The 2000s commodity boom and the exchange rate in Argentina

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Abstract

Purpose – This paper aims to estimate the impact of the 2000s commodity boom in the major Latin American economies.

Design/methodology/approach – The author used a structural vector autorregresive analysis where the selection of variables is conditional on a New Keynesian Model for a small open economy.

Findings – The evidence indicates that the Argentinean nominal exchange rate appreciated less while its output and inflation grew more than those of the other nations when subjected to commodity shocks. These results are interpreted as a more aggressive leaning-against-the-wind intervention by Argentina, probably to avoid the Dutch disease. Although the effects with regard to output were indeed stronger in Argentina, this was only at the expense of higher inflation and volatility suffered during the boom.

Originality/value – At the time of the writing of this paper, no work had evaluated Argentinean underperformace to the manner in which its exchange rate policy was handled in comparison with the rest of the region during the boom. This paper intends to fill this gap.

Keywords Argentina, Commodity prices, Exchange rate policy, High inflation, Structural VARs

Paper type Research paper

1. Introduction

During the 2000s, the prices of commodities nearly doubled in what would become one of the three major booms experienced since the Second World War. Because Latin American countries are important commodity exporters, they greatly benefited through increases in export revenues. However, they also faced difficulties due to the boom's magnitude and duration, which challenged the exchange rate policy. This is, there was a trade-off between favoring stability and boosting growth during the years of the boom. On the one hand, allowing flexibility in the currency's value would have led to appreciation that could have softened the impact on local prices and reduced output volatility. In fact, it has been known since Friedman (1953) that flexible exchange rates have better insulating properties than

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fixed ones. For developing countries, Broda (2001) and Broda (2004) confirmed that floats reduced output volatility more than fixes, when subjected to terms of trade shocks.

On the other hand, preventing appreciation would have reduced competitiveness loss and, hence, boosted output growth. Indeed, most countries tended to prioritize growth, and there were strong currency interventions during those years. This behavior has been called fear of appreciation by Levy-Yeyati *et al.* (2013). While Frenkel and Rapetti (2012) and Ahumada and Cornejo (2015) argued that this leaning-against-the-wind policy had the objective of avoiding the Dutch disease, Levy-Yeyati *et al.* (2012) contended that it served the purpose of reserve accumulation. Additionally, Daude *et al.* (2016) claimed that the countercyclical exchange rate policy should rather be regarded as the monetary authority's desire to maintain real exchange rate stability in an attempt to reduce macroeconomic and financial volatility.

The present article contributes to the evaluation of the exchange rate regimes in their capacity to foster growth while not jeopardizing macroeconomic stability. It is evidenced that, true as it was that leaning-against-the-wind was the norm during the boom, Argentinean interventions were much stronger than those of regional counterparts. Moreover, this more aggressive counter-cyclicality indeed favored activity, but only to the serious detriment of stability. This difference in magnitude in the policy adopted by Argentina can explain part of the country's poorer macroeconomic performance: i.e. its higher inflation and greater volatility, as shown in Table I. At the time of the writing of this paper, no work had evaluated Argentinean underperformace to the manner in which its exchange rate policy was handled in comparison with the rest of the region during the boom. This article intends to fill this gap.

The results were obtained using a structural vector autoregressive (VAR) analysis where the selection of variables is conditional on the model by Lubik and Schorfheide (2007), which is a prototypical New Keynesian (NK) dynamic stochastic general equilibrium (DSGE) model of a small open-economy. This methodological approach has the advantage of letting the data speak for themselves, as the estimation is performed using a reduced-form model, while the economically relevant shock is supported by a widely accepted theory (the prototypical DSGE model). Although this formally supported structural VAR approach is widely used, to the best of my knowledge, it has not often been applied to Latin American countries in general or Argentina in particular.

The remainder of the paper is organized as follows: Section 2 provides a review of the related literature and contextualizes the contribution of this work, Section 3 describes the empirical methodology, Section 4 presents and interprets the empirical results, and Section 5 summarizes the conclusions.

2. Literature review

Exchange rate policy is probably one of the most debated issues in emerging economies. The reason for this is that these nations are very vulnerable to variations in their terms of trade, which, at the same time, depend heavily on volatile commodity prices. The effect of commodities prices over domestic ones has been studied by Blejer (1983), among others, who

Table I. Yearly growth rates 2003-2015 – median and standard deviations

	Arg	Br	Ch	Col	Mex	Peru	LATAM*
Output growth	5.6 (5.5)	3.0 (3.4)	4.8 (2.6)	4.8 (1.8)	3.1 (2.6)	5.8 (2.8)	4.3 (2.6)
Inflation	22.0 (9.5)	6.2 (3.0)	2.2 (1.6)	4.2 (1.6)	3.9 (0.8)	2.9 (1.4)	3.9 (1.7)

Note: *All countries in the table average, excluding Argentina
Source: National Statistics Institutes and Cavallo (2013) for Argentina

found an important impact in Argentina due to its large share of traded commodities. As for the effects on activity, the influential work of Mendoza (1995) used a calibrated real business cycle model and found that disturbances to terms of trade can explain the bulk of output fluctuations in developing countries. More recently, Drechsel and Tenreyro (2018) used a modified version of Mendoza's model estimated for Argentina and concluded that commodity price shocks caused around one-third of output growth fluctuations post 1950. Finally, Camacho and Perez-Quiros (2014) estimated a reduced-form Markov-switching model that allowed for nonlinearities and found that commodity price shocks are procyclical, although this depends on the size and sign of the shock, as well as on the state of the economy.

