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HOW IMPORTANT ARE TERMS-OF-TRADE SHOCKS?*

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According to conventional wisdom, terms-of-trade shocks represent a major source of business cycles in emerging and poor countries. This view is largely based on the analysis of calibrated business-cycle models. We argue that the view that emerges from empirical structural vector autoregression (SVAR) models is strikingly different. We estimate country-specific SVARs using data from 38 countries and find that terms-of-trade shocks explain less than 10% of movements in aggregate activity. We then estimate key structural parameters of a three-sector business-cycle model country by country and find a disconnect between the importance assigned to terms-of-trade shocks by theoretical and SVAR models.

1. INTRODUCTION

The conventional wisdom is that terms-of-trade shocks represent a major source of business cycles in emerging and poor countries. This view is largely based on the analysis of calibrated business-cycle models. Essentially, this result is obtained by first estimating a process for the terms of trade and then feeding it to an equilibrium business-cycle model to compute the variance of macroeconomic indicators of interest induced by this type of disturbance. Then this variance is compared to the observed unconditional variance of the corresponding macroeconomic indicator to obtain the share of variance explained by terms-of-trade shocks. Consistently, this methodology arrives at the conclusion that more than 30% of the variance of output and other macroeconomic indicators is attributable to terms-of-trade shocks (Mendoza, 1995; Kose, 2002).

In this article, we argue that there is a disconnect between theoretical and empirical models when it comes to gauging the role of terms-of-trade disturbances in generating business cycles. We estimate country-specific structural vector autoregression (SVAR) models using data from 38 poor and emerging countries and find that on average terms-of-trade shocks explain only 10% of movements in aggregate activity. The result that emerges from the SVAR analysis is, therefore, that terms-of-trade shocks account for a modest fraction of business-cycle fluctuations.

We then perform country-by-country comparisons of the predictions of the empirical SVAR model with the predictions of a theoretical model. The comparison is disciplined by four principles. First, the SVAR is based on the identification restriction that the terms of trade in poor and emerging countries are exogenous. This assumption is universally embraced by the related literature whether empirical or theoretical. Second, we use (a generalized version of) the theoretical environment upon which the conventional wisdom was built. This is a model with three sectors, importables, exportables, and nontradables, featuring production, domestic absorption, capital, and labor in all three sectors. Third, the empirical SVAR model and the theoretical

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model share the same terms-of-trade process for each country in the sample. Fourth, both the empirical and theoretical models are estimated country by country on the same time series. Specifically, the structural parameters of the theoretical model are estimated by matching the impulse responses to terms-of-trade shocks implied by the SVAR model. This last principle gives the theoretical model a larger chance to match the data than is customary in the related literature.

We find that when macroeconomic indicators are measured in the same units in the theoretical model as in the data, then terms-of-trade shocks explain on average around 10% of the variance of output and other key macroeconomic indicators. On the surface this result appears as consistent with the predictions of the SVAR model. However, we find that at the country level the theoretical and empirical models are disconnected. There is virtually no relationship between the importance assigned to terms-of-trade shocks in the two models, despite the fact that both share the same country-specific terms-of-trade process and are estimated on the same data.

This article is related to a number of theoretical and empirical studies on the effects of terms-of-trade shocks in poor and emerging countries. On the theoretical side, Mendoza (1995) and Kose (2002) find, using calibrated models, that terms-of-trade shocks are a major driver of short-run fluctuations. These two papers are the standard reference for the conventional view that terms of trade represent a major source of fluctuations for developing countries. Fernández et al. (2015) and Shousha (2015) focus on commodity exporters (countries for which commodities represent a large fraction of total exports) and find that movements in commodity prices have played an important role in explaining business cycles since the mid-1990s. On the empirical side, Broda (2004), using an SVAR methodology, finds that terms-of-trade shocks play a much larger role in generating business cycles in fixed-exchange rate economies than they do in flexible-exchange rate economies. The present article is most closely related to Lubik and Teo (2005), who estimate 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 terms-of-trade shocks, and to Aguirre (2011), who estimates an SVAR and a business-cycle model and finds that in the theoretical model output and other macroeconomic aggregates display a larger response to terms-of-trade shocks than in the empirical SVAR model.

The remainder of the article is presented in seven sections. Section 2 estimates country-specific SVAR models and presents the implied share of aggregate fluctuations attributable to terms-of-trade shocks. Section 3 extends the SVAR analysis to allow for interest rate spread shocks. Section 4 develops the theoretical model. Section 5 presents the calibration of the theoretical model and performs country-specific estimates of key structural parameters. Section 6 analyzes the importance of terms-of-trade shocks predicted by the theoretical model. Section 7 presents a country-by-country comparison of the contribution of terms-of-trade shocks to business cycles implied by theoretical and SVAR models. Section 8 concludes.

2. HOW IMPORTANT ARE TERMS-OF-TRADE SHOCKS? SVAR ANALYSIS

Movements in the terms of trade are generally believed to be an important driver of business cycles. But how important? In this section, we address this question by providing an empirical measure of the contribution of terms-of-trade shocks to aggregate fluctuations based on an SVAR model.

The model includes six variables, namely, the terms of trade, the trade balance, output, consumption, investment, and the real exchange rate, and is estimated on annual data from 38 emerging and poor countries covering the period 1980–2011. The data source is the World Bank's World Development Indicators (WDI) database. The criteria for a country to be included in the panel is to have at least 30 consecutive annual observations on all components of x_t and to belong to the group of poor and emerging countries.[2] The countries that satisfy both criteria and are therefore included in the panel are Algeria, Argentina, Bolivia, Botswana, Brazil, Burundi, Cameroon, Central African Republic, Colombia, Congo, Costa Rica, Côte d'Ivoire, Dominican Republic, Egypt, El Salvador, Ghana, Guatemala, Honduras, India, Indonesia, Jordan, Kenya, Madagascar, Malaysia, Mauritius, Mexico, Morocco, Pakistan, Paraguay, Peru, Philippines, Senegal, South Africa, South Korea, Sudan, Thailand, Turkey, and Uruguay.

The terms of trade of a given country are defined as the relative price of its exports in terms of its imports. Letting P_t^x and P_t^m denote, respectively, indices of world prices of exports and imports of the particular country in question, the terms of trade for that country are given by

$$tot_t \equiv \frac{P_t^x}{P_t^m}.$$

In constructing the terms of trade for a particular country, the WDI uses trade-weighted export and import unit value indices.

Our empirical measure of the real exchange rate is the bilateral U.S. dollar real exchange rate defined as

$$RER_t = \frac{\mathcal{E}_t P_t^{US}}{P_t},$$

where $\mathcal{E}_t$ denotes the dollar nominal exchange rate, given by the domestic-currency price of one U.S. dollar, P_t^{US} denotes the U.S. consumer price index, and P_t denotes the domestic consumer price index.[3] Details of the data are provided in the Appendix.

All variables are quadratically detrended.[4] The trade balance is first divided by the trend component of output and then quadratically detrended. The results are robust to scaling the trade balance by output instead of the trend component of output (Supporting Information Appendix, Section 4).

The empirical model takes the form

$$\mathbf{A}_0 x_t = \mathbf{A}_1 x_{t-1} + \mu_t, \tag{1}$$

where the vector x_t is given by

$$x_t \equiv \begin{bmatrix} \widehat{tot}_t \\ \widehat{tb}_t \\ \widehat{y}_t \\ \widehat{c}_t \\ \widehat{i}_t \\ \widehat{RER}_t \end{bmatrix}.$$

The variables $\widehat{tot}_t$, $\widehat{y}_t$, $\widehat{c}_t$, $\widehat{i}_t$, and $\widehat{RER}_t$ denote log-deviations of the terms of trade, real output per capita, real private consumption per capita, real gross investment per capita, and the real exchange rate from their respective time trends. The variable $\widehat{tb}_t$ denotes the deviation from trend of the ratio of the trade balance to trend output.

[2] We define the group of poor and emerging countries as all countries in the WDI database with average PPP converted GDP per capita in U.S. dollars of 2005 over the period 1990–2009 below 25,000 dollars.

[3] An alternative measure of RER_t is the real effective exchange rate, which is based on the value of a currency against a trade-weighted average of foreign currencies. Our results are robust to using this measure (Supporting Information Appendix, Section 1). We do not use it in the baseline estimation because it has a more limited time and country coverage.

[4] The results are robust to Hodrick–Prescott (HP) filtering and first differencing (Supporting Information Appendix, Sections 2 and 3).

The objects $\mathbf{A}_0$ and $\mathbf{A}_1$ are 6-by-6 matrices of coefficients, and $\mathbf{A}_0$ is assumed to be lower triangular with 1 on the main diagonal. The variable μ_t is a 6-by-1 random vector with mean 0 and diagonal variance-covariance matrix Σ. Pre-multiplying the system by $\mathbf{A}_0^{-1}$, we can write

$$x_t = \mathbf{A}\, x_{t-1} + \Pi \epsilon_t, \tag{2}$$

where

$$\mathbf{A} \equiv \mathbf{A}_0^{-1}\mathbf{A}_1, \quad \Pi \equiv \mathbf{A}_0^{-1}\Sigma^{1/2}, \quad \text{and} \quad \epsilon_t \equiv \Sigma^{-1/2}\mu_t.$$

The vector ϵ_t is a random variable with mean 0 and identity variance–covariance matrix.

The typical emerging country is a small player in the world markets for the goods it exports or imports. Therefore, we, like much of the related literature, assume that the emerging country takes the terms of trade as exogenously given. Accordingly, we postulate that the terms of trade follow a univariate autoregressive process. This hypothesis is supported by the data. An F-test against the alternative that the terms of trade depend on lagged values of the trade balance, output, consumption, and investment is rejected at the 5% level for 32 out of the 38 countries in the sample.[5] Specifically, we impose the restriction that all elements of the first row of $\mathbf{A}_1$ except the first be 0. Thus the first equation of the SVAR system (2) represents the law of motion of the terms of trade and is given by

$$\widehat{tot}_t = a_{11}\widehat{tot}_{t-1} + \pi_{11}\epsilon_t^1, \tag{3}$$

where a_{11} and π_{11} denote the elements (1,1) of $\mathbf{A}$ and Π, respectively. As a result, the first element of ϵ_t, denoted ϵ_t^1, has the interpretation of a terms-of-trade shock, because it is the only innovation that affects the terms of trade contemporaneously. The assumption that $\mathbf{A}_0$ is lower triangular is not needed for the identification of the terms-of-trade shock. All that is required is that the elements of the first row of $\mathbf{A}_0$ except the first be 0. Also, because our analysis focuses on the effects of terms-of-trade shocks, the ordering of elements 2 to 6 of x_t in the SVAR is immaterial. We estimate the matrices $\mathbf{A}_0$, $\mathbf{A}_1$, and Σ country by country by OLS.

Table 1 displays country-specific estimates of Equation (3). The cross-country median of the estimated autocorrelation coefficient, a_{11}, is 0.52. This means that terms-of-trade shocks vanish relatively quickly, having a half life of about one year. The median unconditional standard deviation of the innovation to the terms of trade, π_{11}, is 0.08. The fit of the AR(1) process is modest, as indicated by a median R^2 of 0.30. Overall, the median estimate of the terms-of-trade process is close to that obtained by Mendoza (1995), who uses terms-of-trade data from 1961 to 1990 for a set of 23 poor and emerging countries, which has 16 countries in common with our 38-country panel. The cross-country estimate of the terms-of-trade process reported in Mendoza (1995) is $\widehat{tot}_t = 0.414\,\widehat{tot}_{t-1} + 0.1071\epsilon_t^1$.

