Evaluating the Argentinian exchange rate policy during the 2000's commodity boom

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June 5, 2017

Abstract

I estimate the effects of the 2000's commodity boom over output growth and inflation in Argentina, as well as in the other major Latinamerican economies. My goal is to see whether commodity shocks had diverse effects between the former and the latter during the boom. My conclusions rely on the estimation of a structural Vector Autoregression where the selection of variables is conditional on the dynamics observed in a standard New Keynesian Dynamic Stochastic General Equilibrium model. The results indicate that the exchange rate policy was more active in Argentina than in the other countries during the boom: i.e., that the Argentinean monetary authority pursued a stronger *leaning against the wind* policy and had more *fear for appreciation* than its regional counterparts. As a consequence, I evidence that the country benefited from a stronger impact on output growth at the expense of higher inflation and volatility. Hence, this can explain part of the higher inflation in Argentina, as well as its larger volatility in prices and output, when compared to the other nations during the analyzed years.

Keywords: Structural VARs; exchange rate regimes; commodity price shocks; Argentina.

JEL Classification: C32; F31; F41; Q02.

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1 Introduction

Exchange rate policy is probably one of the most conflicting macroeconomic issues in emerging economies. The reason for this is that external shocks are typically considered an important source of output volatility in these countries. For example, Mendoza [1995] and Kose [2002] used a calibrated busyness cycles model and find that terms of trade shocks explain more than half of output fluctuations in developing countries. Consequently, commodity prices (or terms of trade) disturbances have always been a major concern in the policy design of these nations. Reducing the exposure to such innovations led to the recommendation of adopting flexible exchange rates.

Since the seminal contribution of Friedman [1953], several works have confirmed the argument that flexible exchange rates have better insulating properties than pegs. For developing countries, Broda [2001] and Broda [2004] evidence with a panel VAR that floats have around 10% of output volatility explained by terms of trade shocks, while for pegs it increases to 30%.

Nevertheless, despite the solid conclusions in academics in favor of floats, emerging countries had hardly ever adopted a truly floating regime: central banks have sold foreign reserves aggressively to avoid large depreciations, and have bought actively to prevent important appreciations. On the one hand, strong intervention to avoid currency devaluations has been called *fear for floating* by Calvo and Reinhart [2002]. On the other hand, aggressive interventions to impede strong appreciations has been called *fear for appreciation* by Levy-Yeyati et al. [2013]. As a matter of fact, Levy-Yeyati and Sturzenegger [2005] find that *de jure* floats are better described as *de facto* dirty floats.

During the 2000's, most Latinamerican countries adopted a countercyclical exchange rate during the commodity boom. While Levy-Yeyati et al. [2012] and Levy-Yeyati et al. [2013] argued that this *leaning against the wind* policy had the objective of accumulating reserves, Frenkel and Rapetti [2012] and Ahumada and Cornejo [2015] stated that it was functional to the development of the country and to avoid the so called Dutch disease. Still others said that countercyclical exchange rate policy should rather be regarded as the desire of the monetary authority to maintain real exchange rate stability (see Daude et al. [2016]).

In the present work, I provide evidence that intends to contribute to the accurate evaluation of the effects the boom had on Argentina, as well as in the other analyzed countries. To obtain my results, I use a semistructural Vector Autoregression (VAR) where shocks to commodity prices are partially identified with contemporaneous zero restrictions. The selection of variables included in the VAR comes from the dynamics observed in a prototypical New Keynesian model of a small open economy. According to this model, in order to identify a commodity price shock in a VAR, the following variables are needed: commodity prices variations, output growth, inflation, nominal exchange rate variations and nominal interest rate.

My results indicate that the Argentinian central bank intervened more aggressively than institutions in the rest of the region when subject to commodity innovations during the boom. In fact, the nominal exchange rate appreciation was weaker in the country after increases in commodity prices. As a consequence, the impact on output was stronger both in the short and the long run in Argentina. Nevertheless, the secondary effect of this policy was a larger influence on inflation. So, this can make sense of the much higher inflation observed in Argentina than in the other countries during the boom.

In an endeavor to reduce the inflationary effects of important rises in commodity prices, local authorities in Argentina implemented export taxes. These taxes were raised from 3% to 35% during the boom and might have acted as a buffer on local inflation when subjected to commodity price shocks. In fact, in Warr [2002] and Piermartini [2004] it is explained that export taxes often reduce domestic prices if the taxed commodity is also consumed at home, as is the case in Argentina. So, the effects on prices might have been even stronger if it not were for export taxes.

Additionally, I evidence a greater part of output and inflation variability explained by commodity disturbances in Argentina than in the rest of the region. Though the differences are not as important as to derive from them the much greater volatility observed in this country during the analyzed years.

In order to locate this paper in the literature, it is useful to think about three different categories: the topic covered, the methodology used and the country studied. Regarding the topic of my work, the effect in a small open economy of changes in its exports prices and the exchange rate policy adopted to deal with these shocks, this paper is related to all of the articles cited above. In what concerns the methodology, this paper is within the structural VAR literature which, starting with Sims [1980], has now a long tradition in macroeconometrics (see Kilian [2011] for a literature revision). As for my case study, the closest analysis to my work are those of Broda [2004] and Lanteri [2008], to my true knowledge. The first uses a Panel VAR to estimate effects of terms of trade shocks in floats and pegs, as mentioned above. The last author uses a structural VAR and finds that positive terms of trade shocks have a positive and permanent effect on real output in Argentina. Actually, the main motivation of this work is to contribute to the scarce VAR literature dedicated to the Argentine economy.

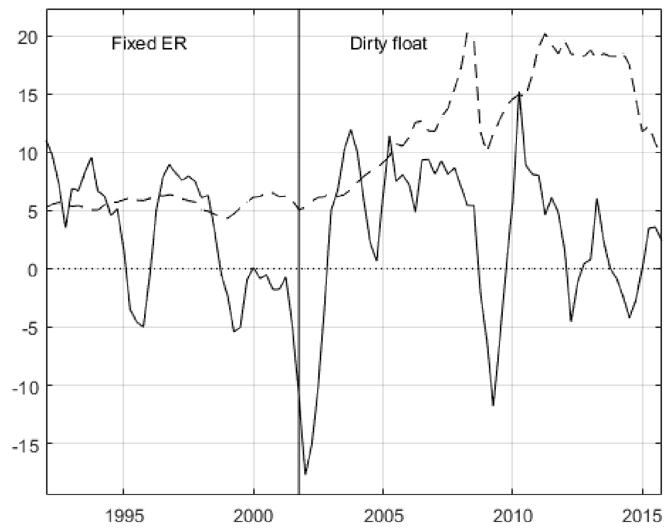
The rest of the paper is structured as follows. Section 2 provides some empirical facts observed in my case studies during the 2000's boom. In particular, it is shown the different macroeconomic outcomes observed between Argentina and the rest of the region in those years. In section 3, I discuss the methodology used, which consists on the estimation of a VAR model where the variables used to identify the commodity shock are conditional on the dynamic responses observed in a simulated DSGE model. Section 4 presents the evidence by plotting the short and accumulated responses of an innovation in commodity prices, as well as the variance decompositions in both Argentina and in the rest of Latinamerican countries. Finally, Section 5 concludes and comments on the policy implications of the article's evidence.

