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ABSTRACT

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 SVAR models is strikingly different. We estimate country-specific SVARs using data from 38 poor and emerging countries and find that terms-of-trade shocks explain only 10 percent of movements in aggregate activity. We then build a fully-fledged, open economy model with three sectors, importables, exportables, and nontradables, and use data from each of the 38 countries to obtain country-specific estimates of key structural parameters, including those defining the terms-of-trade process. In the estimated theoretical business-cycle models terms-of-trade shocks explain on average 30 percent of the variance of key macroeconomic indicators, three times as much as in SVAR models.

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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 percent of the variance of output and other macroeconomic indicators is attributable to terms-of-trade shocks (Mendoza, 1995; Kose, 2002).

In this paper, 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 percent of movements in aggregate activity. The insight 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 a single identification restriction, namely 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 build. 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 model share the same terms-of-trade process for each country in the sample. Fourth, both the parameters of the empirical SVAR model and key parameters of the theoretical model are estimated country by country using the same time series. Moreover, the estimation of the structural parameters of the theoretical model matches second moments conditional on 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 according to the theoretical model terms-of-trade shocks explain on average around 30 percent of the variance of output and other aggregates. Thus, terms-of-trade shocks are three times more important in the theoretical model than they are in the SVAR model.

The disconnect between the empirical and theoretical models extends, to a lesser degree, to the role of terms-of-trade shocks in explaining fluctuations in aggregate prices. An important relative price for open economies is the real exchange rate, defined as the relative price of a representative basket of goods domestically in terms of the same basket abroad. The real exchange rate measures the economy's competitiveness relative to the rest of the world. Fluctuations in this variable guide the allocation of factors of production and absorption across tradable and nontradable sectors. We find that in the empirical model terms-of-trade shocks explain on average 14 percent of the variance of the real exchange rate. By contrast, in the theoretical model, terms-of-trade disturbances account on average for only 1 percent of the variance of the real-exchange-rate. It is noteworthy, that while the theoretical model exaggerates the role of terms of trade shocks in explaining variations in aggregate quantities, it underpredicts their role in generating movements in the real exchange rate.

This paper is related to a number of theoretical and empirical studies on the effect 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. 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 paper 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 paper is presented in five sections. Section 2 estimates country-specific SVAR models and presents the implied share of aggregate fluctuations attributable to terms-of-trade shocks. Section 3 presents the theoretical model. Section 4 presents the calibration of the model and performs country-specific estimates of key structural parameters. Section 5 presents a comparative analysis of the contribution of terms of trade shocks to business cycles implied by theoretical and SVAR models. Section 6 concludes.

2 How Important Are Terms of Trade Shocks?

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.

Consider the empirical VAR model

$$x_t = \mathbf{A}\, x_{t-1} + u_t,$$

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 $\widehat{tb}_t$ is the ratio of the trade balance to trend output. The variable u_t is a 6-by-1 vector with mean zero and variance-covariance matrix Σ, and $\mathbf{A}$ is a 6-by-6 matrix of coefficients.

All variables are quadratically detrended. The trade balance is first divided by the trend component of output and then quadratically detrended. The data source is the World Bank's World Development Indicators (WDI) database. The panel contains 38 countries and covers the period 1980 to 2011 at an annual frequency. 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.[1]

For a given country, the terms of trade 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

[1] 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 to 2009 below 25,000 dollars. 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, 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.

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.

As the empirical measure of the real exchange rate, RER_t, we use 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.[2] Details on the data are provided in the appendix.[3]

The typical emerging country is a small player in the world markets for the goods it exports or imports. Therefore, we assume that the emerging country takes the terms of trade as exogenously given. This assumption is commonplace in the existing related literature. Thus, variations in the terms of trade can be regarded as an exogenous source of aggregate fluctuations. 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 output, consumption, and investment is rejected at the five-percent level for 32 out of the 38 countries in the sample.[4] To this end, we impose the following two identification restrictions. First, we assume that the off-diagonal elements of the first row of the matrix $\mathbf{A}$ are zero, $a_{1j} = 0$ for $j = 2, \ldots, 6$, where a_{ij} denotes the element (i, j) of the matrix $\mathbf{A}$. Second, we assume that

$$u_t = \Pi \epsilon_t,$$

where Π is a 6-by-6 matrix and ϵ_t is a 6-by-1 vector of white noises with mean zero and identity variance-covariance matrix. Thus,

$$\Sigma = \Pi\, \Pi'.$$

[2] 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. However, we do not use it in the baseline estimation because it has a more limited time and country coverage.

[3] 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.

