EMERGING ECONOMIES BUSINESS CYCLES: THE ROLE OF THE TERMS OF TRADE REVISITED

Nadav Ben-Zeev, Evi Pappa and
Alejandro Vicondoa

Discussion Paper No. 16-10

November 2016

Monaster Center for
Economic Research
Ben-Gurion University of the Negev
P.O. Box 653
Beer Sheva, Israel

Fax: 972-8-6472941
Tel: 972-8-6472286

Emerging Economies Business Cycles: The Role of the Terms of Trade Revisited*

Nadav Ben Zeev † Evi Pappa ‡ Alejandro Vicondoa §

June 13, 2016

Abstract

Common wisdom and standard models suggest that terms-of-trade (TOT) shocks are an important source of cyclical fluctuations in small open economies. Recently, Schmitt-Grohe and Uribe (2015) have challenged this hypothesis by showing that in the data unexpected TOT shocks explain only 10% of output movements in emerging countries. We confirm their findings for a sample of Latin American countries and show that TOT news shocks account for 26% of output fluctuations. TOT news shocks are identified as the shocks that best explain future movements in the TOT over an horizon of five quarters and that are orthogonal to current TOT. Augmenting the standard small open economy model with labor adjustment costs, we match theoretical and empirical predictions for both shocks.

JEL classification: E32, F41

Keywords: Terms of Trade, Small Open Economy DSGE Models, News Shocks, Maximum Forecast Error Variance

---

*We are grateful to seminar participants at the GPEFM Alumni meeting 2015, University of York, LUISS Guido Carli, University of Bonn, Bocconi University and University of Surrey for helpful comments and suggestions.

†Department of Economics, Ben-Gurion University of the Negev, Beer-Sheva, Israel. *E-mail:* nadavbz@bgu.ac.il.

‡Department of Economics, European University Institute, Florence, Italy; UAB; BGSE; and CEPR. *E-mail:* evi.pappa@eui.eu.

§Department of Economics, European University Institute, Florence, Italy. *E-mail:*alejandro.vicondoa@eui.eu.

1 Introduction

Until recently it has been commonly accepted in the international macroeconomics literature (see, e.g., Mendoza (1995) and Kose (2002)) that terms of trade shocks (henceforth, TOT) - shocks to the price of exports relative to the price of imports - were an important determinant of macroeconomic dynamics in most emerging market economies (henceforth, EMEs). In their latest article, Schmitt-Grohe and Uribe (2015) have challenged this traditional view by estimating annual country-specific SVARs for 38 poor and EMEs and showing that TOT shocks explain only 10% of movements in aggregate activity on average. The literature on the important role of the TOT in propagating business cycles in EMEs countries is basically based on the analysis of calibrated business-cycle models. Indeed, Schmitt-Grohe and Uribe (2015) show that in standard estimated small open economy models TOT shocks explain on average 30% of the variance of key macroeconomic indicators, three times as much as in their SVAR model.

To address this disconnect between empirical and theoretical models, the starting point of our analysis is that many TOT movements are anticipated. For example, the increases in the TOT observed during the 2000s for many economies were largely due to rising commodity prices, driven by strong economic growth in countries such as China and India (Kilian and Hicks (2013)). To the extent that agents recognize the underlying causes of changes in the TOT, it is reasonable to assume that they are able to forecast these changes. Also, the existence of futures prices for many commodities confirms that part of the TOT movements are anticipated. Futures prices can be thought of as providing "forecasts" of future commodity prices (Chinn and Coibion (2014)). Hence, it is important to examine whether anticipated movements in the TOT matter for business cycle dynamics of small emerging countries.

There has recently been a renewed interest in theories of expectation-driven business cycles, focusing in particular on the effects of news shocks: shocks which are realized and observed before they materialize. Beaudry and Portier (2006) and Jaimovich and Rebelo (2009) present theoretical models in which news about future productivity is a primary source of business cycle fluctuations. Beaudry and Portier (2006) were the first to provide empirical evidence in favor of this hypothesis in the context of structural VARs. Schmitt-Grohé and Uribe (2012) estimate a closed economy DSGE model with flexible prices, which incorporates news about future fundamentals, and show that anticipated shocks account for around half of aggregate fluctuations in the U.S.

In the current paper, we first try to examine whether the empirical findings of Schmitt-Grohe and Uribe (2015) can be challenged by analysing different SVAR models. We repeat their analysis using quarterly data for five Latin American countries and confirm their results and establish their robustness when using alternative: a) TOT series, b) data sample and frequency c) specifications that control for omitted variables. We then study the macroeconomic effects of anticipated shocks to the TOT and their sensitivity to the empirical model specification.

In their work, Beaudry and Portier (2006) use variations in stock prices to identify news about TFP. Following their approach, we could use fluctuations in commodity future prices to extract news shocks about the TOT. However, the accuracy of those forecasts is not high since the options markets tell us that we should not put a lot of confidence in the price forecasts that can be obtained from the futures markets. Commodity prices are difficult to forecast because their expected price depends on both the spot price of the commodity in the future but also on a risk premium associated with the commodities risk exposure (see, e.g. Husain and Bowman (2004)).

Given the shortcomings of using futures on commodity prices to identify anticipated shocks in the TOT, we employ an alternative identification scheme for extracting news about TOT movements in the data. Our identification strategy relies on "medium-run" restrictions and builds on Uhlig (2003) and Barsky and Sims (2011). We identify TOT news shocks as the shocks that best explain future movements in the TOT over a horizon of five quarters, and that are orthogonal to current TOT movements. In particular, we estimate country-specific quarterly VARs for Argentina, Brazil, Chile, Colombia, and Peru and construct average responses to anticipated and surprise shocks to the TOT. The benchmark VAR includes the TOT, real output, consumption, investment, the trade balance to GDP ratio, the real exchange rate and one year ahead future commodity prices.

Individual and mean responses confirm the findings of Schmitt-Grohe and Uribe (2015): unexpected changes in the TOT explain on average 18% of business cycles fluctuations in EMEs.[1] Yet, in those countries, our identified TOT news shock explains on average 26% of cyclical fluctuations. Unanticipated increases in the TOT improve significantly on impact the trade balance, induce prolonged increases in private investment and consumption, and cause the country to become more expensive vis-a-vis the rest of the world. Similarly, anticipated increases in the TOT induce significant and persistent increases in output, the trade balance and consumption. Investment drops on impact after the realisation of the news but bounces back quickly and increases persistently until reaching its peak after five quarters. Notably, the TOT news shocks induces a significant impact response of the unrestricted futures prices. As in the case of unexpected shocks, TOT news shocks appreciate the real exchange rate.

We perform various robustness analysis and show that our results hold even when we we use annual data and the extended sample of developing countries considered in Schmitt-Grohe and Uribe (2015). They also hold when alternative commodity based TOT series are used in the VAR to identify the shocks and when we control for TFP movements, the conduct of fiscal policy, or variations in the world interest rate.

TOT news shocks matter at least as much as unexpected TOT shocks for business cycle fluctuations in emerging countries. Moreover, anticipated shocks induce a significant and persistent fall in the country sovereign spread and significant increases in government spending. Fernandez, Gonzalez, and Rodriguez (2015) and Shousha (2016) suggest that unexpected commodity price shocks are important in Latin American countries because they reduce country spreads causing larger expansions that would otherwise occur. On the one hand, in our exercise, it is the anticipated movements in the TOT that induce significant and persistent variations in country spreads and government spending on impact. On the other hand, surprise TOT shocks induce a short-lived reduction in country spreads and do not induce in the short run a significant response of government expenditure. Since it is hard to differentiate between endogenous and direct feedbacks, we

[1] Schmitt-Grohe and Uribe (2015) find that TOT surprise shocks explain on average 10% of output fluctuations in EMEs. However, the Forecast Error Variance (FEV) increases up to 19% if we consider only Argentina, Brazil, Colombia, and Peru, which are the countries considered in our sample and to 27% if we consider all the Latin American countries of their sample.

conclude that possible government and market reactions in anticipation to news about the TOT can make the role of TOT news shocks as potential source of cyclical fluctuations more important relative to the standard unexpected TOT shocks examined in the literature so far.

Turning to the theoretical model, we show that feeding the standard small open economy model suggested by Schmitt-Grohe and Uribe (2015) with TOT news and unexpected shocks helps us match reasonably well model and empirical predictions for news shocks, while the model exacerbates the role of unexpected TOT shocks. Allowing for adjustment costs in labor helps the model match somewhat better the empirical responses. Our assumption can be rationalized by the abundance of evidence for the existence of labor rigidities in Latin America (see Heckman and Pagés-Serra (2007)). To be able to compare consistently model and data predictions, we simulate series from our model and use our identification strategy in the simulated series in order to recover the two types of TOT shocks identified in the empirical exercise. In particular, we perform a Monte Carlo exercise in which we simulate data using as the data generating process our suggested small open economy model. For each simulation, we apply our identification method on the artificial data and include in the Monte Carlo VAR the same variables that we use in the empirical exercise. The two structural shocks in the model are the unanticipated and anticipated TOT shocks, which we calibrate by using the estimated TOT process for each country (as in Kurmann and Otrok (2013)). We then perform a forecast error variance decomposition analysis in the simulated data. Both unexpected and anticipated TOT shocks explain on average 46% and 44% of output fluctuations in the MC exercise and the empirical model, respectively. While TOT News shocks explain 20% of output variations in the model and 26% in the data, unexpected shocks explain the remaining 26% of output variations in the Monte Carlo exercise. In terms of individual responses, the model matches pretty well the empirical predictions for Argentina, Brazil, Colombia, and Peru while it under-emphasizes the role of both TOT shocks in Chile. We conclude that the role of the TOT as a source of cyclical fluctuations in Latin America is, by no means, dead.

The remainder of the paper is organized as follows. Section 2 describes the econometric framework. Section 3 presents the benchmark empirical results and also reports results from additional robustness exercises and extensions. Section 4 describes briefly the small open economy model, presents forecast error variance decompositions based on simulated data and compares them with their empirical counterpart. Finally, Section 5 concludes.

2 Econometric Strategy

To identify news and surprise TOT shocks, we need to estimate first a SVAR that includes the main transmission channels of both shocks. In particular, we estimate a baseline VAR that includes: TOT series, which are defined as the price of exports relative to the price of imports; the trade balance, measured as net exports over output; GDP; consumption; investment; a real exchange rate index; and a country-specific indicator of future commodity prices, computed as a weighted average of the future price of the main commodities exported by each country. We include future commodity prices in the benchmark model for several reasons. TOT news shocks generate foresight about changes in future fundamentals and lead to an undeniable missing state variable problem and, hence, non-invertible VAR representations. As is shown in Sims (2012), conditioning on more information ameliorates or eliminates invertibility problems altogether. As a result, including futures in the VAR is essential for addressing the missing information problem. Moreover, introducing future prices in our VAR we offer our methodology a chance to be confronted with the data. Since we do not restrict the responses of futures at any horizon, the reaction of future prices to our news shocks is a natural way to test the validity of our identification approach.