Figure 1 displays the response of the variables included in the vector x_t to a 10% improvement in the terms of trade. We choose a 10% improvement because it is a round number and because it is close to the median standard deviation of the terms of trade innovation, π_{11}, of 8%. The displayed impulse responses are point-by-point medians of the corresponding country-specific impulse responses. On impact, a 10% increase in the terms of trade causes an improvement in the trade balance of half a percent of GDP. Thus, the data lend support to the Harberger–Laursen–Metzler (HLM) effect. In fact, the HLM effect obtains for 29 out of the 38 countries in our sample. This result concurs with Otto (2003), who finds a positive response in the trade balance to an improvement in the terms of trade in 36 out of a sample of 40 developing countries spanning the period 1960–1996.

[5] The countries for which the null hypothesis of a univariate specification is rejected at the 5% confidence level are Botswana, Malaysia, Mauritius, South Africa, Sudan, and Thailand.

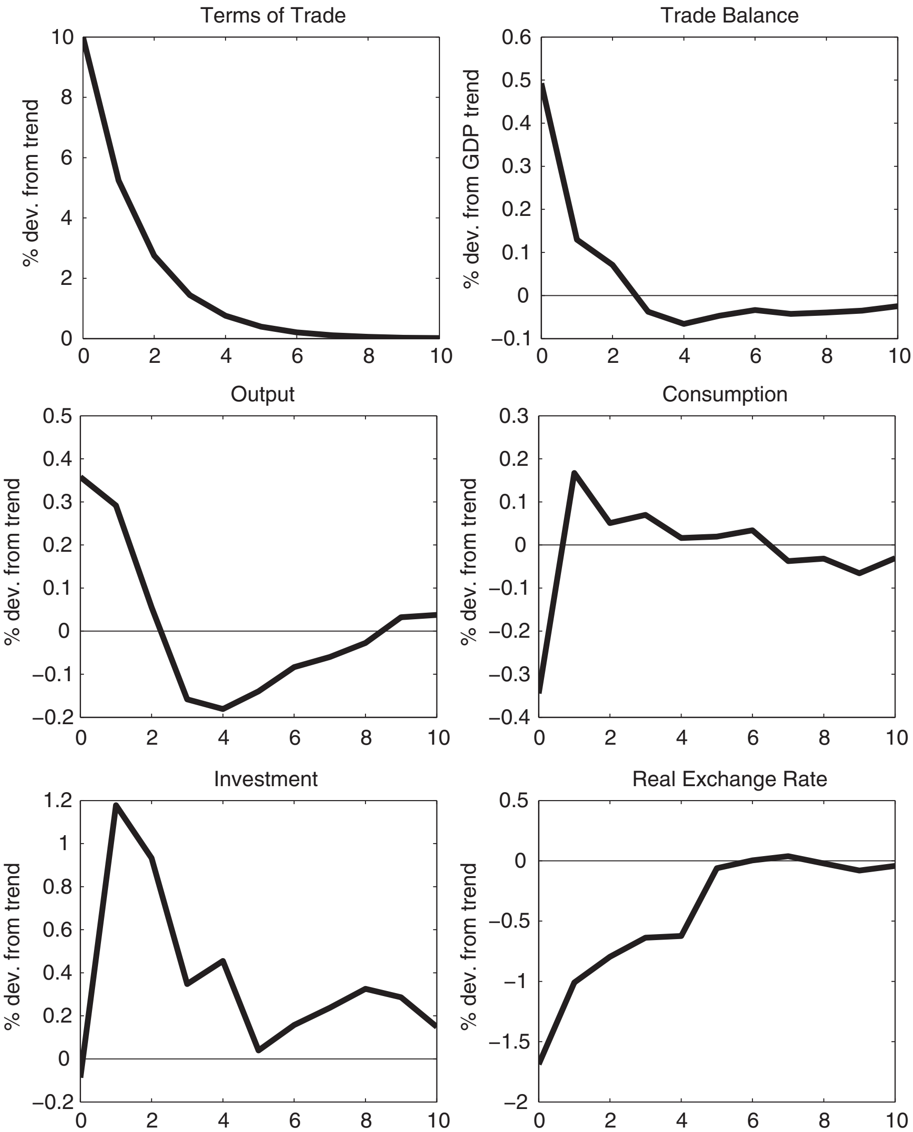
TABLE 1
THE TERMS-OF-TRADE PROCESS: COUNTRY-BY-COUNTRY ESTIMATES $\widehat{tot}_t = a_{11}\widehat{tot}_{t-1} + \pi_{11}\epsilon^1_t$; $\epsilon^1_t \sim (0, 1)$

Country	a_{11}	π_{11}	R^2
Algeria	0.43	0.20	0.18
Argentina	0.41	0.08	0.19
Bolivia	0.52	0.08	0.29
Botswana	0.52	0.06	0.33
Brazil	0.53	0.08	0.31
Burundi	0.59	0.17	0.34
Cameroon	–0.05	0.13	0.00
Central African Republic	0.86	0.09	0.71
Colombia	0.29	0.08	0.08
Congo, Dem. Rep.	0.41	0.14	0.17
Costa Rica	0.53	0.07	0.30
Côte d'Ivoire	0.46	0.16	0.22
Dominican Republic	0.44	0.09	0.19
Egypt, Arab Rep.	0.70	0.09	0.50
El Salvador	0.32	0.13	0.12
Ghana	0.17	0.09	0.03
Guatemala	–0.43	0.11	0.19
Honduras	0.55	0.10	0.32
India	0.63	0.09	0.38
Indonesia	0.55	0.11	0.30
Jordan	0.48	0.08	0.22
Kenya	0.66	0.07	0.52
Korea, Rep.	0.69	0.05	0.41
Madagascar	0.65	0.09	0.43
Malaysia	0.51	0.05	0.27
Mauritius	0.57	0.05	0.40
Mexico	0.78	0.09	0.60
Morocco	0.41	0.06	0.17
Pakistan	0.61	0.08	0.39
Paraguay	0.40	0.12	0.15
Peru	0.52	0.08	0.27
Philippines	0.53	0.08	0.35
Senegal	0.75	0.09	0.50
South Africa	0.74	0.04	0.53
Sudan	0.61	0.09	0.40
Thailand	0.55	0.04	0.34
Turkey	0.32	0.05	0.11
Uruguay	0.39	0.07	0.19
Median	0.52	0.08	0.30
Median Absolute Deviation	0.11	0.01	0.11

NOTES: The variable $\widehat{tot}_t$ denotes log-deviations of the terms of trade from trend. The data are annual and cover the period 1980–2011, with the following three exceptions: Algeria 1980–2009, Indonesia 1981–2011, and Madagascar 1980–2009.

The improvement in the terms of trade causes an expansion in aggregate activity. Specifically, the 10% increase in the terms of trade causes an increase of 0.36% in GDP. Investment displays a larger expansion, albeit with a one-year delay. Private consumption contracts on impact and then swiftly bounces above its trend path. The 10% improvement in the terms of trade leads to a 1.6% real exchange rate appreciation on impact, with a half life of about two years. This means that the improvement in the terms of trade causes the country to become more expensive vis-a-vis the rest of the world.

There is, however, substantial dispersion in the impulse response estimates both within and across countries. Section 5 of the Supporting Information Appendix displays country-by-country impulse responses with 66% confidence bands computed using bootstrapping methods. Although, as we just discussed, on average across countries a positive terms-of-trade shock



NOTE: Impulse responses are point-by-point medians across countries. Section 5 of the Supporting Information Appendix presents country-specific impulse responses with 66% confidence bands.

FIGURE 1

IMPULSE RESPONSE TO AN INNOVATION IN THE TERMS OF TRADE: SVAR EVIDENCE

causes an improvement in the trade balance and an expansion in output, this improvement is statistically insignificant (as measured by the error bands including 0) in 18 countries for the trade balance and in 24 countries for output in our panel of 38 countries. Similar results obtain for the other variables included in the SVAR. These findings are a prelude to the main result of this section, namely, that SVAR evidence suggests that terms-of-trade shocks are not a major source of fluctuations in emerging and poor countries during the sample period considered.

A common way to gauge the importance of a particular shock in driving business cycles is to compute the fraction of the variance of indicators of interest it explains. Table 2 displays the share of the variance of the six variables in the SVAR explained by terms-of-trade shocks. The estimates reported in the table indicate that, on average, terms-of-trade shocks explain about

TABLE 2
SHARE OF VARIANCE EXPLAINED BY TERMS-OF-TRADE SHOCKS: COUNTRY-LEVEL SVAR EVIDENCE

Country	*tot*	*tb*	*y*	*c*	*i*	*RER*
Algeria	100	67	7	58	8	24
Argentina	100	28	22	14	16	33
Bolivia	100	6	6	8	12	7
Botswana	100	20	50	32	32	8
Brazil	100	47	16	4	28	57
Burundi	100	4	2	4	1	9
Cameroon	100	9	14	13	13	16
Central African Republic	100	37	6	14	13	53
Colombia	100	7	18	7	13	13
Congo, Dem. Rep.	100	3	1	1	7	12
Costa Rica	100	17	3	1	2	2
Côte d'Ivoire	100	30	43	36	43	70
Dominican Republic	100	20	17	16	28	14
Egypt, Arab Rep.	100	62	58	46	65	48
El Salvador	100	8	2	4	4	22
Ghana	100	4	4	3	3	4
Guatemala	100	5	1	2	2	13
Honduras	100	7	5	1	7	15
India	100	4	13	19	1	1
Indonesia	100	13	22	17	23	14
Jordan	100	31	13	32	4	5
Kenya	100	6	4	9	12	2
Korea, Rep.	100	17	2	3	28	36
Madagascar	100	7	8	1	3	6
Malaysia	100	6	5	3	5	1
Mauritius	100	9	2	6	2	4
Mexico	100	12	17	12	10	28
Morocco	100	2	2	2	3	10
Pakistan	100	3	10	2	2	3
Paraguay	100	12	7	8	10	1
Peru	100	16	19	14	23	15
Philippines	100	19	13	17	8	38
Senegal	100	4	8	3	19	57
South Africa	100	12	11	9	8	23
Sudan	100	20	38	10	21	18
Thailand	100	14	13	15	2	25
Turkey	100	4	14	19	31	3
Uruguay	100	20	36	37	15	30
Median	100	12	10	9	10	14
Median absolute deviation	0	7	6	6	7	10

NOTE: Shares are expressed in percent.

10% of the variances of output, consumption, investment, and the trade balance and 14% of the variance of the real exchange rate. There is sizable cross-country variation with a median absolute deviation about three-fourths as high as the median.

A similar result obtains when the cyclical component is computed by HP filtering with a smoothing parameter of 100 (Supporting Information Appendix, Section 2) or by first differencing (Supporting Information Appendix, Section 3). Under HP filtering, the cross-country median of the variances of the trade balance, output, consumption, investment, and the real exchange rate explained by terms-of-trade shocks are 14%, 12%, 11%, 12%, and 13%, respectively. Under first differencing, the corresponding shares are 6%, 9%, 9%, 11%, and 11%. Taken together, we interpret these results as indicating that SVAR models predict a relatively minor role for terms-of-trade shocks as a source of aggregate fluctuations in poor and emerging countries.