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

We pick Π to be the lower-triangular Cholesky decomposition of Σ. This choice identifies the first element of ϵ_t, denoted ϵ_t^1, as the terms of trade shock, and element $(1,1)$ of Π, denoted π_{11}, as the standard deviation of the innovation to the terms of trade process. The serial correlation of tot_t is the first element of the matrix $\mathbf{A}$, a_{11}. Thus, the terms-of-trade process takes the form

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

Because our analysis focuses on the effects of terms-of-trade shocks, the ordering of elements 2 to 6 of x_t in the, now structural, VAR is immaterial. We estimate the SVAR equation by equation and country by country by OLS.

Table 1 displays country-specific estimates of the first equation of the SVAR, which defines the stochastic process of the terms of trade. 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, our estimates of the terms-of-trade process are close to those obtained by Mendoza (1995) who uses terms-of-trade from 1961 to 1990 for a set 23 poor and emerging countries which has 16 countries in common with our 38-country panel.

Figure 1 displays the response of the variables included in the vector x_t to a 10 percent improvement in the terms of trade.[5] The displayed impulse responses are point-by-point medians of the corresponding country-specific impulse responses. On impact, a ten-percent increase in the terms of trade causes an improvement in the trade balance of half a percent of GDP. Thus, the data lends 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 to 1996.

The improvement in the terms of trade causes an expansion in aggregate activity. Specifically, the 10 percent increase in the terms of trade causes an increase of 0.36 percent 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 ten-percent improvement in the terms of trade leads to a 1.6 percent real exchange rate appreciation on impact, with a half life of about 2 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.

[5] We choose a 10 percent improvement because it is a round number and because it is close to the median standard deviation of ϵ_t^1 of 8 percent.

Table 1: The Terms of Trade Process: Country-by-Country Estimates

$$\widehat{tot}_t = a_{11}\widehat{tot}_{t-1} + \pi_{11}\epsilon_t^1; \quad \epsilon_t^1 \sim (0,1)$$

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
Cote 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

Figure 1: Response of the Real Exchange Rate and Other Variables to An Innovation in the Terms of Trade: SVAR Evidence