Our identification strategy relies on the Maximum Forecast Error Variance (MFEV) identification approach put forward by Uhlig (2003) and later extended by Barsky and Sims (2011). The TOT news shock is identified as the shock that best explains future movements in TOT over an horizon of one year and that is orthogonal to current TOT. Our underlying identifying assumption is that the TOT news shock is the only shock that affects future TOT while having no impact effect on current movements of TOT. This assumption is consistent with the reasonable notion that TOT does not respond to domestic economic variables in a small open economy, which implies that it is driven by only two shocks, one being the traditional unanticipated TOT shock which moves TOT on impact and the other being the TOT news shock which moves TOT with a lag. An example of a process that would satisfy this condition is:

$$TOT_t = \rho TOT_{t-1} + \varepsilon_t^{sTOT} + \varepsilon_{t-s}^{TOTnews} \tag{1}$$

where $0 < \rho < 1$, ε^{sTOT} and $\varepsilon^{TOTnews}$ are the surprise and anticipated innovations in TOT, respectively, and the news shock is realized $s > 0$ periods in advance. As explained in Barsky and Sims (2011), an appealing way to identify news shocks to a fundamental that is driven by an unanticipated shock and a news shock, is to estimate a reduced-form multivariate VAR where all variables, including the fundamental itself, are regressed on their own lags as well as the other variables' lags, and then use the resulting reduced-form VAR innovations to search for the structural shock that is *i*) contemporaneously orthogonal to the fundamental and that *ii*) maximally explains the future variation in the fundamental over some finite horizon. We therefore consider a VAR that includes TOT together with other domestic macroeconomic variables.

Specifically, let the VAR in the observables be given by:

$$y_t = F_1 y_{t-1} + F_2 y_{t-2} + \ldots + F_p y_{t-p} + F_c + e_t \tag{2}$$

where y_t represents the vector of observables, F_i are $7 \,\mathrm{x}\, 7$ matrices, p denotes the number of lags, F_c is a $7 \,\mathrm{x}\, 1$ vector of constants, and e_t is the $7 \,\mathrm{x}\, 1$ vector of reduced-form innovations with variance-covariance matrix Σ. The reduced form moving average representation in the levels of the observables is:

$$y_t = B(L) e_t \tag{3}$$

where $B(L)$ is a 7x7 matrix polynomial in the lag operator, L, of moving average coefficients and e_t is the $B(L)$ is a 7x1 vector of reduced-form innovations. We assume that there exists a linear mapping between the reduced-form innovations and structural shocks, ε_t, given as:

$$e_t = A\varepsilon_t. \tag{4}$$

Equation (3) and (4) imply a structural moving average representation:

$$y_t = C(L)\varepsilon_t, \tag{5}$$

where $C(L) = B(L)A$ and $\varepsilon_t = A^{-1}e_t$. The impact matrix A must satisfy $AA' = \Sigma$. There are, however, an infinite number of impact matrices that solve the system. In particular, for some arbitrary orthogonalization, $\widetilde{A}$ (we choose the convenient Cholesky decomposition[2]), the entire space of permissible impact matrices can be written as $\widetilde{A}D$, where D is a 7x7 orthonormal matrix ($D' = D^{-1}$ and $DD' = I$, where I is the identity matrix).

The h step ahead forecast error is:

$$y_{t+h} - E_t y_{t+h} = \sum_{\tau=0}^{h} B_\tau \widetilde{A} D \varepsilon_{t+h-\tau}, \tag{6}$$

where B_τ is the matrix of moving average coefficients at horizon τ. The contribution to the forecast error variance of variable i attributable to structural shock j at horizon h is then given as:

$$\Omega_{i,j} = \sum_{\tau=0}^{h} B_{i,\tau} \widetilde{A} \gamma \gamma' \widetilde{A}' B'_{i,\tau}, \tag{7}$$

[2]The Cholesky decomposition allows us to recover comparable unexpected shocks to the TOT to the ones identified in the Schmitt-Grohe and Uribe (2015) empirical framework.

where γ is the jth column of D, $\widetilde{A}\gamma$ is a 7x1 vector corresponding to the jth column of a possible orthogonalization, and $B_{i,\tau}$ represents the ith row of the matrix of moving average coefficients at horizon τ. We index the unanticipated TOT shock as 1 and the TOT news shock as 2 in the ε_t vector. TOT news shocks identification requires finding the γ which maximizes the sum of contribution to the forecast error variance of the TOT over a range of horizons, from 0 to H (the truncation horizon), subject to the restriction that these shocks have no contemporaneous effect on the TOT. Formally, this identification strategy requires solving the following optimization problem:

$$\begin{aligned}
\gamma^* = \text{argmax} \sum_{h=0}^{H} \Omega_{1,2}(h) &= \text{argmax} \sum_{h=0}^{H} \sum_{\tau=0}^{h} B_{1,\tau} \widetilde{A} \gamma \gamma' \widetilde{A}' B_{1,\tau}' && (8) \\
\text{subject to } \gamma(1,1) &= 0 && (9) \\
\gamma' \gamma &= 1. && (10)
\end{aligned}$$

The first constraints impose on the identified news shock to have no contemporaneous effect on the TOT. That is, our news shock is orthogonal to the unanticipated TOT shock. The second restriction that imposes on γ to have unit length ensures that γ is a column vector belonging to an orthonormal matrix. This normalization implies that the identified shocks have unit variance.

We follow the conventional Bayesian approach to estimation and inference by assuming a diffuse normal-inverse Wishart prior distribution for the reduced-form VAR parameters. Specifically, we take 1000 draws from the posterior distribution of reduced form VAR parameters $p(F, \Sigma \mid data)$,[3] where for each draw we solve optimization problem (8); we then use the resulting optimizing γ vector to compute impulse responses to the identified shock. This procedure generates 1000 sets of impulse responses which comprise the posterior distribution

[3]Note that F here represents the stacked $(7 \times (p+1)) \times 7$ reduced form VAR coefficient matrix, i.e., $F = [F_1, \ldots, F_p, F_c]\prime$.

of impulse responses to our identified shock. Our benchmark choices for the number of lags and truncation horizon are p=4 and H=5, respectively. We have set H=5 since, according to Chinn and Coibion (2014) and Husain and Bowman (2004), the optimal horizon for predicting commodity prices varies between one and two years.[4]

3 Empirical Evidence

3.1 Data

We estimate five country-specific VARs. Data are quarterly and samples are as follows: Argentina 1994:Q1-2013:Q3, Brazil 1995:Q1-2014:Q3, Chile 1996:Q1-2014:Q3, Colombia 1994:Q1-2014:Q3, and Peru 1994:Q1-2014:Q3. Appendix A contains a detailed description of the data. Following Shousha (2016), we focus on Latin American commodity exporters, defined as countries where exports of commodities account for more than 30% of total exports, but later draw comparisons with samples with more emerging countries when relevant. Moreover, we found that pooling all set of Latin American and Asian countries together in the benchmark regression, as Schmitt-Grohe and Uribe (2015) and Shousha (2016) do, was not a good idea for several reasons: a) the two regions are different both in TOT performance and in terms of output dynamics, b) in Latin America there is a lack of potential supply conditions to determine the TOT by smaller economies – instead in Asia some economies have become in a few years star cases in terms of export performance in manufactured products, and c) TOT shocks appear to be more important in Latin America than in the typical developing country.

[4]We have confirmed the robustness of our results to different VAR lag specifications and truncation horizons. These results are available upon request from the authors.

3.2 The Identified News Shock

Following the identification strategy outlined in Section 2, we identify news and surprise TOT shock series for all the countries included in our sample. One way to assess the identification procedure is to see whether the identified TOT news shock matches some events in the data. To provide an example, Figure 1 displays this series for Brazil. In particular, we can see that the storm 'El Niño', which affected Brazil and other South American countries during the period under analysis, is associated with a positive news shock in this country. This storm generated changes of temperatures and increases in rainfalls that affected negatively the supply of many agricultural products and, therefore, was reflected in higher expected prices of these products (i.e. better TOT for Brazil). This series also peaks in the expected way with the two main collapses of financial markets, the burst of the Dot-Com Bubble and the collapse in the end of 2008, and the macroeconomic crisis that affected EMEs. In both cases, markets were uncertain about future demand for commodities and this is reflected as a negative peak in our news series. The series also reflects the recent oil discoveries in Brazil. These episodes, which occurred in years of higher oil prices, generated a wealth effect in the economy and are captured as positive news shocks in our series. Hence, our identified news series captures important events that affected the Brazilian TOT during the sample period.[5]

Another important characteristic of the recovered news shocks for each country is that they have a very low correlation with each other, implying that what is identified as a news shock in one country does not reflect necessarily a factor which is global, like changes in world demand or supply. For example, the anticipated shock identified for Brazil has on average low correlation (0.14) with the shocks identified in the other four Latin American countries

[5]Notice that, although our shocks correlate positively with oil discoveries, they do not induce the same dynamics for all the variables to the news shocks identified in Arezki, Ramey, and Sheng (2015). This may be due to the fact that they just focus on news about oil discoveries, while we consider news about other commodities as well, and/or that they consider a more heterogenous sample, which includes Asian, European and Latin American economies.

that vary from (0.21 for the pair Brazil-Chile to 0.08 for the pair Brazil-Colombia). This result is encouraging to us because it implies that our TOT news shocks are not common future world productivity or demand shocks that we mislabel as TOT news shocks.

3.3 Impulse Responses and Forecast Error Variance Decomposition

Figure 2 shows the estimated cross country average of impulse responses of all variables to a one standard deviation unanticipated TOT shock from the benchmark VAR. The bands in the figures are one standard error bands, where the standard error is the one corresponding to the standard error of the average estimate obtained from using the variances of the individual countries impulse responses. All responses should be interpreted as the typical responses of a Latin American country to an unexpected increase in the TOT. We present the individual responses in the Online Appendix.

The identification of the unexpected TOT shock does not actually differ substantially from what other researchers have studied in the literature. In particular, Figure 2 is comparable with the findings of Schmitt-Grohe and Uribe (2015). Our responses are not qualitatively very different from theirs besides the fact that the sample and frequency of the data as well are different. The TOT shocks appreciates the real exchange rate and moves positively on impact the trade balance. Contrary to their findings, the initial consumption, investment, and output responses to the unexpected TOT positive disturbance are small but positive and they increase with a lag. Turning to the variance decompositions (see Table 1) we also confirm the Schmitt-Grohe and Uribe (2015) findings. Unexpected TOT shocks explain over a two-year horizon on average 9%-18% of fluctuations in output, consumption, investment, and the trade balance and they explain approximately 45% of TOT fluctuations. With the exception of Colombia, where unexpected TOT shocks explain almost 30% of output fluctuations, those numbers are comparable across countries.

In Figure 3 we plot the estimated average impulse responses of all variables to a positive news shock in the TOT. News about TOT increase TOT persistently and the TOT response reaches its peak in the fourth quarter, before the horizon for which news shocks explain the biggest share of TOT variations. In response to the news about the positive shock to the TOT, future prices increase on impact and continue growing, following the actual path of the TOT. Since we have not imposed any restrictions on those series, their impulses imply that our identified shocks seem to capture news about future movements in the TOT pretty well. The response of output and the trade balance is significant and economically important on impact. Consumption increases on impact and investment declines initially, while it bounces back in later periods, after the increase in the TOT. The real exchange rate sluggishly appreciates. Turning to the variance decomposition in Table 2, we observe that TOT news shocks explain on average 26% of output fluctuations and 38% of TOT fluctuations, while they explain a considerable amount of future prices fluctuations (29% approximately).[6] There is more heterogeneity in the responses at the country level relative to the unanticipated shocks.

TOT news seem to be an important source of fluctuations in Argentina and Chile and less important for the variations in output in Brazil and Colombia. Since petroleum is Colombia's main export, making over 45% of Colombia's exports and is a net oil exporter, production of oil might be adjusting to hedge against the TOT news shocks in this country. For Argentina, since agricultural goods still account for a relevant share of exports when processed foods are included (soy products alone - soybeans, vegetable oil- account for almost one fourth of the total exports) it is not surprising to find that news shocks to the TOT might affect significantly the Argentinian economy. Similarly Chile is mostly exporting mining products, news about changes in the price of cooper might make firms adjust the production in the mining industry in advance affecting significantly the cyclical fluctuations in Chile.

