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The Adjustment to Commodity Price Shocks in Chile,
Colombia, and Peru

by Francisco Roch

***IMF Working Papers* describe research in progress by the author(s) and are published to elicit comments and to encourage debate.** The views expressed in IMF Working Papers are those of the author(s) and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

I N T E R N A T I O N A L M O N E T A R Y F U N D

IMF Working Paper

Western Hemisphere Department

The Adjustment to Commodity Price Shocks in Chile, Colombia, and Peru

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Authorized for distribution by Ravi Balakrishnan and Jorge Roldós

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Abstract

This paper presents a comparative analysis of the macroeconomic adjustment in Chile, Colombia, and Peru to commodity terms-of-trade shocks. The study is done in two steps: (i) an analysis of the impulse responses of key macroeconomic variables to terms-of-trade shocks and (ii) an event study of the adjustment to the recent decline in commodity prices. The experiences of these countries highlight the importance of flexible exchange rates to help with the adjustment to lower commodity prices, and staying vigilant in addressing depreciation pressures on inflation through tightening monetary policies. On the fiscal front, evidence shows that greater fiscal space, like in Chile and Peru, gives more room for accommodating terms-of-trade shocks.

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I. INTRODUCTION

The “commodity super-cycle” has come to an end as commodity prices have been decreasing steadily since 2011, and this external shock is likely to be persistent. Commodity prices experienced a remarkable increase during the 2000s, the so-called commodity super-cycle, which was only slightly interrupted by the global financial crisis, generating a terms of trade (ToT) boom for many commodity-exporting economies. For instance, in Chile and Peru, the terms of trade doubled from 2000 to 2011, and in Colombia they increased by 70 percent. However, the prices of metals and oil declined after 2011 and mid-2014, respectively. Through deteriorating ToT, the shock resulted in lower national incomes, wider current account deficits, and weaker national currencies.

Large ToT movements can have important implications for macroeconomic performance as relative prices and incomes change. This paper compares the macroeconomic adjustment in Chile, Colombia, and Peru in response to fluctuations in commodity prices. This comparison is relevant as these are commodity exporters’ emerging economies (mainly copper for Chile and Peru, and oil for Colombia), which are comparable in size and have sound macroeconomic frameworks in place, including fiscal rules and inflation-targeting regimes. Moreover, according to the Economist Intelligence Unit these countries rank better than most other Latin American countries with respect to macroeconomic, political, labor, and foreign-trade risks. Similarly, these countries are also considered to be relatively more open to trade than the rest of the region according to the Heritage Foundation’s Index of Economic Freedom.

First, we estimate the macroeconomic responses to a commodity ToT shock. Using a vector auto-regression methodology (VAR), the implications of movements in the ToT (using a country-specific commodity price index) on government revenues and expenditures, GDP growth, the real effective exchange rate (REER), and the current account are analyzed. Once the relevant shocks are identified, impulse response and forecast error variance decomposition analyses are conducted.

Second, we conduct an event study of the actual adjustment to the recent drop in commodity prices. In the three economies, current account and trade deficit widened, while currencies depreciated significantly. However, despite these similar patterns, the timing and size of the adjustment has differed between the economies, largely because metal prices began their

downward adjustment in 2011, while oil prices started to decline only since mid-2014. Thus, Chile and Peru are in the final stages of the adjustment process, while Colombia is in the midst of adjusting to more recent price declines in oil. The experiences of Chile, Colombia, and Peru highlight the importance of flexible exchange rates to help with the adjustment to the new commodity prices.

The results from the impulse response analysis show that ToT shocks have substantial impact on fiscal aggregates. In the three countries, public revenues co-move with the ToT. However, public spending reacts positively only in Colombia and Peru, in line with the documented procyclical fiscal policy in emerging economies.¹ In the case of Chile, public expenditures decline after a ToT shock. This could suggest that the fiscal rule adopted by Chile has been more effective in terms of allowing for more counter-cyclical fiscal policy. Not surprisingly, the results also suggest that a positive ToT shock would have sizable spillovers to GDP in the three cases. Interestingly, for the case of Peru the ToT shock does not lead to the expected depreciation of the real exchange rate, as in the cases of Chile and Colombia. Finally, the results from the variance decomposition analysis confirm that fluctuations in the ToT have a significant role in the behavior of the key macroeconomic variables of these countries.

The event analysis shows that the flexibility of the exchange rate is key in facilitating the adjustment to the ToT shock. However, the experiences in Chile, Colombia and Peru suggest that most of the external adjustment is not coming from a surge in non-traditional exports in response to the exchange rate depreciation, but rather to import compression. Moreover, in the three cases there has been a substantial pass-through to inflation from the exchange rate depreciation. However, the monetary policy tightening according to their inflation targeting regimes in place has proved effective in reverting inflation on a downward path towards the target ranges. Finally, on the fiscal front, evidence shows that greater fiscal space, like in Chile and Peru, gives more room for accommodating terms-of-trade shocks.

The rest of the paper is organized as follows. Section II presents the related literature. Section III describes the data and presents the methodology used to estimate the impact of commodity prices on key macroeconomic variables. Section IV discusses the results from the VAR

¹ Gavin and Perotti (1997) show that fiscal policy in Latin America is procyclical. Talvi and Vegh (2005) and Kaminsky, Reinhart, and Vegh (2005) generalize this finding to all emerging economies.

approach. Section V presents an event study around the recent decline in commodity prices. Section VI concludes, summarizing the key findings.

II. RELATED LITERATURE

There is a large literature focusing on the impact of ToT shocks on macroeconomic fluctuations, especially on the current account. Harberger (1950) and Laursen and Metzler (1950) show that a negative shock to the ToT would worsen the current account. Ostry and Reinhart (1992) find that ToT shocks generate sizable variations in real exchange rates and the current account. Cashin and McDermott (1998) find that ToT shocks account for a large proportion of the variability in the current account in Australia and New Zealand. Cashin and Kent (2003) find that the current account tends to move in the opposite direction to the ToT shock. Agenor and Aizenman (2004) find that increases in the permanent component of the ToT are associated with higher private savings rates in sub-Saharan Africa.

Deaton and Miller (1996) examines the effects of commodity-price fluctuations on national output and its components in sub-Saharan Africa, and do not find that commodity booms are generally harmful. However, Bleaney and Greenway (2001) find that growth in this region is negatively affected by terms of trade instability. Raddatz (2007) find that shocks to commodity prices are an important source of variation in developing countries' income per capita.

Kaminsky (2010) finds that ToT booms do not necessarily lead to larger government surpluses, particularly in emerging markets and especially during capital flows bonanzas. Cespedes and Velasco (2014) find that fiscal policy tended to be more countercyclical in the recent commodity price boom, due to the presence of fiscal rules. Medina (2016) show that government expenditures in countries with fiscal rules respond less to commodity prices shocks.