As mentioned above, the seminal contribution of Friedman (1953) was followed by several works that confirmed the argument that flexible exchange rates have better insulating properties than fixed ones. Despite the solid conclusions in academia in favor of floats, emerging countries have hardly ever adopted a truly floating regime, showing fear of floating (Calvo and Reinhart, 2002). In fact, Levy-Yeyati and Sturzenegger (2005) found that *de jure* floats were better described as *de facto* dirty floats. This was particularly true during the boom of the 2000s, when most countries prevented currency appreciations through the use of aggressive interventions. Although the advantages of leaning-against-the-wind have been greatly studied in the literature [see Frenkel and Rapetti (2008) in addition to the works cited in the introduction], to the best of my knowledge, no articles link this policy to the higher inflation and volatility suffered by Argentina during those years.

At the same time, this article relies on a structural VAR, which has not commonly been applied to Argentina[1]. So, the present work is also a case study contribution to the structural VAR literature. This methodology has become very popular in applied studies since the seminal work of Sims (1980). The main advantage of this approach, when compared to other empirical models, is that it is less restrictive in terms of prior determination of endogeneity and exogeneity. In VARs, all variables are endogenous, and it is in the variance-covariance matrix where the identifying restrictions are imposed. In the present work, the selection of variables is based on a prototypical NK model, and the restrictions imposed are of the exclusion type, which is the most common identification scheme used in the literature. Another advantage of the VAR methodology is that the results are usually presented with impulse response functions (IRFs) and variance decompositions, which allow insight into the impact of the identified shocks at different time horizons, together with bootstrapped confidence intervals.

Finally, because the NK model adopted here belongs to the family of DSGE models, this article is also related to this very extensive literature. DSGEs are micro-funded models that became popular after Lucas's critique and are frequently used for projections and policy analysis by central banks. In fact, the European Central Bank currently uses two Bayesian DSGE models for these purposes: the New Area Wide Model (NAWM) of the euro Area by Christoffel *et al.* (2008) and the one by Christiano *et al.* (2008). Both of them share a common core block but are designed to focus on different aspects: while the first is tailored to investigate foreign developments in trade over the local economy, the latter is better suited for dealing with the financial sector. To this extent, the model by Lubik and Schorfheide (2007) can be circumscribed to the same strand as that of the NAWM. Needless to say, DSGE models are not without shortcomings. In particular, they have been criticized for weak identification (Canova and Sala, 2009) or implausible assumptions. However, the DSGE framework is only used here for conditioning the variables included and the restrictions imposed in the VAR. That is, the main conclusions of this work are derived from the latter rather than from the former model. A reader interested in a more structural framework can consult Elosegui *et al.* (2007) and Escudé (2009) for DSGE models specifically designed for Argentina.

3. Methodology

This section describes the methodology used, which is based on Lutkepohl (2005) and Kilian and Lutkepohl (2017). The starting point is the following reduced-form VAR:

$$x_t = A_1 x_{t-1} + A_2 x_{t-2} + \ldots + A_p x_{t-p} + u_t \qquad u_t \sim (0,\ \Sigma_u) \tag{1}$$

where x_t is a vector of endogenous variables, A_i (with $i = 1, \ldots, p$) are the coefficients matrices, and u_t are the reduced form residuals. These are related to their structural counterparts w_t by $u_t = B_0^{-1} w_t$, where B_0^{-1} is the impact matrix.

There are two important decisions to make to estimate equation (1) and compute the IRFs: the first is which variables to include in the vector x_t, and the second is which restrictions to impose on the impact matrix B_0^{-1} such that orthogonal disturbances w_t can be recovered from the reduced-form residuals u_t. Here, both decisions are based on the dynamics observed in the model of Lubik and Schorfheide (2007). This model features a dynamic IS and a Phillips curve derived from the optimization problems of the households and firms, respectively. It also includes a monetary rule that endogenously determines the interest rate, while the exchange rate affects the consumer price index (CPI) under the assumption that relative purchasing power parity (PPP) holds.

The dynamic IS curve is defined as[2]:

$$\begin{aligned} y_t = {} & E_t y_{t+1} - [\tau + \alpha(2-\alpha)(1-\tau)](R_t - E_t \pi_{t+1}) - \rho_z z_t \\ & - \alpha[\tau + \alpha(2-\alpha)(1-\tau)] E_t\ \Delta q_{t+1} + \alpha(2-\alpha)\frac{1-\tau}{\tau} E_t\ \Delta y^*_{t+1}, \end{aligned} \tag{2}$$

where aggregate output (y_t) is determined by its expected value, the interest rate (R_t) once expected CPI inflation (π_t) is discounted, and an AR(1) technology process (z_t) with ρ_z as a persistence parameter. Aggregate output is also affected by expected changes in the terms of trade (Δq_t) and in world output (y^*_t), both of which are assumed to follow an AR(1). The parameter $0 < \alpha < 1$ is the import share, and τ is the intertemporal elasticity of substitution between home and foreign goods[3]. In equation (2), aggregate output is also affected by terms of trade shocks through a decrease in the interest rate caused by nominal appreciation, which comes after the increase in terms of trade, as described in equation (4).