[6]The fact that the sum of the share of the variances of unexpected and expected shocks does not add up to one has to do with the fact that some domestic shocks (such as TFP, as we show in Section 3.4.6) affect still the variability of the TOT. In Section 3.4.7 we do not allow for such a feedback from domestic variables to examine the sensitivity of our results to this assumption.

3.4 Alternative SVAR Specifications

In this section, we consider alternative VAR specifications for our empirical exercise. The impulse responses of all the exercises performed in this section are included in the Online Appendix. Here, for ease of exposition, we only present the share of variance explained by the TOT unanticipated and news shocks in every exercise on average in Tables 3 and 4, respectively.

3.4.1 Country Spreads

According to Uribe and Yue (2006) country spreads respond endogenously to business cycle conditions in EMEs and might be affected by external and anticipated shocks, such as the shocks in the TOT. For that reason, it is important to include this series in the VAR. We construct country spreads for each country by using the JP Morgan EMBI Global Index (Stripped Spread). Details of the series used are described in Appendix A. We estimate the baseline SVAR including spreads as an endogenous variable in the system. The first row of Tables 3 and 4, respectively, presents the average share of variance explained by the two identified TOT shocks in this exercise. The addition of country spreads in the analysis does not change results regarding the importance of the two identified shocks in explaining aggregate fluctuations in emerging countries. On average, surprise shocks explain 21% of output fluctuations and TOT news shocks explain 20% of output fluctuations. The numbers for the rest of the variables included in the SVAR are similar.

Fernandez, Gonzalez, and Rodriguez (2015) and Shousha (2016) suggest that commodity price shocks are important in Latin American countries because they reduce country spreads causing a larger expansion that would otherwise occur with constant country spreads. The impulse responses presented on the Online Appendix confirm that TOT shocks, unexpected or anticipated, reduce significantly the country spread. Moreover, according to our findings in Tables 3 and 4, TOT news shocks explain 27% of variations in country spreads while unexpected TOT shocks explain 23% of spread fluctuations. Taking the findings of Fernandez, Gonzalez, and Rodriguez (2015), Shousha

(2016) and ours together suggests that TOT news shocks might have a more important role in generating output fluctuations since they affect significantly movements in spreads that feedback in the small open economy.

3.4.2 Government Spending

Since sovereign spreads are negatively affected by TOT shocks, the government reaction to such shocks might be key for shaping business cycle fluctuations. Ilzetzki and Vegh (2008) provide evidence that fiscal policy is procyclical in developing countries. The problem of procyclicality seems to be more acute in commodity rich nations since commodity related revenues can be a large proportion of total government revenues (see Sinnott (2009)). Cespedes and Velasco (2014) study the behavior of fiscal variables across the commodity cycle and show that there is a negative relation between the fiscal balance and the behavior of commodity prices.

In this exercise, we introduce government expenditure as an additional endogenous variables in our benchmark SVAR. The second row of Tables 3 and 4, respectively, presents the share of variance explained by the two identified TOT shocks when we control for movements in government spending in our analysis. The share of output variations explained by TOT news and surprises remains almost the same. Moreover, we learn from this exercise that government reacts more to news about changes in the TOT relative to unexpected changes in the TOT. News shocks about the TOT explain 17% of government spending variability, while unexpected TOT shocks explain only 6% of the variability of government expenditure on average in our sample. This is an additional reason for why news about TOT affect more severely the economy relative to unexpected shocks.[7]

3.4.3 Federal Funds Rate

Recent literature has identified variations in the world interest rate as an important source of

[7]We have also run exercises including both government spending and spreads in the benchmark VAR. Results are robust and are available by the authors upon request.

business cycle fluctuations in EMEs. Lubik and Teo (2005) estimates a small open economy model using full information Bayesian methods and find that interest rate shocks are a more important source of business cycles than TOT shocks. Shousha (2016) uses a similar empirical model to ours, controlling for the U.S. interest rate in an exogenous block together with a commodity price index, and investigates the importance of both commodity prices and world interest rate shocks in generating cyclical fluctuations in emerging countries. Following his modelling, we introduce the Federal Funds rate in our baseline regressions and investigate how much the introduction of this additional source of variations affects our results about the role of TOT surprises and news shocks as a source of business cycle variations. Adopting his assumptions, we postulate that foreign variables are completely exogenous and that TOT have no effect on the U.S. interest rate. While, innovations in the U.S. interest rate have a contemporaneous effect on the TOT to take into account the phenomenon of financialization of commodity markets (see for example Cheng and Xiong (2014)). Results of this exercise appear in the third row of Tables 3 and 4. Introducing an additional variable in the VAR mechanically decreases the predictive power of TOT shocks: TOT surprise shocks explain on average 11% of cyclical fluctuations, while TOT news shocks explain 17% of output fluctuations on average. On the other hand, when we look at the capacity of world interest rate shocks in explaining cyclical fluctuations, we find that FFR shocks account for 19% and 24% of TOT and output variation, respectively. However, the combined effect of TOT surprises and news implies that the role of shocks to the TOT in cyclical fluctuations in Latin American countries is not negligible (i.e. they explain 28% of output variations), confirming the results of Shousha (2016).

3.4.4 Commodity-Based TOT

In their conclusions, Schmitt-Grohe and Uribe (2015) suggest that an improvement in their empirical model could stem from entertaining the hypothesis that commodity prices are a better measure of the TOT than aggregate indices of export and import unit values, especially for countries whose exports or imports are concentrated in a small number of commodities. Fernandez, Gonzalez, and Rodriguez (2015) and Shousha (2016) estimate a VAR including commodity prices and find that they explain between 25% and 42% of fluctuations in GDP in EMEs. In order to investigate whether their and our conclusions are sensitive to the measure of the TOT used in the empirical model, we have re-estimated our benchmark model substituting commodity-based TOT with our benchmark TOT index. We define the commodity-based TOT as the ratio of weighted average price of the main commodity exports to weighted average price of main commodity imports. The index is available at annual frequency from IMF's website.[8] Spatafora and Tytell (2009) constructed it from prices of six commodity categories (food, fuels, agricultural raw materials, metals, gold, and beverages) measured against the manufacturing unit value index (MUV) of the World Economic Outlook database. Relative commodity prices of six categories are weighted by the time average (over 1980–2009) of export and import shares of each commodity category in total trade (exports and imports of goods and services). Exports and imports by commodity category are obtained from the United Nations International Trade Statistics Database (COMTRADE) at SITC second digit level. Results from the exercise with annual data and the alternative measure of TOT appear in the fourth row of Tables 3 and 4. Using commodity-based TOT series in our baseline regressions does not change the fact that unexpected and anticipated movements in the TOT explain a significant part of cyclical fluctuations in emerging countries. TOT shocks explain in total 34% of output fluctuations on average while the contribution of unexpected TOT shocks in explaining output fluctuations remains unchanged with respect to the benchmark model.

3.4.5 The Schmitt-Grohe and Uribe (2015) Specification

We continue by analyzing the empirical specification used in Schmitt-Grohe and Uribe (2015), in

[8] See https://www.imf.org/external/pubs/cat/longres.aspx?sk=23307.0 for more information on this series. Fernandez, Gonzalez, and Rodriguez (2015) and Shousha (2016) compute country-specific commodity price indexes following a similar methodology at quarterly frequency. However, their series are not available to use for comparisons.

order to compare directly our empirical results with theirs and to show that differences are not due to the different sample, different frequency, or different variables included in the VAR. In this exercise we use exactly the same specification and sample as Schmitt-Grohe and Uribe (2015). That is, we estimate country by country VARs using annual data for 38 countries that include log deviations of the TOT, real output, private consumption and gross investment per capita, and the real exchange rate from their respective time trends, as well as series for the ratio of trade balance to trend output.[9] We present impulse responses to a positive one standard deviation shock to the unexpected TOT shock and to TOT news in the Online Appendix, and in the fifth row of Tables 3 and 4 we present the share of variance explained by the two identified TOT shocks in this exercise. The predictions concerning the importance of unexpected TOT shocks in generating business cycles are very similar with the numbers documented in Schmitt-Grohe and Uribe (2015). In this specification, TOT news shocks are also important, but slightly less relative to the benchmark specification in explaining the variance of output on average. Note that restricting our sample to the Latin American countries of their sample would make results deviate even further. In the sixth row of Tables 3 and 4 we present the corresponding numbers of the exercise with annual data and the specification used in Schmitt-Grohe and Uribe (2015) when we use only the sample of Latin American countries.[10] What we see is that results are very different when looking at the forecast error variance of unexpected TOT shocks. The SVAR with annual data overstates the importance of surprises in generating aggregate fluctuations while news, although still important, become less significant in generating cyclical fluctuations in annual data. Hence, we conclude that, although

[9]The Schmitt-Grohe and Uribe (2015) data set includes the following countries: Algeria, Argentina, Bolivia, Botswana, Brazil, Burundi, Cameroon, Central African Republic, Colombia, Congo Dem. Rep., Costa Rica, Cote d'Ivoire, Dominican Republic, Egypt Arab Rep., El Salvador, Ghana, Guatemala, Honduras, India, Indonesia, Jordan, Kenya, Korea Rep., Madagascar, Malaysia, Mauritius, Mexico, Morocco, Pakistan, Paraguay, Peru, Philippines, Senegal, South Africa, Sudan, Thailand, Turkey, and Uruguay for the period 1980 to 2011.

[10]The Latin American sample consists of: Argentina, Bolivia, Brazil, Colombia, Mexico, Peru, and Uruguay. Appendix A contains more information about the data set. Results are similar if we restrict the sample to the four countries for which their and our data set coincide (i.e. Argentina, Brazil, Colombia, and Peru) and are available upon request.

the frequency of the sample might affect overall the relative importance of TOT surprises versus news in explaining cyclical fluctuations, the joint importance of both shocks in generating aggregate variability in emerging countries remains relatively robust to the frequency of the data used.

3.4.6 TOT News and TFP Shocks

For our identification procedure to be valid, TOT should be exogenous. Clearly, TOT is largely exogenous from a small open economy's perspective. Yet, in many standard models, an adverse shock to the TOT acts like an adverse shock to productivity along many dimensions. We show that this is true also in our framework. Using annual Latin American country-specific VARs and annual data on TFP, we show in the Online Appendix that both unexpected and anticipated increases in the TOT induce significant increases in the TFP; here we present in the seventh row of Tables 3 and 4 the shares of the two-year variation in the variables accounted for the unanticipated shock and the news shock, respectively.[11] It is noteworthy that TOT unanticipated and news shocks account for 21% and 19% of the variation in TFP, respectively. We have also confirmed that TFP unanticipated and news shocks also explain similar shares of the variation in TOT by using our identification strategy to identify TFP news shocks (15% and 20%, respectively).[12] Hence, we can conclude that while there is an obvious relation between TOT and TFP shocks, this relation seems to be quite limited and, when we take it into account, it does not alter the main results of our analysis.

3.4.7 Exogeneity of TOT Shocks

Another important concern is that, according to our methodology, the true TOT news shock is identified as the linear combination of all other VAR innovations apart from surprise TOT shocks

[11]The sample of countries consists of: Argentina 1994-2011, Bolivia 1990-2011, Brazil 1994-2011, Colombia 1990-2011, Costa Rica 1990-2011, Dominican Republic 1990-2011, Mexico 1990-2011, Peru 1994-2011, and Uruguay 1990-2011. TFP series are available since 1990. Appendix A contains detailed information about the data set.