Adler and Sosa (2011) find that a country's ultimate degree of vulnerability to commodity price shocks is to a great extent determined by the flexibility and quality of its policy framework. Adler and Magud (2015) argue that greater aggregate savings in the recent boom than in previous episodes reflect mainly the sheer size of the exogenous income shock rather than a greater effort to save it. Adler et al (2017) show that exchange rate flexibility played an important buffering role during ToT booms, but less so during busts.

III. DATA AND METHODOLOGY

A country-by-country VAR to analyze the implications of a shock in commodity prices on key macroeconomic variables is estimated. As in Medina (2016), the analysis mostly relies on a country-specific bivariate VAR estimation. In particular, the model used is:

$$\begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix} \begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} c_{10} \\ c_{20} \end{bmatrix} + \begin{bmatrix} a_{11}(L) & a_{12}(L) \\ a_{21}(L) & a_{22}(L) \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} e_{yt} \\ e_{zt} \end{bmatrix}$$

where y_t is the country-specific commodity price index (included in all regressions); z_t is the macroeconomic variable of interest; c_{10} and c_{20} are the constant terms; $a_{ij}(L)$ is the polynomial lag operator; and e_{it} is the uncorrelated disturbance. The domestic variables of interest include: public expenditures, public revenues, and real GDP. However, for the external variables a three-variable VAR is estimated which includes the REER, current account, and the commodity price index. For each VAR, the number of lags is determined based on the Aikake information criterion. The identification of structural shocks is achieved through a Cholesky decomposition, assuming that the domestic variables do not affect the terms of trade contemporaneously.² In the next section, we use this identification to analyze the response of these key macroeconomic variables to commodity price shocks by examining the impulse responses, and we account the importance of these shocks as a source of variation through a variance decomposition analysis.

The estimation uses quarterly data from the first quarter of 1999 until the last quarter of 2015 and a country-specific commodity price index aimed at capturing the impact of variations in commodity prices at the country level.³ This is a point of departure with respect to many studies in the literature that use either a non-country specific measure of commodity prices or standard ToT measures. However, the former can fail at capturing the price variations of the specific commodities a country trades, while the latter is influenced by non-commodity prices and by the country's composition of exports. The country-specific commodity price index used in this

² Kilian and Vega (2011) argue that this ordering captures the price taking behavior of small open economies. Kilian (2009) and Pedersen (2015) use sign restrictions to identify different types of shocks (e.g., supply versus demand shocks). This would be an interesting avenue for future research.

³ This commodity price index was constructed by Gruss (2014). The time period was selected due to data availability.

paper is constructed with both international prices and country-level data on exports for individual commodities, assigning a weight based on net exports of each commodity.⁴

The domestic variables of interest are public primary expenditures, public revenues, real GDP, the REER, and the current account balance. All the series are seasonally adjusted. As the data are likely to be nonstationary, all series are log-differenced except for the current account balance which is expressed as a percentage of GDP.

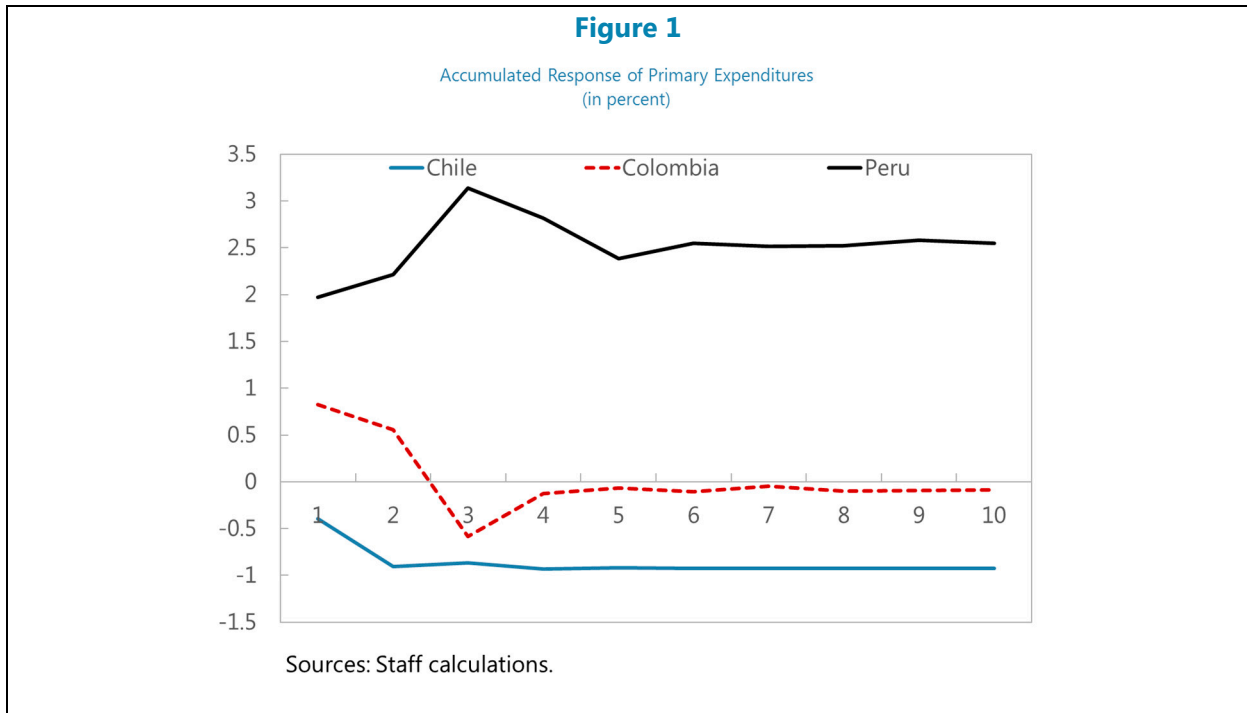
IV. RESULTS FROM VAR METHODOLOGY

This section discusses the propagation mechanism of commodity price shocks through the analysis of impulse responses, and quantifies the variation in key macroeconomic variables that is accounted by these shocks using a forecast error variance decomposition analysis.

Impulse Response Function Analysis

Primary public expenditures respond differently across the three countries to a commodity price shock. Figure 1 shows the estimated accumulated impulse response functions of primary expenditures. In the case of Chile, a one standard deviation shock to commodity prices leads to a one percent decline in primary expenditure. However, in the case of Peru, this shock leads to an increase of 2 percent in primary expenditures. Finally, primary expenditures in Colombia are insensitive to commodity price shocks after some initial volatility.

