	0.0091	0.0085	0.0115	0.014
GDP	0.0063	-0.0057	0.0718	0.0912	0.0779	0.1366	0.0879	0.056	0.0686

Note: Values are the posterior median; the \* (asterisk) represents the statistical significance at 68 percent equal-tailed probability ( $H_0: \text{IRF}==0$ ). The posterior estimations are based on 10,000 independent draws. CPI = consumer price index; GDP = gross domestic product; MXWO = Morgan Stanley world stock market index; RER = real exchange rate.

### 3.3. Persistent Shocks

Finally, we report the IRFs of a third estimation on the effects of persistent changes in the international variables included in our specification. To do so, we added another restriction to the ones described in section 2: that every shock (one standard deviation movement in the international variable) has a duration of at least four quarters.

Once again, as can be seen in Table 12, Ecuador was the Andean country most affected by the shock to global activity, with a statistically significant reduction in GDP that began in the quarter of the shock and lasted until Q3. Bolivia's GDP also reacted negatively to global demand shocks in this exercise, although this effect was found to be statistically

significant only in Q1. Surprisingly, in this third estimation, the real economies of Colombia and Peru did not react negatively to global demand shocks. We also observed a contemporaneous appreciation of the RER in Bolivia and Ecuador, while that of Colombia depreciated in Q2 and no statistically significant effects were found on the RER of Peru. The effects of the shock on the exchange rate, therefore, were shorter lived in this third estimation than in the previous two exercises. In turn, the stock of foreign exchange reserves fell in the fixed exchange rate regimes, with an accumulated reduction of 1.92% in Bolivia between Q1 and Q4, and of 0.65% in Ecuador during this same period. This effect was not found in Colombia and Peru where, if anything, the stock of international reserves increased after the shock, a result that was not statistically significant. The new restrictions only produced higher persistence in the effects than the second estimation.

The negative impact of the shock on public finances was larger and more sustained in Ecuador (deterioration of 2.1% of GDP in the fiscal balance from Q0 to Q3) than in the other countries in our sample. In Bolivia, we also found a statistically significant negative effect in Q1 and Q3, while in Peru the fiscal impact was both shorter lived (Q0) and of a smaller magnitude, and Colombia's public finances did not appear to suffer as a result of a persistent global demand shock. Colombia's trade balance deteriorated from Q1 to Q3, as did that of Ecuador in Q0 and Q2 and Bolivia in Q2. By contrast, the impact of the shock on the Peruvian trade balance was both smaller and not statistically significant. Persistent global demand shocks tended to reduce the inflation rate of Andean nations, although this effect was not statistically significant in most quarters.

**Table 12: Impulse Response of Persistent Global Demand Shock**

Variables	Periods after shock								
	0	1	2	3	4	8	12	16	20
World GDP	-9.3116*	-7.3907*	-3.3502*	-2.8991*	-3.3457*	-2.0033*	-1.7489*	-1.3923	-1.0332
<b>Bolivia</b>									
RER	0.4213*	-0.0919	-0.2748	-0.0977	-0.1968	-0.0822	-0.0618	0.0419	-0.0668
Trade Balance	-0.4199	-0.1511	-0.7515*	-0.3736	0.2718	0.5659	-0.3434	0.2977	0.0456
Intl. Reserves	0.0118	-0.4289*	-0.6802*	-0.8104*	-0.5483	-0.6826	-0.5872	-0.3588	-0.2793
Fiscal Balance	-0.0721	-0.8541*	-0.5095	-1.0781*	0.2407	0.2826	-0.2637	0.2649	0.0387
Inflation (CPI)	0.0518	-0.0045	-0.232*	-0.0699	-0.0657	-0.0439	-0.0177	-0.0276	-0.0067
GDP	0.0251	-0.1368*	-0.0883	0.1137	0.073	0.0407	-0.0016	-0.0077	-0.0005
<b>Colombia</b>									
RER	-0.4505	-0.2517	-0.5792*	-0.5413	-0.3372	0.132	0.1618	-0.0961	-0.0826
Trade Balance	-0.0412	-0.0946*	-0.1853*	-0.1978*	-0.1306	-0.0884	-0.0274	-0.0551	-0.0678
Intl. Reserves	0.0504	0.0925	0.0718	0.1825*	0.2327*	0.2552	0.2207	0.2288	0.2627
Fiscal Balance	0.0169	-0.0987	-0.0639	0.1934	0.2853*	-0.1524	-0.1317	-0.0117	-0.0237
Inflation (CPI)	-0.0085	0.007	-0.0246	0.0182	0.0615*	0.0101	0.0062	0.0092	0.0238
GDP	0.0152	0.0356	0.0368	0.1038	0.0052	-0.1034	-0.0372	0.0058	-0.0055
<b>Ecuador</b>									
RER	0.405*	-0.0043	0.0215	-0.3236*	-0.396*	-0.0629	-0.096	-0.1066	-0.0822
Trade Balance	-0.2517*	-0.1362	-0.2908*	0.0579	0.1924	-0.1655	-0.18	-0.111	-0.087
Intl. Reserves	-0.024	-0.143*	-0.2843*	-0.2256*	-0.133	-0.1091	-0.1355	-0.1607	-0.152
Fiscal Balance	-1.0006*	-0.2694*	-0.3784*	-0.487*	-0.001	-0.2527	-0.152	-0.1008	-0.0667
Inflation (CPI)	-0.0049	-0.0381	-0.058	-0.1654*	-0.0867*	-0.0994	-0.069	-0.0591	-0.0577
GDP	-0.0961*	-0.1775*	-0.1601*	-0.2605*	-0.0983	-0.0211	-0.0593	-0.053	-0.0384
<b>Peru</b>									
RER	0.007	0.3277	-0.0908	0.117	0.0831	-0.1266	-0.1186	0.0117	0.064
Trade Balance	-0.0655	0.0704	0.3166*	0.2494	0.0897	0.0748	0.0028	-0.1343	-0.0789
Intl. Reserves	0.0056	0.2157	-0.1424	0.148	0.3853*	0.5431*	0.7225*	0.8127	0.7356
Fiscal Balance	-0.049*	0.0113	-0.1515	-0.1298	-0.123	0.0058	0.1815	0.0493	-0.0688
Inflation (CPI)	0.0063	-0.0226	-0.0315	-0.0626	-0.0606	0.0587	0.0408	0.0137	0.0208
GDP	0.0193	0.0206	0.089	0.1511	0.2485*	0.1604	0.0377	0.033	0.0462

Note: Values are the posterior median; the \* (asterisk) represents the statistical significance at 68 percent equal-tailed probability ( $H_0: IRF=0$ ). The posterior estimations are based on 10,000 independent draws. CPI = consumer price index; GDP = gross domestic product; RER = real exchange rate.