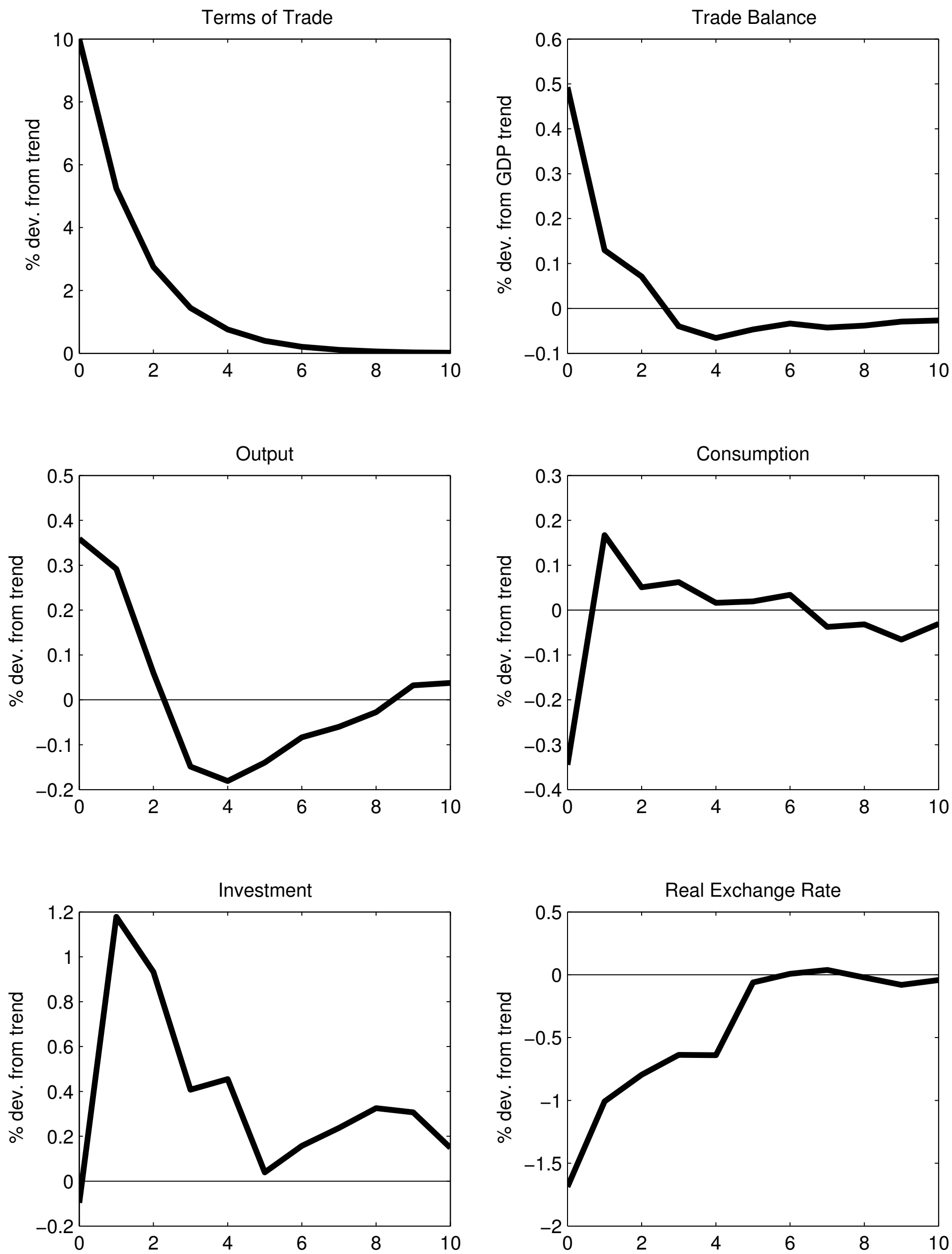


Table 2: Share of Variance Explained by Terms of Trade Shocks: Country-Level SVAR Evidence

Country	tot	tb	y	c	i	RER
Algeria	100	67	8	58	10	25
Argentina	100	28	22	14	16	33
Bolivia	100	6	6	8	11	6
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
Cote 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	2	7	2	1	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	7	6	7	11

Note. Shares are expressed in percent.

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 10 percent of the variances of output, consumption, investment, and the trade balance, and 14 percent of the variance of the real exchange rate. A similar result obtains when the cyclical component is computed by HP filtering with a smoothing parameter of 100. In this case, the cross-country median of the variances of output, consumption, investment, the trade balance, and the real exchange rate explained by terms-of-trade shocks are 12, 11, 12, 14, and 13 percent, respectively. Therefore, the SVAR evidence presented here suggests that 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.

3 The Theoretical Model

The model includes three sectors, an importable sector, an exportable sector, and a nontradable sector. 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 over the business cycle. This feature adds realism to the theoretical model, since these sectors, especially the import competing sector, represent a nonnegligible source of employment fluctuations. Second, we allow the nontraded sector to use capital in production. This assumption is guided by the fact that investment shares in the nontraded sector are nonnegligible. Third, we assume that investment goods are not fully imported, but can have nontraded components. Again, this modification is introduced to make the model more realistic, since a large fraction of capital is nontraded in nature (e.g., structures).

The reason why we choose to study this particular model is that, to a large extend, 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 re-computing 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, (a) we estimate key structural parameters of the model country by country, and (b) we match second moments of the data conditional on terms of terms shocks. This approach departs from the existing related literature by using information extracted from the country-by-country estimates of the SVAR model.

3.1 Households

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

$$E_0 \sum_{t=0}^{\infty} \beta^t U(c_t, h_t^m, h_t^x, h_t^n), \tag{2}$$

where c_t denotes consumption, h_t^m denotes 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

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

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 increasing 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 good 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 good, 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

$$k_{t+1}^m = (1-\delta)k_t^m + i_t^m, \tag{3}$$

$$k_{t+1}^x = (1-\delta)k_t^x + i_t^x, \tag{4}$$

and

$$k_{t+1}^n = (1-\delta)k_t^n + i_t^n. \tag{5}$$

Using these laws of motion to eliminate i_t^m, i_t^x, and i_t^n 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_t^m,

h_t^x, h_t^n, d_{t+1}, k_{t+1}^m, k_{t+1}^x, and k_{t+1}^n are, respectively,

$$U_1(c_t, h_t^m, h_t^x, h_t^n) = \lambda_t \tag{6}$$

$$-U_2(c_t, h_t^m, h_t^x, h_t^n) = \lambda_t w_t^m \tag{7}$$

$$-U_3(c_t, h_t^m, h_t^x, h_t^n) = \lambda_t w_t^x \tag{8}$$

$$-U_4(c_t, h_t^m, h_t^x, h_t^n) = \lambda_t w_t^n \tag{9}$$

$$\lambda_t p_t^\tau = \beta(1+r_t) E_t \lambda_{t+1} p_{t+1}^\tau \tag{10}$$

$$\lambda_t \left[1 + \Phi_m'(k_{t+1}^m - k_t^m)\right] = \beta E_t \lambda_{t+1} \left[u_{t+1}^m + 1 - \delta + \Phi_m'(k_{t+2}^m - k_{t+1}^m)\right] \tag{11}$$