2 Empirical facts

In the midst of emerging market crisis at the late 1990's, there was a strong debate about which exchange rate policy should these countries adopt: options went from floating to dollarization (see Dornbusch [2001]). There was strong support for the latter in Argentina, as it had defaulted on its dollar denominated debt and was suffering inflationary and currency devaluation pressures (see Calvo [2000]). Ultimately, Argentina adopted a managed floating in 2002 and commodity prices experienced a boom shortly after. So, the 2000's commodities boom and the exchange regime switch were contemporaneous events just by chance.

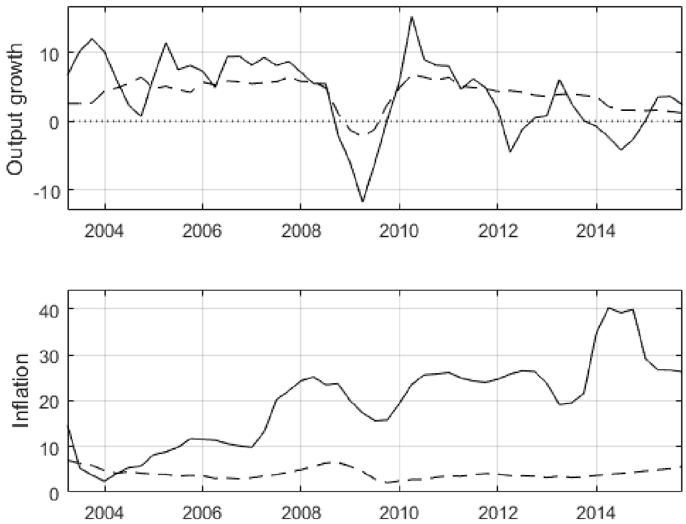
Figure 1 shows the episodes' sequence: Argentina defaulted on its sovereign debt and changed its currency regime in January 2002; shortly after, the commodity boom started. As it can be seen in the figure, high growth was achieved during the boom. Some saw in commodities rising prices the main reason for the country's impressive output growth of the following years. Specially considering that Argentina is manly a commodity exporting country. Now, in the aftermath of the events, it is possible to evaluate the performance of the selected exchange rate by quantitatively assessing the effects of the boom in the economy.

Fig. 1: Argentinian output growth (—) and commodity prices (−−).



The 2000's commodity boom practically doubled commodity prices in a few years. This was one of the three major commodity booms experienced since the second world war, as described by Radetzki [2006]. Given that Latinamerican countries are important commodity exporters, they were particularly affected by the boom. These were prosperous years for the region: economic growth was high and stable and inflation was kept under control. However, Argentina was an exception. It did grew as the region did but output was much more volatile than in the rest of the countries. Additionally, inflation was much higher and volatile in Argentina than in the other nations. These facts are evidenced in Figure 2, where I show the output growth and inflation rate of Argentina and the average of the rest of the region during the years of the boom.

Fig. 2: Argentina (—) and rest of LA (−−).



The rest of the Latinamerican countries considered here are the other major economies in the region: Brazil, Chile, Colombia, Mexico and Peru (Venezuela is not included because of lack of data during the sampled years). The figure shows that, while the level of output growth in Argentina was similar than in the rest of Latinamerican countries, Argentinian output was twice as volatile. Regarding inflation, Argentina had 5 times a higher level and 6 times more volatility than the rest of the analyzed countries. Why was Argentinian macroeconomic outcome so much worse than that of the rest of its counterparts?

One might think of three possible reasons for this: (i) either Argentina was subject to more volatile shocks than the rest of the region was, or (ii) the exchange rate policy in the country tended to amplify the effects of common Latinamerican disturbances while it was not so in the other economies, or (iii) there were other country specificities in Argentina that can be accountable for this distinct macroeconomic outcome, i.e. how monetary or fiscal policy was conducted in the country *vis a vis* the rest of its counterparts.

In this paper, I analyze the option (ii) as I estimate the effects of similar commodity shocks that affected the whole region during the commodity boom of the 2000's and I evaluate the exchange rate policies carried out by these countries in terms of their capacity to achieve stable growth and low and stable inflation. This is a particular relevant question to try to disentangle the causes of the Argentinian worse performance, as well as the tools to improve future outcomes.

As mentioned by Heymann and Leijonhufvud [1995], high inflation affects notably the economic performance and, in particular, economic growth. They claim that *the evidence indicates that countries suffering macroeconomic instability in general, and high inflation in particular, perform less well than would be the case under more stable conditions.* And they continue by noting that *external shocks may indeed complicate the picture. And countries that inflate also tend to have other policies inimical to growth* (p.38).

The reader must be aware that all analyzed countries had a flexible exchange rate during the analyzed years, though the level of flexibility was heterogeneous along the region. According to the IMF Annual report on exchange arrangements and exchange restrictions, all my case studies were *de jure* floats, but Argentina had a crawl-like arrangement. In fact, my findings verify that Argentina had a *de facto* less flexible regime as it allowed a weaker response in its exchange rate when subjected to commodity innovations than the rest of the countries did. I find evidence that can help to explain part of the different macroeconomic performance shown in Figure 2. Particularly, my results indicate that Argentina was more affected than the rest of its counterparts to commodity shocks during the boom. In this sense, the exchange rate policy was somehow responsible for Argentinian worse outcome.

In fact, my results show that commodity shocks were transmitted quite distinctly in Argentina when compared to the rest of Latinamerica. These differences were not qualitative but quantitative and responded mainly to the fact that appreciations in the nominal exchange rate were twice as stronger in Latinamerica than in Argentina when subjected to rises in commodity prices. Consequently, innovations in commodity prices had as much as six times a larger impact in the level of inflation both in the short and in the long run in Argentina. So, these disturbances, or the policy response to them, can explain part of the inflation divergence observed in Argentina during the boom.