**Table 13: Impulse Response of Persistent Primary Commodity Shock**

Variables	Periods after shock								
	0	1	2	3	4	8	12	16	20
Fuel price	-2.4719*	-1.5071*	-1.1328*	-0.5312*	1.0848	0.1008	0.0752	0.0625	0.0319
<b>Bolivia</b>									
RER	0.3788*	-0.3469*	-0.2118	-0.3311*	-0.0857	-0.0267	0.0251	0.043	-0.0108
Trade Balance	-0.7244*	-0.3818*	-0.2454	0.0137	0.259	-0.1945	-0.2906	0.154	-0.1915
Intl. Reserves	-0.1779*	-0.3646*	-0.2587	-0.1138	0.0429	-0.0798	-0.0352	0.1138	0.0622
Fiscal Balance	-0.7578*	-0.584	-0.3885	-0.319	0.8757*	-0.3512	-0.0935	0.1806	-0.1254
Inflation (CPI)	0.0589	-0.1738*	-0.1859*	-0.272*	-0.0535	0.0332	0.0056	0.0002	0.0145
GDP	-0.0695*	-0.0593	-0.0813	0.0336	-0.0349	0.0213	-0.0191	-0.0029	-0.0019
<b>Colombia</b>									
RER	-0.8223	-0.3707*	-0.5047*	0.1888	0.0597	-0.1026	0.2648	-0.0011	-0.0213
Trade Balance	-0.0514	-0.1064*	-0.1399*	-0.1853*	-0.1942*	-0.0556	0.0004	-0.0617	-0.0549
Intl. Reserves	0.0671*	0.1376*	0.2137*	0.1951*	0.2185*	0.2826*	0.1565	0.1028	0.1234
Fiscal Balance	-0.0975	-0.2278	-0.0299	0.2831	-0.2559*	-0.2607*	-0.2368	0.0338	-0.0353
Inflation (CPI)	-0.0044	0.0431	0.0718*	-0.0183	0.0178	0.0934*	0.011	0.0026	0.0158
GDP	0.0479	0.0377	0.1133*	-0.0261	0.0193	-0.0156	-0.0068	0.0379	0.0092
<b>Ecuador</b>									
RER	0.1133	0.0217	-0.0286	0.0493	0.0035	0.0905	0.1189	0.1082	0.0816
Trade Balance	-0.2031*	-0.4046*	-0.2795*	-0.1566	0.1036	0.2037	0.2351	0.0921	0.0618
Intl. Reserves	-0.0412*	-0.0994*	-0.1819*	-0.099	-0.1967*	0.076	0.2162	0.2094	0.1731
Fiscal Balance	0.0672	-0.0449	0.2068	-0.2091	-0.1082	0.1532	0.1335	0.0579	0.0514
Inflation (CPI)	-0.0277*	-0.0308	-0.1112*	-0.036	0.0191	0.0385	0.0836	0.068	0.0582
GDP	-0.0175	-0.1244*	-0.0922*	-0.1623*	-0.1631*	0.0646	0.043	0.0503	0.0371
<b>Peru</b>									
RER	0.094*	0.5209*	0.4127*	-0.3553*	-0.0892	-0.0949	0.0255	-0.0596	-0.1016
Trade Balance	-0.107*	-0.1263	0.0318	0.5412*	0.2029*	0.4072*	0.0879	0.0316	0.0533
Intl. Reserves	0.1179*	0.1415	-0.0703	-0.4495*	0.1485	0.1332	0.3767	0.7003	0.9921*
Fiscal Balance	0.0451*	0.2795*	0.3322*	-0.1226	-0.1555	0.0867	0.0941	0.0763	0.102
Inflation (CPI)	-0.003	0.0043	0.0038	0.0002	-0.0335	-0.0607	-0.0147	0.0332	0.0212
GDP	-0.0075	-0.1183*	-0.0869	-0.033	0.0327	0.0469	0.1659	0.1872*	0.1701

Note: Values are the posterior median; the \* (asterisk) represents the statistical significance at 68 percent equal-tailed probability ( $H_0: \text{IRF}=0$ ). The posterior estimations are based on 10,000 independent draws. CPI = consumer price index; GDP = gross domestic product; RER = real exchange rate.

As can be seen in Table 13, prolonged falls in oil prices had a strong and persistent impact on Ecuador's GDP, which fell cumulatively by 0.5% in the first year.<sup>8</sup> Bolivia's GDP also fell in the quarter of the shock, that of Peru in Q1, while the Colombian real economy was unaffected by persistent declines in oil prices orthogonal to the global demand shock analyzed above. The exchange rate appeared to function as a shock absorber in Colombia, with a statistically significant cumulative depreciation of 0.9% between Q0 and Q3. Surprisingly, this was not the case in Peru, where the RER actually appreciated in the quarter of the shock and for the following three quarters. In turn, the contemporaneous

<sup>8</sup> It is worth noting that this third estimation satisfies the identifying restrictions and, therefore, the primary commodity shocks that are being considered are not rooted in the other international variables that we included in our specification.

appreciation of the RER that we observed in Bolivia quickly reverted, while that of Ecuador was not statistically significant.

The fiscal impact of the shock was positive in Peru and statistically significant only in a few quarters in Bolivia (Q0) and Colombia (Q4 and Q8), although with the expected negative sign. In spite of the depreciation of its RER, the negative impact of the shock on the trade balance was more persistent in Colombia (between Q1 and Q4) and Ecuador (from Q0 to Q3) than in the other countries in the sample (Bolivia in Q0 and Q1 and Peru only in Q0, with a positive reaction of the trade balance from Q3 onward). Finally, the shock tended to reduce inflation in Bolivia and Ecuador, and its effect was ambiguous on the CPIs of Colombia and Peru.

**Table 14: Impulse Response of Persistent Other Commodities Shock**

Variables	Periods after shock								
	0	1	2	3	4	8	12	16	20
Non fuel price	-0.5733*	-0.5511*	-0.3995*	-0.197*	0.3627*	0.095	0.0503	0.0326	0.0171
<b>Bolivia</b>									
RER	0.2718*	-0.4107*	-0.1079	-0.1768	-0.216	0.163	0.0265	0.0866	-0.0058
Trade Balance	-0.3955*	-0.4875*	-0.6867*	-0.2834	0.1034	0.1162	-0.606	0.1316	-0.1758
Intl. Reserves	-0.1668*	-0.4247*	-0.583*	-0.4249	-0.5155*	-0.2224	-0.0545	0.1133	0.1413
Fiscal Balance	-1.3254*	-0.1976	-1.1324*	-0.2018	0.1685	0.0759	-0.277	0.2315	-0.112
Inflation (CPI)	0.0123	-0.1043*	-0.092	-0.182*	-0.1706*	0.0315	0.058	-0.0001	0.0182
GDP	-0.0913*	-0.0114	0.0407	-0.1104*	-0.072	-0.0164	-0.0228	-0.0098	0.0002
<b>Colombia</b>									
RER	-1.1508*	-0.1769	-0.5356	0.0496	-0.2	-0.0152	0.1635	-0.044	-0.0203
Trade Balance	-0.0694*	-0.0869	-0.0865	-0.0975	-0.034	-0.0122	0.0189	-0.0113	-0.0045
Intl. Reserves	0.0694	0.0315	0.1039	0.0883	0.1111	0.0531	-0.007	-0.0113	0.0036
Fiscal Balance	-0.1309*	0.1179	0.1547	0.3174	-0.144	-0.1122	-0.0663	0.0177	-0.0054
Inflation (CPI)	-0.0014	0.0536*	0.0563*	0.0418	-0.013	0.0187	-0.0008	-0.0041	0.0023
GDP	0.0749*	0.0213	0.1105*	-0.1093	0.0064	0.0206	-0.0084	0.0083	-0.0043
<b>Ecuador</b>									
RER	0.0929	-0.0749	-0.009	0.0711	0.0037	0.0936	0.1288	0.1134	0.0845
Trade Balance	-0.1754	-0.2953	-0.1673	-0.1041	0.0589	0.2447	0.2227*	0.0928	0.0598
Intl. Reserves	-0.0376	-0.0677	-0.1635	-0.0307	-0.098	0.142	0.2479	0.2474	0.1969
Fiscal Balance	0.125	0.0127	0.1189	-0.0913	-0.192	0.1434	0.1192	0.0455	0.0344
Inflation (CPI)	-0.0206	-0.0109	-0.0825	-0.0367	0.025	0.07	0.0964*	0.0745	0.0623
GDP	-0.016	-0.0734	-0.0762	-0.0897	-0.1158*	0.0607	0.0542	0.0512	0.0359
<b>Peru</b>									
RER	-0.0126	0.1689	0.4128*	-0.1159	-0.115	-0.0133	-0.0418	-0.0477	0.0026
Trade Balance	-0.0598	0.1092	0.0431	0.4314	0.1971	0.2787*	0.0554	0.0004	0.0357
Intl. Reserves	-0.0254	-0.1069	0.0197	-0.3156*	-0.07	0.0973	0.3453	0.539	0.6932
Fiscal Balance	0.0034	0.0104	0.1605	-0.1674	-0.204*	0.077	0.1467	0.0563	0.0085
Inflation (CPI)	-0.0056	0.0172	-0.0229	-0.0319	0.0085	-0.0114	-0.0064	0.0115	0.0106
GDP	-0.0071	-0.0587	-0.0258	0.1434	0.0811	0.0913	0.0943	0.111	0.1444