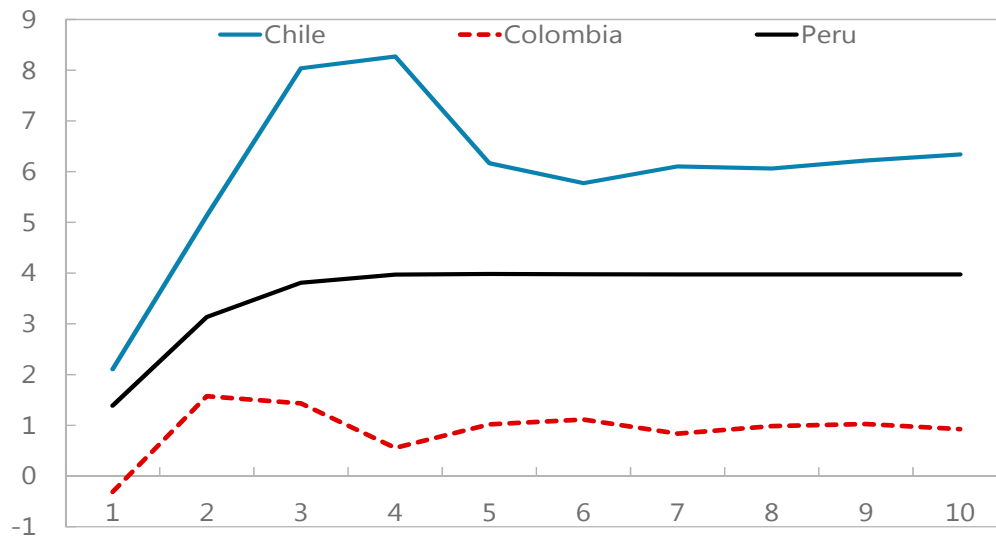
⁴ Thus, this methodology allows to capture net income effects from changes in commodity prices.



For all three countries, a positive shock to commodity prices is associated with higher GDP growth and public revenue. Figure 2 and 3 show the estimated accumulated response functions for public revenue and real GDP growth, respectively. Regarding public revenue, Chile is the country that experiences the biggest response of around 8 percent after 4 quarters. In Colombia and Peru, the responses are more moderate, peaking at 4 and 1.5 percent respectively after 3 quarters. With respect to real GDP growth, the initial response is broadly similar in the three cases during the first two quarters. However, in the medium term, Peru is the country that benefits the most from a positive ToT shock.

Figure 2

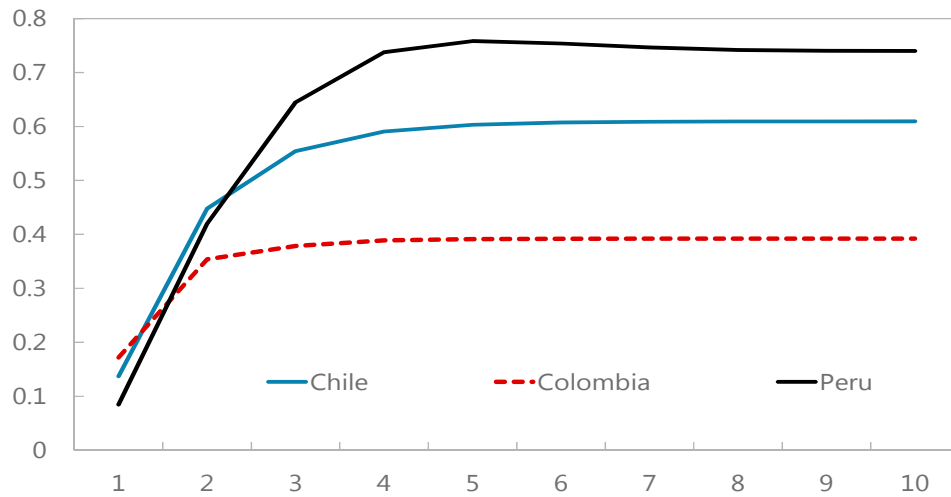
Accumulated Response of Public Revenues
(in percent)



Sources: Staff calculations.

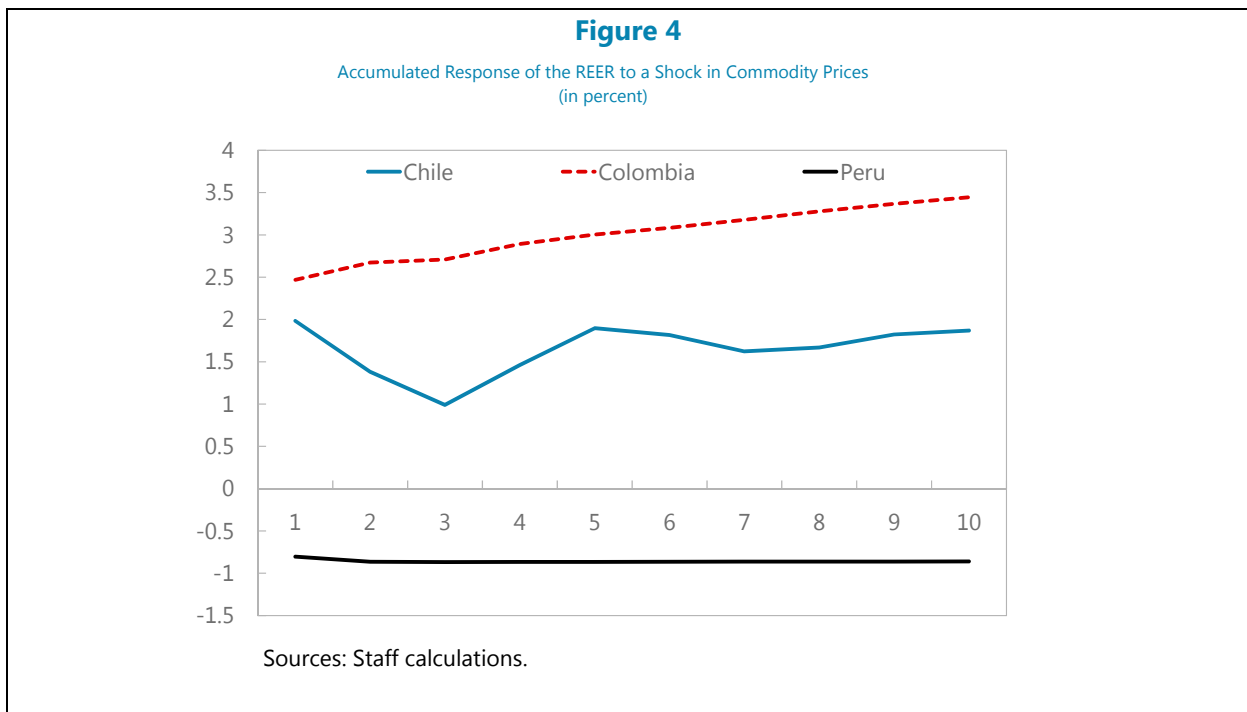
Figure 3

Accumulated Response of Real GDP
(in percent)



Sources: Staff calculations.

With respect to the external adjustment, the REER and the current account appear to be more flexible in the case of Colombia. Figures 4 and 5 show the estimated accumulated response functions for the REER and the current account. Intuitively, a positive commodity price shock should lead to an appreciation in the real exchange rate. Indeed, the results suggest that relationship for both Chile and Colombia, with a stronger appreciation in the latter. However, in the case of Peru we observe a slight depreciation of the REER, perhaps explained by the active intervention policy of the Central Reserve Bank of Peru. As expected, in the three economies the current account improves after a positive ToT shock. The shock has a stronger positive effect in the case of Chile, while the current accounts of Colombia and Peru adjust in similar ways during the initial five quarters. Over the medium term, the current account improves more in Chile, with an average response of around 2 percent.