Additionally, I find a stronger response in Argentinian output growth in the short run but, most notably, in the long run. Which suggests that the monetary authority might have targeted a high real exchange rate to avoid the Dutch disease. And, finally, I evidence that commodity shocks accounted for a bigger share of output and prices volatility in Argentina, though these differences are not very significant. Hence, the higher volatility experienced by Argentina, as documented in Figure 2, can not be derived only because of the effects of commodity disturbances.

3 Methodology

Since the Cowles Commission approach to model building broke down in the 1970's, the VAR methodology has gain popularity in macroeconometrics. Under this procedure, pioneered by Sims [1980], a structural model is assumed to have a reduced form representation that can be estimated and, under specific identifying restrictions, be able to describe variables' dynamics to structural shocks.

During the last decades, applied macroeconomic researchers have provided practical information to policy makers about the consequences of, for example, monetary or fiscal policies using VARs. The novelty of this framework is that it is a gray area between econometrics and theory, because it goes from a reduced form VAR to a structural VAR model. Going from the former to the latter is where the link between reality and theory resides. Or as Fry and Pagan [2011] put it, *the VAR is a reduced form that summarizes the data; the SVAR provides an interpretation of the data.*

A structural VAR typically derives in three elements that are very useful to perform macroeconomic analysis: the impulse response functions to structural shocks, the uncertainty about these impulse response functions and a variance decomposition analysis that indicates the contribution of the disturbances to macroeconomic variable's fluctuations.

The key step in the SVAR analysis, as in any empirical study, is the identification of structural shocks. In a theoretical model, any analyzed innovation is structural by definition. This is not the case in an empirical model, where shocks are nothing but reduced form disturbances. As noted by Kilian [2011], *only after decomposing forecast errors into structural shocks that are mutually uncorrelated and have an economic interpretation, can we assess the causal effects of these shocks on the model variables.*

If we want to do a structural analysis with an empirical model, we need to transform reduced form into structural innovations. To do so, the reduced form variance covariance matrix is used. There are many identification schemes currently used. But, by far, the most popular one is the Cholesky decomposition, which is the one used here. There are two economic assumptions implied by this identification scheme in this article: that innovations to commodity prices affect all variables contemporaneously, and that commodity prices are predetermined (i.e., exogenous). This is, they are not affected by any domestic disturbance. These assumptions are set by the ordering of the variables in the VAR, as detailed below.

3.1 The DSGE model

The point of departure of any structural VAR analysis is a theoretical model that allows the practitioner to identify the shock of interest in the empirical strategy. Or, as Ravn et al. [2007] put it, *an important step in the process of isolating structural shocks is identification.*

Data analysis based purely on statistical methods will in general not result in a successful identification. Economic theory must be at center stage in the identification process.

The model used here is taken from Lubik and Schorfheide [2007], which is a simplified version of Galí and Monacelli [2005]. As the reader will see, this model has terms of trade shocks which I will assume to have similar dynamics to innovations in commodity prices.

The model features the three key ingredients any New Keynesian (NK) model has: the existence of money, such that nominal prices are present; monopolistic competition, where firms have some market power to set the price of differentiated goods; and nominal rigidities in prices represented by the NK Phillips curve. At the same time, the model incorporates explicitly the exchange rate, the terms of trade, exports, imports and international financial markets. So it is a Small Open Economy (SOE) model. In this sense, the NK framework, which typically consists of a two-equation dynamical system with a NK Phillips curve and a dynamic IS-type equation plus the monetary rule, is augmented with the *law of one price* and a dynamic rule for the terms of trade.

Regarding household's behavior, consumption maximization leads to the Euler equation that can be expressed as an open economy dynamic IS-curve:

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

where $0 < \alpha < 1$ is the import share and τ is the intertemporal substitution elasticity between home and foreign goods. Endogenous variables are aggregate output y_t and CPI inflation rate π_t. The terms of trade q_t, defined as the relative price of exports in terms of imports, enter in first differences (Δq_t) and will be assumed to be exogenous, as described below. R_t is the nominal interest rate, y^*_t is exogenous world output and z_t is the growth rate of the technology process A_t with ρ_z as persistence parameter. In order to guarantee stationarity of the model, all real variables are expressed in terms of percentage deviations from A_t.

With respect to the producer side, domestic firm's maximization leads to the following open economy Phillips curve:

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

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

$$\bar{y}_t = \frac{-\alpha(2-\alpha)(1-\tau)}{\tau}y^*_t \tag{3}$$

The monetary authority is assumed to follow a policy rule where, besides inflation gap and output gap, nominal exchange rate depreciation (Δe_t) is targeted:

$$R_t^* = \pi^* + \rho_R R_{t-1} + (1-\rho_R)[\phi_\pi(\pi_t - \pi^*) + \phi_y \tilde{y}_t + \phi_e \Delta e_t] \tag{4}$$

where $\pi^* = 5$ is the inflation target, $\tilde{y} = y - \bar{y}$ is the output gap and policy coefficients are assumed to be $\phi_\pi, \phi_y, \phi_e \geq 0$. The persistence parameter is $0 < \rho_R < 1$, while ε_{R_t} is an exogenous policy shock which can be interpreted as the non-systematic component of the monetary policy.

Following the *law of one price*, it is assumed that relative PPP holds:

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

where π_t^* is a world inflation shock which is treated as unobservable. Yet, another interpretation for π_t^* is that it captures deviations from PPP.

Regarding terms of trade, they follow an AR(1) process:

$$\Delta q_t = \rho_q \Delta q_{t-1} + \varepsilon_{q_t} \qquad ; \qquad \varepsilon_{q_t} \sim \mathcal{N}(0, \sigma_q^2) \tag{6}$$

where $0 < \rho_q < 1$ is the persistence parameter and ε_{q_t} is the TOT innovation.

Model parameters' values come from the benchmark posterior distribution obtained by Lubik and Schorfheide [2007] using Canadian data. The exception is the policy parameters that I estimate by OLS for Argentina[1] The policy rule (4) is estimated by reexpresing it as:

$$R_t = \rho_R R_{t-1} + \beta_1 \pi_t + \beta_2 \tilde{y}_t + \beta_3 \Delta e_t + \varepsilon_{R_t} \tag{7}$$

where $\beta_i = (1-\rho_R)\phi_i$ for the i_{th} variable, respectively. The function (7) is estimated using Argentinian quarterly data from 2003:3 to 2015:4 of nominal interest rate (R), yearly inflation (π), yearly changes in nominal excahnge rate (Δe) and the output gap ($\tilde{y}$) (See Data appendix on page 21 for sources and sample periods.).