TABLE 3
SHARE OF VARIANCE EXPLAINED BY TERMS-OF-TRADE SHOCKS IN THE SVARS WITH INTEREST-RATE SPREADS

Specification	*tot*	*s*	*tb*	*y*	*c*	*i*	*RER*
Baseline (no *s*)	100	–	12	10	9	10	14
tot first	95	9	11	7	10	9	11
s first	91	5	9	7	8	9	11

NOTE: Cross-country medians. Shares are expressed in percent. Section 6 of the Supporting Information Appendix provides country-by-country results.

3. SVAR MODEL WITH INTEREST RATE SPREADS

A number of studies have shown that world interest rates play a role in driving business cycles in emerging economies (among others, Neumeyer and Perri, 2005; Uribe and Yue, 2006; García-Cicco et al., 2010; Fernández-Villaverde et al., 2011; Akinci, 2013). For the purpose of the present study, it is therefore of interest to ascertain the robustness of our results to expanding the SVAR system to include some measure of the international cost of funds. In choosing such a measure, we follow Akinci (2013), who shows that the Baa corporate bond spread is a more relevant variable for emerging countries than less risky global interest-rate measures such as the U.S. Federal Funds rate. The Baa corporate spread is defined as the difference between Moody's seasoned Baa corporate bond yield and the federal funds rate (see the Appendix for details). As before, the SVAR system takes the form given in Equation (2), where the vector x_t now includes, in addition to the six variables considered in Section 2, the interest rate spread, denoted $\widehat{s}_t$ and expressed in deviations from trend.

As in the related literature, we assume that the typical emerging economy takes the terms of trade and the U.S. interest-rate spread as exogenously given. We consider two identification schemes for the terms-of-trade shock. The first provides continuity with respect to the identification strategy of Section 2. It assumes that terms-of-trade shocks affect the spread contemporaneously, but spread shocks affect the terms of trade only with a one-period lag. Formally, the first two equations of the SVAR model are assumed to take the form

$$\begin{bmatrix} \widehat{tot}_t \\ \widehat{s}_t \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} \widehat{tot}_{t-1} \\ \widehat{s}_{t-1} \end{bmatrix} + \begin{bmatrix} \pi_{11} & 0 \\ \pi_{21} & \pi_{22} \end{bmatrix} \begin{bmatrix} \epsilon_t^1 \\ \epsilon_t^2 \end{bmatrix}. \tag{4}$$

As in the baseline identification, this scheme implies that the innovation to the terms-of-trade equation, ϵ_t^1, is the terms of trade shock. In addition, the innovation to the spread equation, ϵ_t^2, has the interpretation of a spread shock. This ordering gives the terms of trade the highest chance to be an important source of fluctuations in domestic variables, as it attributes any innovation in the terms of trade to terms of trade shocks.

We also consider the alternative specification in which the terms of trade are placed second in the SVAR, that is,

$$\begin{bmatrix} \widehat{s}_t \\ \widehat{tot}_t \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} \widehat{s}_{t-1} \\ \widehat{tot}_{t-1} \end{bmatrix} + \begin{bmatrix} \pi_{11} & 0 \\ \pi_{21} & \pi_{22} \end{bmatrix} \begin{bmatrix} \epsilon_t^1 \\ \epsilon_t^2 \end{bmatrix}. \tag{5}$$

In this case, ϵ_t^1 represents an interest-rate shock and ϵ_t^2 a terms-of-trade shock. We estimate the SVAR system by OLS equation by equation.

Table 3 displays cross-country medians of the estimated shares of the variances of the variables included in the SVAR explained by terms-of-trade shocks. The results obtained under the baseline SVAR specification are robust to including interest-rate spreads. Independently of whether the terms of trade are ordered first or second in the SVAR, their contribution to explaining movements in key macroeconomic aggregates is around 10%. We interpret the results presented here as further evidence that, when viewed through the lens of an SVAR model, the contribution of terms-of-trade shocks to business-cycle fluctuations in emerging and poor economies is modest. What do theoretical models have to say about this? This is the subject of the following sections.

4. THE THEORETICAL MODEL

The model includes three sectors, an importable sector (the m sector), an exportable sector (the x sector), and a nontradable sector (the n sector). We refer to this framework as the MXN model. The structure of the model is similar to Mendoza (1995), with three generalizations. First, we assume that employment in the importable and exportable sectors is not fixed, but can vary endogenously over the business cycle. This feature adds realism to the model, since these sectors represent a nonnegligible source of employment fluctuations. Second, we allow for capital accumulation in the nontraded sector. This assumption is guided by the fact that investment in the nontraded sector displays sizable volatility over the business cycle (McIntyre, 2003). Third, we assume that investment goods are not fully imported and can have nontraded components. Again, this modification is introduced to make the model more realistic, since a large fraction of investment is made up of nontraded goods (Bems, 2008).

The reason why we choose to study this particular model is that, to a large extent, it has given shape to the conventional wisdom that terms-of-trade shocks are a major driver of business cycles. A natural question is why bother recomputing the predictions of this model. Our contribution in this regard is to parameterize the model in a way that we believe gives it a greater chance to match the data. In particular, (i) we use country-specific estimates of the exogenous driving forces, (ii) we estimate key structural parameters of the model country by country, and (iii) we place particular emphasis on expressing variables in the same units in the MXN and empirical models by using deflators defined in a consistent fashion.

4.1. *Households.* The model economy is populated by a large number of identical households with preferences described by the utility function

$$E_0 \sum_{t=0}^{\infty} \beta^t U\left(c_t, h_t^m, h_t^x, h_t^n\right), \tag{6}$$

where c_t denotes consumption, h_t^m hours worked in the importable sector, h_t^x hours worked in the exportable sector, and h_t^n hours worked in the nontradable sector. Households maximize their lifetime utility subject to the sequential budget constraint

$$\begin{aligned} c_t + i_t^m + i_t^x + i_t^n + \Phi_m\left(k_{t+1}^m - k_t^m\right) + \Phi_x\left(k_{t+1}^x - k_t^x\right) + \Phi_n\left(k_{t+1}^n - k_t^n\right) + p_t^\tau d_t \\ = \frac{p_t^\tau d_{t+1}}{1+r_t} + w_t^m h_t^m + w_t^x h_t^x + w_t^n h_t^n + u_t^m k_t^m + u_t^x k_t^x + u_t^n k_t^n, \end{aligned}$$

where i_t^j, k_t^j, w_t^j, and u_t^j denote, respectively, gross investment, the capital stock, the real wage, and the rental rate of capital in sector j, for $j = m, x, n$ with the superscripts m, x, and n denoting the sector producing, respectively, importable, exportable, and nontraded goods. The functions $\Phi_j(\cdot)$, $j = m, x, n$, introduce capital adjustment costs and are assumed to be nonnegative and convex and to satisfy $\Phi_j(0) = \Phi_j'(0) = 0$. The variable p_t^τ denotes the relative price of the tradable composite goods in terms of final goods (to be formally defined below), d_t denotes the stock of debt in period t, expressed in units of the tradable composite goods, and r_t denotes the interest rate on debt held from period t to $t+1$. Consumption, investment, wages, rental rates, debt, and capital adjustment costs are all expressed in units of final goods.

The capital stocks obey the familiar laws of motion

$$k_{t+1}^m = (1-\delta)k_t^m + i_t^m, \tag{7}$$

$$k^x_{t+1} = (1-\delta)k^x_t + i^x_t, \tag{8}$$

and

$$k^n_{t+1} = (1-\delta)k^n_t + i^n_t. \tag{9}$$

Using these laws of motion to eliminate i^m_t, i^x_t, and i^n_t from the household's budget constraint and letting $\lambda_t\beta^t$ denote the Lagrange multiplier associated with the resulting budget constraint, we have that the first-order optimality conditions with respect to c_t, h^m_t, h^x_t, h^n_t, d_{t+1}, k^m_{t+1}, k^x_{t+1}, and k^n_{t+1} are, respectively,

$$U_1\left(c_t, h^m_t, h^x_t, h^n_t\right) = \lambda_t \tag{10}$$

$$-U_2\left(c_t, h^m_t, h^x_t, h^n_t\right) = \lambda_t w^m_t \tag{11}$$

$$-U_3\left(c_t, h^m_t, h^x_t, h^n_t\right) = \lambda_t w^x_t \tag{12}$$

$$-U_4\left(c_t, h^m_t, h^x_t, h^n_t\right) = \lambda_t w^n_t \tag{13}$$

$$\lambda_t p^\tau_t = \beta(1+r_t)E_t\lambda_{t+1}p^\tau_{t+1} \tag{14}$$

$$\lambda_t\left[1+\Phi'_m\left(k^m_{t+1}-k^m_t\right)\right] = \beta E_t\lambda_{t+1}\left[u^m_{t+1}+1-\delta+\Phi'_m\left(k^m_{t+2}-k^m_{t+1}\right)\right] \tag{15}$$

$$\lambda_t\left[1+\Phi'_x\left(k^x_{t+1}-k^x_t\right)\right] = \beta E_t\lambda_{t+1}\left[u^x_{t+1}+1-\delta+\Phi'_x\left(k^x_{t+2}-k^x_{t+1}\right)\right] \tag{16}$$

$$\lambda_t\left[1+\Phi'_n\left(k^n_{t+1}-k^n_t\right)\right] = \beta E_t\lambda_{t+1}\left[u^n_{t+1}+1-\delta+\Phi'_n\left(k^n_{t+2}-k^n_{t+1}\right)\right]. \tag{17}$$

It is clear from these expressions that the rates of return on capital may display cyclical differences across sectors but are equalized in the steady state. By contrast, sectoral wage differences may persist even in the steady state.

4.2. *Firms Producing Final Goods.* Final goods are produced using nontradable goods and a composite of tradable goods via the technology $B(a^\tau_t, a^n_t)$, where a^τ_t denotes domestic absorption of the tradable composite goods, and a^n_t denotes domestic absorption of nontraded goods. The aggregator function $B(\cdot,\cdot)$ is assumed to be increasing, concave, and homogeneous of degree 1. Final goods are sold to households, which then allocate them to consumption or investment purposes. Producers of final goods behave competitively. Their profits are given by

$$B\left(a^\tau_t, a^n_t\right) - p^\tau_t a^\tau_t - p^n_t a^n_t,$$

where p^n_t denotes the relative price of nontradable goods in terms of final goods. The firm's profit maximization conditions are

$$B_1\left(a^\tau_t, a^n_t\right) = p^\tau_t \tag{18}$$

and

$$B_2\left(a_t^\tau, a_t^n\right) = p_t^n. \tag{19}$$

These expressions define the domestic demand functions for nontradables and for the tradable composite goods.

4.3. *Firms Producing the Tradable Composite Good.* The tradable composite goods are produced using importable and exportable goods as intermediate inputs, via the technology

$$a_t^\tau = A\left(a_t^m, a_t^x\right), \tag{20}$$

where a_t^m and a_t^x denote the domestic absorptions of importable and exportable goods, respectively. The aggregator function $A(\cdot, \cdot)$ is increasing, concave, and linearly homogeneous. Profits are given by

$$p_t^\tau A\left(a_t^m, a_t^x\right) - p_t^m a_t^m - p_t^x a_t^x,$$

where p_t^m denotes the relative price of importable goods in terms of final goods and p_t^x denotes the relative price of exportable goods in terms of final goods. Firms in this sector are assumed to behave competitively in intermediate and final goods markets. Then, profit maximization implies that

$$p_t^\tau A_1\left(a_t^m, a_t^x\right) = p_t^m \tag{21}$$

and

$$p_t^\tau A_2\left(a_t^m, a_t^x\right) = p_t^x. \tag{22}$$

These two expressions represent the domestic demand functions for importable and exportable goods.