$$\lambda_t \left[1 + \Phi_x'(k_{t+1}^x - k_t^x)\right] = \beta E_t \lambda_{t+1} \left[u_{t+1}^x + 1 - \delta + \Phi_x'(k_{t+2}^x - k_{t+1}^x)\right] \tag{12}$$

$$\lambda_t \left[1 + \Phi_n'(k_{t+1}^n - k_t^n)\right] = \beta E_t \lambda_{t+1} \left[u_{t+1}^n + 1 - \delta + \Phi_n'(k_{t+2}^n - k_{t+1}^n)\right]. \tag{13}$$

It is clear from this expressions that the rate 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.

3.2 Firms Producing Final Goods

Final goods are produced using nontradable goods and a composite of tradable goods via the technology $B(a_t^\tau, a_t^n)$, where a_t^τ denotes the tradable composite good and a_t^n denotes the nontraded good. The aggregator function $B(\cdot,\cdot)$ is assumed to be increasing, concave, and homogeneous of degree one. 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

$$B(a_t^\tau, a_t^n) - p_t^\tau a_t^\tau - p_t^n a_t^n,$$

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

$$B_1(a_t^\tau, a_t^n) = p_t^\tau \tag{14}$$

and

$$B_2(a_t^\tau, a_t^n) = p_t^n. \tag{15}$$

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

3.3 Firms Producing the Tradable Composite Good

The tradable composite good is produced using importable and exportable goods as intermediate inputs, via the technology

$$a_t^\tau = A(a_t^m, a_t^x). \tag{16}$$

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

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

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

$$p_t^\tau A_1(a_t^m, a_t^x) = p_t^m \tag{17}$$

and

$$p_t^\tau A_2(a_t^m, a_t^x) = p_t^x. \tag{18}$$

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

3.4 Firms Producing Importable, Exportable, and Nontradable Goods

Importable, exportable, and nontradable goods are produced with capital and labor via the technologies

$$y_t^m = A^m F^m(k_t^m, h_t^m) \tag{19}$$

$$y_t^x = A^x F^x(k_t^x, h_t^x), \tag{20}$$

and

$$y_t^n = A^n F^n(k_t^n, h_t^n), \tag{21}$$

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 one. Profits of firms producing exportable, importable, or nontraded goods are given by

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

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

$$p_t^m A^m F_1^m(k_t^m, h_t^m) = u_t^m \tag{22}$$

$$p_t^m A^m F_2^m(k_t^m, h_t^m) = w_t^m \tag{23}$$

$$p_t^x A^x F_1^x(k_t^x, h_t^x) = u_t^x \tag{24}$$

$$p_t^x A^x F_2^x(k_t^x, h_t^x) = w_t^x \tag{25}$$

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

$$p_t^n A^n F_2^n(k_t^n, h_t^n) = w_t^n. \tag{27}$$

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.

3.5 Competitive Equilibrium

In equilibrium the demand for final goods must equal the supply of this type of goods

$$c_t + i_t^m + i_t^x + i_t^n + \Phi_m(k_{t+1}^m - k_t^m) + \Phi_x(k_{t+1}^x - k_t^x) + \Phi_n(k_{t+1}^n - k_t^n) = B(a_t^\tau, a_t^n). \tag{28}$$

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

$$a_t^n = y_t^n. \tag{29}$$

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

$$m_t = p_t^m(a_t^m - y_t^m). \tag{30}$$

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,

$$x_t = p_t^x(y_t^x - a_t^x). \tag{31}$$

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

$$p_t^\tau \frac{d_{t+1}}{1+r_t} = p_t^\tau d_t + m_t - x_t. \tag{32}$$

To ensure a stationary equilibrium process for external debt, we assume that the country interest-rate premium is debt elastic,

$$r_t = r^* + p(d_{t+1}), \tag{33}$$

where r^* denotes the sum of the world interest rate and the constant component of the country interest-rate premium, and $p(d)$ denotes the debt-elastic component of the country interest-rate premium. 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

$$tot_t = \frac{p_t^x}{p_t^m}. \tag{34}$$

As in the empirical analysis of section 2, we assume that the country is small in international product markets and therefore takes the evolution of the terms of trade as given. Also in line with the empirical analysis, we assume an AR(1) structure for the law of motion of the logarithm of the terms of trade

$$\ln\left(\frac{tot_t}{\overline{tot}}\right) = \rho \ln\left(\frac{tot_{t-1}}{\overline{tot}}\right) + \eta \epsilon_t^{tot}, \tag{35}$$

where ϵ_t^{tot} is a white noise with mean zero and unit variance, and $\overline{tot} > 0$, $\rho \in (-1, 1)$, and $\eta > 0$ are parameters.