[12]These results are available upon request from the authors.

that maximize the residual forecast error variance of TOT over a finite horizon. In other words, in our setting, domestic variables may be relevant to identify news about TOT. Since such an assumption may raise suspicions about the validity of our results, we implement an alternative VAR framework in which the TOT and future prices are included in the exogenous block of the VAR. The identification restriction of news shocks implies that only TOT and futures prices movements can affect the evolution of the TOT. Results regarding the quantitative contribution of the TOT news shocks to the forecast error variance decompositions of macroeconomic variables are robust to this specification. Moreover, using this specification, contrary to Schmitt-Grohe and Uribe (2015), the quantitative importance of unexpected changes in TOT doubles.

4 The Predictions of a Small Open Economy Model

In this section, we adopt the theoretical model used in Schmitt-Grohe and Uribe (2015) in order to perform country-by-country comparisons of the predictions of the empirical SVAR model with the predictions of a theoretical model concerning the effects of unexpected and anticipated TOT shocks. Following the authors, the comparison is disciplined by the same three principles: 1) the SVAR is based on the identification restriction that the TOT in emerging countries are exogenous and driven by an expected and an unexpected component; 2) the empirical SVAR model and the theoretical model share the same terms-of-trade processes for each country in the sample; 3) some of the parameters of the model are calibrated to minimize the empirical findings country by country. Finally, an additional principle that disciplines our comparisons, for the Monte Carlo exercise, is that the TOT shocks are identified exactly the same way in the model and in the data. That is we use the same identification technique to recover the unexpected and TOT news shocks in the theoretical model as we do in the empirical one. In this way, we can investigate the validity of our identification technique in recovering the true surprise and news shocks from the data. In order to make the comparisons meaningful, we augment the Schmitt-Grohe and Uribe (2015) model with labor market rigidities, in the form of labor adjustment costs, in order to give it a larger chance to match the data. In the next subsection, we describe the model. Subsection 4.9 describes the Monte Carlo exercise we have performed in order to recover the shocks from our simulated series.

4.1 The Model

We borrow the model directly from Schmitt-Grohe and Uribe (2015), the only additional feature of our model relative to theirs is the assumption of labor adjustment costs in the production of intermediate goods. We present the model and the calibration briefly below. The model includes three sectors: exportable, importable and nontradable. Households derive utility from consumption and disutility from working in the different sectors of the economy. They accumulate sectoral capital, which is subject to adjustment costs, and issue international debt. Final goods are produced using tradable and nontradable, while tradable goods are a composite of exportable and importable goods. The production function of each sector is assumed to be Cobb-Douglas and domestic nontradables are consumed at home, while net exports are the difference between exportable and importable goods. To ensure stationarity, we assume that the country spread is debt elastic.

4.2 Households

The economy is populated by a continuum of homogenous households with preferences described by the following utility function:

$$U_t = \mathbb{E}_t \sum_{t=0}^{\infty} \beta^t \left(\frac{\left(c_t - G\left(h_t^m, h_t^x, h_t^n\right)\right)^{1-\sigma} - 1}{1-\sigma} \right) \tag{11}$$

where c_t denotes consumption and h_t^m,h_t^x, and h_t^n denote hours worked in the importable, exportable and nontradable sector, respectively. In particular, $G\left(h_t^m, h_t^x, h_t^n\right)$ has the following functional form:

$$G\left(h_t^m, h_t^x, h_t^n\right) = \frac{\left(h_t^m\right)^{\omega_m}}{\omega_m} + \frac{\left(h_t^x\right)^{\omega_x}}{\omega_x} + \frac{\left(h_t^n\right)^{\omega_n}}{\omega_n} \tag{12}$$

Households are subject to the following budget constraint:

$$\begin{gathered} c_t + i_t^x + i_t^m + i_t^n + \frac{\phi_x}{2}\left(k_{t+1}^x - k_t^x\right)^2 + \frac{\phi_m}{2}\left(k_{t+1}^m - k_t^m\right)^2 + \frac{\phi_n}{2}\left(k_{t+1}^n - k_t^n\right)^2 + \rho_t^\tau d_t = \\ \frac{\rho_t^\tau d_{t+1}}{1+r_t} + w_t^x h_t^x + w_t^m h_t^m + w_t^n h_t^n + u_t^x k_t^x + u_t^m k_t^m + u_t^n k_t^n + \pi_t^x + \pi_t^m + \pi_t^n \end{gathered} \tag{13}$$

where i_t^i,k_t^i,ϕ_t^i,w_t^i, and u_t^i denote investment, capital stock, capital adjustment costs, wages, and rents for each sector $i = \{m, x, n\}$. ρ_t^τ denotes the relative price of the tradable composite good in terms of the final good c_t (to be defined below), d_t denotes the stock of debt that matures in period t, which is expressed in units of the tradable composite good, and r_t denotes the interest rate on debt. The capital stock dynamics of each sector are described by the following equations:

$$k_{t+1}^i = (1-\delta)k_t^i + i_t^i \tag{14}$$

for $i = \{x, m, n\}$ and where δ denotes the depreciation rate of capital.

4.3 Production of Final Goods

Final goods are produced using tradable and nontradable goods via the following technology:

$$B(a_t^\tau, a_t^n) = \left(\chi_\tau \left(a_t^\tau\right)^{1-\frac{1}{\mu_\tau}} + (1-\chi_\tau)\left(a_t^n\right)^{1-\frac{1}{\mu_\tau}}\right)^{\frac{1}{1-\frac{1}{\mu_\tau}}} \tag{15}$$

where a_t^τ denotes the domestic absorption of the tradable composite good, and a_t^n denotes the domestic demand for nontradable goods. Final goods are sold to households and can be either consumed or invested. Firms of this sector behave competitively. Their profits are given by the following expression:

$$B(a_t^\tau, a_t^n) - p_t^\tau a_t^\tau - p_t^n a_t^n \tag{16}$$

where p_t^n denotes the relative price of nontradable goods in terms of final goods.

4.4 Production of the Tradable Composite Good

The tradable composite good is produced using exportable and importable goods via the following technology:

$$a_t^{\tau} = A(a_t^m, a_t^x) = \left(\chi_m \left(a_t^m\right)^{1-\frac{1}{\mu_m}} + (1-\chi_m)\left(a_t^x\right)^{1-\frac{1}{\mu_m}}\right)^{\frac{1}{1-\frac{1}{\mu_m}}} \tag{17}$$

where a_t^m and a_t^x denote the domestic absorption of importable and exportable goods, respectively. Firms in this sector also behave competitively. Profits are given by the following expression:

$$p_t^{\tau} A(a_t^m, a_t^x) - p_t^m a_t^m - p_t^x a_t^x \tag{18}$$

4.5 Production of Exportable, Importable, and Nontradable Goods

Exportable, importable, and nontradable goods are produced with the following technologies:

$$y_t^i = A_t^i F^i(k_t^i, h_t^i) = A_t^i (k_t^i)^{\alpha_i} (h_t^i)^{1-\alpha_i} \tag{19}$$

for each $i = \{x, m, n\}$, where A_t^i and y_t^i denote productivity and output of each sector. Firms in each sector are homogenous and behave competitively both in factor and product markets.

Following Mumtaz and Zanetti (2015), we assume that each firm is subject to quadratic labor adjustment costs. Thus, profits are given by the following expression:

$$\mathbb{E}_t \sum_{t=0} \beta^t \mathbb{E}_t \frac{u'(c_{t+1})}{u'(c_t)} \left(p_t^i y_t^i - u_t^i k_t^i - w_t^i h_t^i - \frac{\gamma^i}{2}\left(\frac{h_t^i}{h_{t-1}^i} - 1\right)^2 y_t^i\right) \tag{20}$$

where γ^i is the parameter that measures the extent of labor adjustment costs. The optimal labor demand decision is given by:

$$p_t^i \left(1-\alpha^i\right) \frac{y_t^i}{h_t^i} = w_t^i + \gamma^i \left(\frac{h_t^i}{h_{t-1}^i} - 1\right) \frac{y_t^i}{h_{t-1}^i} - \beta \frac{\mathbb{E}_t\left(u'(c_{t+1})\right)}{u'(c_t)} \gamma^i \left(\frac{\mathbb{E}_t\left(h_{t+1}^i\right)}{h_t^i} - 1\right)\left(\frac{\mathbb{E}_t\left(h_{t+1}^i\right)}{h_t^2}\right) y_t^i \tag{21}$$

4.6 Market Clearing Conditions and Definitions

This is the market clearing condition for the final goods:

$$c_t + i_t^x + i_t^m + i_t^n + \frac{\phi_x}{2}\left(k_{t+1}^x - k_t^x\right) + \frac{\phi_m}{2}\left(k_{t+1}^m - k_t^m\right) + \frac{\phi_n}{2}\left(k_{t+1}^n - k_t^n\right) = B(a_t^\tau, a_t^n) \tag{22}$$

This is the market clearing condition for the nontradable good:

$$a_t^n = y_t^n \tag{23}$$

The economy wide resource constraint is:

$$p_t^\tau \frac{d_{t+1}}{1+r_t} = p_t^\tau d_t + \overbrace{p_t^m(a_t^m - y_t^m)}^{=m_t} - \overbrace{p_t^x(y_t^x - a_t^x)}^{=x_t} \tag{24}$$

where m_t and x_t denote aggregate import and export, respectively. Finally, we define two key variables for this economy. First, the TOT (tot_t) are characterized by the following expression:

$$tot_t = \frac{p_t^x}{p_t^m} \tag{25}$$

Second, we define the real exchange rate (rer_t) as:

$$rer_t = \frac{\varepsilon_t P_t^*}{P_t} = \varepsilon_t p_t^\tau \tag{26}$$

where ϵ_t denotes the nominal exchange rate. This definition is in line with the index we are using in the VAR (i.e. an increase (decrease) means a depreciation (appreciation)).

4.7 Exogenous Processes

In order to close the model we need to define the exogenous processes. First, to ensure a stationary equilibrium process for external debt, we assume that the country spread, which is defined as the difference between the domestic interest rate and the international one, is debt elastic:

$$r_t - r_t^* = \psi \left(e^{d_t - \bar{d}} - 1 \right) \tag{27}$$

where r_t^* denotes the world interest rate and ψ captures the sensitivity of the country spread with respect to deviations of debt with respect to its steady state.

Following our empirical specification, we introduce the estimated country-specific TOT exogenous process, including the news and surprise shocks as follows:

$$\text{tot}_t = \sum_{i=1}^{I} \rho_i^{\text{tot}} \text{tot}_{t-i} + \sum_{j=1}^{J} \rho_j^{\text{news}} \text{news}_{t-j,t}^{\text{tot}} + \sum_{k=1}^{K} \rho_j^{\epsilon} \epsilon_{t-k}^{tot} + \epsilon_t^{tot} \tag{28}$$

where $\{\text{news}_{t-j,t}, \epsilon_t^{tot}\}$ denote the news about changes in TOT that occur in period t that were revealed in period $t-j$ and the surprise shock, respectively. In line with our empirical analysis, we use the estimated process for each country.

4.8 Calibration

We calibrate the model following Schmitt-Grohe and Uribe (2015). Since our empirical analysis is in quarterly frequency, we modify some parameters accordingly. Table 5 displays the values of the parameters common across countries.