Forecast Error Variance Decomposition Analysis

Expenditures and revenues in Chile and Peru are similarly affected by the fluctuations in commodity prices, but that is not the case in Colombia. Tables 1 and 2 present the estimated variance decomposition of forecast errors of expenditures and revenues, which allows quantifying the contribution of a shock in commodity prices to fluctuations in the domestic variable of interest. Movements in commodity prices account for about 5 percent of variations in primary expenditures at a 10-quarter horizon for both Chile and Peru, while they account for only 2 percent in Colombia. Similarly, commodity price fluctuations explain 25 and 20 percent of fluctuations in revenues in Chile and Peru respectively, and roughly 3 percent in the case of Colombia.

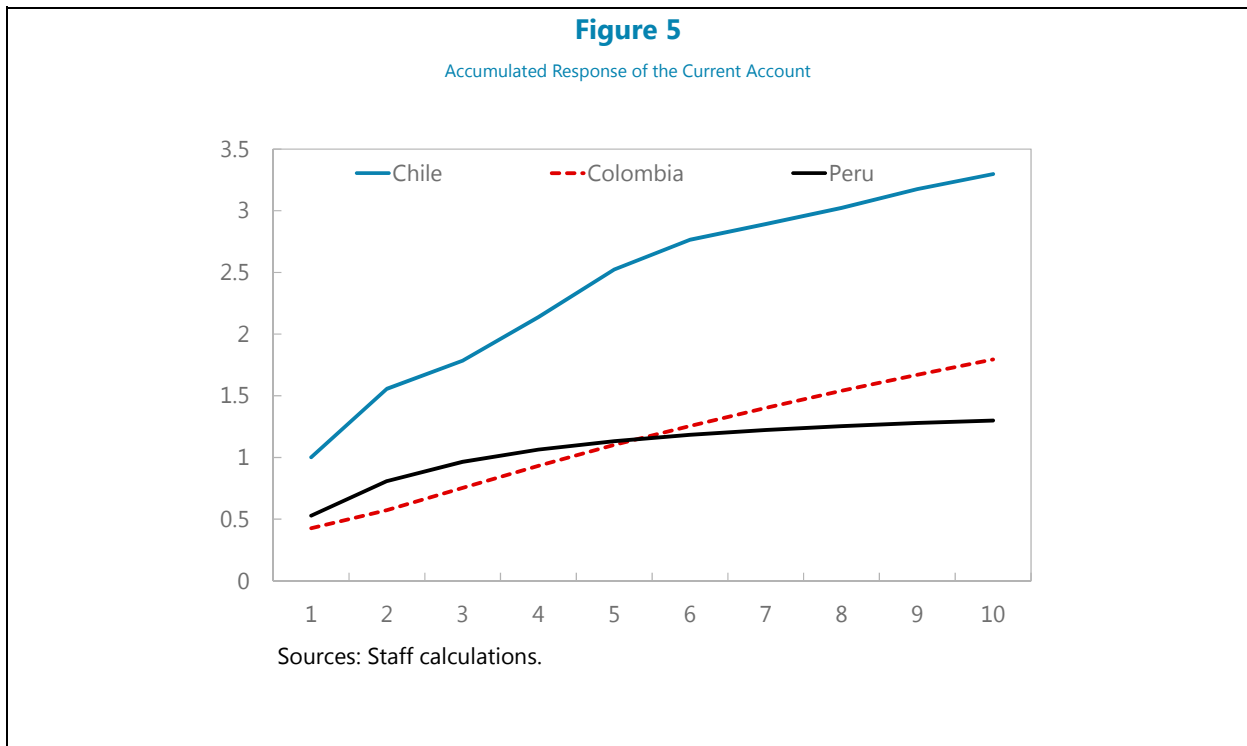


Table 1

Contribution of commodity prices shocks to the variance of primary expenditure growth			
Quarters after the shock	Chile	Colombia	Peru
1	2.06	0.89	6.53
2	4.56	0.69	4.31
3	4.46	1.81	5.16
4	4.48	1.99	5.16
5	4.48	1.98	5.23
6	4.48	1.98	5.23
7	4.48	1.98	5.23
8	4.48	1.98	5.22
9	4.48	1.98	5.22
10	4.48	1.98	5.23

Table 2

Contribution of commodity prices shocks to the variance of revenue growth			
Quarters after the shock	Chile	Colombia	Peru
1	7.73	0.09	8.17
2	15.54	2.44	18.68
3	22.97	2.44	19.94
4	22.30	2.69	19.99
5	25.03	2.75	19.99
6	25.14	2.75	19.99
7	25.15	2.76	19.99
8	25.14	2.76	19.99
9	25.16	2.76	19.99
10	25.17	2.77	19.99

Not surprisingly, commodity price fluctuations play a remarkable role in accounting for variations in GDP, the REER, and the current account. Tables 3, 4, and 5 present the estimated variance decomposition of forecast errors of real GDP, the REER, and the current account. The contribution of commodity prices shocks to the variance of real GDP is on average 10 percent, broadly similar in the three cases. As expected, the variation in commodity prices account for a large part of the variance in the REER, especially in Chile and Colombia where the

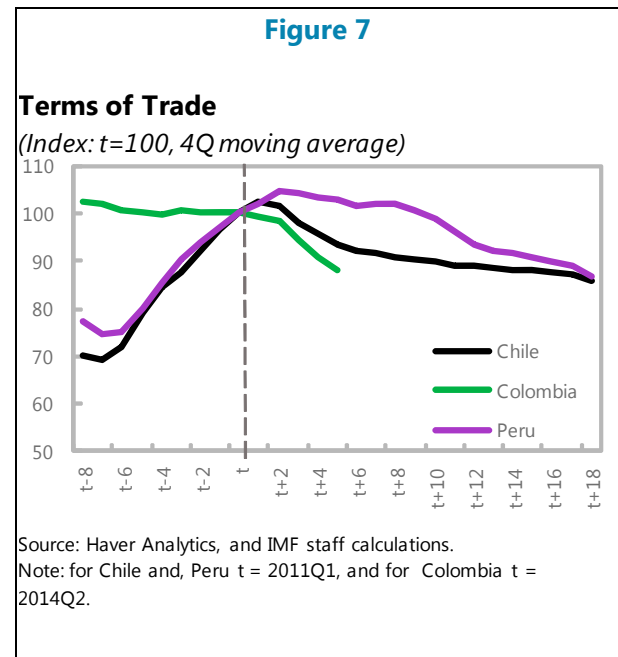
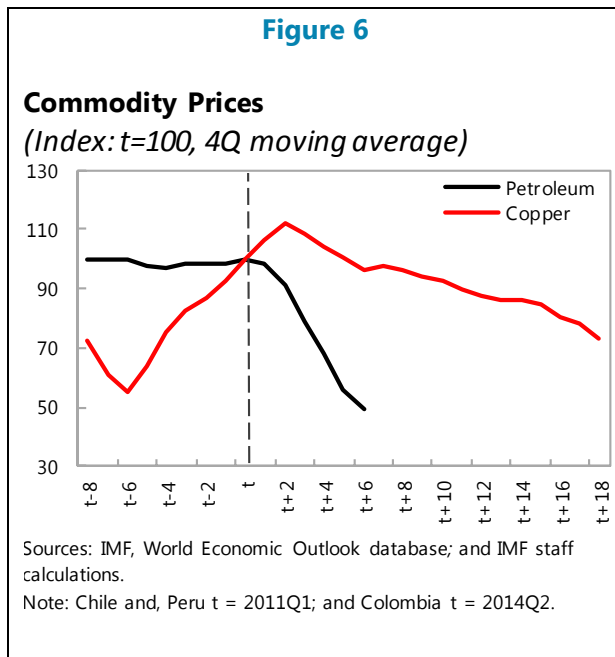
contributions are estimated at around 34 and 24 percent respectively. Similarly, the fluctuations in commodity prices account for a significant part of the variance of the current account, with a larger share in Chile and Colombia.