Note: Values are the posterior median; the \* (asterisk) represents the statistical significance at 68 percent equal-tailed probability ( $H_0: \text{IRF}==0$ ). The posterior estimations are based on 10,000 independent draws. CPI = consumer price index; GDP = gross domestic product; RER = real exchange rate.



As shown in Tables 14, 15, and 16, with relatively few exceptions, the other persistent shocks contemplated in this section had minor impacts on the domestic macroeconomic variables of interest, among which the following stand out in particular. Other commodity price shocks had a significant negative impact on Bolivia's trade balance that lasted from Q0 to Q3. A persistent increase in the Federal Reserve's interest rate negatively affected the real economy of the fixed exchange rate regimes (Bolivia's GDP in Q1 and Ecuador's GDP in Q0 and Q3), while also leading to a fall in the stock of international reserves of Bolivia (Q1 and Q2) and to a deterioration in Ecuador's trade balance in Q0, which reverted in Q3 and Q4. The international stock market shock led to a persistent fall in the Bolivian stock of international reserves, and negatively affected the Ecuadorean trade balance from Q3 onward.

**Table 15: Impulse Response of Persistent Federal Reserve Shock**

Variables	Periods after shock								
	0	1	2	3	4	8	12	16	20
FED rate	0.0823*	0.081*	0.1354*	0.1529*	0.1659*	0.1184*	0.0469	0.0072	-0.0011
<b>Bolivia</b>									
RER	0.1871	-0.2191	-0.1842	0.0226	-0.0258	0.1707	0.1376	0.1434	0.0137
Trade Balance	-0.2734	-0.2276	-0.4882	-0.2743	0.3085	0.0415	-0.5704	0.1434	-0.1607
Intl. Reserves	-0.0612	-0.2963*	-0.481*	-0.3106	-0.159	0.3655	0.733	0.9863	0.9562
Fiscal Balance	-0.6237	-0.2255	-0.7823	-0.2526	0.2654	0.3223	-0.2572	0.1818	-0.1595
Inflation (CPI)	0.0007	-0.0394	-0.1386	-0.0699	-0.0054	0.0909	0.0856	0.0383	0.0433
GDP	-0.0174	-0.0953*	-0.0016	0.0178	0.0513	0.024	0.0088	0.0089	0.0177
<b>Colombia</b>									
RER	-0.4871	-0.224	-0.2675	0.0193	0.1085	0.0698	0.1173	-0.0679	-0.0413
Trade Balance	-0.033	-0.0645	-0.1075	-0.132	-0.0871	-0.0528	-0.0134	-0.0531	-0.0667
Intl. Reserves	0.0361	0.0663	0.0768	0.1499	0.198	0.2717	0.2635	0.2539	0.2594
Fiscal Balance	-0.0594	0.0049	0.0504	0.1256	0.058	0.0071	-0.0617	0.025	-0.0142
Inflation (CPI)	0.0003	0.0205	-0.0029	0.0109	0.0368	0.0269	0.0069	0.0117	0.0246
GDP	0.0285	-0.0044	0.0124	-0.0447	-0.0654	-0.0807	-0.0328	0.0222	0.0164
<b>Ecuador</b>									
RER	0.1861	-0.0127	0.05	-0.0496	-0.1451	0.1792	0.1355	0.0837	0.049
Trade Balance	-0.2261*	-0.0444	0.0412	0.3429*	0.5957*	0.2449	0.1275	0.0229	-0.0139
Intl. Reserves	-0.0255	-0.0676	-0.1163	-0.0138	0.1068	0.3136*	0.3371*	0.2333	0.1341
Fiscal Balance	-0.489	-0.0366	-0.0692	-0.1036	0.2504	0.0739	0.014	-0.0292	-0.0243
Inflation (CPI)	-0.0257	-0.0324	-0.0001	-0.0017	0.0613	0.0861	0.1043	0.0699	0.0363
GDP	-0.0465*	-0.0591	-0.0973*	-0.1575	-0.0345	0.111*	0.0541	0.0397	0.0224
<b>Peru</b>									
RER	-0.0245	0.1157	0.0284	0.1471	0.074	-0.1202	-0.0996	0.1081	0.085
Trade Balance	-0.0106	0.118	0.1744	0.0284	-0.0443	-0.0056	-0.0688	-0.1338	-0.0253
Intl. Reserves	-0.0442	0.0499	-0.0393	0.1375	0.2125	0.2626	0.2587	0.1584	-0.019
Fiscal Balance	-0.0337	-0.0216	-0.109	-0.0941	-0.0962	0.0517	0.1195	-0.083	-0.0865
Inflation (CPI)	0.0009	-0.0199	-0.0264	-0.0319	0.015	0.0512	0.0076	-0.0046	0.0086
GDP	0.0047	0.0322	0.0714	0.1745	0.1478	0.0128	-0.0783	-0.0408	-0.0264

Note: Values are the posterior median; the \* (asterisk) represents the statistical significance at 68 percent equal-tailed probability ( $H_0: IRF=0$ ). The posterior estimations are based on 10,000 independent draws. CPI = consumer price index; FED = Federal Reserve; GDP = gross domestic product; RER = real exchange rate.