Disciplined by our three principles, we adjust the sectoral investment and labor adjustment costs and the interest rate elasticity to external debt to match the dynamics of trade balance and investment in response to both shocks. Table 6 displays the values of the parameters for each country.

4.9 Monte Carlo Exercise

In order to evaluate whether there is a disconnect between the theoretical and the empirical predictions, we need to find a way to compare data and theory consistently. The literature on the econometric relationship between DSGE models and VAR models is by now pretty extensive. In particular, if the model shocks cannot be recovered from the SVAR shocks, model estimation and validation become meaningless. This issue has been very much debated in the literature (see Chari, Kehoe, and McGrattan (2008) vs. Christiano, Eichenbaum, and Vigfusson (2007)).[13] In order to avoid these critiques, we treat simulated and actual data in the same manner. Given that in our VAR exercise we have only identified TOT news and unexpected shocks, neglecting the identification of other shocks, we use the same identification technique to recover news and unexpected TOT shocks also in the simulated data. This way the comparison between theoretical and empirical predictions is direct.[14]

To this end, we simulate 1000 sets of data from the standard small open economy DSGE model presented in Section 4.1, where the sample sizes correspond to our empirical country specific sample sizes. For each simulation, we estimate the median impulse response from a Bayesian VAR based on 1000 draws from the posterior distribution of the VAR parameters; we include in the Monte Carlo VAR the same variables that we used in the empirical exercise. The only difference in our Monte Carlo exercise relative to the empirical VAR is that we do not include a commodities futures variable because our theoretical model does not contain a natural counterpart to the futures series we have in the empirical VAR.[15] Also note that, to keep things simple, our model does not include any other structural shock apart from the unanticipated and anticipated TOT shocks.

We draw the unanticipated and anticipated TOT shocks from the normal distribution. To avoid stochastic singularity, we add measurement errors to output, consumption, and investment. We calibrate the standard deviations of the measurement errors such that estimated contributions to

[13]It is worthwhile noting that much of the criticism by Chari, Kehoe, and McGrattan (2008) focuses on the unsuitability of using long-run restrictions for the identification of technology shocks. The MFEV identification method has been recently shown by Francis, Owyang, Roush, and DiCecio (2014) to significantly outperform long-run restrictions based identification strategies in terms of estimation precision. Moreover, Barsky and Sims (2011) have shown the effectiveness of a suitably extended MFEV identification strategy, as the one we use in this paper, in identifying news shocks. Hence, there is a good reason to believe, a priori, that our identification method is not susceptible to the criticism put forward in Chari, Kehoe, and McGrattan (2008). The results we present in this section confirm this belief.

[14]Schmitt-Grohe and Uribe (2015) compare theoretical and empirical predictions by computing the share of variance explained by unexpected TOT shocks as the ratio between the variance conditional on terms-of-trade shocks predicted by the model divided by the unconditional variance implied by the empirical country specific SVAR model, implicitly assuming that SVAR and DSGE model are directly comparable. We perform their exercise for the sake of comparing results, but we opted for presenting the Monte Carlo exercise since we find that this is the only way to accurately compare theoretical and empirical predictions.

[15]We have nevertheless confirmed that the simulation results are generally insensitive to adding a variable that is equal to the true news shock series and some reasonably calibrated measurement error that could proxy for future prices.

the forecast error variance of output reasonably match their empirical counterparts. The standard deviations of the TOT shocks and measurement errors for our five countries are presented in Table 7. These measurement errors are also drawn from the normal distribution.

For illustrative reasons, in Figures 4 and 5 we depict the SVAR impulse responses with their bands, the theoretical model responses, and the estimated median impulse responses averaged over the simulations to an unanticipated TOT shock and a TOT news shock in Brazil.[16] The SVAR responses are given by the solid lines, with the shaded areas depicting the 90% confidence bands, the theoretical responses are represented by the dashed lines, and the average estimated median responses over the simulations are depicted by the dotted lines.[17] Responses to the unanticipated shock are comparable to the typical responses presented in Section 3.3 (see Figure 2) and to the estimated responses from the MC exercise. In responses to TOT news, the model fails to generate the persistent fall in the trade balance observed in the Brazilian data.[18] The responses of the other variables are comparable with the responses presented in Figure 3 and the estimated median responses from the MC exercise. Tables 8 and 9 present the estimated contributions of the unanticipated and news shocks to the two-year variation in output using the simulated data, along with their empirical counterparts from Section 3.3, respectively. The model attributes a slightly more important role to unexpected TOT shocks in explaining cyclical fluctuations in EMEs but much smaller relative to the one reported in Schmitt-Grohe and Uribe (2015).[19] For all the countries in the sample but Colombia, the model still slightly overpredicts the contribution of unexpected TOT shocks in explaining macroeconomic fluctuations (see also Aguirre (2011)).

When we focus on the case of TOT news, model and data predictions square well for all the countries except Argentina and Chile. This is not surprising given the estimates of Table 2. In our

[16] In the Appendix we depict similar graphs for all the five Latin American countries.

[17] In exercises that we have done and do not present here for economy of space, we confirm that our identification procedure enables us to properly identify the effects of unexpected and anticipated TOT shocks, by showing that the bands from the MC exercise always include the true theoretical responses for all the variables considered in the MC VAR.

[18] Notice that the typical response of EMEs in our sample does not fit the response of the trade balance in Brazil.

[19] In the absence of labor adjustment costs, the theoretical FEV of unexpected TOT shocks for output increases by almost 30% relative to the number reported in Table 8.

calibration exercise, we have only assumed that those countries differ only in their investment and labor adjustment costs and the interest rate elasticity with respect to external debt. Thus, it is not surprising that we cannot match the data country-by-country perfectly well and this was not the purpose of our exercise. Our exercise highlights the combined importance of unexpected and anticipated TOT shocks as a source of cyclical fluctuations in EMEs and shows that overall the standard small open economy model augmented with labor adjustment costs can depict well the role of those shocks in generating cyclical fluctuations. Adding up the numbers in Tables 8 and 9, it results that TOT news and surprise shocks explain on average 46% of output fluctuations in EMEs according to our theoretical model, whereas the data suggests a corresponding number of 42%. Hence, we conclude that data and model agree on the joint importance of TOT shocks.

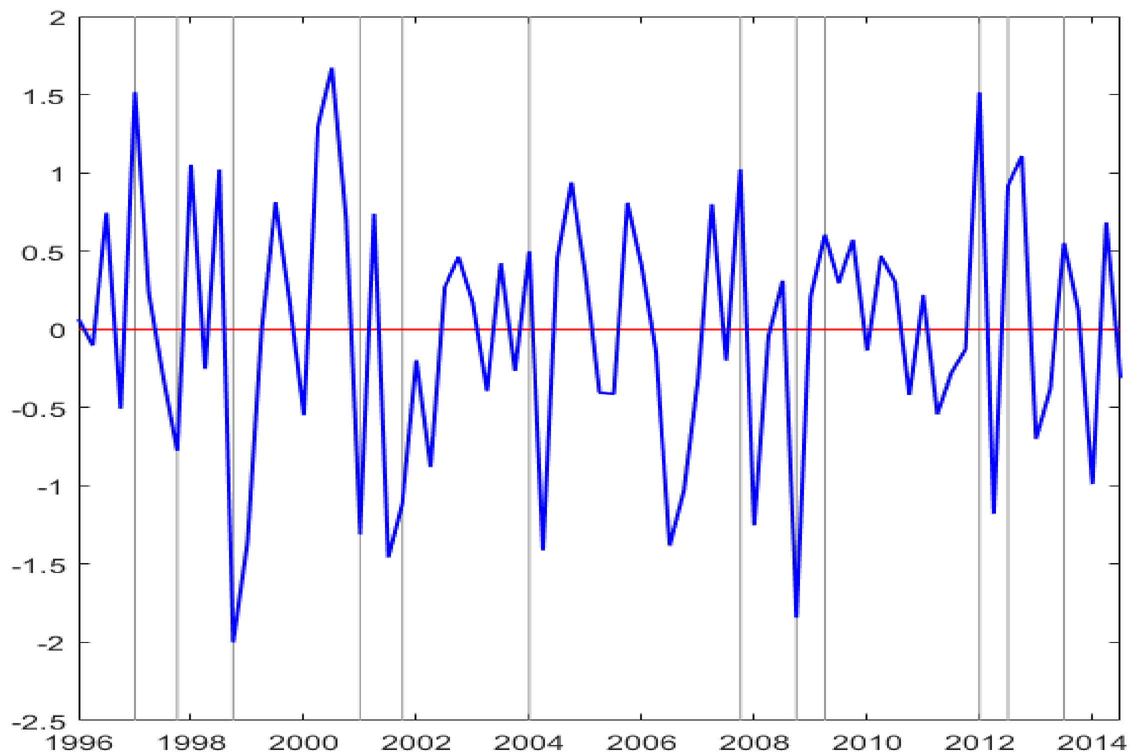
5 Conclusions

The TOT of many commodity-producing small open economies are subject to large shocks that can be an important source of macroeconomic fluctuations. The literature so far based on calibrated business-cycle models has traditionally suggested this to be the case. In their recent article Schmitt-Grohe and Uribe (2015) challenge this view by providing evidence from SVAR that show that unexpected changes in the TOT account for a small share of output variations in developing countries.

In this paper we confirm the findings of Schmitt-Grohe and Uribe (2015) and examine the sensitivity of their results when using quarterly instead of annual SVARs and when we complement their analysis with additional information such as country spreads, the world interest rate, fiscal policy and futures commodity prices. We show that their results are robust when alternative commodity based TOT are used to identify TOT shocks and when we control for TFP movements and account for the exogeneity of the TOT. Yet, we also show that in all these specifications TOT news shocks are equally or even more important as sources of business cycle fluctuations in EMEs, mainly because they move country spreads and fiscal policy triggering larger expansions after they occur.

When we feed a standard small open economy model with unexpected and TOT news shock series, we show that both shocks can account jointly for around 46% of variation in output volatility in emerging countries, matching on average the empirical predictions from our SVAR exercises. We humbly conclude that TOT shocks, when controlling for anticipation effects, matter more than what originally stated by Schmitt-Grohe and Uribe (2015). Future work, following the work of Lubik and Teo (2005), should consider various sources of business cycles fluctuations in small open economies and investigate the importance of both surprise and news shocks in accounting for aggregate fluctuations in EMEs.