The price dynamics follow an open-economy NK Phillips curve:

$$\pi_t = \beta E_t \pi_{t+1} + \alpha\beta E_t \Delta q_{t+1} - \alpha\ \Delta q_t + \frac{\kappa}{\tau + \alpha(2-\alpha)(1-\tau)}(y_t - \bar{y}_t), \tag{3}$$

where $0 < \beta < 1$ is the household discount factor and $\kappa > 0$ is the slope of the Phillips curve that captures the degree of price stickiness. Potential output, defined as output in the absence of nominal rigidities, is as follows:

$$\bar{y}_t = \frac{-\alpha(2-\alpha)(1-\tau)}{\tau} y^*_t$$

The Phillips curve [equation (3)] implies that inflation has an expectational component and an output gap component ($y_t - \bar{y}_t$). Moreover, it is affected by the expected variations in terms of trade compared with its actual value.

As for the monetary authority, it sets the interest rate according to the following policy rule:

$$R_t = \rho_R R_{t-1} + (1-\rho_R)\left(\phi_\pi \pi_t + \phi_y y_t + \phi_e\, \Delta e_t\right) + \varepsilon_t^R, \tag{4}$$

where e_t is the nominal exchange rate, ϕ_π, ϕ_y, $\phi_e \geq 0$ are the policy coefficients, $0 < \rho_R < 1$ is the persistence parameter, and ε_t^R is an exogenous money shock. Equation (4) is a typical Taylor rule of an open economy where the variations in the nominal exchange rate have been included. In fact, the main goal in Lubik and Schorfheide (2007) was to see whether the parameter ϕ_e was significant in Australia, Canada, New Zealand and the UK and, as a consequence, to verify if their central banks considered the nominal exchange rate when setting the interest rate.

In addition, the nominal exchange rate affects local inflation through the relative PPP:

$$\pi_t = \Delta e_t + (1-\alpha)\, \Delta q_t + \pi_t^*, \tag{5}$$

where π_t^* is world inflation. (Alternatively, it can be interpreted as deviations from relative PPP.)

The model is simulated with Dynare using the parameter values of the benchmark posterior distribution obtained by Lubik and Schorfheide (2007) with data from Canada[4]. As shown in Figure 1, a positive terms-of-trade shock produces nominal appreciation because relative PPP holds. This leads to a decrease in the interest rate, as described in the monetary rule [equation (4)], which stimulates output according to the IS curve [equation (2)]. Inflation decreases on impact but then increases because of output expansion, as described in equation (3). In the following section, the reader will find that the VAR estimates generate dynamics that are qualitatively similar to those of the DSGE model simulation, except for inflation's impact in Argentina and the interest rate in the Latin American countries. While the former can result from weak appreciation in Argentina, the latter can be explained by no policy reactions to appreciations.

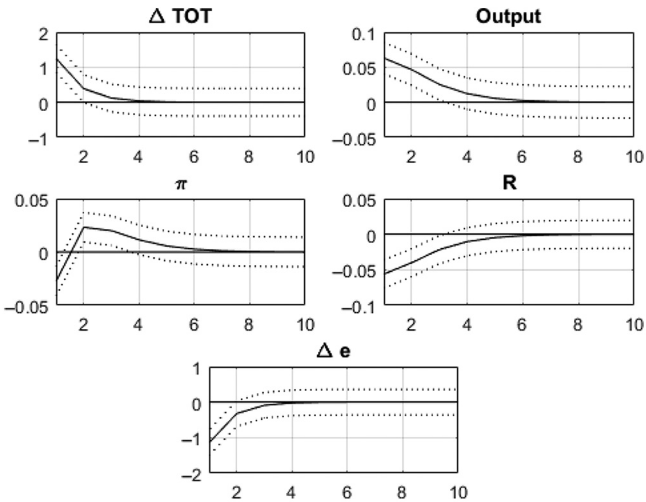


Figure 1.
DSGE IRFs

Note: Effects of a one-standard-deviation tot shock with 68% (⋯) confidence bands

The dynamics observed in Figure 1 will define which variables to include in the estimation of the reduced-form VAR[5]. However, there are two differences in the data used for the estimation of the VAR with respect to those used by Lubik and Schorfheide (2007) in their estimation of the model equations (2)-(5). First, commodity prices are used instead of terms of trade, as the goal of the paper is precisely to estimate the effects of the commodity boom. In this sense, it is assumed that increases in commodity prices have similar dynamics to rises in terms of trade, which seems reasonable since export prices are driven primarily by commodities in Latin America[6]. Second, industrial production (IP) indexes are used as the output measure, meaning that the VAR estimation can occur at a monthly rather than the quarterly frequency that would be available if GDP were used. Increasing the number of observations is advisable given the short time period analyzed, which allows greater precision in the estimation. In addition, it is reasonable to consider private agents, as well as the central bank, responding within the month to commodity price shocks in countries that are mainly commodity exporters, as the present case studies are.