**Table 16: Impulse Response of Persistent Developed Country Stock Prices Shock**

Variables	Periods after shock								
	0	1	2	3	4	8	12	16	20
MXWO	-1.4388*	-0.6706*	-0.521*	-0.7198*	-0.6963*	0.2586	0.2234	0.1148	0.0327
<b>Bolivia</b>									
RER	0.2402	-0.0863	-0.1811	-0.1796	-0.4794*	-0.2299	-0.2979	-0.1122	-0.1026
Trade Balance	-0.0502	-0.0556	-0.6077*	-0.3401	-0.0063	1.2536*	0.1237	0.3619	0.4258
Intl. Reserves	-0.0083	-0.2585*	-0.4609*	-0.7216*	-0.895*	-1.454*	-1.7925*	-1.8879*	-1.644
Fiscal Balance	-0.2382	-0.3543	-0.3619	-0.731*	-0.4972	0.4047	-0.1513	0.2179	0.2907
Inflation (CPI)	0.0492	0.0728	-0.0543	0.0017	-0.2265*	-0.2446*	-0.083	-0.0926	-0.0634
GDP	-0.024	0.0262	0.0018	-0.1092	-0.0101	-0.0172	-0.0153	-0.0268	-0.0206
<b>Colombia</b>									
RER	-0.7673	0.1308	-0.3619	-0.3818	-0.609	-0.0434	-0.0353	-0.0293	-0.0097
Trade Balance	-0.0449	-0.0258	-0.0172	0.024	0.0666	-0.0136	-0.017	0.0333	0.0454
Intl. Reserves	0.0468	-0.0387	-0.0349	-0.075	-0.0727	-0.2169	-0.2044	-0.1685	-0.1576
Fiscal Balance	-0.0106	0.1006	0.0776	0.2297	0.0873	-0.0751	-0.0222	-0.0781	-0.0046
Inflation (CPI)	-0.0125	0.031	0.0334	0.0592*	-0.0168	-0.0436	0.0025	-0.0107	-0.0171
GDP	0.0575	0.0538	0.0777	0.0563	0.1045*	0.0792	0.0002	-0.0321	-0.0278
<b>Ecuador</b>									
RER	0.0805	-0.2219*	-0.0232	-0.1476	-0.1756	-0.3749*	-0.3079*	-0.2475*	-0.1687*
Trade Balance	0.0872	0.1188	-0.1574	-0.5281*	-0.8145*	-0.5044*	-0.392*	-0.1707	-0.0716
Intl. Reserves	-0.0055	0.0233	-0.075	-0.1238	-0.2348	-0.615*	-0.6863*	-0.5628*	-0.4072
Fiscal Balance	-0.087	-0.0475	-0.321*	-0.1491	-0.6078*	-0.36	-0.2395	-0.0893	-0.0534
Inflation (CPI)	0.0224	0.0398	0.0086	-0.1679*	-0.1695*	-0.2192*	-0.2376*	-0.1783*	-0.1221*
GDP	-0.0212	0.0241	-0.0393	0.0527	-0.0446	-0.2084*	-0.1453*	-0.1236*	-0.0853
<b>Peru</b>									
RER	-0.0252	-0.0229	0.2837	-0.1557	0.0295	-0.0958	0.0137	-0.1162	-0.1391
Trade Balance	-0.0566	-0.0977	-0.0672	0.2891	0.3089*	0.1904	0.1444	0.1224	0.0139
Intl. Reserves	0.0293	0.0301	0.0775	-0.2712	-0.1725	0.2157	0.6347	0.9659*	1.3133*
Fiscal Balance	-0.0109	-0.0886	-0.0407	-0.0519	0.0479	0.068	-0.0138	0.1597	0.1703
Inflation (CPI)	0.005	-0.0034	-0.0489*	-0.0071	-0.0313	-0.0445	0.0063	0.0386	0.0281
GDP	0.0019	-0.0804	0.0495	-0.0924	-0.0122	0.2503*	0.288*	0.1879	0.1619

Note: Values are the posterior median; the \* (asterisk) represents the statistical significance at 68 percent equal-tailed probability ( $H_0: \text{IRF}=0$ ). The posterior estimations are based on 10,000 independent draws. CPI = consumer price index; GDP = gross domestic product; MXWO = Morgan Stanley world stock market index; RER = real exchange rate.

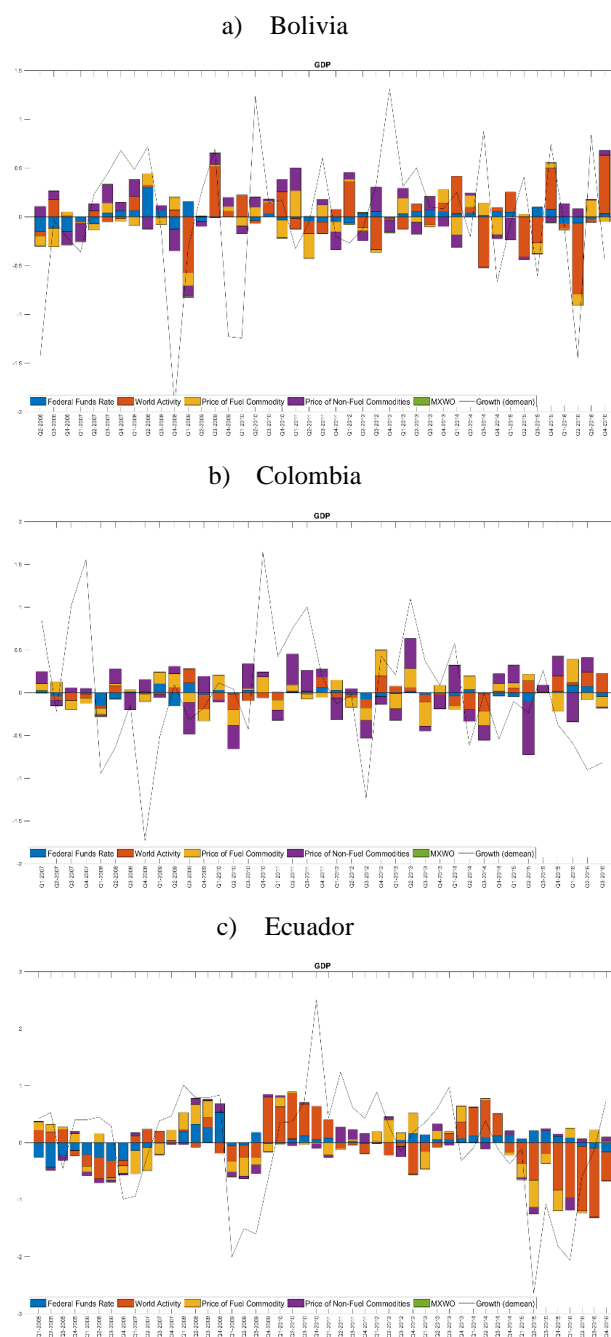
### 3.4. Historical and Variance Decomposition

To further illustrate the relevance of global economic fluctuations in the Andean region, we carried out two extensions of the estimations presented in section 3.2: (i) a historical decomposition of our four countries' demeaned GDP, which showed how the accumulated effect of the five shocks under consideration evolved over time; and (ii) a forecast error variance decomposition (FEVD) at 40 quarters, which showed the long-run contribution of the international shocks analyzed in this paper to the macroeconomic performance of Bolivia, Colombia, Ecuador, and Peru.