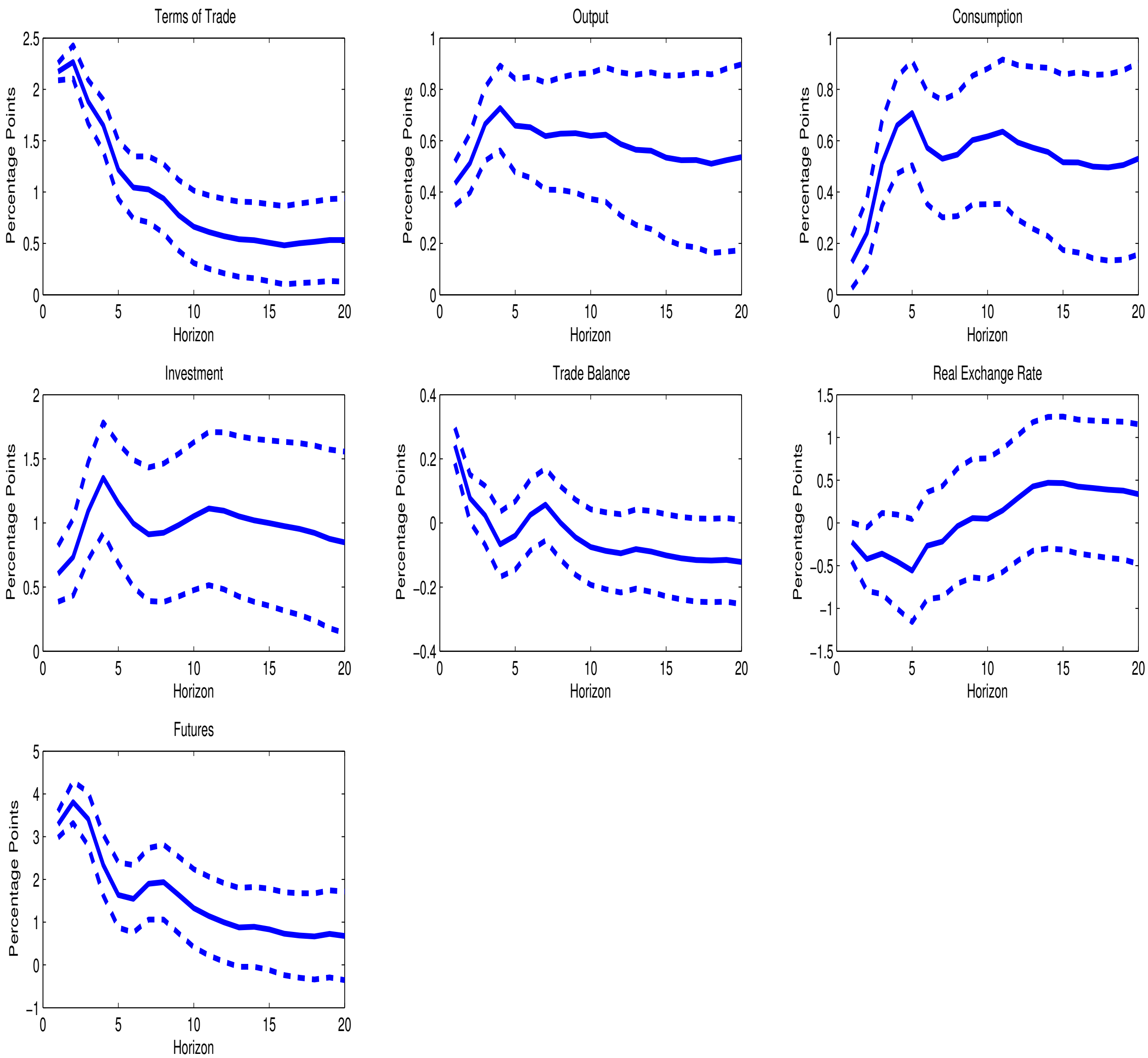
Figure 1: **Estimated TOT News Shocks for Brazil**.



Notes: Solid line denotes the estimated TOT news shocks for Brazil using our baseline VAR. Vertical lines denote the dates of these TOT events:

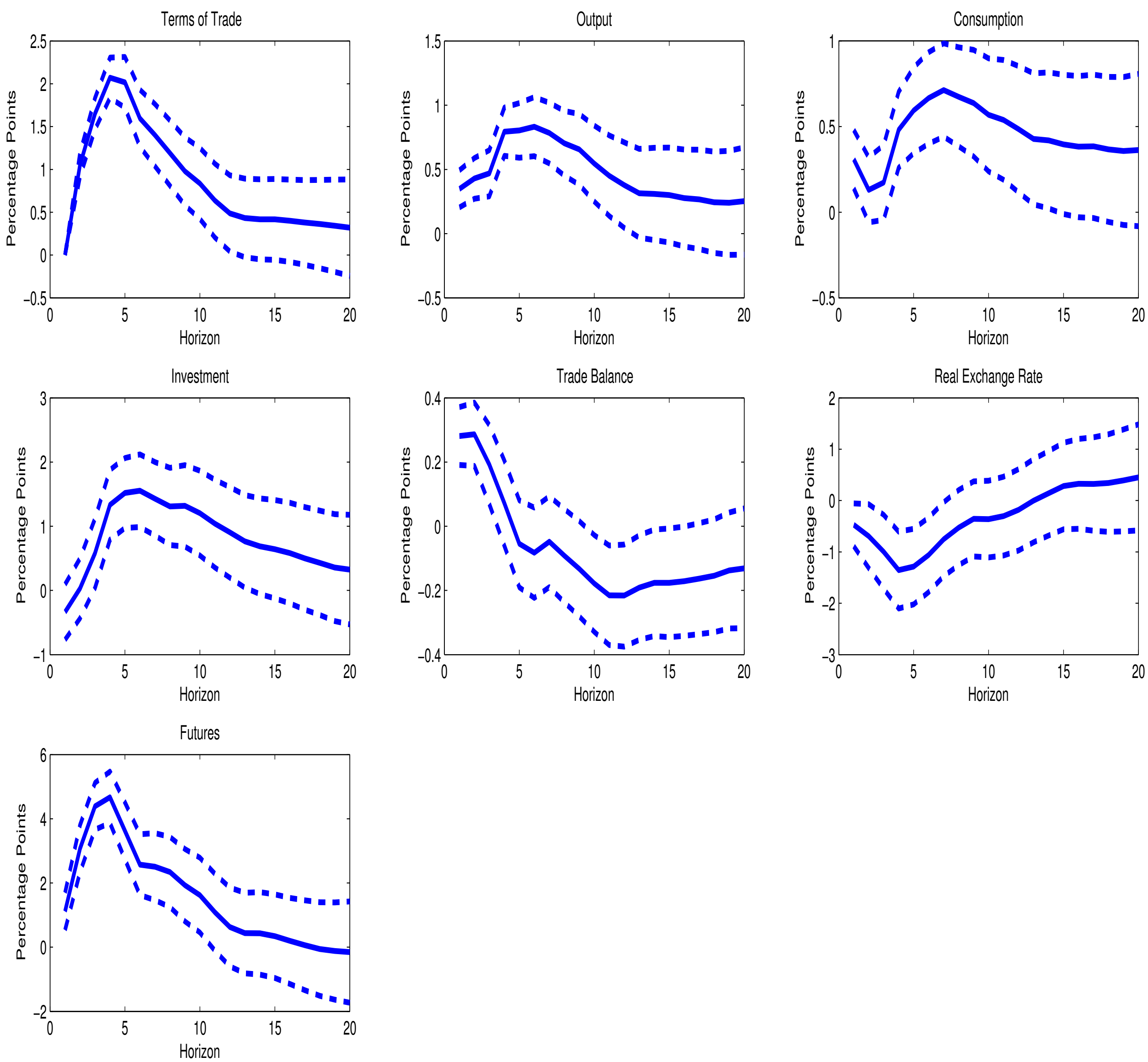
- 1997:Q1: Storm 'El Niño' affected Latin America.
- 1997:Q3-Q4: Asian Crisis
- 1998:Q3-Q4: Russian Crisis
- 2001:Q1: Burst of 'Dot-Com' Bubble U.S
- 2001:Q4: Argentinian Crisis
- 2004:Q1: Storm 'El Niño' affected Latin America.
- 2007:Q4: Discovery of field of oil and forecast of record agricultural production
- 2008:Q4: World Recession
- 2009:Q2: Draught affected regions of Brazil
- 2012:Q1: Oil reservoir discovery (Pão de Aucar)
- 2012:Q3: Oil reservoir discovery
- 2013:Q3: Oil reservoir discovery

Figure 2: **Impulse Responses to a One Standard Deviation Unanticipated TOT Shock from the Benchmark VARs (solid lines)**.



Notes: The solid lines are the average of the country-specific median responses to the unanticipated TOT shock. The dashed lines are one standard error bands computed as the square root of the average variance across countries. The underlying country-specific estimates are based on 1000 draws taken from the posterior distribution of the VAR parameters, where the unanticipated TOT shock is identified as the VAR innovation in TOT. Horizon is in quarters.

Figure 3: **Impulse Responses to a One Standard Deviation TOT News Shock from the Benchmark VARs (solid lines)**.



Notes: The solid lines are the average of the country-specific median responses to the TOT news shock. The dashed lines are one standard error bands computed as the square root of the average variance across countries. The underlying country-specific estimates are based on 1000 draws taken from the posterior distribution of the VAR parameters, where the TOT news shock is identified in accordance with the MFEV estimation procedure described in Section . Horizon is in quarters.

Table 1: **Share of Forecast Error Variance Explained by Unanticipated TOT Shocks: Country-Level SVAR Evidence**.

Country	TOT	GDP	C	I	TB	REER	Fut
Argentina	49	17	13	4	7	11	28
Brazil	54	16	7	20	5	19	21
Chile	37	10	14	12	10	14	10
Colombia	56	27	19	19	5	17	16
Peru	30	18	9	14	16	8	24
Average	45	18	12	14	9	14	20

Notes: This table presents the estimated contribution of the TOT unanticipated shock to the two-year variation in the variables obtained from each of the 5 country-level VARs. Average estimate is simple mean of the country specific estimates. Shares are expressed in percent. Column variables are: Terms of Trade (TOT), Output (GDP), Consumption (C), Investment (I), Trade Balance to GDP ratio (TB), Real Exchange Rate (REER), and Commodity Futures (Fut).

Table 2: **Share of Forecast Error Variance Explained by TOT News Shocks: Country-Level SVAR Evidence**.

Country	TOT	GDP	C	I	TB	REER	Fut
Argentina	29	30	27	19	10	9	31
Brazil	33	16	38	18	27	31	23
Chile	41	49	21	13	11	39	35
Colombia	30	16	16	15	24	24	13
Peru	56	18	29	26	47	10	42
Average	38	26	26	18	24	23	29

Notes: This table presents the estimated contribution of the TOT news shock to the two-year variation in the variables obtained from each of the 5 country-level VARs. Average estimate is simple mean of the country specific estimates. Shares are expressed in percent. Column variables are: Terms of Trade (TOT), Output (GDP), Consumption (C), Investment (I), Trade Balance to GDP ratio (TB), Real Exchange Rate (REER), and Commodity Futures (Fut).

Table 3: **Robustness Table: Share of Forecast Error Variance Explained by Unanticipated TOT Shocks for Various Alternative SVAR Specifications.**

Specification	TOT	GDP	C	I	TB	REER	Fut	Spreads	G	TFP
Spreads	41	21	14	14	14	15	15	23		
G	42	17	11	14	10	17	20		6	
FFR	32	11	8	8	7	7	14			
Commodity-TOT(Annual)	72	18	16	17	13	20				
SGU	72	16	16	15	17	19				
SGU (LA Sample)	75	27	22	19	14	24				
TFP	63	23	22	20	16	17				21
TOT & Fut Exo Block	89	42	29	28	25	25	42			

Notes: This table presents the average estimated contribution of the TOT unanticipated shock to the two-year variation in the variables. Each row corresponds to an alternative SVAR specification described in Section 3.4. Shares are expressed in percent. Column variables are: Terms of Trade (TOT), Output (GDP), Consumption (C), Investment (I), Trade Balance to GDP ratio (TB), Real Exchange Rate (REER), Commodity Futures (Fut), Country Spreads (Spreads), Government Spending (G) and Total Factor Productivity (TFP). Rows specifications are: Country Spreads (Spreads, Section 3.4.1), Government Spending (G, Section 3.4.2), Federal Funds Rate (FFR, Section 3.4.3), Commodity-based TOT series at annual frequency (Commodity-TOT(Annual), Section 3.4.4), SGU Sample (SGU, Section 3.4.5), SGU Latin American economies sample (SGU (LA Sample), Section 3.4.5), Total Factor Productivity (TFP, Section 3.4.6) and TOT and Commodity Futures included in an exogenous block (TOT & Fut Exo Block, Section 3.4.7).