Consequently, the endogenous variables in the VAR [equation (1)] are changes in commodity prices (Δcp_t) together with industrial production growth (Δy_t), CPI inflation, the nominal interest rate and variations in the nominal exchange rate (see the Data Appendix for details). One VAR is estimated by OLS for each country[7]: Argentina, Brazil, Chile, Colombia, Mexico and Peru[8].

Then, an identification scheme is applied such that structural shocks can be evaluated. The approach adopted here is to impose the dynamics observed in Figure 1: i.e. all variables respond on impact to the shocks, as is common in a DSGE framework. One simple way of achieving this is with a Cholesky decomposition of the covariance matrix and assuming that the first shock in the structural residuals vector is an innovation in commodity prices. The Cholesky identification is appealing in this case because both orthogonality and an economic interpretation of the structural shock are achieved simultaneously. Additionally, this identification does not constrain the sign of the response as would be the case under a sign restrictions scheme. In this sense, we are letting the data speak in a minimally restrictive environment.

The structural moving average (MA) representation for the first period is as follows:

$$\underbrace{\begin{bmatrix} \Delta cp_t \\ \Delta y_t \\ \pi_t \\ R_t \\ \Delta e_t \end{bmatrix}}_{x_{t=0}} = \underbrace{\begin{bmatrix} \theta_{11} & 0 & 0 & 0 & 0 \\ \theta_{21} & \theta_{22} & 0 & 0 & 0 \\ \theta_{31} & \theta_{32} & \theta_{33} & 0 & 0 \\ \theta_{41} & \theta_{42} & \theta_{43} & \theta_{44} & 0 \\ \theta_{51} & \theta_{52} & \theta_{53} & \theta_{54} & \theta_{55} \end{bmatrix}}_{B_0^{-1}} \underbrace{\begin{bmatrix} w_t^1 \\ w_t^2 \\ w_t^3 \\ w_t^4 \\ w_t^5 \end{bmatrix}}_{w_{t=0}} \tag{6}$$

In equation (6), w_t^1 is interpreted as a commodity shock, whereas $w_t^2, \ldots, w_t^5$ are disturbances with no economic interpretation and are, thus, left unidentified. This semistructural or partial identification is common practice in the VAR literature. It implies that the domestic unidentified shocks cannot contemporaneously affect the prices of commodities, which seems reasonable considering that, even if Argentina and the other Latin American countries analyzed here are large players in some commodity markets, they are nevertheless price takers. This identification scheme is similar to that used by Kilian and Vega (2011) to analyze oil price shocks in the USA. In this sense, it is postulated that commodity prices in Latin American countries can be assumed to be an exogenous and predetermined variable, just as oil prices are in the USA.

Once the impact matrix is obtained, it is possible to calculate the IRFs, the accumulated responses and the variance decompositions. Next, bootstrapping methods are used to characterize the extent of uncertainty around the estimates. Specifically, 10,000 bootstrapped series are generated by taking random draws of estimated residuals and feeding them back into the estimated series. For every bootstrapped series, there is a B_0^{-1} impact matrix that is used to generate the response distributions.

Finally, the average of the IRFs, the accumulated responses and the variance decompositions are taken for Brazil, Chile, Colombia, Mexico and Peru to generate mean responses among these countries. In the following section, the effects of commodity shocks in Argentina are compared to those in the other Latin American countries[9]. These comparisons still hold if the other Latin American countries are taken separately or if their IRFs are instead obtained using a Panel VAR[10].

4. Evidence

In Figures 2 to 5, the IRFs, the accumulated responses and the variance decompositions to a 10 per cent commodity price shock in Argentina and in the rest of the countries, Brazil, Chile, Colombia, Mexico and Peru, are shown. The goal is to verify whether the effects of the commodity shocks were significantly different between Argentina and the rest of Latin America and, thus, whether they could help to explain the distinct macroeconomic performances shown in Table I. As the reader will see, the evidence suggests that increases in commodity prices had a stronger impact on growth in Argentina through weaker appreciation than its counterparts. But this had as side effects higher inflation and larger output and price volatilities in that country during the analyzed period.

Figure 2 presents the effects that commodity shocks had on output growth for Argentina and the rest of the countries considered. The first row shows that the shapes of the