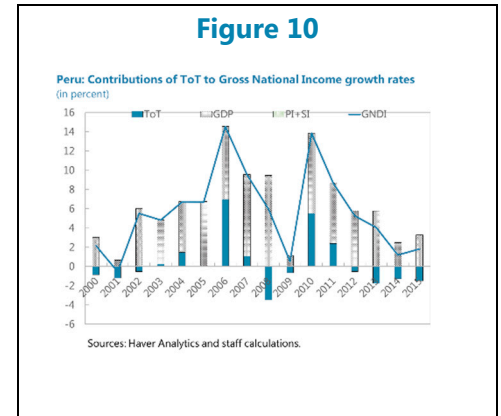
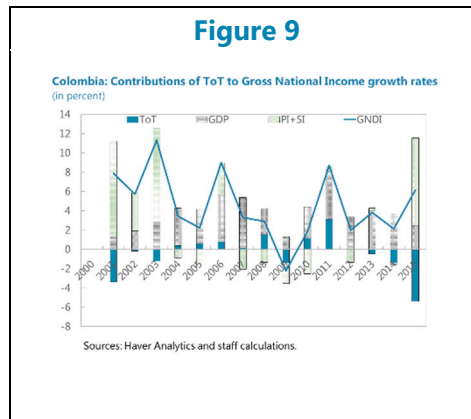
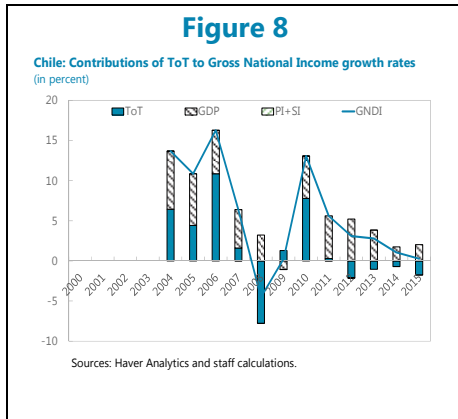
Table 3				Table 4			
Contribution of commodity prices shocks to the variance of GDP growth				Contribution of commodity prices shocks to the variance of the REER			
Quarters after the shock	Chile	Colombia	Peru	Quarters after the shock	Chile	Colombia	Peru
1	1.41	3.87	0.58	1	33.89	25.34	18.58
2	7.98	7.75	8.16	2	33.85	25.01	18.58
3	8.68	7.82	11.21	3	33.87	24.79	18.57
4	8.77	7.83	11.69	4	33.88	24.77	18.57
5	8.78	7.83	11.70	5	34.47	24.70	18.57
6	8.78	7.83	11.70	6	34.25	24.63	18.57
7	8.78	7.83	11.70	7	34.42	24.57	18.57
8	8.78	7.83	11.71	8	34.34	24.53	18.57
9	8.78	7.83	11.71	9	34.40	24.49	18.57
10	8.78	7.83	11.71	10	34.38	24.46	18.57

Table 5			
Contribution of commodity prices shocks to the variance of the current account			
Quarters after the shock	Chile	Colombia	Peru
1	25.92	22.44	13.67
2	21.12	18.18	10.59
3	17.60	16.16	9.00
4	16.48	15.30	8.14
5	16.38	14.71	7.66
6	16.03	14.25	7.37
7	15.69	13.93	7.20
8	15.49	13.69	7.09
9	15.44	13.50	7.02
10	15.39	13.35	6.98

V. EVENT STUDY

The timing and size of the shock in Chile and Peru have been different than in Colombia. While the price of copper has been declining since 2011, the oil price decline began in the second half of 2014 (Figure 6). Thus, Chile and Peru are in the final stages of the adjustment process, while Colombia is in the midst of adjusting to more recent price declines in oil. Moreover, the shock that Colombia suffered was more severe in that oil prices plunged by about 40 percent in 5 quarters, whereas the price of copper took 18 quarters to decrease by 45 percent. As expected, these large commodity price shocks deteriorated the ToT substantially, with Colombia experiencing the largest impact (Figure 7). Thus, the contribution of the ToT to Gross National Disposable Income after the shock was negative and sizeable, especially in Colombia (Figures 8, 9, and 10).



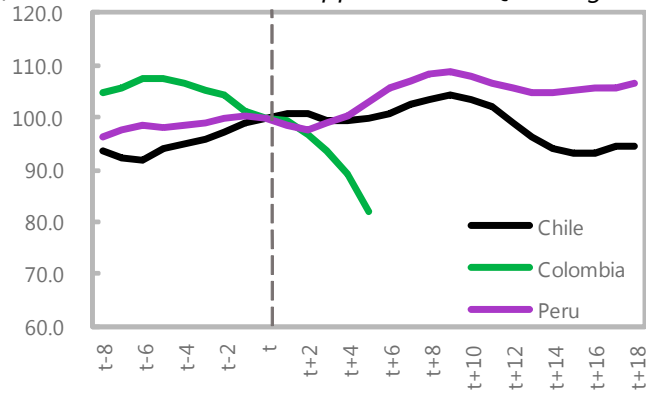


The exchange rate and current account adjustments are important elements of the macroeconomic response to the terms of trade fall (Figures 11 and 12). In the case of Chile, when the terms of trade initially started to fall, the exchange rate was relatively slow to adjust. However, by the end of its adjustment process, Chile's real effective exchange rate had depreciated by 5 percent. In contrast, given the magnitude and speed of the shock, Colombia experienced a sharp and fast real depreciation of its exchange rate of around 18 percent. The slight and strong depreciation observed in Chile and Colombia, respectively, are consistent with the results from the impulse response analysis from the previous section. Peru, however, had a minor real appreciation of about 6 percent (also in line with the results from the VAR analysis), which could be in part the result of the Central Bank of Peru interventions in the FX market to prevent sharp movements in its currency. Consistent with this more muted adjustment in the real exchange rate, the current account deficit in Peru has deteriorated from 2 percent of GDP in 2011 to 4.4 percent of GDP in 2015. The exchange rate adjustment in Chile allowed for a significant adjustment in the current account, with a deficit that is now mostly closed. Finally, in Colombia the current account deteriorated as a result of the oil prices decline, and has yet to reflect the adjustment in quantities.