Output gap is estimated using the Blanchard and Quah [1989] decomposition, where the cyclical component of output is identified as shocks having no effect on long term output in a bivariate VAR with real GDP growth and unemployment. The estimation results are the following:

$$\hat{R}_t = 0.92^{***} R_{t-1} + 0.08^{*} \pi_t - 0.06 \tilde{y}_t + 0.01 \Delta e_t$$

where *** and * denote 99% and 90% significance levels, respectively. It is then straightforward to recuperate the monetary rule parameters considering $\beta_i = (1-\rho_R)\phi_i$, which are presented in Table 1:

[1] As mentioned by Lubik and Schorfheide [2007], OLS estimation of the policy rule is questionable because of endogeneity problems. Nevertheless, I consider unnecessary to use system based estimation methods, like Bayesian, as I am only using this estimation to observe qualitative responses, not to derive quantitative effects.

Table 1: Parameter values

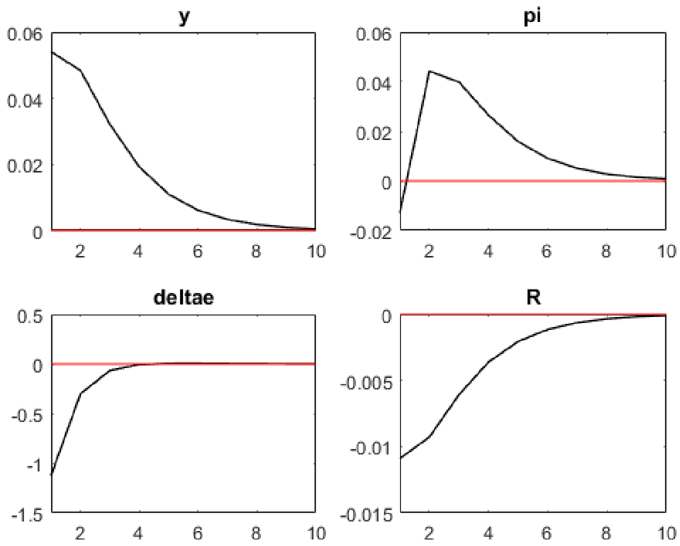
Name	Symbol	Value
Inflation gap parameter	ϕ_π	0.96
Output gap parameter	ϕ_y	-0.77
Exchange rate parameter	ϕ_e	0.11
Interest rate persistence	ρ_R	0.92

In the parameter estimates there are two relevant features to highlight: first, that the *Taylor principle* is not satisfied as the inflation gap coefficient is $\phi_\pi < 1$. Second, that the output gap parameter ϕ_y is negative, which implies that the monetary authority did not seek to stabilize this variable. For the simulations, I set that output gap parameter to $\phi_y = 0$.

As described in Woodford [2003], parameter's values like these are inconsistent with a low inflation and equilibrated output outcome. The higher output and inflation volatility experienced by Argentina during the analyzed years, as shown in Figure 1, can come from this lack of stabilization tools rather than from commodity shocks. In fact, the estimated variance decompositions of these variables for my case studies suggest this was the case, as the reader will see below.

The model is linearized around the zero steady state and solved using Sims [2002] method. Linearization, solution and simulation of the model is performed with Dynare software as referred to in Adjemian et al. [2011]. The dynamics generated after a TOT shock are presented in Figure 3. An improvement in terms of trade is followed by a nominal exchange rate appreciation (which is a fall in Δe_t) because, as is clear from (5), relative PPP holds. The nominal exchange rate appreciation has a negative effect on nominal interest rate as the monetary authority reacts according to the rule (4). Now, using a NK model where rigidities in prices exist, a nominal variation will have real effects, at least in the short run. So, output rises according to (1). At the same time, there is an increase in inflation according to (2), which mitigates the real effect in the medium term horizon. The rise in prices is such that there is a rise in the real interest rate and the increase in output is rapidly muted.

Fig. 3: Effects of a one std shock in TOT



Calibrating the intertemporal substitution elasticity τ for a higher value and the Phillips curve slope κ for a lower one, decrease the impact that output increment, that follows an improvement of the terms of trade, has on inflation according to the NK Phillips curve (2). Intuitively, if local and foreign goods are perfectly substitutable, increment of local prices are moderated when there is an output rise. But still, exchange rate will appreciate as PPP holds and nominal interest rate will fall as is clear from the monetary rule. There is then more room for a persistent rise in output as the real nominal rate decreases. In the following section, the reader will find that the VAR estimates generate responses that are qualitatively similar to those generated by the DSGE model.

3.2 The VAR model

In this section, I explain step by step the methodology used to to estimate and identify the VAR model. I begin by estimating for each country the following VAR(p) model:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + ... + A_p Y_{t-p} + u_t \tag{8}$$

where $Y_t \equiv [\Delta cp_t \quad \Delta y_t \quad \pi_t \quad R_t \quad \Delta e_t]'$, with $\Delta cp_t, \Delta y_t, \pi_t, R_t$ and Δe_t being the yearly changes in commodity prices, yearly growth rate in real GDP, yearly CPI inflation, nominal interest rate and yearly variations in nominal exchange rate, respectively. I obtain six different estimations of (8), one for each country: Argentina, Brazil, Chile, Colombia, Mexico and Peru (See Data appendix on page 21 for sources and sample periods.)

In order to select the lag order, I use a maximum lag of 18 months and I follow Ivanov and Kilian [2005], who recommend the Akaike Information criterion for monthly VARs. The lag order is changed whenever residual autocorrelation is detected. I also verify non-normality to be present in some countries VAR's residuals. However, as noted by Berkowitz and Kilian [2000], bootstrapping techniques, used here to characterize uncertainty around the estimates, reduce the risk of working with non-normal residuals.

As the VAR is stationary, it has the following MA representation:

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

where L is the lag operator and $\Phi_i = J\mathbf{A}^i J'$, being $\mathbf{A}$ the companion form matrix, $J := [I_N : 0 : \cdots : 0]$ and N the VAR's dimension. I recover the structural shocks from (9) by using:

$$Y_t = \Theta(L)w_t \tag{10}$$

where $\Theta_i = \Phi_i P$ and $w_t = P^{-1}u_t$ are with noise orthogonal residuals with unit variance. The impact matrix P is obtained by the Cholesky decomposition of the reduced form residuals variance-covariance matrix such that $\Sigma_u = PP'$. As $\Phi_0 = I_N$, then $\Theta_0 = P$. So, on impact, (10) is as follows:

$$\underbrace{\begin{bmatrix} \Delta cp_t \\ \Delta y_t \\ \pi_t \\ R_t \\ \Delta e_t \end{bmatrix}}_{y_t} = \underbrace{\begin{bmatrix} \theta_{11} & 0 & 0 & 0 & 0 \\ \theta_{21} & \theta_{22} & 0 & 0 & 0 \\ \theta_{31} & \theta_{32} & \theta_{33} & 0 & 0 \\ \theta_{41} & \theta_{42} & \theta_{43} & \theta_{44} & 0 \\ \theta_{51} & \theta_{52} & \theta_{53} & \theta_{54} & \theta_{55} \end{bmatrix}}_{\Theta_0} \underbrace{\begin{bmatrix} w_t^1 \\ w_t^2 \\ w_t^3 \\ w_t^4 \\ w_t^5 \end{bmatrix}}_{w_t} \tag{11}$$

In this article, I only care about one structural shock: an increase in commodity prices. This is why I do a VAR analysis that is semistructural or partially identified, rather than a fully identified one. Here, I identify w_t^1 as a commodity price shock, whereas the other four shocks do not have an economic interpretation. This implies that the price of commodities is predetermined with respect to all domestic macroeconomic aggregates.