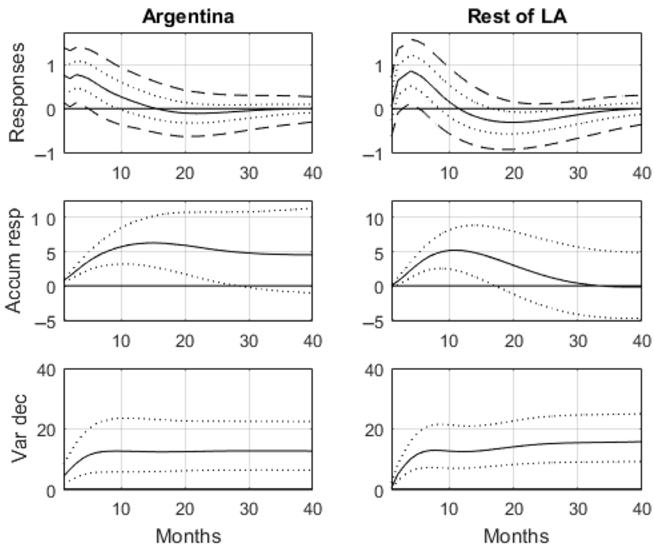
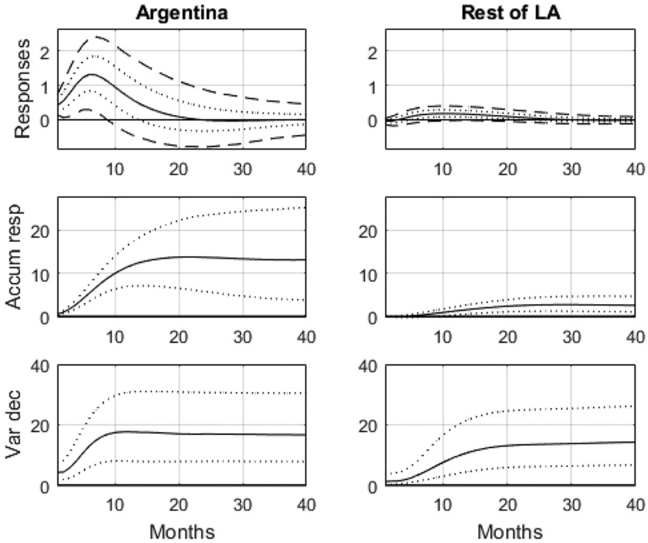


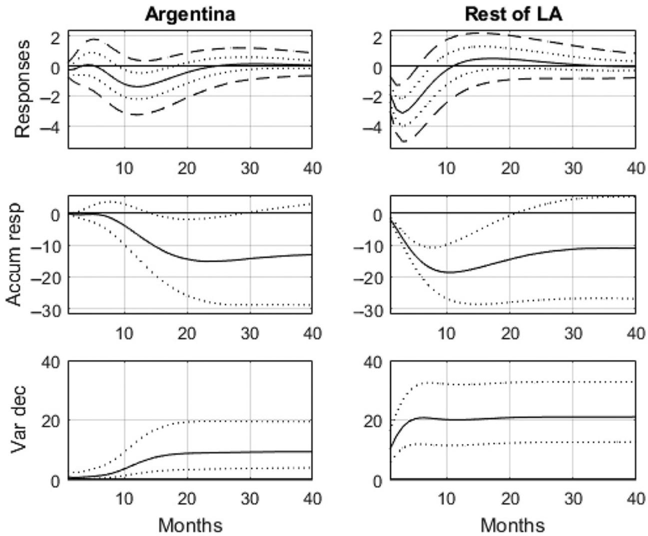
Figure 2. VAR IRFs

Note: Effects of a 10% increase in commodity prices on output growth: median (–) with 68% (···) and 95% (– –) confidence bands



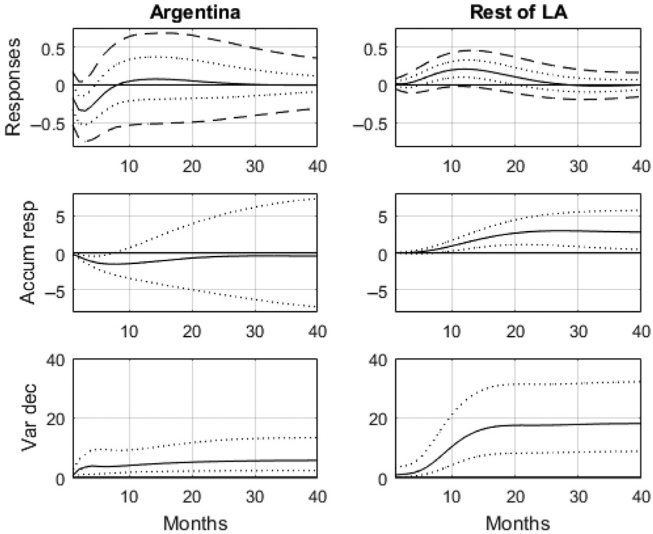
Note: Effects of a 10% increase in commodity prices on inflation: median (–) with 68% (···) and 95% (– –) confidence bands

Figure 3.
VAR IRFs



Note: Effects of a 10% increase in commodity prices on exchange rate variations: median (–) with 68% (···) and 95% (– –) confidence bands

Figure 4.
VAR IRFs



Note: Effects of a 10% increase in commodity prices on the interest rate: median (–) with 68% (···) and 95% (– –) confidence bands

Figure 5.
VAR IRFs

responses were quite different: while in Argentina, it increased on impact, displaying an inverted J-curve, it exhibited a hump-shaped curve in the other countries. This distinct shape in the responses can be explained by the difference in the exchange rate reactions, as shown in Figure 4. As described below, while the exchange rate appreciated on impact in Latin American countries, softening the real effects the commodity shock might have had, this was not the case in Argentina. Thus, this evidence can explain part of the higher output volatility observed in this country.