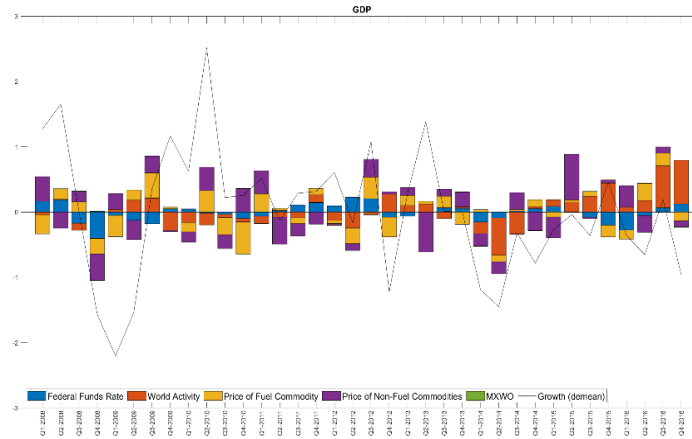
Figure 1 presents the historical decomposition for each of the countries in our sample. A visual inspection of these graphs indicates that global demand and fuel commodity shocks

were particularly important to explain the recent growth performance of Bolivia and Ecuador, especially during downturns such as that which occurred around the global financial crisis and after the end of the commodity supercycle. The real business cycles of Colombia and Peru seem to have been more shielded from these two types of shocks, a result that may be related to the macroeconomic management of these economies and the flexibility provided by their exchange rate regimes.

**Figure 1: Historical Decompositions of the Andean Countries' GDP**



d) Peru



Note: We present the (four quarter) accumulated posterior median, based on 10,000 independent draws.

Figure 1 shows that the monetary policy shock has lost relevance over time, a result that is unsurprising given that the Federal Reserve's rate remained essentially flat between 2009 and 2015. Before the global monetary expansion that characterized the aftermath of the global financial crisis, the Federal Reserve's rate was more relevant as a determinant of GDP fluctuations in the Andean countries, especially in Bolivia, Colombia, and Ecuador. The ongoing normalization of the Federal Reserve's policy, therefore, might increase the economic relevance of global monetary shocks for the Andean region once again. As already shown in the previous two sections, shocks to developed country stock markets appeared to have a marginal impact on the recent macroeconomic performance of the countries in our sample.

Finally, we conducted an FEVD to obtain the contributions of the international shocks under analysis to the macroeconomic fluctuations of the Andean region in the long run. As shown in Table 17, the sum of the shocks explains more than 60% of the variance of all our domestic variables, with relatively minor differences between the countries in our sample. Interestingly, stock market price fluctuations in advanced economies had the largest share for all countries and all variables in the long run, a result that is at odds with the estimations presented above, in which this shock played a relatively minor role. This apparent incompatibility may reflect the fact that the MXWO financial index is more volatile than the other variables included in the international block. As a result, although each individual stock market shock may not be as relevant as the other shocks, their cumulative combined effect could still be relevant. In other words, the financial transmission channel should not be disregarded in the Andean region.

**Table 17: Forecast Error Variance Decomposition of International Shocks**

Variables	Federal Reserve	Global Demand	Primary Commodity	Other Commodities	Developed Stock Prices	Sum
<b>Bolivia</b>						
RER	0.14	0.14	0.12	0.11	0.15	0.66
Trade Balance	0.13	0.13	0.11	0.10	0.14	0.62
Intl. Reserves	0.07	0.07	0.05	0.05	0.12	0.36
Fiscal Balance	0.14	0.16	0.14	0.13	0.15	0.72
Inflation (CPI)	0.13	0.13	0.11	0.12	0.15	0.65
GDP	0.14	0.17	0.12	0.14	0.14	0.71
<b>Colombia</b>						
RER	0.14	0.15	0.15	0.16	0.14	0.74
Trade Balance	0.15	0.19	0.14	0.17	0.15	0.80
Intl. Reserves	0.14	0.15	0.09	0.11	0.13	0.60
Fiscal Balance	0.14	0.17	0.15	0.16	0.15	0.76
Inflation (CPI)	0.15	0.16	0.19	0.18	0.15	0.82
GDP	0.15	0.15	0.15	0.17	0.15	0.77
<b>Ecuador</b>						
RER	0.10	0.12	0.08	0.10	0.13	0.53
Trade Balance	0.11	0.09	0.09	0.10	0.14	0.54
Intl. Reserves	0.08	0.06	0.06	0.09	0.13	0.42
Fiscal Balance	0.10	0.14	0.08	0.10	0.13	0.55
Inflation (CPI)	0.08	0.07	0.07	0.10	0.13	0.45
GDP	0.11	0.15	0.10	0.12	0.15	0.63
<b>Peru</b>						
RER	0.14	0.17	0.15	0.15	0.15	0.76
Trade Balance	0.14	0.17	0.16	0.17	0.16	0.79
Intl. Reserves	0.10	0.15	0.08	0.11	0.11	0.56
Fiscal Balance	0.13	0.16	0.13	0.14	0.14	0.69
Inflation (CPI)	0.14	0.18	0.13	0.14	0.15	0.75
GDP	0.12	0.15	0.13	0.14	0.14	0.69

Note: The posterior medians are based on 10,000 independent draws at horizon 40. CPI = consumer price index; GDP = gross domestic product; RER = real exchange rate.

#### 4. Concluding Remarks

This study employs an agnostic SVAR approach to analyze the response of the Andean economies to a variety of international shocks. Our contributions to the literature are twofold. First, we focus on a narrow subset of commodity exporters for which contagion effects have seldom been studied in isolation, and we take a broad definition of shocks in order to shed some light on the vulnerabilities associated with the way in which these countries have integrated into the global economy. Second, we combine Zha's (1999) block exogeneity procedures with the algorithm recently developed by Arias et al. (2018) to impose sign and zero restrictions on the international block. More specifically, we focus on the response of GDP, the trade balance, the fiscal result, the real exchange rate, inflation, and the stock of international reserves to global demand, commodity prices, monetary, and financial shocks in Bolivia, Colombia, Ecuador, and Peru.

Our results confirm that international shocks are important determinants of the Andean region's macroeconomic performance. However, despite these economies' similar characteristics in terms of their income level or productive specialization, we found substantial heterogeneity in the reactions of our domestic variables of interest to the shocks that we considered. Although, *a priori*, Ecuador is less commercially and financially integrated into the global economy than Colombia or Peru, it is by far the country in our sample most affected by global demand and commodity shocks. This may reflect the inflexibility of Ecuador's macroeconomic framework as a dollarized economy, and the weakness of its external buffers (low level of international reserves, lack of fiscal space, or the absence of a stabilization fund) to respond to a deterioration of the international conditions in which it operates (for more details, see Díaz-Cassou and Ruiz-Arranz, 2018). Our results also suggest that the other fixed exchange rate regime in our sample, Bolivia, has been better able than Ecuador to shield its real economy from the effects of international shocks, in part by using up its stock of international reserves to respond to external fluctuations.

Why are Colombia and Peru less affected by international shocks than Bolivia and Ecuador? In the case of the former, the exchange rate has functioned as a shock absorber, with simultaneous depreciations of the RER found in the quarter of various shocks or soon thereafter. This effect is less clear in the case of Peru, where the moderate impact of the shocks under consideration might be more related to the solid macroeconomic framework that this country has managed to put in place over the past decades. Substantiating this point, Werner and Santos (2015) offer a detailed account of the Peruvian authorities' proactive use of monetary and fiscal policies to counteract the effect of the global financial crisis of 2009, and how this was made possible by the series of reforms that had been gradually implemented since the 1990s.