Figure 11

Real Effective Exchange Rate

(Index: $t = 100$, increase=appreciation, 4Q moving average)



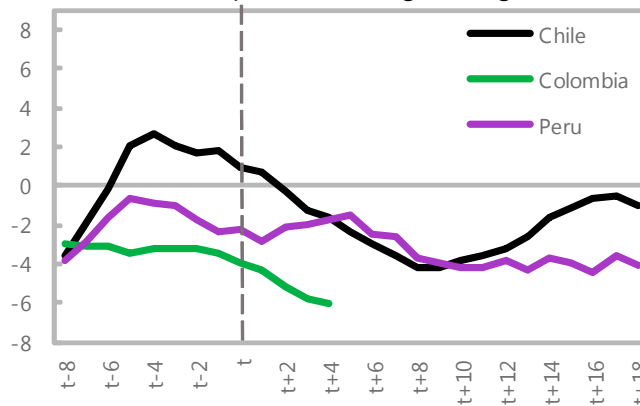
Source: IMF, International Financial Statistics database, and IMF staff calculations.

Note: for Chile and Peru $t = 2011Q1$, and Colombia $t = 2014Q2$.

Figure 12

Current Account

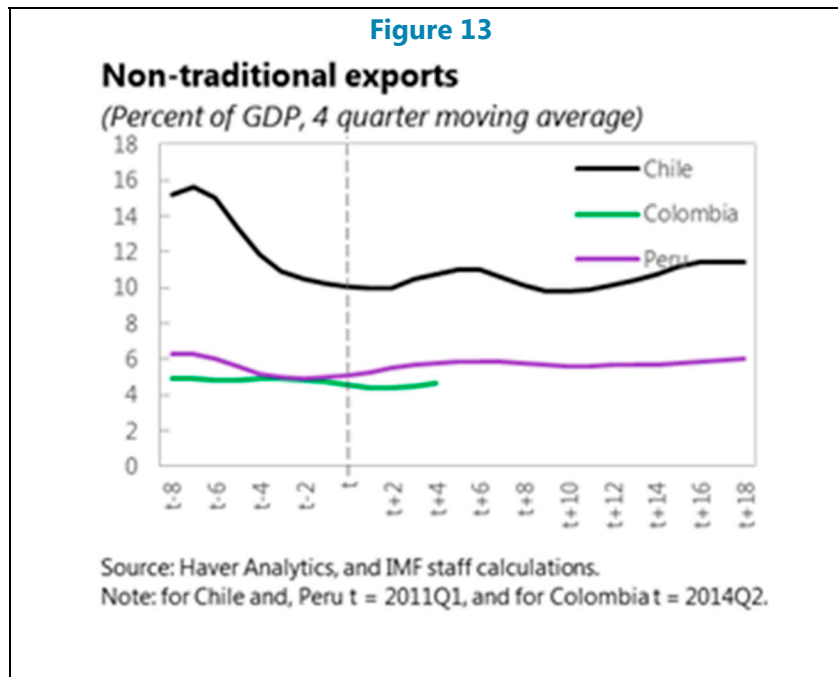
(Percent of GDP, 4 quarter moving average)

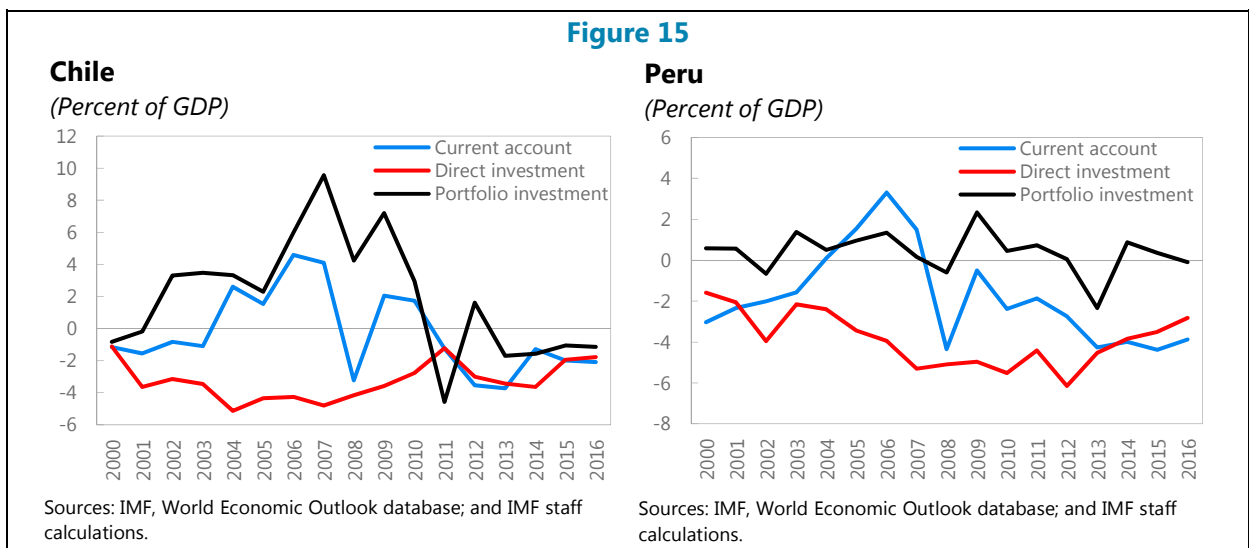
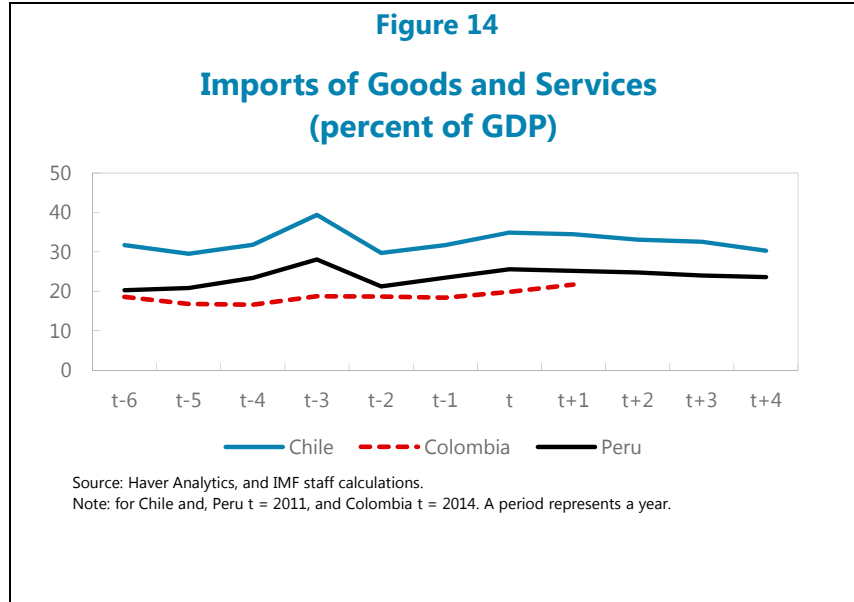


Source: Haver Analytics, and IMF staff calculations.