This identification scheme is similar to the one performed by Edelstein and Kilian [2009] to analyze oil price shocks. Actually, Kilian and Vega [2011] provide empirical evidence that supports the identifying assumption of predetermined oil prices. In this sense, I am postulating that commodity prices can be assumed to be an exogenous and predetermined variable, just as oil prices are. This seems a plausible assumption if we consider that, even if Argentina and the rest of Latinamerican countries analyzed here are big players in some commodity markets, they are still price takers.

Regarding the accumulated long run responses, I use:

$$\Xi_n = \sum_{i=0}^{n} \Theta_i \tag{12}$$

I also compute the h-step forecast error variance decomposition analysis of variable j after a shock in variable k with:

$$\omega_{jk,h} = \sum_{i=0}^{h-1} (e_j' \Theta_i e_k)^2 / MSE[y_t(h)] \tag{13}$$

where e_k is the k-th column of I_K and

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

is the predictor that minimizes the forecast mean squared errors. The diagonal elements of this matrix are to be used in (13).

I use bootstrapping methods to characterize the extent of uncertainty around the estimates. More specifically, I generate 10,000 bootstrapped series by doing random draws of estimated residuals and feeding them back into the estimated series. For every bootstrapped series there is a P impact matrix which I use to build responses' distributions.

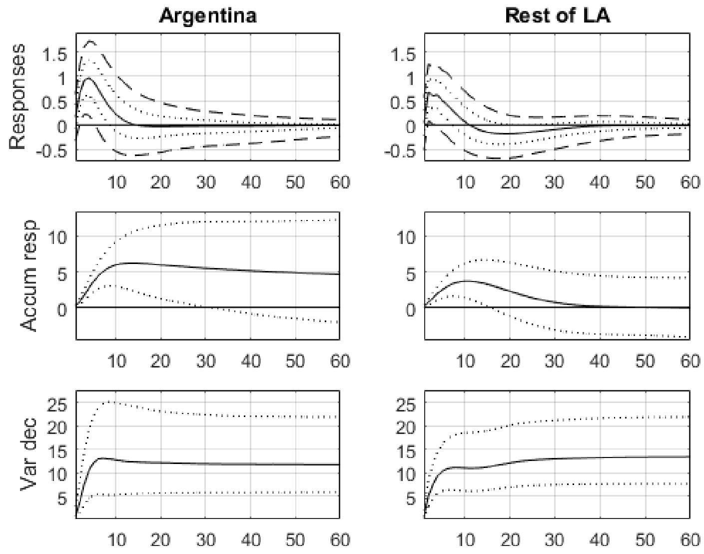
Finally, I take the average of the IRFs, the accumulated responses and the variance decompositions for Brazil, Chile, Colombia, Mexico and Peru in orther to build mean responses among these countries. In the following section, I compare the effects in Argentina with that of the rest of Latinamerican countries.

4 Evidence

In Figures 4 to 7 I show the short run IRFs, the long run accumulated responses and the variance decompositions to a 10% commodity price shock in Argentina and in the rest of the countries: Brazil, Chile, Colombia, Mexico and Peru. My goal is to verify whether the effects to the commodity shocks were significantly different between Argentina and the rest of Latinamerica. The median estimate together with bootstrapped 68% and 95% confidence bands are plotted. These figures represent the main results of this work. As the reader will see, I find evidence suggesting that commodity prices contributed to the higher inflationary level observed in Argentina during the analyzed years, though not so much to its larger volatility in output and inflation.

Figure 4 shows the effect the commodity shock had in output growth for Argentina and the rest of the countries, using the IP index as a proxy for output. In the first row, it can be seen that the responses are qualitatively similar, though the impact was stronger in Argentina than in the rest of the region. In particular, output increases to a maximum of 1% in Argentina by the 4^{th} month, while the peak effect in the rest of Latinamerica is of 0.6% around the same period. The influence of the disturbance is significant until the 8^{th} month for all the economies. Additionally, the qualitative effects of the commodity innovation in both the Argentinian VAR and in the rest of the countries are similar to the one derived from the DSGE model when subject to a terms of trade shock, as shown in Figure 3.

Fig. 4: Effects of a 10% increase in commodity prices over output growth: median (—) with 68% (···) and 95% (−−) confidence bands



As for the effects in longer time horizons, the second row of the graph shows that it is clearly stronger in Argentina than in its counterparts. In the former, it accounts for a 5% increase in the long run and it is significant for more two and a half years, while in the rest of the economies there is almost no significant effect beyond the first year. These greater accumulated response in Argentina comes from the fact that the country intervened more aggressively in the exchange rate market to prevent its local currency from appreciating. As presented below, nominal exchange rate appreciation was weaker in Argentina than in its counterparts when subject to a commodity shock. This suggests that the Argentinian central bank had a stronger *leaning against the wind* policy probably because it was more worried about the Dutch disease than the rest of the countries were.

In the third row of the figure I plot the variance decompositions of the disturbance, i.e., the contribution of commodity shocks to the output variability in my case studies. The estimates indicate that commodity shock explains around 13% of output variability in Argentina by the end of the first year, while a similar level of variability in the rest of the countries by the third year. This is, the short run output variability is more affected by commodity shocks in Argentina than in the other economies.

The reader might remember that, as described in the introduction, Argentina had twice as much output volatility than the rest of the region during the analyzed period. While my evidence can explain part of this larger volatility being due to commodity shocks, it cannot account for such a big difference. This is, there is no conclusive evidence here that can explain the much higher output volatility observed in Argentina, as shown in Figure 1. Therefore, this empirical fact can come from either specific shocks hitting the country, or to the way fiscal and monetary policy were conducted in Argentina.