In sum, a central message that emerges from this paper is that, although the vulnerability of the Andean region to abrupt changes in external conditions is undeniable, these economies have policy tools at their disposal to mitigate the impact of international shocks and better take advantage of their presence in global markets. Shock absorbers, be they in the form of exchange rate and monetary flexibility or fiscal space, constitute a crucial element of the macroeconomic framework required for Andean countries to cushion the effects of global demand fluctuations on the price of the commodities that dominate these countries' export baskets. Peru and, to a lesser extent, Colombia have

already managed to move in that direction, but Bolivia and, especially, Ecuador are still more exposed to international shocks as a result of some of the shortcomings that characterize their macroeconomic framework.

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## Appendix

### A. Data

Country	Sample
International variables	2003:Q1–2016:Q4
Bolivia	2004:Q2–2016:Q4
Colombia	2005:Q1–2016:Q3
Ecuador	2003:Q1–2016:Q4
Peru	2006:Q1–2016:Q4

### B. Tables

**Table B.1: Forecast Error Variance Decomposition in the Preliminary Estimation**

Variables	Federal Reserve	Global Demand	Primary Commodity	Other Commodities	Developed Stock Prices
<b>Bolivia</b>					
RER	0.48	0.27	0.30	0.50	0.61
Trade Balance	0.66	0.40	0.28	0.28	0.29
Intl. Reserves	0.62	0.67	0.28	0.53	0.17
Fiscal Balance	0.47	0.34	0.28	0.41	0.34
Inflation (CPI)	0.80	0.21	0.19	0.45	0.33
GDP	0.42	0.18	0.23	0.30	0.32
<b>Colombia</b>					
RER	0.41	0.48	0.44	0.22	0.52
Trade Balance	0.61	0.38	0.61	0.29	0.35
Intl. Reserves	0.62	0.45	0.67	0.29	0.41
Fiscal Balance	0.50	0.36	0.39	0.19	0.37
Inflation (CPI)	0.59	0.43	0.34	0.23	0.27
GDP	0.73	0.58	0.29	0.17	0.28
<b>Ecuador</b>					
RER	0.43	0.23	0.36	0.31	0.30
Trade Balance	0.64	0.24	0.29	0.27	0.26
Intl. Reserves	0.72	0.27	0.26	0.19	0.20
Fiscal Balance	0.63	0.40	0.41	0.23	0.40
Inflation (CPI)	0.67	0.19	0.26	0.18	0.24
GDP	0.64	0.40	0.47	0.35	0.26
<b>Peru</b>					
RER	0.19	0.18	0.42	0.24	0.30
Trade Balance	0.31	0.29	0.35	0.21	0.53
Intl. Reserves	0.47	0.76	0.49	0.19	0.45
Fiscal Balance	0.33	0.32	0.53	0.36	0.41
Inflation (CPI)	0.30	0.25	0.38	0.21	0.31
GDP	0.26	0.23	0.36	0.20	0.38

Note: The posterior medians are based on 10,000 independent draws at horizon 40. CPI = consumer price index; GDP = gross domestic product; RER = real exchange rate.

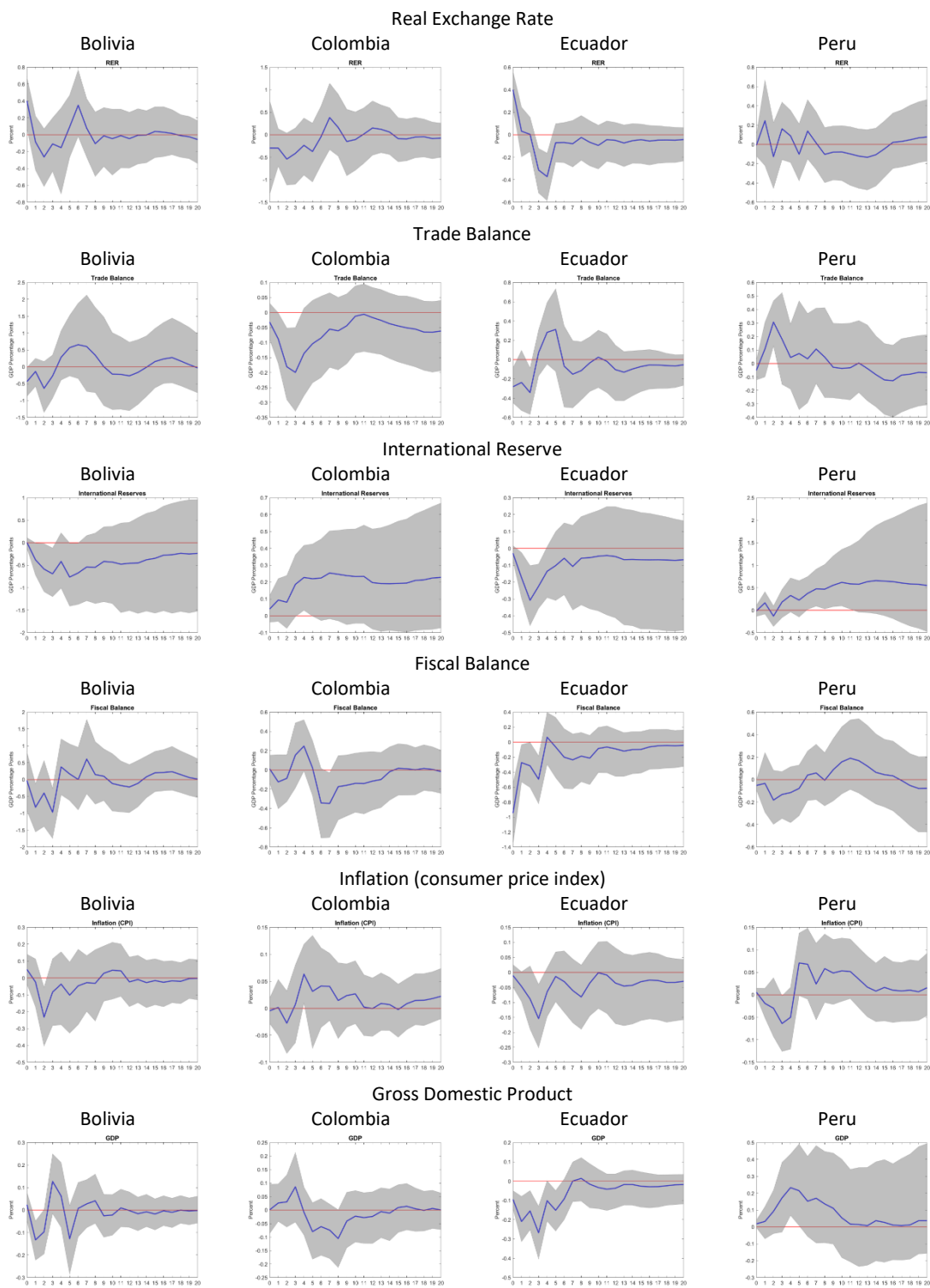
**Table B.2: Forecast Error Variance Decomposition of the Agnostic Approach**