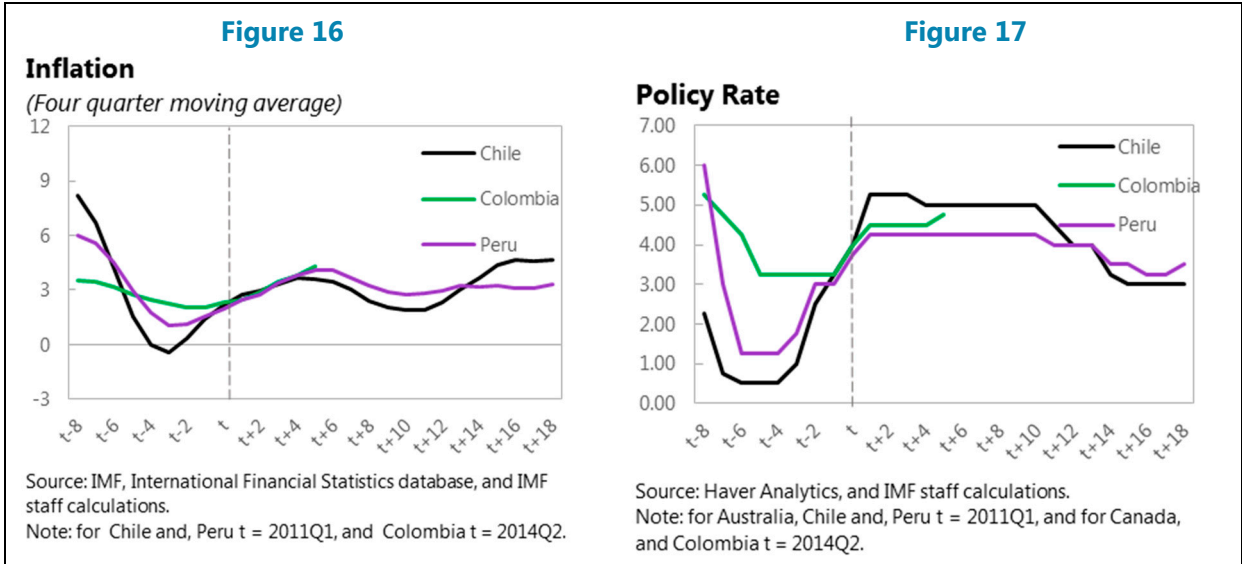
Note: for Chile and Peru $t = 2011Q1$, and for Colombia $t = 2014Q2$.

In Chile, most of the adjustment in the current account comes from import contraction. In Chile, the current account deficit initially widened due to the decline in the value of its traditional exports. However, after 18 quarters the current account deficit was roughly zero. This was achieved mainly by a decline in imports (from 35 to 30 percent of GDP) rather than a pick-up of non-traditional exports (Figures 13 and 14). In Peru, there have not been significant fluctuations in non-traditional exports and imports, consistent with a stickier current account deficit and more stable FDI (Figure 15).