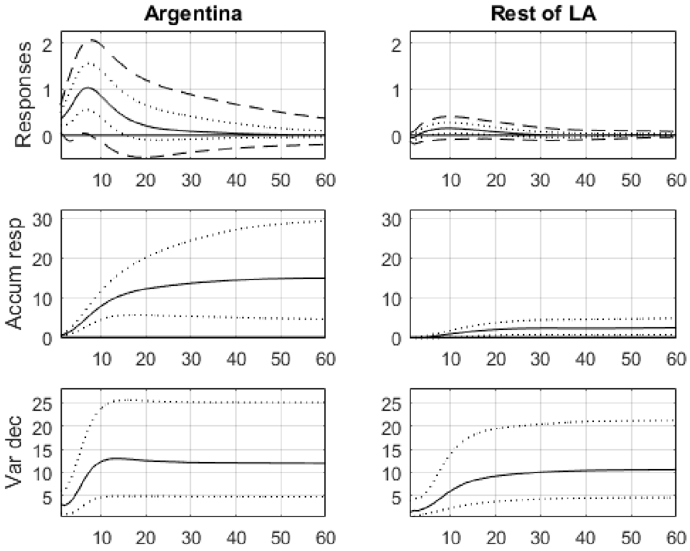
A suggesting piece of evidence is found in the parameter estimates of the monetary policy rule (4) done in the previous section for Argentina. As shown in Table 1, the output gap parameter was negative for the country, which means that the monetary authority did not cared at all about output stabilization when designing its monetary instruments. This fact, rather than the commodity shocks, can explain the greater volatility in output the country experienced during the analyzed years.

It is worth taking into account that these estimates are based on the Industrial Production (IP) index, rather than real GDP. The IP index is used mainly for two reasons: one statistical and other theoretical. Regarding the former, given the short time period analyzed (and considering that I am estimating a five-dimensional VAR) using quarterly data can result in very imprecise estimates. As for the latter, it is quite reasonable to consider private agents, as well as the central bank, responding within the month to commodity prices shocks in countries which are mainly commodity exporters, as my case studies are.

It can be argued then that the effects over real GDP would have been probably two or even three times higher than those estimated using the IP index. If this were the case, the short run impact of a 10% commodity innovation in Argentina would be between 2 and 3%, the accumulated response between 12 and 18% and the variance decomposition between 26 and 39%. In the small open economy literature, effects of terms of trade shocks on output volatility go from 90%, as in the seminal work of Mendoza [1995], to around 10%, as in Broda [2004]. For the case of Argentina, Lanteri [2008] estimates output variability attributed to terms of trade shocks to be around 7%.

In Figure 5, I plot the short run, accumulated and variance decompositions of inflation for Argentina and the average of the rest of Latinamerica after a commodity innovation. My evidence reflects that there were significantly different effects of commodity shocks in Argentinean prices *vis a vis* the other countries. Specifically, the first and second rows of the figure show that short and long run responses were much stronger in Argentina. So, this is evidence suggesting that the much higher level of inflation observed in Argentina, as shown in Figure 2, was importantly due to the stronger influence of commodity shocks in its price level. Quite probably, the response would have been even stronger in Argentina if it not were for the export taxes implemented in 2002. Because it is possible that these taxes acted as a buffer over inflation weakening the link between local and international prices.

Fig. 5: Effects of a 10% increase in commodity prices over inflation: median (—) with 68% (···) and 95% (−−) confidence bands



The first row presents the IRFs of inflation to the commodity disturbance. The peak effect in Argentina is around 1% in the 8^{th} month, while it was around 0.15% in the rest of the region. Interestingly, the effect on impact is much stronger in Argentina than in the other countries: of around 0.3% within the same month of the shock in the former, while it is only significantly different to 0 from the 6^{th} month in the latter. This is consistent with the weaker appreciation on impact observed in Argentina than in the other countries, as shown below.

If we compare the qualitative effect of the commodity innovation in the VAR with the one derived from the DSGE model when subject to a terms of trade shock, as shown in Figure 3, we do find same differences. In particular, Figure 3 shows a negative effect on impact that turns fast into a positive hike, which is more consistent with the Latinamerican VAR response than with the Argentinean one. However, the reader must be aware that the DSGE output response will look the same as the latter one if the output gap parameter in (4) is set to a negative value, just as it was originally estimated for Argentina.

In the second row the accumulated responses are exhibited. They evidence that the long run effect in Argentina was considerably higher than in the rest of the region. Especially, the results indicate that in Argentina there was an accumulated effect of 10% right after the first year, evidencing a total pass through of commodity to local prices by then. In longer term horizons, the effect increases to around 15%, while the long run effect in the rest of the countries is, at the most, barely 2%.

As shown in Figure 2, one of the main differences observed between Argentina and the rest of the countries in the region during the 2000's, was the much higher level of inflation. In fact, while inflation in Argentina was 25% on average, that in the rest of the economies was 5%. The evidence presented here imply that commodity shocks, or the exchange rate policy reaction to them, can be accounted for an important driver of such difference.

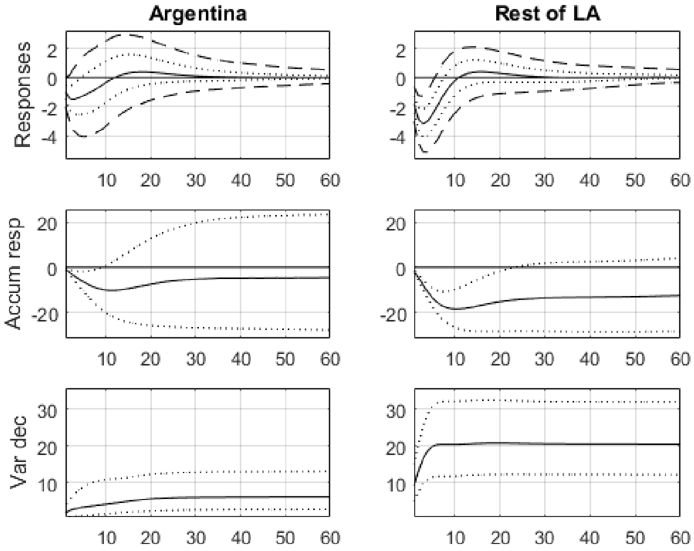
The third row of Figure 5 plots the variance decomposition of the inflation corresponding to commodity innovations. The variability in Argentina is almost twice as larger in short run: it is 13% by the end of the first year in the country, while it is 7% for the rest of the region. However, there is no significant difference in volatilities in longer time horizons.

In the introduction of this work, I pointed out that inflation was as much as 6 times more volatile in Argentina than in the rest of Latinamerica, as shown in Figure 2. So, the evidence presented here can explain that this feature was partly because of the way commodity shocks hit Argentina. Nevertheless, this shock can only account for a 13% of prices variability. Which means that at least 85% of the price variability observed during the analyzed period responded to other shocks.