4.4. *Firms Producing Importable, Exportable, and Nontradable Goods.* Importable, exportable, and nontradable goods are produced with capital and labor via the technologies

$$y_t^m = A^m F^m\left(k_t^m, h_t^m\right) \tag{23}$$

$$y_t^x = A^x F^x\left(k_t^x, h_t^x\right), \tag{24}$$

and

$$y_t^n = A^n F^n\left(k_t^n, h_t^n\right), \tag{25}$$

where y_t^j and A^j denote, respectively, output and a productivity factor in sector $j = m, x, n$. The production functions $F^j(\cdot, \cdot)$, $j = m, x, n$, are assumed to be increasing in both arguments, concave, and homogeneous of degree 1. Profits of firms producing exportable, importable, or nontraded goods are given by

$$p_t^j F^j\left(k_t^j, h_t^j\right) - w_t^j h_t^j - u_t^j k_t^j,$$

for $j = m, x, n$. Firms are assumed to behave competitively in product and factor markets. Then, the first-order profit maximization conditions are

$$p_t^m A^m F_1^m\left(k_t^m, h_t^m\right) = u_t^m \tag{26}$$

$$p_t^m A^m F_2^m\left(k_t^m, h_t^m\right) = w_t^m \tag{27}$$

$$p_t^x A^x F_1^x\left(k_t^x, h_t^x\right) = u_t^x \tag{28}$$

$$p_t^x A^x F_2^x\left(k_t^x, h_t^x\right) = w_t^x \tag{29}$$

$$p_t^n A^n F_1^n\left(k_t^n, h_t^n\right) = u_t^n \tag{30}$$

$$p_t^n A^n F_2^n\left(k_t^n, h_t^n\right) = w_t^n. \tag{31}$$

These efficiency conditions represent the sectoral demand functions for capital and labor. Together with the assumption of linear homogeneity of the production technologies, they imply that firms make zero profits at all times.

4.5. *Competitive Equilibrium.* In equilibrium the demand for final goods must equal the supply of this type of goods:

$$c_t + i_t^m + i_t^x + i_t^n + \Phi_m\left(k_{t+1}^m - k_t^m\right) + \Phi_x\left(k_{t+1}^x - k_t^x\right) + \Phi_n\left(k_{t+1}^n - k_t^n\right) = B\left(a_t^\tau, a_t^n\right). \tag{32}$$

Also, the demand for nontradables must equal the production of nontradables:

$$a_t^n = y_t^n. \tag{33}$$

Imports, denoted m_t, are defined as the difference between the domestic absorption of importables, a_t^m, and importable output, y_t^m, or

$$m_t = p_t^m\left(a_t^m - y_t^m\right). \tag{34}$$

The price of importables appears on the right-hand side of this definition because m_t is expressed in units of final goods, whereas y_t^m and a_t^m are expressed in units of importable goods. Similarly, exports, denoted x_t, are given by the difference between exportable output, y_t^x, and the domestic absorption of exportables, a_t^x,

$$x_t = p_t^x\left(y_t^x - a_t^x\right). \tag{35}$$

Like imports, exports are measured in terms of final goods.

Combining the above two definitions, the household's budget constraint, and the definitions of profits in the final- and intermediate-good markets and taking into account that firms make zero profits at all times yields the following economy-wide resource constraint:

$$p_t^\tau \frac{d_{t+1}}{1 + r_t} = p_t^\tau d_t + m_t - x_t. \tag{36}$$

To ensure a stationary equilibrium process for external debt, we follow Schmitt-Grohé and Uribe (2003) and assume that the country interest rate is debt elastic:

$$r_t = r^* + s_t + p(d_{t+1}), \tag{37}$$

where r^* denotes the risk-free world interest rate, s_t denotes the global component of the interest-rate spread, and $p(d)$ denotes the domestic component of the interest-rate spread. We assume that $p(\bar{d}) = 0$ and $p'(\bar{d}) > 0$, for some constant $\bar{d}$.

Given the definition of the terms of trade as the relative price of exportable goods in terms of importable goods, we have that

$$tot_t = \frac{p_t^x}{p_t^m}. \tag{38}$$

As in the empirical analysis of Section 3, we assume that the country is small in international product and asset markets and therefore takes the evolution of the terms of trade, tot_t, and the global component of the interest-rate spread, s_t, as exogenously given. Also in line with the empirical analysis of Section 3, we assume that tot_t and s_t follow the joint law of motion given in Equation (4), with $\widehat{tot}_t \equiv \ln(tot_t/\overline{tot})$, $\widehat{s}_t \equiv s_t - \bar{s}$, and $\overline{tot}$ and $\bar{s}$ denoting the deterministic steady-state values of tot_t and s_t, respectively.

As explained earlier, the real exchange rate is defined as the ratio of the foreign consumer price index to the domestic consumer price index. Formally,

$$RER_t = \frac{\mathcal{E}_t P_t^*}{P_t},$$

where $\mathcal{E}_t$ denotes the nominal exchange rate, defined as the domestic-currency price of one unit of foreign currency, P_t^* denotes the foreign price of consumption, and P_t denotes the domestic price of consumption. Dividing the numerator and denominator by the domestic-currency price of the tradable composite goods, denoted P_t^τ, yields $RER_t = (\mathcal{E}_t P_t^*/P_t^\tau)/(P_t/P_t^\tau)$. We assume that the law of one price holds for importable and exportable goods and that the technology for aggregating importables and exportables into the tradable composite goods, $A(\cdot, \cdot)$, is common across countries. Then, the law of one price must also hold for the tradable composite goods, that is, $\mathcal{E}_t P_t^{\tau *} = P_t^\tau$, where $P_t^{\tau *}$ denotes the foreign price of the tradable composite goods. This yields $RER_t = (P_t^*/P_t^{\tau *})/(P_t/P_t^\tau)$. We assume that the terms-of-trade shocks that are relevant to our small open economy do not affect the relative price of the tradable composite goods in terms of consumption goods in the rest of the world. We therefore assume that $P_t^*/P_t^{\tau *}$ is constant. Without loss of generality, we normalize $P_t^*/P_t^{\tau *}$ to unity. Finally, noting that $p_t^\tau \equiv P_t^\tau/P_t$, we have

$$RER_t = p_t^\tau, \tag{39}$$

which says that the real exchange rate equals the relative price of the tradable composite goods in terms of final goods. It can be shown that there is a one-to-one negative relationship between p_t^τ and p_t^n. That is, the tradable goods becomes more expensive relative to the final consumption goods if and only if the nontradable goods becomes cheaper relative to the final consumption goods. This means that we can express the real exchange rate as a decreasing function of the relative price of nontradables, $RER_t = \gamma(p_t^n)$, $\gamma' < 0$.

A competitive equilibrium is then a set of 33 processes k_{t+1}^m, i_t^m, k_{t+1}^x, i_t^x, k_{t+1}^n, i_t^n, c_t, h_t^m, h_t^x, h_t^n, λ_t, w_t^m, w_t^x, w_t^n, p_t^τ, RER_t, r_t, u_t^m, u_t^x, u_t^n, a_t^m, a_t^x, a_t^τ, p_t^m, p_t^x, a_t^n, p_t^n, y_t^m, y_t^x, y_t^n, m_t, x_t, and d_{t+1}, satisfying Equations (7) to (39), given initial conditions k_0^m, k_0^x, k_0^n, and d_0, and the joint stochastic process for tot_t and s_t given in Equation (4).

4.6. *Observables*. In the present model, c_t denotes consumption expressed in units of final (consumption) goods. GDP, investment, and the trade balance expressed in units of final consumption goods, denoted y_t, i_t, and tb_t, respectively, are given by

$$y_t = p_t^m y_t^m + p_t^x y_t^x + p_t^n y_t^n, \tag{40}$$

GDP

$$i_t = i_t^m + i_t^x + i_t^n,$$

and

$$tb_t = x_t - m_t.$$

The data used in the empirical analysis of Section 2, however, are not expressed in terms of final consumption goods. A meaningful comparison of the model predictions with data requires expressing theoretical and empirical variables in the same units. In the SVAR analysis of Section 2, data on GDP, consumption, investment, and the trade balance are deflated by a Paasche GDP deflator. In this section we derive the corresponding theoretical counterparts. In the theoretical model, GDP at current prices is given by

$$P_t^m y_t^m + P_t^x y_t^x + P_t^n y_t^n,$$

where P_t^i denotes the nominal price of goods i in period t, for $i = m, x, n$. The data source (WDI) uses a Paasche index for the GDP deflator, defined as the ratio of current-price to constant-price GDP. That is, the GDP deflator in period t is given by

$$\frac{P_t^m y_t^m + P_t^x y_t^x + P_t^n y_t^n}{P_0^m y_t^m + P_0^x y_t^x + P_0^n y_t^n},$$

where $t = 0$ indicates the base year. Real GDP is nominal GDP divided by the GDP deflator, that is,

$$P_0^m y_t^m + P_0^x y_t^x + P_0^n y_t^n.$$

The nominal prices in the base year, P_0^m, P_0^x, and P_0^n, as well as all other nominal prices in period 0 are indices without a real unit attached. Therefore, without loss of generality we can set one nominal base price arbitrarily. Thus we set the nominal price of consumption in period 0 equal to 1, $P_0 = 1$. This means that $P_0^i = p_0^i$ for $i = m, x, n$ (recall that p_t^i is the relative price of goods i in terms of final consumption goods for $i = m, x, n$). Real output in period t is then given by

$$p_0^m y_t^m + p_0^x y_t^x + p_0^n y_t^n.$$

Finally, we must take a stance on what the state of the economy looked like in the base period. We assume that in the base period the economy was in the deterministic steady state, so that $p_0^i = p^i$ for $i = m, x, n$. Then, the theoretical counterpart of the observed measure of real GDP, which we denote by y_t^o, is given by[6]

$$y_t^o = p^m y_t^m + p^x y_t^x + p^n y_t^n. \tag{41}$$

[6] In the SVAR, real variables are expressed in per capita terms. In the theoretical model, there is no population growth, so real GDP and real GDP per capita are the same.