Variables	Federal Reserve	Global Demand	Primary Commodity	Other Commodities	Developed Stock Prices	Sum
<b>Bolivia</b>						
RER	0.14	0.14	0.12	0.11	0.15	0.66
Trade Balance	0.13	0.13	0.11	0.10	0.14	0.62
Intl. Reserves	0.07	0.07	0.05	0.05	0.12	0.36
Fiscal Balance	0.14	0.16	0.14	0.13	0.15	0.72
Inflation (CPI)	0.13	0.13	0.11	0.12	0.15	0.65
GDP	0.14	0.17	0.12	0.14	0.14	0.71
<b>Colombia</b>						
RER	0.14	0.15	0.15	0.16	0.14	0.74
Trade Balance	0.15	0.19	0.14	0.17	0.15	0.80
Intl. Reserves	0.14	0.15	0.09	0.11	0.13	0.60
Fiscal Balance	0.14	0.17	0.15	0.16	0.15	0.76
Inflation (CPI)	0.15	0.16	0.19	0.18	0.15	0.82
GDP	0.15	0.15	0.15	0.17	0.15	0.77
<b>Ecuador</b>						
RER	0.10	0.12	0.08	0.10	0.13	0.53
Trade Balance	0.11	0.09	0.09	0.10	0.14	0.54
Intl. Reserves	0.08	0.06	0.06	0.09	0.13	0.42
Fiscal Balance	0.10	0.14	0.08	0.10	0.13	0.55
Inflation (CPI)	0.08	0.07	0.07	0.10	0.13	0.45
GDP	0.11	0.15	0.10	0.12	0.15	0.63
<b>Peru</b>						
RER	0.14	0.17	0.15	0.15	0.15	0.76
Trade Balance	0.14	0.17	0.16	0.17	0.16	0.79
Intl. Reserves	0.10	0.15	0.08	0.11	0.11	0.56
Fiscal Balance	0.13	0.16	0.13	0.14	0.14	0.69
Inflation (CPI)	0.14	0.18	0.13	0.14	0.15	0.75
GDP	0.12	0.15	0.13	0.14	0.14	0.69

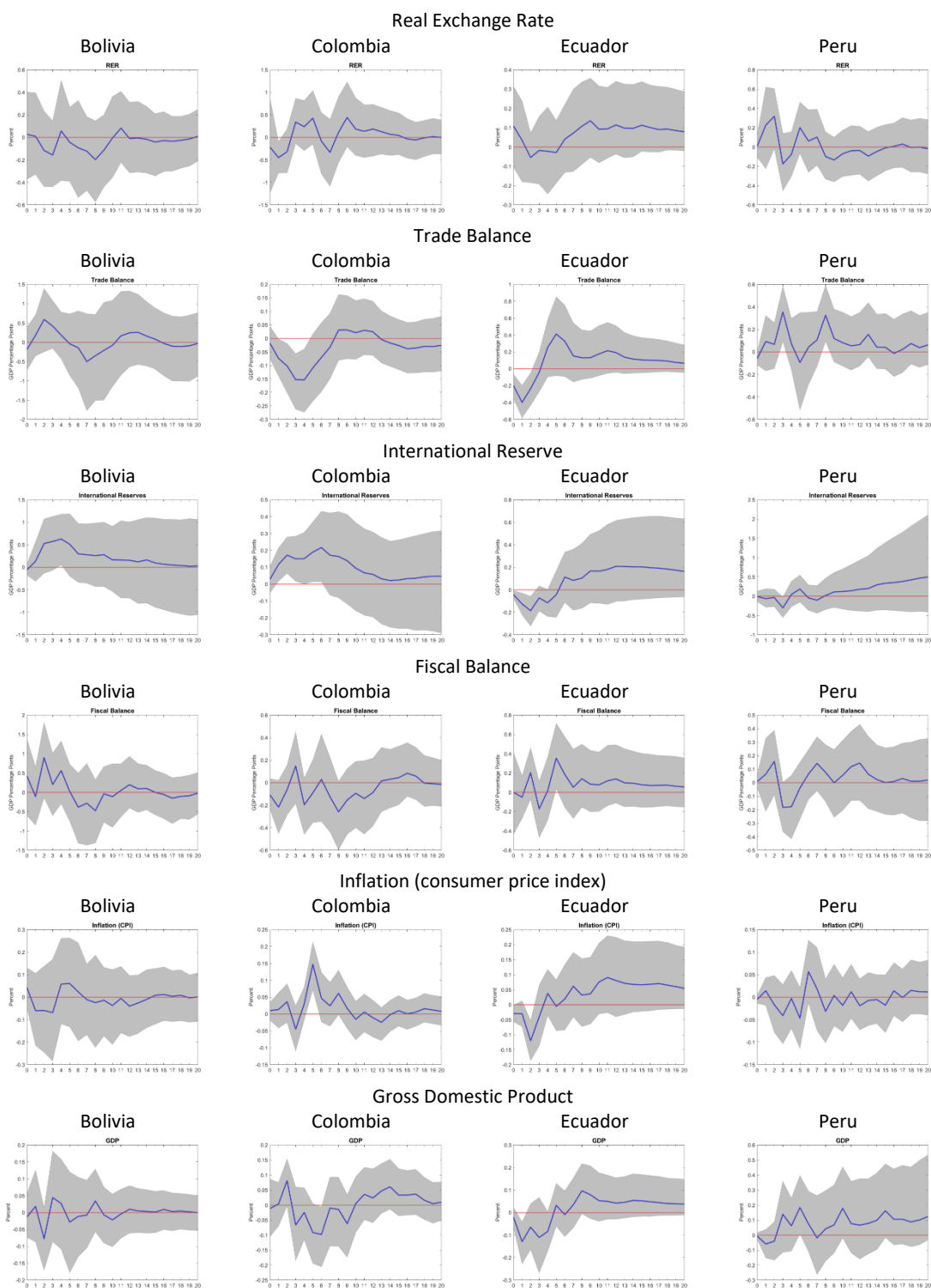
Note: The posterior medians are based on 10,000 independent draws at horizon 40. CPI = consumer price index; GDP = gross domestic product; RER = real exchange rate.