Once again, the reader might find useful the estimation of the monetary policy rule (4) done in the previous section for Argentina. As it is presented in Table 1, the *Taylor principle* is not met for the country, because the inflation gap parameter is lower than one. This fact, rather than the effects of commodity shocks, might be explaining the bulk of the price volatility experienced by Argentina during the analyzed years.

Figure 6 presents de short and long run responses to innovations in commodity prices of the variation in the nominal exchange rate for Argentina and the other countries, as well as the contribution of the shock to the exchange rate variability. This evidence implies that the currency appreciation was much weaker in Argentina than in the rest of its counterparts, which is in line with the stronger output and, specially, prices response plotted in Figures 4 and 5, respectively.

Fig. 6: Effects of a 10% increase in commodity prices over nominal exchange rate variations: median (—) with 68% (···) and 95% (−−) confidence bands



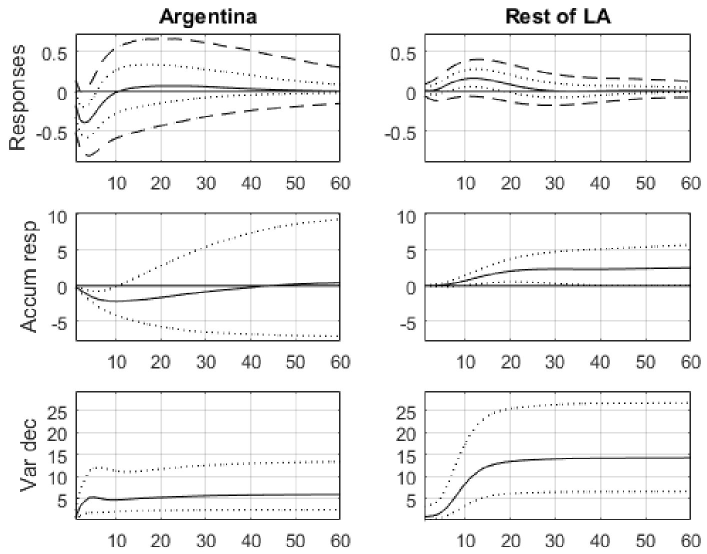
The first row of the figure shows the IRFs of the exchange rate after a commodity shock. It is quite clear that the response in Argentina was much weaker than in the rest of the region. In effect, the appreciation is more than twice as strong in the Latinamerican average than in Argentina. While in the latter the nominal exchange rate appreciates at the most by 1.5% in the 3^{rd} month, in the former it appreciates by 3.2% after a commodity disturbance of 10%. It is also more persistent in Latinamerica than in Argentina: it is significant during eight months in the first, but only five in the second. Additionally, the VAR responses are qualitatively similar than those simulated by the DSGE model, as presented in Figure 3.

The accumulated responses of the exchange rate to the innovation in commodity prices are plotted in the second column of Figure 6. It is quite clear that the accumulated appreciation was much stronger in the rest of Latinamerica when compared to the one in Argentina. In particular, the maximum accumulated appreciation is by the end of the first year and reaches -10% for Argentina, but almost twice as that for the other countries. In longer horizons, the point estimates indicate a -5% for Argentina and a -13% in average for the rest of the economies. In addition, the accumulated response is significantly different from 0 during two years for Latinamerica, but only for nine months in Argentina.

The third row of the figure plots the variance decomposition and indicates a much higher contribution of commodity shocks to the variability in the exchange rate of the rest of the Latinamerican countries than in Argentina. While in the latter it amounted to a maximum of 6% by the 3^{rd} year, in the former it raised to 20% by the 6^{th} month. This indicates that the monetary authority in Argentina decided to keep nominal exchange rate stable at the expense of a higher impact in output and inflation, as shown in the Figures 4 and 5.

Lastly, in Figure 7 I show the short and long run response, as well as the variance decompositions of the nominal interest rate to commodity shocks for Argentina and the rest of Latinamerica. The evidence indicates that the reactions were qualitatively different in Argentina when compared to those of the other countries: while there was a decrease in the interest rate of Argentina, there is an increase in the rest of the region. Though quantitatively the reactions were not that important.

Fig. 7: Effects of a 10% increase in commodity prices over the interest rate: median (—) with 68% (···) and 95% (−−) confidence bands



The first row of the figure plots the IRFs of the interest rate when subjected to an innovation in commodity prices. The response in the short run is quite different in Argentina than in the rest of the countries. Particularly, interest rate is significantly reduced in the short run which indicates the sensibility of the central bank to appreciations in the nominal exchange rate. However, the amount of the reduction in the interest rate is quite small. My estimates indicate that the interest rate reduced by a minimum of -0.4% by the 3^{rd} month in Argentina, while there was barely a change in the other countries. The reduction observed in Argentinean interest rate resembles that of the DSGE estimates presented in Figure 3.

The second row shows the accumulated response of interest rate to the innovation. The plots show that the long run response is almost insignificant for all countries. As for the variance decomposition of the third row in the graph, the variability of the interest rate attributable to commodity shocks were much higher in Latinamerica than in Argentina, as it represented a 5% for the second and three times that for the first.

5 Conclusions

In this article I investigate whether commodity shocks can account for the different macroeconomic outcomes observed between Argentina and the other major Latinamerican economies during the 2000's commodities boom. In particular, I evaluate if commodity shocks can account for the higher level of inflation, as well as the larger prices and output volatilities, observed in Argentina during the analyzed period. Actually, I find that commodity disturbances did have an important influence in the level of inflation but can explain just partly the larger variability observed in Argentina.

My estimates indicate that the monetary authority in Argentina had *fear of appreciating* and acted more aggressively in the exchange rate market than the rest of its counterparts did. This resulted in a weaker appreciation of the nominal exchange rate in the country than in the rest of the region when subjected to rises in commodity prices.

The reason for this greater activism of the Argentinian monetary authority in the exchange rate market was very likely to avoid the Dutch disease. In fact, it is evidenced that output growth was significantly more influenced in Argentina than in the rest of the region after innovations in commodity prices during the boom.

To obtain my results, I estimate a VAR for six countries: Argentina, Brazil, Chile, Colombia, Mexico and Peru, where the variables included are justified by a standard New Keynesian Dynamic Stochastic General Equilibrium model. These variables are: terms of trade variations, output growth, inflation, nominal interest rate and nominal exchange rate variations. In the VAR estimation, I replace the terms of trade by the commodity prices because I rather care about shocks to this variable. In addition, I use the IP index as a proxy for output to extend the reduced sample size by increasing the variables' frequencies. Lastly, I compare the Argentinean effects with those of the rest of Latinamerica by taking the average responses in the remaining countries.