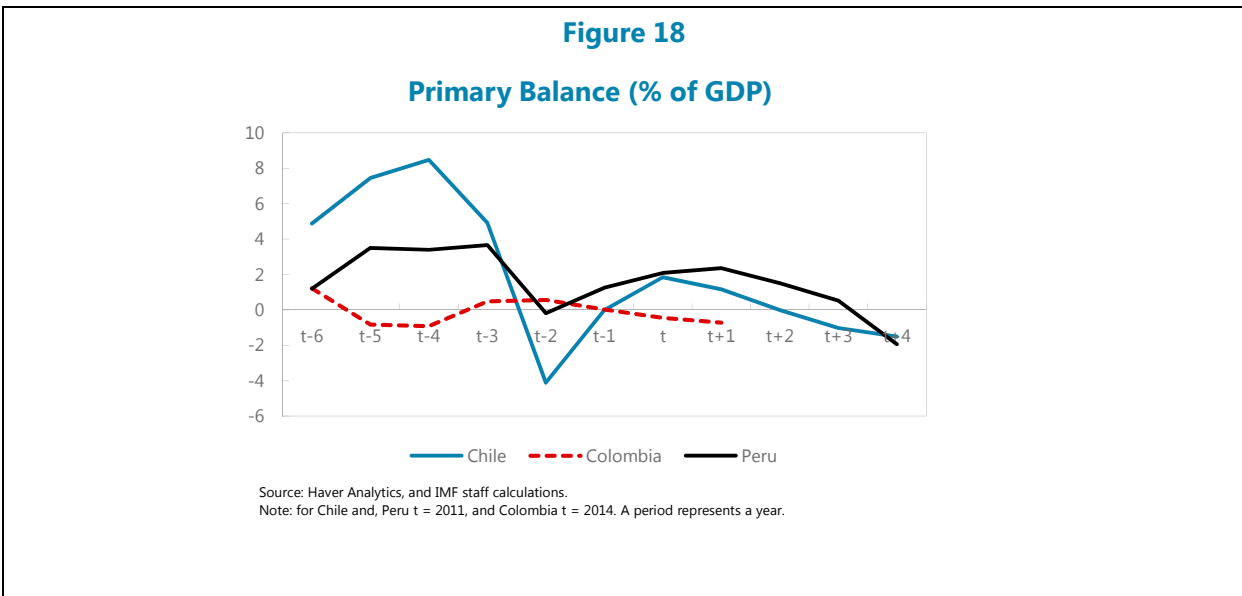


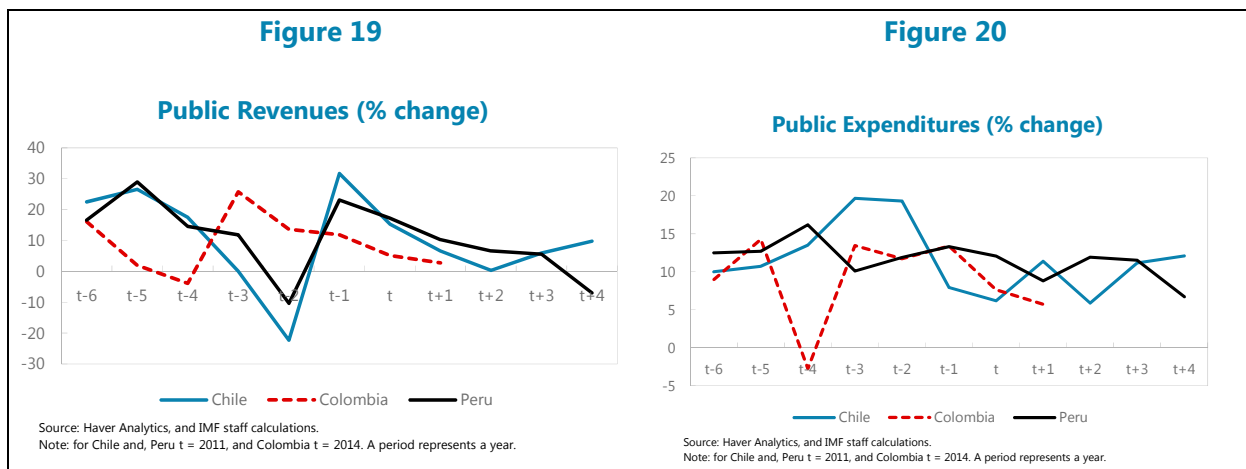


The depreciation of the currencies has influenced the dynamics of inflation. In the three cases, the shock to commodity prices created inflationary pressures (Figure 16), which reduced the policy space to conduct countercyclical monetary policy and pushed central banks in the three countries to raise the policy rate in order to keep inflation inside the target range (Figure 17). Moreover, in the case of Colombia, the tightening of monetary policy has also aimed at moderating domestic demand in order to contain the widening current account deficit. These timely policy actions supported the credibility of the inflation targeting regimes, and contained inflationary pressures.

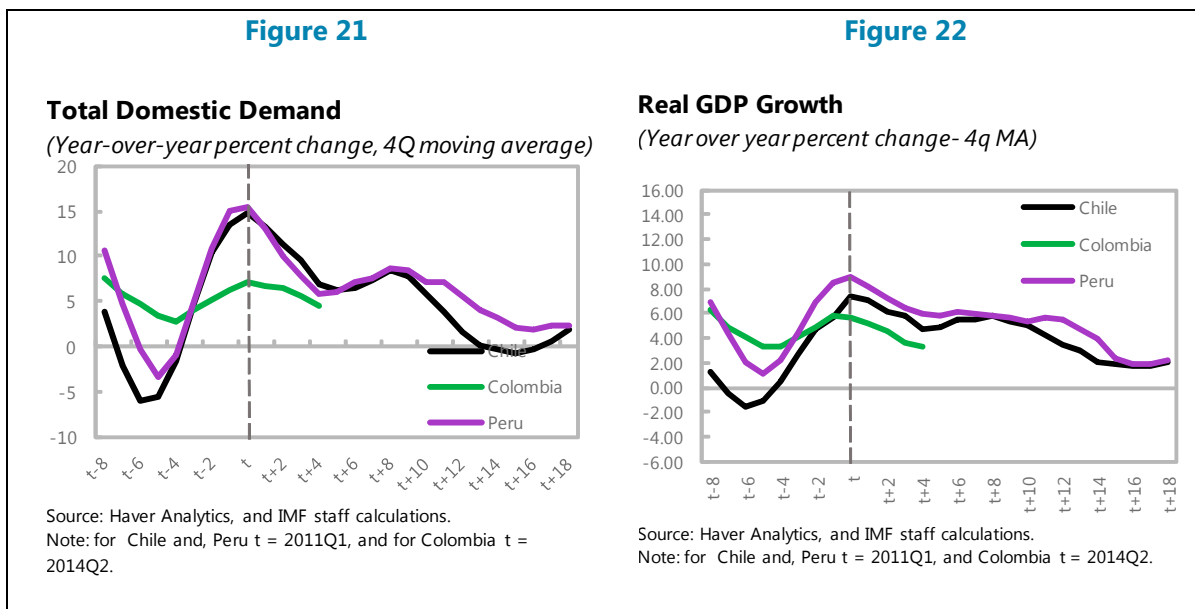


On the fiscal front, primary balances have deteriorated steadily in all three countries (Figure 18). In line with the VAR analysis above, the shock to commodity prices reduced commodity related revenues, which is reflected in the lower growth rates of public revenues observed after the shock (Figure 19). At the same time, except for the case of Colombia, the growth rate of public expenditures remained broadly stable (Figure 20). This might reflect the fact that at the time the shock hit, Colombia was already featuring a primary deficit while both Chile and Peru exhibited surpluses. Thus, the latter two countries had more room to implement a gradual fiscal adjustment, which helped smoothing the adjustment to the shock.





In all three cases we observe a slowdown in total domestic demand at the time the shock hit (Figure 21). However, one salient difference is that the initial slowdown in Chile and Peru was significantly more abrupt than in Colombia, despite the shock being more acute in the latter. Furthermore, in the final stages of the transition, Chile had a stronger adjustment in domestic demand than Peru, which is consistent as well with the adjustment in the current account explained above. The macroeconomic adjustment in these countries has also affected the dynamics of real GDP growth (Figure 22), as expected from the impulse response function analysis (Figure 3). In the cases of Chile and Peru, real GDP growth has decreased continuously after the fall in their terms of trade. Colombia seems to be following the same path as GDP growth also declined after oil prices started plunging. However, the strong policy frameworks in place allowed these countries to withstand the large ToT shock and still post positive growth rates. Moreover, GDP growth has started to recover in the case of Peru.



VI. CONCLUSIONS

Overall, despite a slowdown in activity, GDP growth remained resilient to the terms of trade shocks in the three countries, reflecting their sound policy frameworks. GDP growth has declined in all three countries in the past couple of years but remained positive and is already recovering in the case of Peru. Fiscal loosening, especially in Chile and Peru, likely contributed to smooth the adjustment to the shock. That may have been a consequence of the wider fiscal space to counteract the negative shock in Chile and Peru than in Colombia during this particular episode. Indeed, the impulse-response analysis suggests that the “usual” behavior of public spending in Peru and Chile are quite different: following ToT shocks, public spending tends to be more procyclical in Peru than in Chile. Public spending tends not to react to ToT shocks in Colombia. The importance of having a fiscal buffer to smooth the negative effects of external shocks should remain a key consideration for fiscal policy in Peru going forward.

More exchange rate flexibility underpins faster current account adjustments to ToT shocks. A rapid depreciation of the currency in Chile is possibly the biggest factor behind the full adjustment in its current account deficit. However, in real effective terms, this was not the case for Peru, probably as a result of the active FX intervention by the central bank to smooth volatility. As a result, Peru’s current account deficit remained elevated by 2015 at 4.4 percent

of GDP. Looking ahead, a continued gradual real depreciation of the sol and an increase in mining exports are expected to halve the Peruvian current account deficit by 2021.

Robust monetary frameworks have limited the response of inflation to ToT shocks. These countries' credible inflation targeting regimes limited the inflationary pressure by both strong communication and hikes in the policy rate. In Chile and Peru, where the ToT shocks started about five years ago, inflation is already moving back toward the target range, and markets expect the same to happen in Colombia.

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