Similarly, the theoretical counterpart of real consumption is the ratio of nominal consumption, $P_t c_t$, to the GDP deflator, or

$$c_t^o \equiv P_t c_t \frac{P_0^m y_t^m + P_0^x y_t^x + P_0^n y_t^n}{P_t^m y_t^m + P_t^x y_t^x + P_t^n y_t^n}.$$

Recalling that $p_t^i \equiv P_t^i / P_t$ and that $P_0^i = p^i$ for $i = m, x, n$, we can write the theoretical counterpart of observed real consumption as

$$c_t^o = c_t \frac{p^m y_t^m + p^x y_t^x + p^n y_t^n}{p_t^m y_t^m + p_t^x y_t^x + p_t^n y_t^n}.$$

The theoretical counterparts of observed real investment and the trade balance can be obtained in a similar fashion, that is,

$$i_t^o = i_t \frac{p^m y_t^m + p^x y_t^x + p^n y_t^n}{p_t^m y_t^m + p_t^x y_t^x + p_t^n y_t^n}$$

and

$$tb_t^o = tb_t \frac{p^m y_t^m + p^x y_t^x + p^n y_t^n}{p_t^m y_t^m + p_t^x y_t^x + p_t^n y_t^n}.$$

When comparing the predictions of the theoretical model to the data, we use predictions regarding y_t^o, c_t^o, i_t^o, and tb_t^o as opposed to the corresponding measures in terms of final goods, y_t, c_t, i_t, and tb_t. This ensures congruency of the data with the model in the definition of variables. As we will see in Section 6, it makes a significant difference for the share of variance explained by terms-of-trade shocks whether one uses data-consistent measures of macroeconomic indicators or measures expressed in terms of final goods.

4.7. *Functional Forms.* We assume that the period utility function displays constant relative risk aversion (CRRA) in a quasi-linear composite of consumption and labor:

$$U(c, h^m, h^x, h^n) = \frac{[c - G(h^m, h^x, h^n)]^{1-\sigma} - 1}{1 - \sigma},$$

where

$$G(h^m, h^x, h^n) = \frac{(h^m)^{\omega_m}}{\omega_m} + \frac{(h^x)^{\omega_x}}{\omega_x} + \frac{(h^n)^{\omega_n}}{\omega_n},$$

with $\sigma, \omega_m, \omega_x, \omega_n > 0$. This specification implies that sectoral labor supplies are wealth inelastic.

The technologies for producing importables, exportables, and nontradables are all assumed to be Cobb–Douglas,

$$F^m(k^m, h^m) = (k^m)^{\alpha_m} (h^m)^{1-\alpha_m},$$

$$F^x(k^x, h^x) = (k^x)^{\alpha_x} (h^x)^{1-\alpha_x},$$

and

$$F^n(k^n, h^n) = (k^n)^{\alpha_n} (h^n)^{1-\alpha_n},$$

TABLE 4
CALIBRATION OF THE MXN MODEL

Calibrated Structural Parameters										
σ	δ	$r^* + \bar{s}$	α_m, α_x	α_n	$\omega_m, \omega_x, \omega_n$	μ_{mx}	$\mu_{\tau n}$	$\overline{tot}$	A^m, A^n	β
2	0.1	0.11	0.35	0.25	1.455	1	0.5	1	1	$1/(1 + r^* + \bar{s})$
Moment Restrictions										
s_n	s_x	s_{tb}	$\frac{p^m y^m}{p^x y^x}$							
0.5	0.2	0.01	1							
Implied Structural Parameter Values										
χ_m	χ_τ	$\bar{d}$	A^x	β						
0.8980	0.4360	0.0078	1	0.9009						
Estimated Parameters										
ϕ_m	ϕ_x	ϕ_n	ψ	a_{11}	a_{12}	a_{21}	a_{22}	π_{11}	π_{21}	π_{22}
*	*	*	*	**	**	**	**	**	**	**

NOTE: $s_n \equiv p^n y^n / y$, $s_x \equiv x/y$, and $s_{tb} \equiv (x - m)/y$, where $y \equiv p^m y^m + p^x y^x + p^n y^n$.
*Country-specific estimates are presented in Table 5. **Country-specific estimates are given in Section 6 of the Supporting Information Appendix.

where $\alpha_m, \alpha_x, \alpha_n \in (0, 1)$. We assume that the Armington aggregators used in the production of the tradable composite goods and the final goods take CES forms, that is,

$$A\left(a_t^m, a_t^x\right) = \left[\chi_m \left(a_t^m\right)^{1-\frac{1}{\mu_{mx}}} + (1 - \chi_m)\left(a_t^x\right)^{1-\frac{1}{\mu_{mx}}}\right]^{\frac{1}{1-\frac{1}{\mu_{mx}}}}$$

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

with $\chi_m, \chi_\tau \in (0, 1)$ and $\mu_{mx}, \mu_{\tau n} > 0$. The specification of the interest-rate premium and the capital adjustment costs are, respectively,

$$p(d) = \psi\left(e^{d-\bar{d}} - 1\right)$$

and

$$\Phi_j(x) = \frac{\phi_j}{2} x^2,$$

with $\psi, \phi_j > 0$, for $j = m, x, n$.

5. CALIBRATION, ESTIMATION, AND IMPULSE RESPONSES

The MXN model is medium scale in size and lies at the intersection of trade and business-cycle analysis. The characterization of the steady state is complex—even numerically. The calibration of the model inherits this complexity.

Tables 4 and 5 summarize the calibration and estimation results. The time unit is meant to be a year. We denote the steady-state value of a variable by dropping the time subscript. The equilibrium conditions (7)–(39) evaluated at the steady state and adopting the assumed functional forms represent a system of 33 equations in 52 unknowns, namely, the 33 endogenous variables listed in the definition of equilibrium given in Subsection 4.5 and 19 structural parameters, namely, A^m, A^x, A^n, δ, ω_m, ω_x, ω_n, β, χ_m, μ_{mx}, χ_τ, $\mu_{\tau n}$, α_m, α_x, α_n, $r^* + \bar{s}$, $\bar{d}$, $\overline{tot}$, and

TABLE 5
COUNTRY-SPECIFIC ESTIMATES OF THE CAPITAL ADJUSTMENT COST PARAMETERS AND THE DEBT ELASTICITY OF THE INTEREST RATE

Country	ϕ_m	ϕ_x	ϕ_n	ψ
Algeria	73.26	79.24	73.60	0.72
Argentina	0.04	10.02	8.80	57.57
Bolivia	76.87	77.26	76.42	60.19
Botswana	0.13	12.74	0.13	66.79
Brazil	77.89	54.61	75.71	71.67
Burundi	0.18	2.97	5.09	0.01
Cameroon	0.81	67.35	78.44	42.29
Central African Republic	1.71	73.39	79.72	50.12
Colombia	12.05	0.97	1.82	5.31
Congo, Dem. Rep.	31.38	79.26	4.23	22.35
Costa Rica	45.07	33.13	78.24	0.02
Côte d’Ivoire	47.36	78.77	69.61	0.31
Dominican Republic	0.05	36.93	0.30	19.62
Egypt, Arab Rep.	39.29	79.06	36.60	0.03
El Salvador	77.66	2.18	79.87	2.09
Ghana	76.86	70.43	79.65	0.05
Guatemala	70.20	77.67	45.93	0.01
Honduras	3.62	2.44	9.46	0.00
India	51.44	12.37	75.14	0.88
Indonesia	8.96	79.52	0.45	78.83
Jordan	33.99	78.59	75.82	0.43
Kenya	38.48	79.10	63.71	0.03
Korea, Rep.	5.50	49.18	68.05	9.65
Madagascar	17.43	22.33	0.91	0.00
Malaysia	48.49	66.90	13.40	0.30
Mauritius	30.50	74.04	68.71	0.03
Mexico	78.24	46.33	68.65	0.29
Morocco	75.85	78.07	68.23	78.82
Pakistan	54.50	79.63	77.57	0.02
Paraguay	77.48	31.66	79.08	6.91
Peru	78.73	74.39	37.65	5.49
Philippines	79.20	7.30	70.09	0.06
Senegal	13.59	79.42	20.80	0.01
South Africa	42.66	79.77	55.58	0.03
Sudan	41.02	35.78	31.75	0.02
Thailand	74.98	37.47	38.05	0.03
Turkey	52.55	1.02	77.12	3.66
Uruguay	68.18	78.29	74.65	78.17
Median	43.87	67.13	68.14	0.58
Median absolute deviation	31.46	12.51	11.54	0.57

σ. (The structural parameters ψ, a_{ij}, π_{ij}, for $i, j = 1, 2$, and ϕ_j, for $j = m, x, n$ do not appear in the steady-state system. We will address the values assigned to these parameters shortly.) Therefore, we must add 19 calibration restrictions (which we enumerate in parenthesis). (1) We set $\sigma = 2$, which is a common value in business-cycle analysis. (2)–(4) $\omega_m = \omega_x = \omega_n = 1.455$. This value implies a sectoral Frisch elasticity of labor supply of 2.2, which is the number assumed in the one-sector model studied in Mendoza (1991). Lacking sector-level information about this elasticity, we assume the same value in the three sectors. (5) We assume a depreciation rate of physical capital of $\delta = 0.1$, which is a standard value. (6) $r^* + \bar{s} = 0.11$ (the split of this value between r^* and $\bar{s}$ is immaterial). This value is taken from Uribe and Yue (2006) and reflects the relatively high average interest rate faced by poor and emerging countries in world financial markets. (7) $\mu_{mx} = 1$. There is a vast literature on estimating the elasticity of substitution between exportable and importable goods, μ_{mx}. One branch of this literature uses aggregate data at quarterly frequency and estimates μ_{mx} in the context of open-economy DSGE models. This body of work typically estimates μ_{mx} to be below unity. For instance, Corsetti et al. (2008), Gust et al. (2009), and Justiniano and Preston (2010) all estimate μ to lie between 0.8 and 0.86. Miyamoto and Nguyen (2014) estimate μ_{mx} to be 0.4. A second branch of the literature infers the value of μ_{mx} from trade liberalization episodes using average changes in quantities and prices observed over periods of 5–10 years. This approach typically yields values of μ_{mx} greater than 1, in the neighborhood of 1.5 (see, for example, Whalley, 1985). It is intuitive that studies based on low frequency data deliver values of μ_{mx} higher than studies based on quarterly data. It is natural to expect that agents can adjust more fully to relative-price changes in the long run than in the short run. Because SVAR analysis Section 2 uses annual data, it is sensible to adopt a value of μ_{mx} in between those stemming from the two aforementioned bodies of work. Accordingly, we set μ_{mx} equal to 1. (8) $\overline{tot} = 1$. (9) $A^m = 1$. (10) $A^n = 1$. (11) $\beta = 1/(1 + r^* + \bar{s})$. Restrictions (8)–(11) are normalizations, with (11) ensuring that the steady-state level of debt coincides with the parameter $\bar{d}$. (12) The average of the ratio of value added exports to GDP across poor and emerging countries computed using data from the OECD's TiVA database is 20%. Therefore, we impose $x/(p^m y^m + p^x y^x + p^n y^n) = 0.2$. (13) In our sample of 38 countries, the average trade balance-to-GDP ratio is 1%, or $(x - m)/(p^m y^m + p^x y^x + p^n y^n) = 0.01$. (14) Na (2015) estimates an average labor share for emerging countries of 70%, so we impose $(w^m h^m + w^x h^x + w^n h^n)/(p^m y^m + p^x y^x + p^n y^n) = 0.7$. (15) It is generally assumed that in emerging and poor countries the nontraded sector is more labor intensive than the export or import producing sectors. For instance, Uribe (1997), based on Argentine data, calculates the labor share in the nontraded sector to be 0.75. We follow this calibration and impose the restriction $w^n h^n/(p^n y^n) = 0.75$. (16) Lacking cross-country evidence on labor shares in the import and export sectors, we assume that the importable and exportable sectors are equally labor intensive; that is, we impose $w^m h^m/(p^m y^m) = w^x h^x/(p^x y^x)$. (17) We follow the usual practice of proxying the share of nontraded output in total output by the observed share of the service sector in GDP. Using data from UNCTAD's Handbook of Statistics on sectoral GDP for poor and emerging countries over the period 1995 to 2012, we obtain an average share of services in GDP of slightly above 50%. Thus, we impose the restriction $p^n y^n/(p^m y^m + p^x y^x + p^n y^n) = 0.5$. (18) Using data from UNCTAD, we estimate that in emerging and poor countries the exportable and importable sectors are of about the same size. Therefore, we impose the restriction $p^x y^x = p^m y^m$. (19) Finally, Akinci (2011) surveys the literature on estimates of the elasticity of substitution between tradables and nontradables in emerging and poor countries and arrives at a value close to 0.5. Thus we set $\mu_{\tau n} = 0.5$. This completes the calibration strategy of the 19 parameters appearing in the set of steady-state equilibrium conditions.