The second row of the graph shows that the accumulated response was clearly stronger in Argentina than in the other countries, which indicates that there were permanent effects on the outputs level in the former. In Argentina, the accumulated response accounted for almost a 5 per cent increase in outputs level, and it was significant for more than two years, while in the rest of the economies, there was almost no significant effect beyond the first year. Again, this greater accumulated response in Argentina could be the result of a more aggressive intervention in the exchange rate market to prevent the local currency from appreciating. This suggests that the Argentinean Central Bank might have pursued a stronger leaning-against-the-wind policy, probably to avoid the Dutch disease.

In the third row of the figure, the forecast error variance decompositions of the disturbance, i.e. the contribution of commodity shocks to predict output fluctuations, is plotted. The estimates indicate that commodity innovations affected Argentina more profoundly than they did the other economies until the fifth month. Later, they explained a maximum of approximately 13 per cent of the output variations in Argentina during the third year and 16 per cent in the other countries by then. That is, changes in output in the short run were more influenced by commodity shocks in Argentina than in the other economies. Although these disturbances can explain a moderate share of output fluctuations, their influence would likely be stronger if GDP were used instead of IP as the output measure[11].

As for their impact on prices, Figure 3 reflects that there were significantly different effects of commodity shocks in Argentina *vis a vis* the other countries. Specifically, the first and second rows of the figure show that IRFs and accumulated responses were much stronger in Argentina than in the rest of the region. Thus, this is evidence suggesting that the much higher level of inflation and greater price volatility observed in that country, as shown in Table I, were substantially due to the stronger influence of commodity shocks over Argentina's price levels.

Note that export taxes were raised to a nonnegligible 35 per cent in Argentina during the commodity boom. On one hand, these taxes might have had an anti-inflationary effect when the taxed commodity was also consumed domestically, as was the case for some of the commodities exported from Argentina (Piermartini, 2004). On the other hand, export taxes could have been inflationary through the fiscal channel, i.e. if the increase in government revenue translated into higher spending. In fact, the principal exported Argentinean commodity, soybeans, is little consumed locally. So, it is debatable if the government's goal when implementing export taxes was more of a fiscal rather than an anti-inflationary nature. In any case, the evidence presented in Figure 3 implies that either the anti-inflationary effect was not enough or that the fiscal channel more than compensated for it[12].

The differences in magnitude of price responses are noteworthy: the first row of Figure 3 shows a peak effect in Argentina of 1.3 per cent in the sixth month and of 0.2 per cent for the rest of the region by the tenth month. The impact point estimate was negative in Latin America, just as the DSGE model predicts (Figure 1), but positive in Argentina. The explanation can be, again, that the nominal exchange rate did not appreciate in this country but did in the others. The second row reports the accumulated responses. They indicate that the effect over the price level was considerably larger in Argentina than in the rest of the region. Specifically, the results indicate that in Argentina, there was a level effect of 10 per cent by the end of the first year, evidencing an important pass-through of the commodity to local prices. Over longer-term horizons, the effect increases to approximately 14 per cent, while the long-run effect in the rest of the region is, at the most, barely 3 per cent. The third row of Figure 3 plots the variance decomposition of the inflation associated with commodity innovations. The bulk of variations in prices did not come from the analyzed shock, although some differences found are noteworthy. In particular, the effects over Argentinean prices were twice as large in the short run: it was 18 per cent by the end of the first year in Argentina, while it accounted for 9 per cent in the rest of the region.

The impact over the exchange rate when subjected to commodity shocks is presented in Figure 4. It is apparent that the responses were quite different: while in Latin American countries, it displayed a J-curve with a strong appreciation on impact, there was no significant effect until the end of the first year in Argentina. This implies that its monetary authority might have targeted a stable nominal exchange rate at the expense of a higher impact on output and inflation, as shown in Figures 2 and 3. The peak appreciation in Latin American countries reached −3.2 per cent at that third month, while it was barely −1.4 per cent by the end of the first year in Argentina.

The changes in the level of the exchange rate to the innovations in commodity prices are plotted in the second row of Figure 4. It is evident that appreciation during the first year was much stronger in the rest of Latin America when compared with that of Argentina, although no significant difference could be verified afterwards. In particular, the exchange rate level changed as much as −15 per cent by the end of the second year in Argentina, while the corresponding value for the other countries was −19 per cent by the tenth month. Furthermore, the accumulated response was significantly different from 0 for almost two years for Latin America countries, while it was barely significant during the second year in Argentina. As for the variance decomposition presented in the third row, it indicates that commodity shocks contributed considerably more to fluctuations in the exchange rate in the other Latin American countries than in Argentina. While in the former, it accounted for a 10 per cent influence immediately on impact and a 20 per cent influence by the fifth month, in Argentina, it barely affected exchange rate variability upon impact and only accounted for 9 per cent in longer horizons.

As aforementioned, the interventions in the currency market were probably performed to avoid the Dutch disease, which is the potential competitiveness loss in nontradables that can come as a consequence of a real exchange rate appreciation. However, if this leaning-against-the-wind policy has an important inflationary impact, the real exchange rate will, eventually, appreciate. Only that such appreciation occurs through higher inflation rather than through a drop in the nominal exchange rate. This is precisely what seems to have happened in Argentina during the commodity boom. In this sense, the remedy could not avoid the (Dutch) disease[13].