Table 4: **Robustness Table: Share of Forecast Error Variance Explained by TOT News Shocks for Various Alternative SVAR Specifications.**

Specification	TOT	GDP	C	I	TB	REER	Fut	Spreads	G	TFP
Spreads	36	20	21	17	20	21	19	27		
G	39	28	28	21	22	21	28		17	
FFR	28	17	17	17	19	14	21			
Commodity-TOT(Annual)	18	16	27	23	33	23				
SGU	24	18	21	23	25	21				
SGU (LA Sample)	22	13	18	25	32	28				
TFP	31	17	15	20	26	23				19
TOT & Fut Exo Block	11	18	17	19	18	26	58			

Notes: This table presents the average estimated contribution of the TOT news shock to the two-year variation in the variables. Each row corresponds to an alternative SVAR specification described in Section 3.4. Shares are expressed in percent.Column variables are: Terms of Trade (TOT), Output (GDP), Consumption (C), Investment (I), Trade Balance to GDP ratio (TB), Real Exchange Rate (REER), Commodity Futures (Fut), Country Spreads (Spreads), Government Spending (G) and Total Factor Productivity (TFP). Rows specifications are: Country Spreads (Spreads, Section 3.4.1), Government Spending (G, Section 3.4.2), Federal Funds Rate (FFR, Section 3.4.3), Commodity-based TOT series at annual frequency (Commodity-TOT(Annual), Section 3.4.4), SGU Sample (SGU, Section 3.4.5), SGU Latin American economies sample (SGU (LA Sample), Section 3.4.5), Total Factor Productivity (TFP, Section 3.4.6) and TOT and Commodity Futures included in an exogenous block (TOT & Fut Exo Block, Section 3.4.7).

Table 5: **Calibration-Common Parameters**

α_x	0.35	α_m	0.35	α_n	0.25	ω_x	1.455	ω_m	1.455	ω_n	1.455	σ	2
χ_m	0.898	χ_τ	0.813	r^*	0.0277	$\overline{d}$	0.2189	δ	0.025	μ_m	1	μ_τ	0.5

Table 6: **Calibration-Country Specific Parameters**

	ϕ_m	ϕ_x	ϕ_n	ψ	γ_m	γ_x	γ_n
Argentina	2.1	1.5	3	0.8	0	0	0.5
Brazil	1	0.5	2	0.8	3	3	12
Chile	3	3	8	0.9	8	8	10
Colombia	0.5	3	7	1.5	5	5	5
Peru	2	5	6	0.1	0	9	9

Table 7: **Monte Carlo Experiment: TOT shocks and Measurement Error Standard Deviations**.

Country	Unanticipated Shock	News Shock	Measurement Errors
Argentina	0.023	0.012	0.03
Brazil	0.054	0.035	0.03
Chile	0.011	0.009	0.03
Colombia	0.013	0.004	0.03
Ecuador	0.029	0.018	0.03
Mexico	0.017	0.007	0.03
Peru	0.024	0.013	0.03

Notes: This table reports the standard deviations of the structural TOT shocks and measurement errors of output, consumption, investment, trade balance, and real exchange rate used to generate the data in the Monte Carlo experiment of Section 4.9. The idiosyncratic measurement errors are simply white noise errors whose purpose is to avoid singularity and are added to GDP, Investment, Consumption, Trade Balance, and Real Exchange Rate.

Table 8: **SVAR and Monte Carlo Estimated Forecast Error Variance Contributions of Unanticipated TOT Shocks.**

	Argentina		Brazil		Chile		Colombia		Peru	
	Data	MC	Data	MC	Data	MC	Data	MC	Data	MC
TOT	49%	63%	54%	71%	37%	59%	56%	56%	30%	59%
GDP	17%	30%	16%	26%	10%	18%	27%	28%	18%	29%
C	13%	23%	7%	15%	14%	16%	19%	21%	9%	19%
I	4%	52%	20%	61%	12%	35%	19%	51%	14%	23%
TB	7%	13%	5%	9%	10%	11%	5%	10%	16%	17%
REER	11%	10%	19%	10%	14%	10%	17%	10%	8%	10%

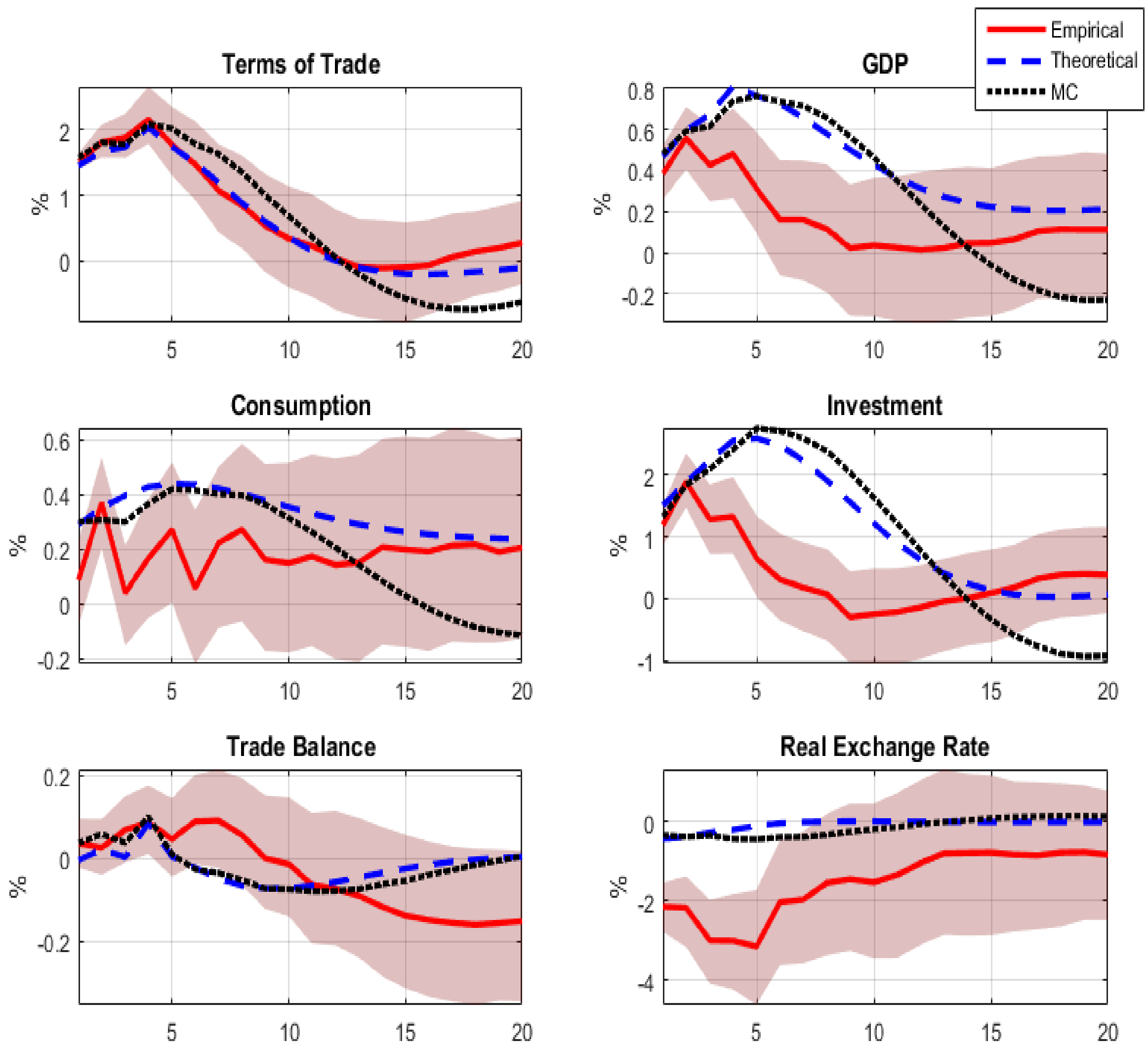
Notes: C, I, TB and REER denote consumption, investment, trade balance to GDP ratio and real exchange rate, respectively.

Table 9: **SVAR and Monte Carlo Estimated Forecast Error Variance Contributions of TOT News Shocks.**

	Argentina		Brazil		Chile		Colombia		Peru	
	Data	MC	Data	MC	Data	MC	Data	MC	Data	MC
TOT	29%	22%	33%	22%	41%	27%	30%	33%	56%	31%
GDP	30%	20%	16%	19%	49%	19%	16%	21%	18%	22%
C	27%	19%	38%	18%	21%	18%	16%	18%	29%	19%
I	19%	21%	18%	20%	13%	23%	15%	29%	26%	24%
TB	10%	19%	27%	18%	11%	17%	24%	15%	47%	21%
REER	9%	18%	31%	18%	39%	17%	24%	15%	10%	15%

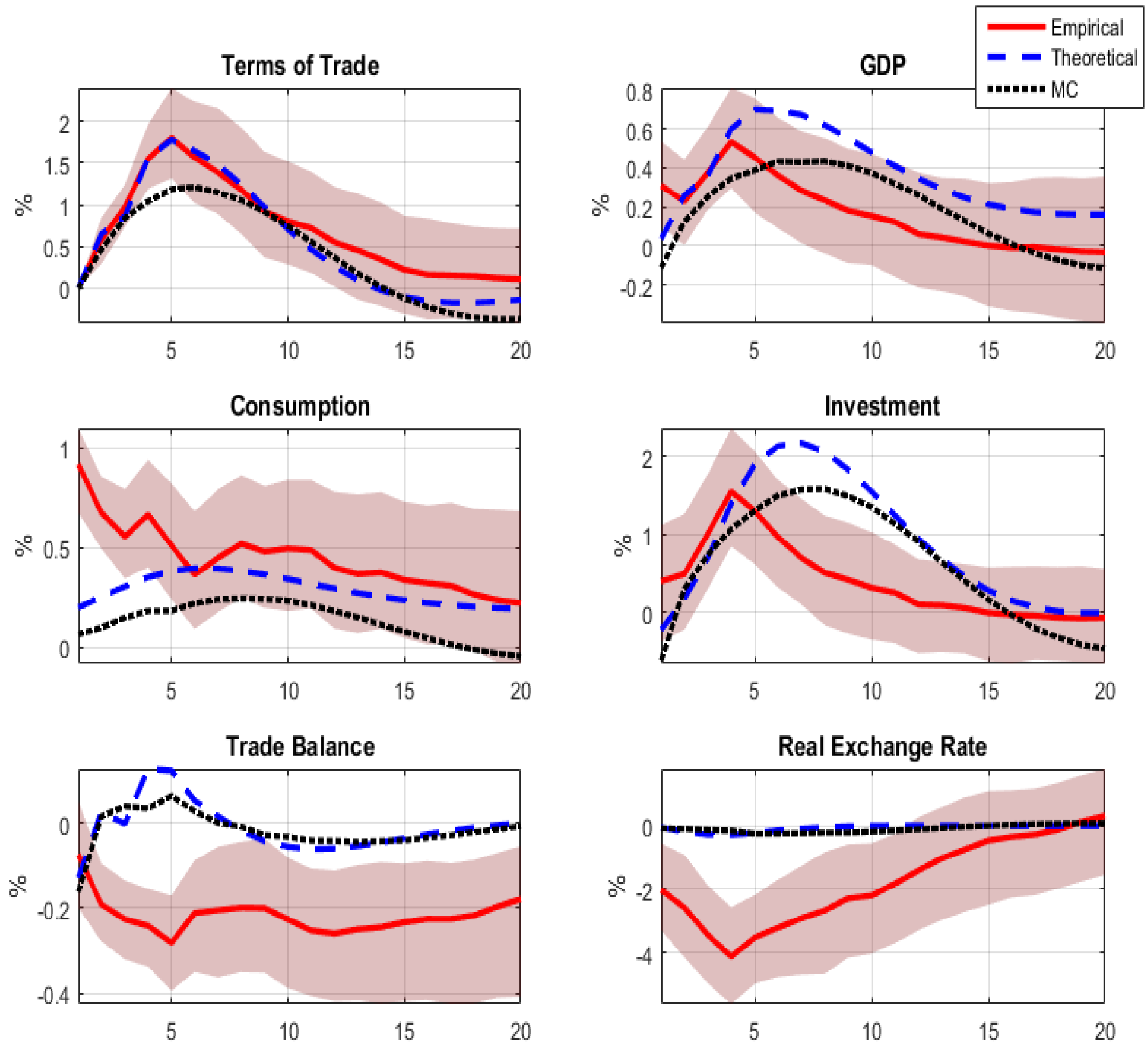
Notes: C, I, TB and REER denote consumption, investment, trade balance to GDP ratio and real exchange rate, respectively.