The parameters a_{ij}, π_{ij} for $i, j = 1, 2$, ϕ_j, for $j = m, x, n$, and ψ do not appear in the steady-state equilibrium conditions but play a role in the equilibrium dynamics. We assign values to a_{ij} and π_{ij} for $i, j = 1, 2$ country by country using the econometric estimates presented in Section 6 of the Supporting Information Appendix. We use a partial information method to estimate the capital adjustment cost parameters, ϕ_m, ϕ_x, ϕ_n, and the parameter ψ governing the debt elasticity of the country premium. Specifically, we set these parameters to minimize a weighted difference between the impulse responses to terms-of-trade and interest-rate-spread shocks of output, consumption, investment, the trade balance, and the real exchange rate implied by the SVAR and MXN models. We consider the first five years of each impulse response function and use as weights the reciprocal of the width of the 66% confidence interval associated with the SVAR impulse responses. Formally, letting $\Theta \equiv [\phi_m\ \phi_x\ \phi_n\ \psi]$, we set Θ as the solution to the problem

$$\min_{\Theta} \sum_{h=tot,s} \sum_{i=0}^{4} \sum_{j=y^o,c^o,i^o,tb^o,RER} \frac{\left| IR_{hij}^{SVAR} - IR_{hij}^{MXN}(\Theta) \right|}{\Delta_{hij}},$$

where IR^{SVAR}_{hij} and $IR^{MXN}_{hij}(\Theta)$ denote the impulse response of variable j i periods after a shock h implied by the SVAR and MXN models, respectively, and Δ_{hij} denotes the width of the 66% confidence band associated with IR^{SVAR}_{hij}. We perform this estimation country by country.

Table 5 displays the estimated parameters. There is substantial cross-country dispersion in the estimated parameter values, especially for ϕ_m and ψ, which have median absolute deviations almost as large as the estimated medians themselves. This suggests that the strategy of estimating parameters country by country is preferred to the standard practice of one parameterization for all countries.

Section 7 of the Supporting Information Appendix displays for each of the 38 countries in the panel the impulse responses to a terms-of-trade shock in the estimated SVAR and MXN models. As a summary, Figure 2 presents the corresponding cross-country median impulse responses. The model fits the data modestly well. The impulse responses of the trade balance and the real exchange rate predicted by the MXN model are similar in magnitude and shape to those implied by the SVAR model. However, the MXN model predicts a much larger median response of output, consumption, and investment than observed in the data.

To facilitate the understanding of the transmission of terms-of-trade shocks in the MXN model, Figure 3 considers the responses of the variables included in Figure 2 along with other variables that were not included in the SVAR system. The figure displays cross-country medians of the response to a 10% improvement in the terms of trade implied by the MXN model. In line with the data, the MXN model implies that an improvement in the terms of trade appreciates the real exchange rate, that is, it makes the country more expensive vis-à-vis the rest of the world. The explanation behind this prediction has to do with substitution and income effects. An increase in the relative price of exportables induces a substitution of importable and nontraded absorption for exportable absorption. At the same time, the increase in the price of exportables produces a positive income effect that boosts the domestic demand for all types of goods. Both effects drive up the price of nontradables, because the expansion in the demand for this type of goods must be met by domestic producers, who require a higher price to produce more. The top right panel of Figure 3 shows that indeed nontradables become more expensive after the positive terms-of-trade shock. In turn, the increase in the price of nontradables translates into an increase in the price of the final goods relative to the price of the tradable composite goods; that is, p^{τ}_t falls.

The increase in the terms of trade produces an expansion in exports and imports and an improvement in the trade balance (second row of Figure 3). Imports increase because, as these goods become cheaper relative to exportable goods, consumers increase demand and domestic producers cut back supply. The net effect on the trade balance turns out to be positive. Thus, the MXN model is in line with the Harberger–Laursen–Metzler effect present in the SVAR model.

Like the SVAR model, the MXN model implies that output expands in response to an improvement in the terms of trade (left panel on the third row of Figure 3). This expansion is the result of increased activity in the export and the nontraded sectors, which is only partially offset by a contraction in the importable sector (row 4 of Figure 3). Sectoral investment mimics the behavior of sectoral production. The improvement in the terms of trade induces firms to increase investment in the export and nontradable sectors and reduce investment in the import sector (bottom row of Figure 3). The reason investment in the exportable and nontradable sectors increases is that the improvement in the terms of trade is persistent, which induces an expected increase in the profitability of these sectors.

6. HOW IMPORTANT ARE TERMS-OF-TRADE SHOCKS? THEORETICAL PREDICTIONS

In this section we address the question of how important terms-of-trade shocks are from the view point of the MXN model and compare the answer to that obtained from the

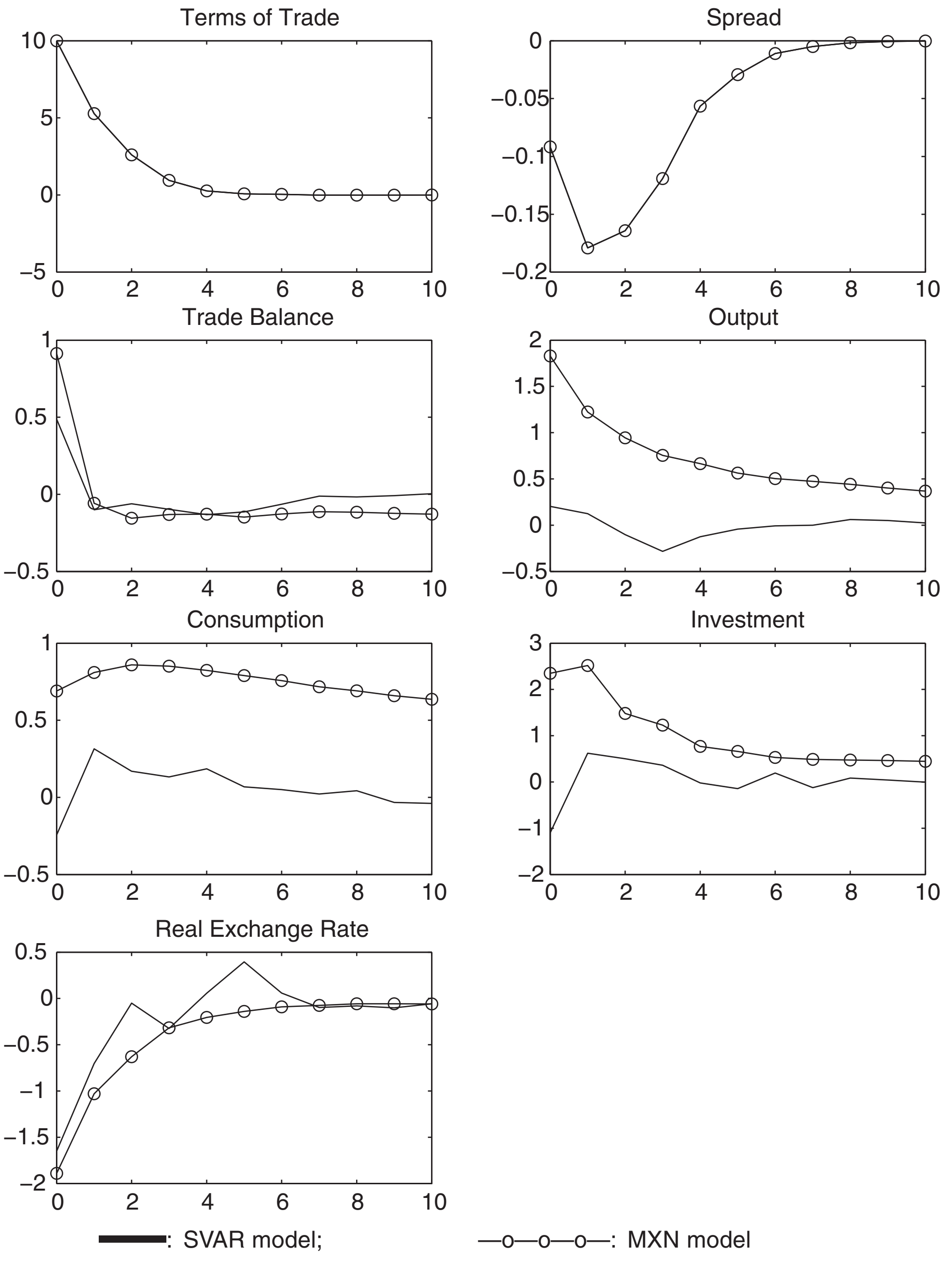
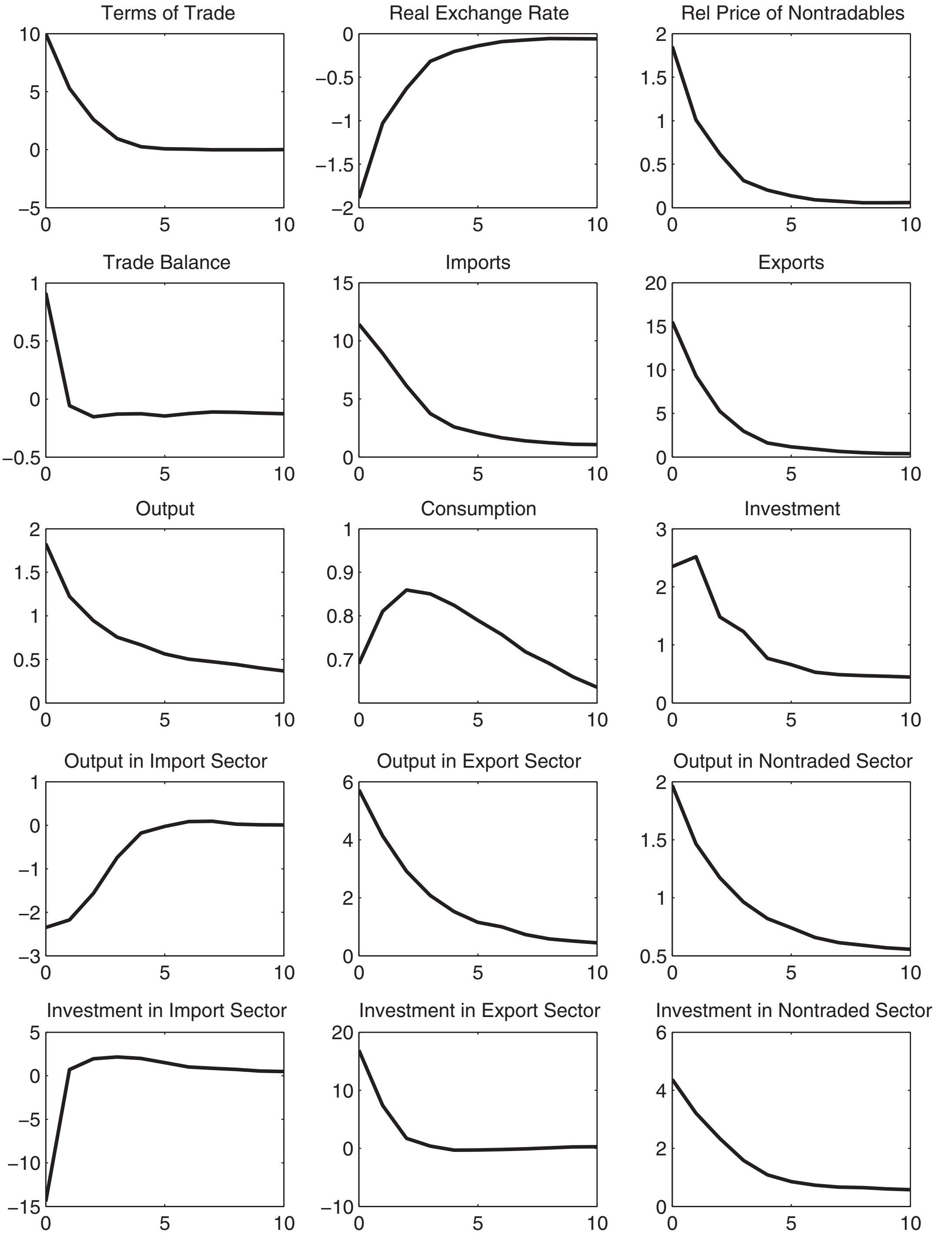