Finally, the first row of Figure 5 shows the IRFs of the interest rate when subjected to an innovation in commodity prices. The response in the short run was quite different in Argentina than in the other countries. Specifically, the interest rate in Argentina was significantly reduced in the short run, suggesting that there was a policy reaction to appreciations in the nominal exchange rate, which resembles that of the DSGE estimates presented in Figure 1. Conversely, there was an increase in the interest rate in the other Latin American countries, although it was significant only beginning in the sixth month. One possible interpretation for this evidence can be that, while the monetary authority in Argentina was more responsive to appreciation, those of the other countries reacted more to output and inflation.

The qualitative differences between Argentina and the other countries become evident in the second row of Figure 5, where the long-run responses are plotted. As shown, while the long-run effect was negative but barely significant in Argentina, it was positive for the rest of the countries. Regarding the variance decomposition presented in the third row of the graph, the evidence indicates that the fluctuations in the interest rate attributable to commodity shocks were higher in Argentina within the first six months but stronger in the other economies afterwards. From the second year onward, it accounted for 6 per cent change in Argentina compared to 18 per cent in the rest of Latin America.

5. Conclusions

This article estimates the effects of commodity shocks during the 2000s commodity boom in Latin America. Specifically, it investigates whether these disturbances were related to the poorer macroeconomic outcome observed in Argentina when compared to the other major economies in the region: i.e. its higher level of inflation and greater price and output volatilities. This study verifies that innovations to commodity prices did have an important influence on the level of inflation and the greater output and price variabilities observed in Argentina during the boom.

The estimates can be interpreted as differences in policy reactions across the case studies, as the results suggest that the monetary authority in Argentina might have acted more aggressively in the exchange rate market than its counterparts did. This stronger leaning-against-the-wind policy resulted in a weaker appreciation of the nominal exchange rate in Argentina than in the rest of the region when subjected to rises in commodity prices.

The reason for this greater presumed activism by the Argentinean monetary authority was very likely to avoid the Dutch disease, as proposed in previous works. In fact, the output level increased significantly more in Argentina than in the rest of the region following the commodity shocks that occurred during the boom. Nevertheless, there were side effects that consisted of a larger inflationary impact and a greater volatility in output and prices suffered by that country.

Some policy implications can be derived from these results. There was a trade-off in macroeconomic outcomes during the boom: either achieving higher growth at the expense of greater volatility and, especially, higher inflation or reducing inflationary pressure with a weaker boost in activity. The former was achieved by a more aggressive countercyclical exchange rate policy, whereas the latter came from allowing greater flexibility in the currency. While Argentina seemed to have opted for the first outcome, the rest of the region chose the second. It remains a question for local monetary authorities to determine which stance to adopt in the future if commodity prices begin rising again.

Notes

1. Some few exceptions are Lanteri (2009) and Lanteri (2011), who used a structural VAR and a structural VEC, respectively, to study the impact of terms of trade in Argentina.
2. The interested reader can refer to Galí and Monacelli (2005) for details on the derivation of (2) and (3).
3. Note that the model reduces to its closed economy version if the import share is $\alpha = 0$.
4. Dynare is an application hosted by MATLAB software and developed by Adjemian *et al.* (2011). This application linearizes the system in equation (2)-(5) around the steady state, finds the solution with the Sims (2002) method and provides statistics and IRFs.
5. Some readers might wonder why an SVAR approach is used instead of a fully structural analysis that can be implemented by estimating the system [equation (2)-(5)] using Argentinian data. The reason is that the DSGE model relies on assumptions that might not apply for this country: i.e. there was no inflation targeting during the analyzed years, as implied by the monetary rule [equation (4)]. It is then preferable to use the DSGE model for the VAR variables' selection and for the impact matrix's restrictions, as done here.
6. Although a DSGE model featuring commodity innovations instead of terms of trade could have been used, it was preferable to rely on the fairly simple and widely popular model by Lubik and Schorfheide (2007), especially considering that it only serves to justify the variables included in the VAR and that the main conclusions are not derived from it.
7. Residual tests are not presented here but are available upon request.
8. Venezuela is not analyzed here because of a lack of recent data.
9. The MATLAB routines programmed to generate the results are available upon request.
10. Panel VAR IRFs were obtained using the BEAR 3.0 toolbox of the European Central Bank, and no significant differences with the average IRFs reported below were found. These results are available upon request.
11. The impact of commodities or terms of trade shocks over the business cycles in emerging countries has been widely studied. Mendoza (1995) calculated that terms of trade accounted for 50 per cent of the business cycles, Drechsel and Tenreyro (2018) estimated that commodity shocks affected less than 40 per cent of the same, and Broda (2001) and Broda (2004) estimated terms of trade to account for 10 per cent in floating regimes. The results obtained here are in line with these last papers, as with that of Lanteri (2009) and Lanteri (2011), as performed specifically for Argentina.