## C. Figures

**Figure C.1: Global Demand Impulse Response Function of the Agnostic Approach**

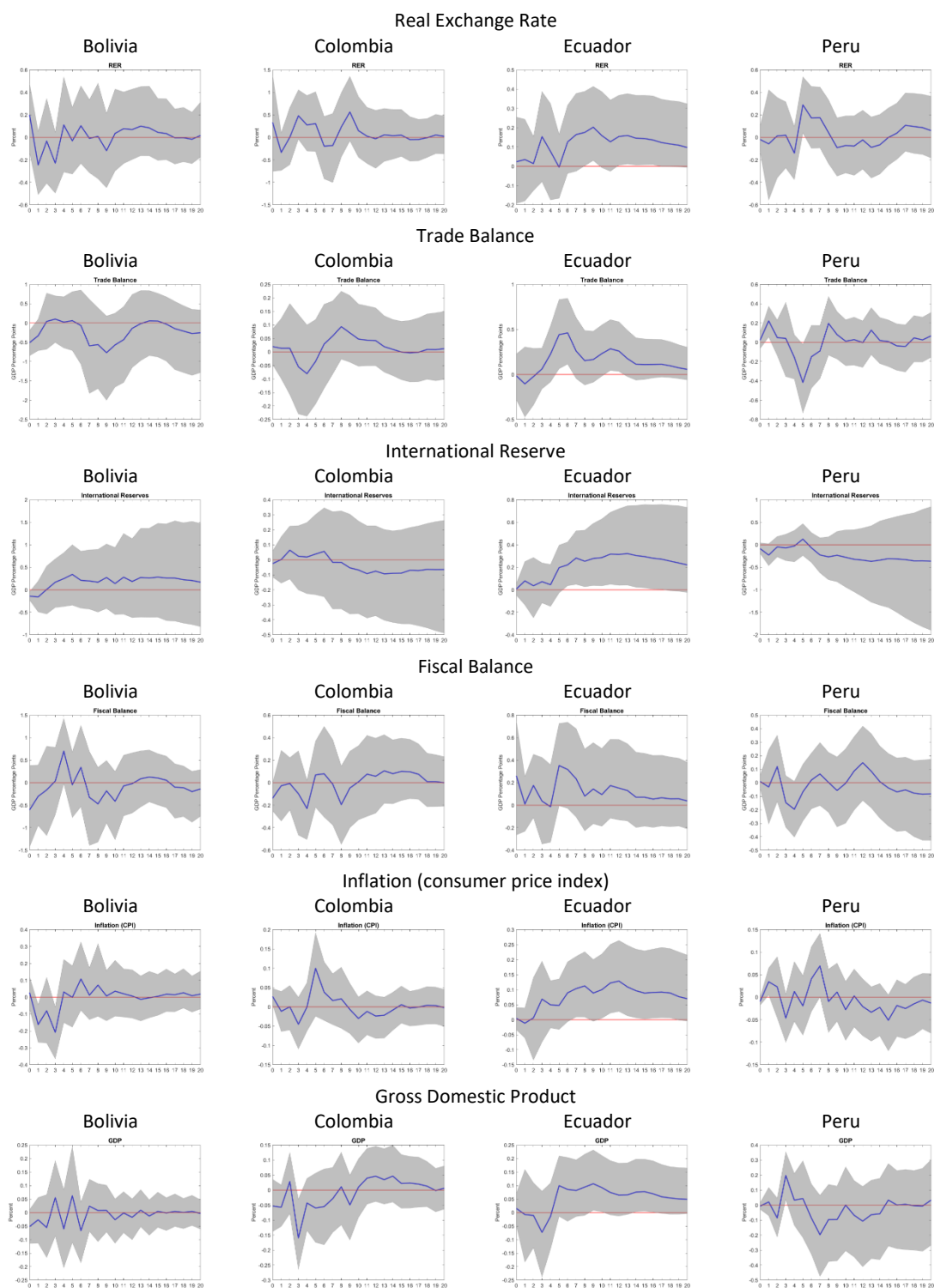


**Figure C.2: Primary Commodity Impulse Response Function of the Agnostic Approach**

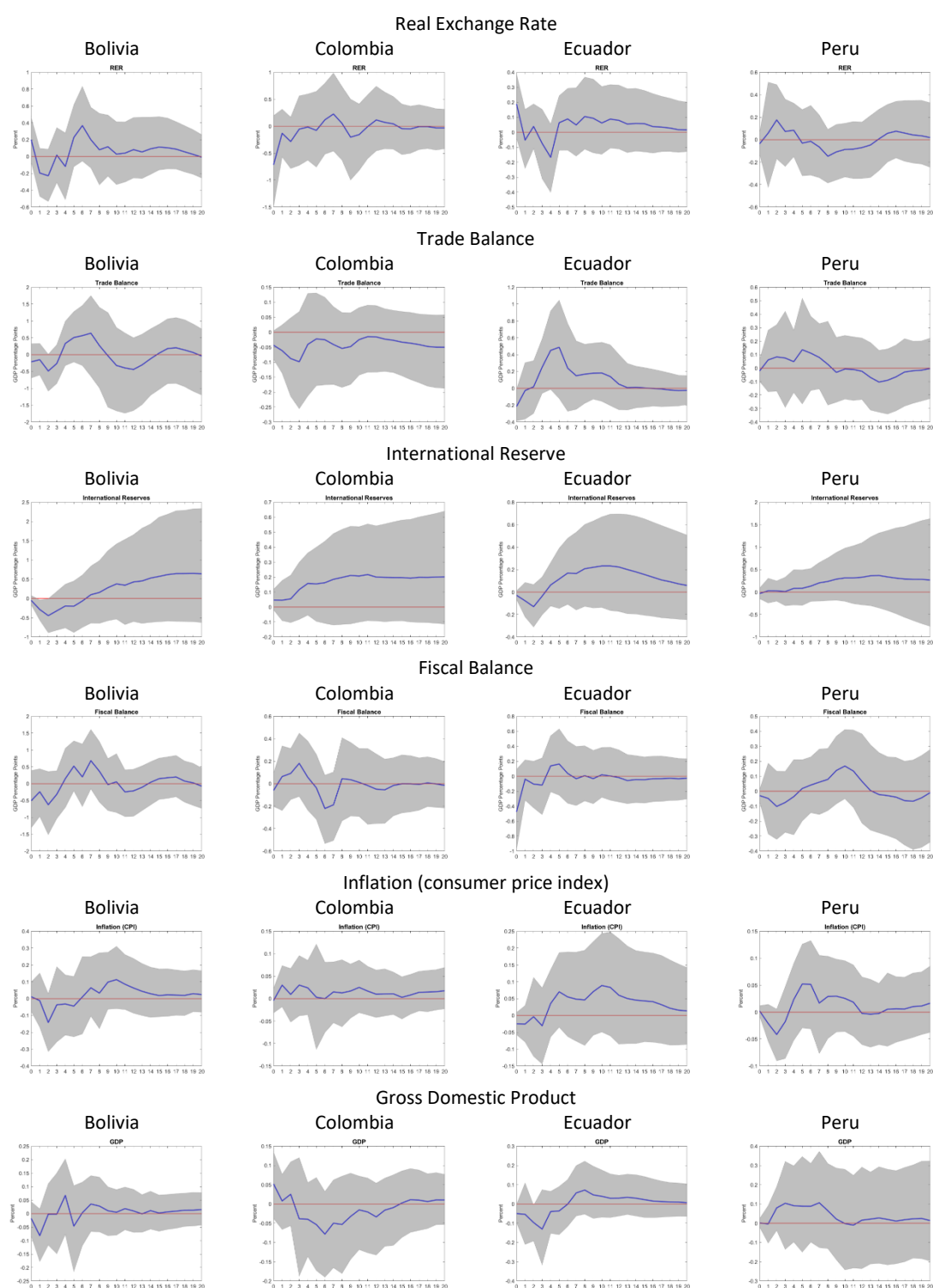




**Figure C.3: Other Commodities Impulse Response Function of the Agnostic Approach**



**Figure C.4: Federal Reserve Impulse Response Function of the Agnostic Approach**



**Figure C.5: Developed Stock Prices Impulse Response Function of the Agnostic Approach**