FIGURE 2

MEDIAN RESPONSE TO A 10% TERMS-OF-TRADE SHOCK: DATA VERSUS MODEL

SVAR model. We compute the share of the variance of output explained by terms-of-trade shocks as the ratio of the variance of output conditional on terms-of-trade shocks implied by the MXN model to the unconditional variance of output implied by the SVAR model of Section 3.

The first two columns of Table 6 show that, like the SVAR model of Section 3, the MXN model assigns a small role to terms-of-trade shocks in explaining the variance of output. In both the SVAR and MXN models, the cross-country median of the share of the variance of



NOTE: All variables with the exception of the trade balance are expressed in percent deviations from steady state. The trade balance is expressed in level deviations from steady state in percent of steady-state output. Impulse responses are cross-country medians. For each country, impulse responses are produced using the country specific estimates of ϕ_m, ϕ_x, ϕ_n, ψ, a_{ij}, and π_{ij}, for $i, j = 1, 2$.

FIGURE 3

RESPONSE OF THE MXN ECONOMY TO A 10% TERMS-OF-TRADE SHOCK

TABLE 6

SHARE OF OUTPUT VARIANCE EXPLAINED BY TERMS-OF-TRADE SHOCKS: SVAR VERSUS MXN MODEL

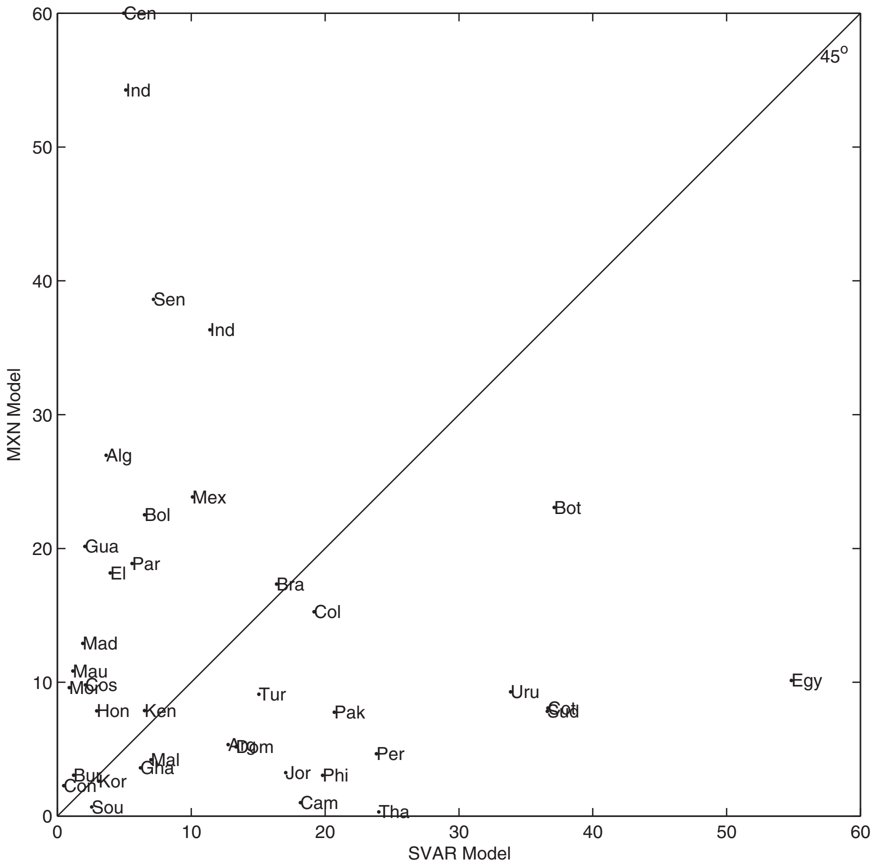
		MXN Model	
	SVAR Model	Paasche GDP Deflator (y_t^o)	Units of Final Goods (y_t)
Median	7.1	9.2	27.4
MAD	5.8	6.1	16.8

NOTE: MAD stands for median absolute deviation. Medians and median absolute deviations are taken over the 38 countries in the panel. Variance shares are computed as the ratio of variances of output conditional on terms-of-trade shocks to the unconditional variance of output implied by the SVAR model of Section 3.

output explained by terms-of-trade disturbances is less than 10%. This result is at odds with the findings in the related literature that uses theoretical models similar to the MXN model studied here, which attributes a major role to terms-of-trade disturbances as drivers of business cycles in poor and emerging countries.

What could account for this discrepancy? As discussed earlier, our estimate of the terms-of-trade process is quite similar to those used in related studies, suggesting that this is not the source of the discrepancy. The third column of Table 6 suggests one possible explanation for the discrepancy between the small role of terms of trade documented here and the large role that is conventionally assigned to this source of uncertainty in the context of theoretical models similar to the MXN model. As mentioned in Subsection 4.6, the empirical measure of output in the WDI database is the result of deflating nominal output by a Paasche GDP deflator. Its counterpart in the theoretical model is output measured at constant prices, y_t^o, as defined in Equation (41). Conventionally, however, theoretical studies measure output in units of final goods, y_t, as defined in Equation (40). Table 6 shows that the importance of terms-of-trade shocks is quite sensitive to the specific deflator used to define real output in the theoretical model. When output is measured in units of final goods, the MXN model predicts that terms-of-trade shocks explain on average almost 30% of the variance of output, which implies a sizable role for the terms of trade as a source of business-cycle fluctuations. However, this conclusion would be misplaced, since it is based on a number that lacks the interpretation of a variance share. To see this, recall that the denominator of this variance share (i.e., the unconditional variance of output implied by the SVAR model) is computed using a measure of output deflated by a Paasche GDP deflator, whereas the numerator is computed using a measure of output expressed in units of current final goods.

The reason the variance of output conditional on terms-of-trade shocks is predicted to be higher when output is measured in units of final goods than when it is deflated by a Paasche GDP deflator is as follows. Recall that when output is deflated by the Paasche GDP deflator, quantities are weighted by time invariant prices. By contrast, when output is measured in units of (current) final goods, quantities are weighted by time-varying prices. Depending on the correlation structure of prices and quantities, the two measures can, in principle, give rise to different results. Consider a simple example of an economy that produces only exportable goods and consumes only importable goods. In this case, we have that $\hat{y}_t^o = \hat{y}_t^x$ and $\hat{y}_t = \hat{p}_t^x + \hat{y}_t^x$, where a hat denotes log-deviation from the steady state. Then we have that $\mathrm{var}(\hat{y}_t^o) = \mathrm{var}(\hat{y}_t^x)$, whereas $\mathrm{var}(\hat{y}_t) = \mathrm{var}(\hat{p}_t^x) + \mathrm{var}(\hat{y}_t^x) + 2\mathrm{cov}(\hat{p}_t^x, \hat{y}_t^x)$. The covariance between $\hat{p}_t^x$ and $\hat{y}_t^x$ has the same sign as the covariance between the terms of trade and $\hat{p}_t^x$, since in this economy one can show that $\hat{p}_t^x$ depends only on and is increasing in the terms of trade. Also, the production of exportables increases with the terms of trade. This implies that the variance of $\hat{y}_t^o$ conditional on terms-of-trade shocks is smaller than that of $\hat{y}_t$. In words, since prices and quantities move in the same direction in response to terms-of-trade shocks, the conditional variance of output is higher when the quantity of exportables is multiplied by current prices than when it is multiplied by steady-state prices. To the extent that the effects of terms-of-trade shocks in the MXN model



NOTE: Variance shares are expressed in percent.

FIGURE 4

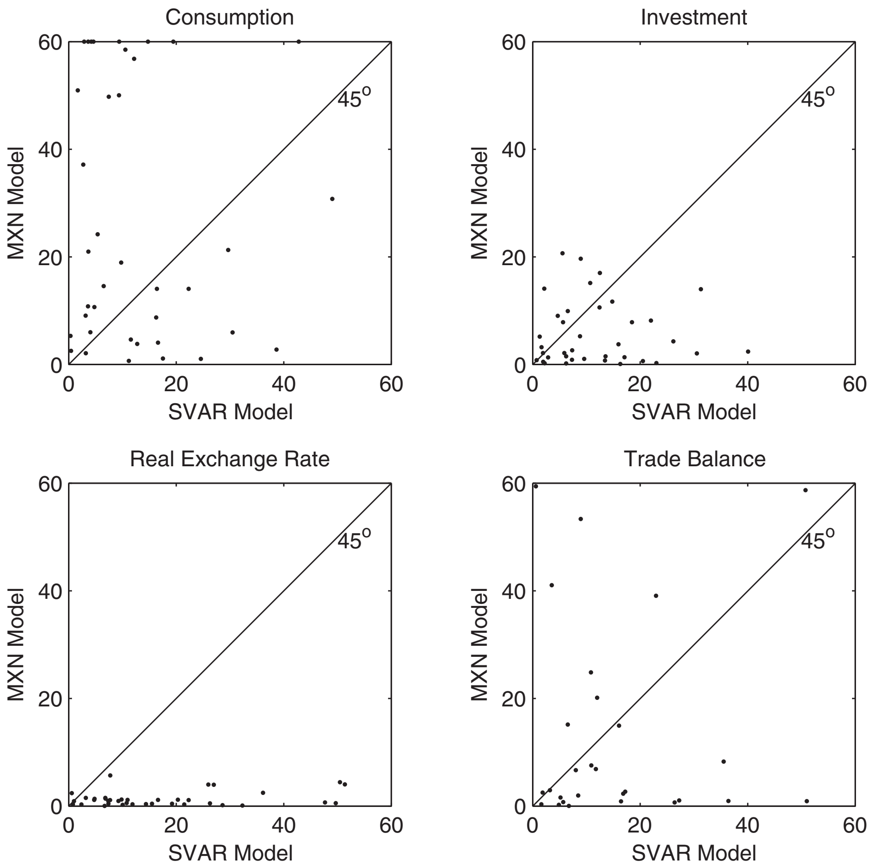
VARIANCE OF OUTPUT EXPLAINED BY TERMS-OF-TRADE SHOCKS: SVAR MODEL VERSUS MXN MODEL

are dominated by the dynamics of the exportable sector, the intuition derived from the simple economy will carry over.