12. I thank an anonymous referee for pointing out the inflationary effects of export taxes through the fiscal channel.

13. I thank an anonymous referee for pointing this out. The real exchange rate responses to commodity shocks are not shown here but are available upon request.

14. A robustness check was performed using the main exported commodity by each country instead of the General Commodity index. These were soybean prices for Argentina and Brazil, copper prices for Chile and Peru and oil prices for Colombia and Mexico. Although the main results were not significantly altered, the differences between Argentina and the rest of the region were moderated. Still, using the General Commodity Index is preferable if the analyzed countries are considered to be important exporters of other commodities besides their main one. Moreover, the weight of the different exported commodities might vary during the analyzed period. I thank an anonymous referee for suggesting this robustness check, which is available upon request.

15. The invertibility of $\Theta(L)$, i.e. the fundamentalness condition, implies that the structural MA has a reduced-form VAR representation. This comes down to ensuring that the information at the econometrician's disposal is sufficient to recover the structural shocks from the data. The fundamentalness condition is not formally addressed in this work. The interested reader can consult Alessi *et al.* (2011).

16. Although the estimation includes a constant vector, it is not included in equation (1) for expository purposes.

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Appendix

Data

The descriptive statistics of Table I were obtained with quarterly series for real GDP and monthly series for CPI inflation. The Latin American average was obtained by taking the mean values of Brazil, Chile, Colombia, Mexico and Peru. The sample period is from 2003:Q2 to 2015:Q4. The sources are the corresponding National Statistics Institutes, except for Argentina, for which CPI inflation is obtained from Cavallo (2013) between 2007 and 2015 because the official inflation estimates are known to be much lower than the true value. Argentinian GDP was also affected by poor statistics during the analyzed period (Camacho *et al.*, 2015). However, this had been corrected by the time of the writing of this paper.

Estimation of the VAR model used yearly growth rates of the commodity price index, the IP index, the CPI and the nominal exchange rate as well as the nominal interest rate. Commodity prices were taken from the General Commodity Index published by the IMF, which includes all commodities (farming, minerals and oil)[14]. The interest rate was obtained from the monetary policy rate (the Call rate for Argentina). All variables were measured at monthly frequencies. The data were from September 2003 to October 2015. Data sources were Argentina [INDEC, BCRA, Cavallo (2013) for CPI since 2007], Brazil (IBGE and BCB), Chile (INE and Central Bank), Colombia (Central Bank), Mexico (INEGI and Central Bank) and Peru (Central Bank).

Methodological details

This appendix shows the methodology applied in greater detail. The following structural MA model is used:

$$x_t = \Theta(L)w_t, \tag{7}$$

where x_t is a $Kx1$ vector of endogenous stationary variables, Θ are h matrices of KxK dimension (with h as the desired horizon of the IRFs), L is the lag operator, and w_t is a $Kx1$ vector of structural shocks, in the sense that they are mutually uncorrelated and have an economic interpretation. If $\theta(L)$ is invertible, then equation (7) has the following structural VAR (p) representation[15]:

$$\begin{aligned} &B(L)x_t = w_t \\ &\left(B_0 - B_1L - B_2L^2 - \ldots - B_pL^p\right)x_t = w_t \\ &B_0x_t - B_1x_{t-1} - B_2x_{t-2} - \ldots - B_px_{t-p} = w_t \\ &B_0x_t = B_1x_{t-1} + B_2x_{t-2} + \ldots + B_px_{t-p} + w_t, \end{aligned} \tag{8}$$

where $B(L) = \Theta(L)^{-1}$. The expression in equation (8) can be taken to its reduced form [equation (1)], where $A_i = B_0^{-1}B_i$ and $u_t = B_0^{-1}w_t$ are *iid* reduced-form residuals with covariance matrix Σ_u, and B_0^{-1} is the impact matrix[16]. The selection of variables is conditional on the DSGE model as described in the main body of the article. Once equation (1) is estimated and stationarity is verified, the process is considered in its MA reduced form:

$$x_t = \Phi(L)u_t, \tag{9}$$

where $\Phi_h = JA^hJ'$, A is the companion matrix, and $J: = [I_K:0:\cdots:0]$. Considering that $\Theta_h = \Phi_hB_0^{-1}$, the structural shocks can be recovered from equation (9) once the impact matrix B_0^{-1} is known. As described in the main body of the article, the identification is performed using a Cholesky decomposition of the covariance matrix $chol(\Sigma_u) = B_0^{-1}$, assuming that the first structural shock in w_t is an innovation to commodity prices. It is then possible to calculate the IRFs, the accumulated responses, and the variance decompositions, respectively, with:

$$\frac{\partial x_{t+i}}{\partial w_t'} = \Theta_i$$
$$\Xi_n = \sum_{i=0}^{n} \Theta_i \tag{10}$$
$$\omega_{jk,h} = \sum_{i=0}^{h-1} (^{e_j' \Theta_i e_k)2} / MSE[x_t(h)]$$

where e_k is the k-th column of I_K and:

$$MSE[x_t(h)] = \sum_{i=0}^{h-1} \Theta_i \Sigma_u \Theta_i'$$

is the predictor that minimizes the forecasted mean squared errors. The diagonal elements of this matrix are to be used in equation (10).

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