Figure 4: **The SVAR Impulse Responses, Monte Carlo Estimated Mean Impulse Responses, and the Theoretical Impulse Responses to the TOT Unanticipated Shock.**



Notes: The figure displays the SVAR IRF (in continuous line) with one standard error confidence bands, the theoretical IRF (in dashed line), and the MC estimated mean IRF (dotted line) for Brazil to an unanticipated TOT shock. MC responses are based on 1000 Monte Carlo simulations of the model of Section 4.1 for Brazil, where in each simulation the impulse responses to the unanticipated and news shock were identified as the median values of impulse responses based on 1000 draws from the posterior distribution of the VAR parameters.

Figure 5: **The SVAR Impulse Responses, Monte Carlo Estimated Mean Impulse Responses, and the Theoretical Impulse Responses to the TOT News Shock.**



Notes: The figure displays the SVAR IRF (in continuous line) with one standard error confidence bands, the theoretical IRF (in dashed line), and the MC estimated mean IRF (dotted line) for Brazil to a TOT news shock. MC responses are based on 1000 Monte Carlo simulations of the model of Section 4.1 for Brazil, where in each simulation the impulse responses to the unanticipated and news shock were identified as the median values of impulse responses based on 1000 draws from the posterior distribution of the VAR parameters.

References

Aguirre, E. (2011): "Essays on Exchange Rates and Emerging Markets," Ph.D. thesis, Columbia University.

Arezki, R., V. Ramey, and L. Sheng (2015): "News Shocks in Open Economies: Evidence from Giant Oil Discoveries," Working Paper 20857, National Bureau of Economic Research.

Barsky, R., and E. R. Sims (2011): "News Shocks and Business Cycles," *Journal of Monetary Economics*, 58(3), 235–249.

Beaudry, P., and F. Portier (2006): "Stock Prices, News, and Economic Fluctuations," *American Economic Review*, 96(4), 1293–1307.

Cespedes, L. F., and A. Velasco (2014): "Was this Time Different?: Fiscal Policy in Commodity Republics," *Journal of Development Economics*, 106(C), 92–106.

Chari, V. V., P. J. Kehoe, and E. R. McGrattan (2008): "Are Structural VARs with Long-Run Restrictions Useful in Developing Business Cycle Theory?," *Journal of Monetary Economics*, 55(8), 1337–1352.

Cheng, I.-H., and W. Xiong (2014): "Financialization of Commodity Markets," *Annual Review of Financial Economics*, 6(1), 419–441.

Chinn, M. D., and O. Coibion (2014): "The Predictive Content of Commodity Futures," *Journal of Futures Markets*, 34(7), 607–636.

Christiano, L. J., M. Eichenbaum, and R. Vigfusson (2007): "Assessing Structural VARs," in *NBER Macroeconomics Annual 2006, Volume 21*, pp. 1–106. MIT Press.

Fernandez, A., A. Gonzalez, and D. Rodriguez (2015): "Sharing a Ride on the Commodities Roller Coaster: Common Factors in Business Cycles of Emerging Economies," Unpublished Manuscript.

Francis, N., M. T. Owyang, J. E. Roush, and R. DiCecio (2014): "A Flexible Finite-Horizon Alternative to Long-Run Restrictions with an Application to Technology Shocks," *Review of Economics and Statistics*, 96(4), 638–647.

Heckman, J., and C. Pagés-Serra (2007): *Law and Employment: Lessons from Latin America and the Caribbean*. Chicago: University of Chicago Press.

Husain, A. M., and C. Bowman (2004): "Forecasting Commodity Prices: Futures Versus Judgment," IMF Working Papers 04/41, International Monetary Fund.

Ilzetzki, E., and C. A. Vegh (2008): "Procyclical Fiscal Policy in Developing Countries: Truth or Fiction?," Unpublished Manuscript.

Jaimovich, N., and S. Rebelo (2009): "Can News About the Future Drive the Business Cycle?," *American Economic Review*, 99(4), 1097–1118.

Kilian, L., and B. Hicks (2013): "Did Unexpectedly Strong Economic Growth Cause the Oil Price Shock of 2003-2008?," *Journal of Forecasting*, 32(5), 385–394.

Kose, M. (2002): "Explaining Business Cycles in Small Open Economies: How Much do World Prices Matter?," *Journal of International Economics*, 56(2), 299 – 327.

Kurmann, A., and C. Otrok (2013): "News Shocks and the Slope of the Term Structure of Interest Rates," *American Economic Review*, 6(103), 2612–32.

Lubik, T., and W. L. Teo (2005): "Do World Shocks Drive Domestic Business Cycles? Some Evidence from Structural Estimation," *John Hopkins University Department of Economics Working Paper*, (522).

Mendoza, E. G. (1995): "The Terms of Trade, the Real Exchange Rate, and Economic Fluctuations," *International Economic Review*, 36(1), 101–37.

Mumtaz, H., and F. Zanetti (2015): "Factor Adjustment Costs: a Structural Investigation," *Journal of Economic Dynamics and Control*, 51, 341–355.

Schmitt-Grohé, S., and M. Uribe (2012): "What's News in Business Cycles?," *Econometrica*, 80, 2733–2764.

Schmitt-Grohe, S., and M. Uribe (2015): "How Important Are Terms Of Trade Shocks?," Working Paper 21253, National Bureau of Economic Research.

Shousha, S. (2016): "Macroeconomic Effects of Commodity Booms and Busts: The Role of Financial Frictions," Unpublished Manuscript.

Sims, E. R. (2012): "News, Non-Invertibility, and Structural VARs," *Advances in Econometrics (fortcoming).*

Sinnott, E. (2009): "Commodity Prices and Fiscal Policy in Latin America and the Caribbean," Unpublished Manuscript.

Spatafora, N., and I. Tytell (2009): "Commodity Terms of Trade: The History of Booms and Busts," *IMF Working Papers*, pp. 1–34.

Uhlig, H. (2003): "What Moves Real GNP?," Unpublished manuscript.

Uribe, M., and V. Z. Yue (2006): "Country Spreads and Emerging Countries: Who Drives Whom?," *Journal of international Economics*, 69(1), 6–36.

A Data

We use quarterly data for the following countries and periods: Argentina 1994:Q1-2013:Q3, Brazil 1995:Q1-2014:Q3, Chile 1996:Q1-2014:Q3, Colombia 1994:Q1-2014:Q3, and Peru 1994:Q1-2014:Q2. The sample varies across countries according to data availability. For each case, we use the following series: GDP, Gross Fixed Capital Formation, Private Consumption Expenditure, and Exports and Imports of Goods and Services. All these variables are expressed in current prices and local currency units. We deflate all the variables (except the last two) using the GDP Deflator. Finally, we compute the trade balance (difference between exports and imports) as a share of current GDP. All these series were downloaded from the International Financial Statistics (IFS) database, which is published by International Monetary Fund. Additionally, we use the Export and Import Price index to compute the TOT series for each country. These indexes were downloaded from the national central banks (Brazil, Chile, Colombia, and Peru) and IMF (Argentina). Finally, we use the Real Exchange Rate index computed by the Bank of International Settlements. This index is calculated as geometric weighted averages of bilateral exchange rates adjusted by relative consumer prices. We compute the quarterly average and reexpress the series such than an increase (decrease) indicates a depreciation (appreciation). All the series were seasonally adjusted using ARIMA X13.

We compute a country-specific commodity price index using the average price of the commodity future contracts of the main commodities exported by each country. Following Shousha (2016), Table A.1 displays the commodities considered for each country and their respective weights.

For each good we use the longest available maturity. In particular, we employ the following contracts: Coffee (6th continuous contract), Cooper, Corn (6th continuous contract), Gold (7th continuous contract), Maize (6h continuous contract), Oil (12th continuous con-

Table A.1: Main exported commodities by country

Country	Main commodities
Argentina	Soybeans (41%), Oil (12%) and Maize (9%)
Brazil	Soybeans (22%), Oil (17%) and Sugar (9%)
Chile	Copper (72%)
Colombia	Oil (45%), Coffee (18%)
Peru	Copper (34%), Gold (29%)

Source: Shousha (2016)

tract), Soybean (8th continuous contract), and Sugar (4th continuous contract). For each country, we compute a weighted quarterly average using the shares of each good in total export commodity bundle as reported in the table. We use the weights computed by Shousha (2016) using annual trade data from UN Comtrade from 1994-2013. For some commodities (Coal, Fish, Iron Ore, Wood, and Zinc), quotations from future markets are not available for the whole sample. In these cases, we do not consider the good in case it is not representative or we replace it for another relevant commodity exported by the same country. The data for commodity prices was downloaded from Quandl.[20]

For the robustness exercise, we use the Emerging Markets Bond Index (EMBI) Global computed by JP Morgan as a measure of country spread. This index is a composite of different US dollar-denominated bonds. The Stripped Spread is computed as an arithmetic, market-capitalization-weighted average of bond spreads over US Treasury bonds of comparable duration.

For the annual specification, we use the same sample of poor and emerging countries and periods as Schmitt-Grohe and Uribe (2015). In particular, the panel contains data for the period 1980 to 2011 for the following countries: Algeria, Argentina, Bolivia, Botswana, Brazil, Burundi, Cameroon, Central African Republic, Colombia, Congo Dem. Rep., Costa

[20] https://www.quandl.com provides continuous series for many commodities based on data from CME.

Rica, Cote d'Ivoire, Dominican Republic, Egypt Arab Rep., El Salvador, Ghana, Guatemala, Honduras, India, Indonesia, Jordan, Kenya, Korea Rep., Madagascar, Malaysia, Mauritius, Mexico, Morocco, Pakistan, Paraguay, Peru, Philippines, Senegal, South Africa, Sudan, Thailand, Turkey, and Uruguay. The Latin American sample at annual frequency includes the following countries: Argentina, Bolivia, Brazil, Colombia, Mexico, Peru, Uruguay. All the data comes from the World Development Indicators (WDI) database, which is published by the World Bank. We add to this database the measure of TFP computed by the Conference Board, which is available for the period 1990-2014.[21]

[21] https://www.conference-board.org/data/economydatabase/index.cfm?id=27762 contains detailed information on how this variable is computed.