7. THE TERMS-OF-TRADE DISCONNECT

The first two columns of Table 6 might give the impression that the SVAR and MXN models speak with the same voice, as both predict that on average terms-of-trade shocks explain less than 10% of the variance of output. This conclusion, however, would be misplaced, because the picture that emerges from a country-by-country analysis suggests a different interpretation.

Figure 4 plots the share of the variance of output explained by the terms of trade according to the empirical SVAR model of Section 3 (horizontal axis) against the corresponding share according to the MXN model (vertical axis). Each point in the figure represents one of the 38 countries in the sample. If the predictions of the theoretical model were in line with the data, all points would lie on the 45° line. However, not only does the cloud of points fail to trace out the 45° line, it does not even suggest a positive relation between the predictions of the empirical and theoretical models. The correlation between the variance shares predicted by the SVAR and MXN models is –0.1. This result is not limited to output. A similar lack of correlation between theory and data obtains for consumption, investment, the trade balance, and the real exchange rate, as shown by Figure 5. These findings lead us to conclude that there is a disconnect between



NOTE. Variance shares are expressed in percent.

FIGURE 5

VARIANCE OF CONSUMPTION, INVESTMENT, THE TRADE BALANCE, AND THE REAL EXCHANGE RATE EXPLAINED BY TERMS-OF-TRADE SHOCKS: SVAR MODEL VERSUS MXN MODEL

data and model when it comes to the importance of terms-of-trade shocks as a source of business cycles.

8. CONCLUSION

In this article, we argue that when one looks at the data through the lens of SVAR models, terms-of-trade shocks play a modest role in generating aggregate fluctuations in emerging and poor countries. A panel of 38 countries containing annual data from 1980 to 2011 yields a median contribution of terms of trade to the overall variance of output of less than 10%.

This result is at odds with the standard view, built on the predictions of calibrated micro-founded dynamic business-cycle models, according to which terms-of-trade disturbances explain at least 30% of movements in aggregate activity. We formulate a more flexible specification of this framework and estimate key structural parameters using country-level data. We find that, when macroeconomic variables are measured in the same units in the theoretical model as in the data on average across countries, this specification predicts that terms-of-trade shocks also explain less than 10% of movements in aggregate activity, which is broadly in line with the predictions of the SVAR model. However, although the importance assigned to terms-of-trade shocks by the theoretical model is on average similar to that predicted by the empirical SVAR model, the predictions of the two models at the country level are far apart. For output, consumption, investment, the trade balance, and the real exchange rate, there is a near-zero cross-country correlation between the share of variance attributed to terms-of-trade shocks by the theoretical model and by the empirical model.

The resolution of the disconnect is likely to involve a combination of better empirical and theoretical models as means to interpret the data. For example, an improvement in the empirical model could stem from entertaining the hypothesis that commodity prices are a better measure of the terms of trade than aggregate indices of export and import unit values—the measure used in the present study. At the same time, the theoretical model could be amended by assuming that the government uses tax or commercial policy to isolate the country from swings in world prices. In this case, movements in the terms of trade will elicit attenuated incentives to change the domestic allocation of output and absorption. A related reason that fluctuations in the terms of trade may have different effects across countries could be the presence of different degrees of nominal rigidities, which may introduce country-specific wedges between domestic and world prices.

Finally, in the present study we produce country-specific estimates of several but not all of the structural parameters of the theoretical model. Expanding the number of parameters estimated at the country level may ameliorate the terms of trade disconnect. This task, however, is not an easy one. The reason is that all of the parameters that we left out of the country-specific estimation affect the deterministic steady state of the model. In turn, multiple-goods general-equilibrium models, like the MXN model studied in this article, deliver steady states that are highly nonlinear, making their numerical solution time consuming. At the writing of this article, this complication renders the application of econometric techniques that rely on repeated solutions of the steady state of the model, such as likelihood-based or GMM methods, impractical.

APPENDIX

Description of Data Sources. Unless noted otherwise the data source is the World Bank's WDI database. The raw data from this source consists of the following annual time series.

(1) $\frac{P_t^x}{P_t^m}$, Net barter terms of trade index (2000 = 100), `TT.PRI.MRCH.XD.WD`
(2) y_t^o, GDP per capita in constant local currency units, `NY.GDP.PCAP.KN`.
(3) $\frac{P_t^i I_t}{P_t^y Y_t}$, Gross capital formation (% of GDP), `NE.GDI.TOTL.ZS`.
(4) $\frac{P_t^m M_t}{P_t^y Y_t}$, Imports of goods and services (% of GDP), `NE.IMP.GNFS.ZS`.
(5) $\frac{P_t^x X_t}{P_t^y Y_t}$, Exports of goods and services (% of GDP), `NE.EXP.GNFS.ZS`.
(6) $\frac{P_t^c C_t}{P_t^y Y_t}$, Household final consumption expenditure, etc. (% of GDP), `NE.CON.PETC.ZS`.
(7) GDP per capita, PPP (constant 2005 international $), `NY.GDP.PCAP.PP.KD`.
(8) Consumer price index (2010 = 100), `FP.CPI.TOTL`.
(9) Official exchange rate (LCU per US$, period average), `PA.NUS.FCRF`.
(10) Real effective exchange rate index (2005 = 100), `PX.REX.REER`.

The criteria for a country to be included in the panel is to have at least 30 consecutive annual observations on all components of the vector x_t and to belong to the group of poor and emerging countries. We define the group of poor and emerging countries as all countries in the WDI database with average PPP converted GDP per capita in U.S. dollars of 2005 over the period 1990–2009 below 25,000 dollars. Forty-two countries satisfy these criteria. However the final sample has 38 countries as we exclude four (Gambia, Swaziland, Gabon, and Panama) because of faulty terms-of-trade data. We quadratically detrend each series on the longest available sample for that series. The SVAR is then estimated using the longest sample for all components of x_t, which turns out to be 1980–2011, with three exceptions: Algeria 1980–2009, Indonesia 1981–2011, and Madagascar 1980–2009. The terms-of-trade data in WDI begin in 1980 and hence dictate the beginning of the sample.

The WDI does not provide CPI data for Argentina. The Argentine CPI index was taken from INDEC until 2006 and from IPC-7-Provincias from 2007 to 2011 due to systematic underreporting by INDEC during this period.

The data source for the corporate bond spread in the United States is Federal Reserve Economic Data, available online at https://fred.stlouisfed.org. We use the series `BAAFFM`, which is defined as Moody's Seasoned Baa Corporate Bond Yield minus the Federal Funds Rate. The spread is monthly and covers the period July 1954 to August 2016. We drop the years for which we do not have 12 monthly observations, which are 1954 and 2016, and then compute the annualized (gross) spread for the years 1955–2015 as the geometric average of the monthly spreads before detrending it.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Online Appendix

REFERENCES

AGUIRRE, E., "Business Cycles in Emerging Markets and Implications for the Real Exchange Rate," Ph.D. Dissertation, Columbia University, 2011.

AKINCI, Ö., "A Note on the Estimation of the Atemporal Elasticity of Substitution Between Tradable and Nontradable Goods," mimeo, Columbia University, 2011.

———, "Global Financial Conditions, Country Spreads and Macroeconomic Fluctuations in Emerging Countries," *Journal of International Economics* 91 (2013), 358–71.

BEMS, R., "Aggregate Investment Expenditures on Tradable and Nontradable Goods," *Review of Economic Dynamics* 11 (2008), 852–83.

BRODA, C., "Terms of Trade and Exchange Rate Regimes in Developing Countries," *Journal of International Economics* 63 (2004), 31–58.

CORSETTI, G., L. DEDOLA, AND S. LEDUC, "International Risk Sharing and the Transmission of Productivity Shocks," *Review of Economic Studies* 75 (2008), 443–73.

FERNÁNDEZ, A., A. GONZÁLEZ, AND D. RODRÍGUEZ, "Sharing a Ride on the Commodities Roller Coaster: Common Factors in Business Cycles of Emerging Economies," mimeo, IDB, 2015.

FERNÁNDEZ-VILLAVERDE, J., P. GUERRÓN-QUINTANA, J. RUBIO-RAMÍREZ, AND M. URIBE, "Risk Matters: The Real Effects of Volatility Shocks," *American Economic Review* 101 (2011), 2530–61.

GARCÍA-CICCO, J., R. PANCRAZI, AND M. URIBE, "Real Business Cycles in Emerging Countries?" *American Economic Review* 100 (2010), 2510–31.

GUST, C., S. LEDUC, AND N. SHEETS, "The Adjustment of Global External Balances: Does Partial Exchange-Rate Pass-Through to Trade Prices Matter?" *Journal of International Economics* 79 (2009), 173–85.

JUSTINIANO, A., AND B. PRESTON, "Can Structural Small Open Economy Models Account for the Influence of Foreign Disturbances?" *Journal of International Economics* 81 (2010), 61–74.

KOSE, M. A., "Explaining Business Cycles in Small Open Economies 'How Much Do World Prices Matter?'" *Journal of International Economics* 56 (2002), 299–327.

LUBIK, T. K., AND W. L. TEO, "Do World Shocks Drive Domestic Business Cycles? Some Evidence from Structural Estimation," mimeo, Johns Hopkins University, 2005.

MCINTYRE, K. H., "Can Non-traded Goods Solve the 'Comovement Problem?'" *Journal of Macroeconomics* 25 (2003), 169–96.

MENDOZA, E., "Real Business Cycles in a Small-Open Economy," *American Economic Review* 81 (1991), 797–818.

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

MIYAMOTO, W., AND T. L. NGUYEN, "Understanding the Cross Country Effects of U.S. Technology Shocks," mimeo, Bank of Canada, 2014.

NA, S., "Business Cycles and Labor Income Shares in Emerging Economies," mimeo, Columbia University, 2015.

NEUMEYER, P. A., AND F. PERRI, "Business Cycles in Emerging Markets: The Role of Interest Rates," *Journal of Monetary Economics* 52 (2005), 345–80.

OTTO, G., "Terms of Trade Shocks and the Balance of Trade: There Is a Harberger–Laursen–Metzler Effect," *Journal of International Money and Finance* 22 (2003), 155–84.
SCHMITT-GROHÉ, S., AND M. URIBE, "Closing Small Open Economy Models," *Journal of International Economics* 61 (2003), 163–85.
SHOUSHA, S., "Macroeconomic Effects of Commodity Booms and Busts," mimeo, Columbia University, 2015.
URIBE, M., "Exchange Rate Based Inflation Stabilization: The Initial Real Effects of Credible Plans," *Journal of Monetary Economics* 39 (1997), 197–221.
———, AND Z. V. YUE, "Country Spreads and Emerging Countries: Who Drives Whom?" *Journal of International Economics* 69 (2006), 6–36.
WHALLEY, J., *Trade Liberalization Among Major World Trading Areas* (Cambridge: MIT Press, 1985).