Some policy implications can be derived from these results. It is shown that there was a trade off in the macroeconomic outcome 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 *leaning against the wind* exchange rate policy, whereas the latter by allowing more flexibility in the currency. While Argentina seemed to have opted for the first outcome, the rest of the region chose the second one. It remains for local monetary authorities which stand to take in the future.

6 Data appendix

In Figure 1 and 2, I use quarterly series for real GDP and monthly series of CPI inflation and the commodity price index, which I convert to quarterly frequency by taking averages within the quarter. The Latinamerican average plotted in Figure 2 is done by taking the mean values of Brazil, Chile, Colombia, Mexico and Peru. The data sample goes from 2003:Q2 to 2015:Q4.

To estimate (8) I use yearly growth rates in the commodity price index, the IP index, the CPI and the nominal exchange rate, as well as the nominal interest rate in levels. All variables are in monthly frequency. The data samples are from June 2003 to December 2015. Data sources are: Argentina (INDEC, BCRA, Cavallo [2012] for CPI and the newspaper Ámbito Financiero for the exchange rate since 2012), Brazil (IBGE and BCB), Chile (INE and central bank), Colombia (central bank), Mexico (INEGI and central bank) and Peru (central bank). I do seasonal adjustment using the X-13ARIMA-SEATS method when necessary.

References

S. Adjemian, H. Bastani, M. Juillard, F. Karamé, F. Mihoubi, G. Perendia, J. Pfeifer, M. Ratto, and S. Villemot. Dynare: Reference Manual, Version 4. *Dynare Working Papers, CEPREMAP*, 1, 2011.

H. Ahumada and M. Cornejo. Long-run effects of commodity prices on the real exchange rate: Evidence from argentina. *Económica*, 61(Enero-Diciembre), 2015.

J. Berkowitz and L. Kilian. Recent developments in bootstrapping time series. *Econometric Reviews*, 19:1–48, 2000.

O. J. Blanchard and D. Quah. The dynamic effects of aggregate demand and supply disturbances,. *American Economic Review*, 79(4):655–673, 1989.

C. Broda. Coping with terms-of-trade shocks: pegs versus floats. *The American Economic Review*, 91(2):376–380, 2001.

C. Broda. Terms of trade and exchange rate regimes in developing countries. *Journal of International Economics*, 63(1):31–58, 2004.

G. Calvo. Testimony on dollarization. *Subcommittee on domestic and monetary policy, Committee on banking and financial services*, 2000.

G. Calvo and C. Reinhart. Fear of floating. *The Quarterly Journal of Economics*, 117(2): 379–408, 2002.

A. Cavallo. Online and official price indexes: measuring Argentina's inflation. *Journal of Monetary Economics*, http://dx.doi.org/10.1016/j.jmoneco.2012.10.002, 2012.

C. Daude, E. Levy-Yeyati, and A.J. Nagenast. On the effectiveness of exchange rate interventions in emerging markets. *Journal of International Money and Finance*, 64: 239–261, 2016.

R. Dornbusch. Fewer monies, better monies. *NBER working paper series*, (8324), 2001.

P. Edelstein and L. Kilian. How sensitive are consumer expenditures to retail energy prices? *Journal of Monetary Economics*, 56(6):766–779, 2009.

R. Frenkel and M. Rapetti. External fragility or deindustrialization: What is the main threat to Latin American countries in the 2010s? *World Economic Review*, 1:37–57, 2012.

M. Friedman. The case for flexible exchange rates. Essays in positive economics. *University of Chicago Press*, pages 157–203, 1953.

R. Fry and A. Pagan. Sign restrictions in structural vector autoregressions: a critical review. *Journal of Economic Literature*, 49(4):938–960, 2011.

J. Galí and T. Monacelli. Monetary Policy and Exchange Rate Volatility in a Small Open Economy. *Review of Economic Studies*, 72:707–734, 2005.

D. Heymann and A. Leijonhufvud. *High Inflation.* Clarendon Press, Oxford, 1995.

V. Ivanov and L. Kilian. A practitioners guide to lag order selection for VAR impulse response analysis. *Studies in Nonlinear Dynamics and Econometrics*, 9(1):Article 2, 2005.

L. Kilian. Structural vector autoregressions. *Centre for Economic Policy Research. Discussion Paper*, (8515), 2011.

L. Kilian and C. Vega. Do energy prices respond to US macroeconomic news? A test of the hypothesis of predetermined energy prices. *The Review of Economics and Statistics*, 93(2):660–671, 2011.

M. Aythan Kose. Explaining business cycles in small open economies 'How much do world prices matter?'. *Journal of International Economics*, 56(2):299–327, 2002.

L. Lanteri. Términos de intercambio externos y balanza comercial. Alguna evidencia para la economía argentina. *Economía mexicana. Nueva época*, 18(2):221–248, 2008.

E. Levy-Yeyati and F. Sturzenegger. Classifying exchange rate regimes: deeds vs. words. *European Economic Review*, 49(6):1603–1635, 2005.

E. Levy-Yeyati, F. Sturzenegger, and P.A. Gluzmann. Exchange rate undervaluation and economic growth: Díaz Alejandro (1965) revisited. *Economics Letters*, 117(3):666–672, 2012.

E. Levy-Yeyati, F. Sturzenegger, and P.A. Gluzmann. Fear of appreciation. *Journal of Development Economics*, 101:233–247, 2013.

T. Lubik and F. Schorfheide. Do central banks respond to exchange rate movements? A structural investigation. *Journal of Monetary Economics*, 54(4):1069–1087, 2007.

E. G. Mendoza. The terms of trade, the real exchange rate, and economic fluctuations. *International Economic Review*, 36(1):101–137, 1995.

R. Piermartini. The role of export taxes in the field of primary commodities. *World Trade Organization*, 2004.

M. Radetzki. The anatomy of three commodity booms. *Resources Policy*, 31:56–64, 2006.

M. O. Ravn, S. Scmitt-Grohé, and M. Uribe. Pricing to habits and the law of one price. *The American Economic Review*, 97(2):232–8, 2007.

C. Sims. Macroeconomics and reality. *Econometrica*, January:1–48, 1980.

C. Sims. Solving linear rational expectations models. *Computational Economics*, 20:1–20, 2002.

P. Warr. Export taxes and income distribution: The Philippines coconut levy. *Review of world economics*, 138(3):437–458, 2002.

M. Woodford. *Interest and Prices.* Princeton University Press, 2003.