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. Divide the numerator and denominator by the domestic-currency price of the tradable composite good, denoted P_t^τ, to get $RER_t = (\mathcal{E}_t P_t^*/P_t^\tau)/(P_t/P_t^\tau)$. 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 good, $A(\cdot,\cdot)$, is common across countries. Then, the law of one price must also hold for the tradable composite good, that is, $\mathcal{E}_t P_t^{\tau*} = P_t^\tau$, where $P_t^{\tau*}$ denotes the foreign price of the tradable composite good. 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 good 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

$$RER_t = p_t^\tau, \tag{36}$$

which says that the real exchange rate equals the relative price of the tradable composite good in terms of final goods. An increase in RER_t, that is, a depreciation of the real exchange rate, means that tradables become more expensive relative to final goods. Conversely, a decrease in RER_t, that is, an appreciation of the real exchange rate, means that tradables become less expensive relative to final goods.

A competitive equilibrium is then a set of 34 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, d_{t+1}, and tot_t satisfying equations (3) to (36), given initial conditions k_0^m, k_0^x, k_0^n, d_0, and tot_{-1}, and the stochastic process ϵ_t^{tot}.

3.6 Functional Forms

We assume that the period utility function is 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

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

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

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

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

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 $j = m, x, n$.

4 Calibration and Estimation

The theoretical 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.

We denote the steady-state value of a variable by dropping the time subscript. The equilibrium conditions (3)-(35) evaluated at the steady state and adopting the assumed functional forms represent a system of 34 equations in 53 unknowns, namely the 34 endogenous variables listed in the definition of equilibrium given in section 3.5 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^*, $\bar{d}$, $\overline{tot}$, and σ.[6] Therefore, we must add 19 calibration restrictions (which we enumerate in parenthesis). We

[6]The structural parameters ψ, ρ, η, and ϕ_j, $j = m, x, n$ do not appear in the steady-state system. We will address the calibration of these parameters shortly.

set (1) $\sigma = 2$, (2)-(4) $\omega_m = \omega_x = \omega_n = 1.455$, (5) $\delta = 0.1$, (6) $r^* = 0.11$,[7] (7) $\mu_{mx} = 1$, (8) $\overline{tot} = 1$, (9) $A^m = 1$, and (10) $\beta = 1/(1 + r^*)$. The average of the ratio of valued added exports to GDP across poor and emerging countries computed using data from the OECD's TiVA database is 20 percent. Therefore, we impose (11) $x/(p^m y^m + p^x y^x + p^n y^n) = 0.2$. In our sample of 38 countries, the average trade balance-to-GDP ratio is 1 percent, or (12) $(x - m)/(p^m y^m + p^x y^x + p^n y^n) = 0.01$. We set A^n to unity, or (13) $A^n = 1$. Na (2015) estimates an average labor share for emerging countries of 70 percent, so we impose (14) $(w^m h^m + w^x h^x + w^n h^n)/(p^m y^m + p^x y^x + p^n y^n) = 0.7$. 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 (15) $w^n h^n/(p^n y^n) = 0.75$. We assume that the importable and exportable sectors are equally labor intensive, that is, we impose (16) $w^m h^m/(p^m y^m) = w^x h^x/(p^x y^x)$. 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 percent. Thus, we impose the restriction (17) $p^n y^n/(p^m y^m + p^x y^x + p^n y^n) = 0.5$. 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 (18) $p^x y^x = p^m y^m$. 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 (19) $\mu_{\tau n} = 0.5$. This completes the calibration strategy of the 19 parameters appearing in the set of steady-state equilibrium conditions.

The parameters η, ρ, ψ, and ϕ_j, for $j = m, x, n$ do not appear in the steady-state equilibrium conditions, but play a role in the equilibrium dynamics. We calibrate η and ρ country by country using the econometric estimates presented in table 1, that is, for each country we set $\rho = a_{11}$ and $\eta = \pi_{11}$. We use a method of moments 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. To this end, we impose three moment restrictions.[8] First, McIntyre (2003) estimates, using OECD data over the period 1970 to 1992, that the standard deviation of investment in the traded sector is 1.5 times as large as its counterpart in the nontraded

[7] This value is high because it is the sum of the world interest rate, which we set at 0.04, and the invariant component of the interest-rate premium, which we set at 0.07 (Uribe and Yue, 2006).

[8] Even though the number of parameters to be estimated (four) exceeds the number of targeted moments (three), there is no under-identification problem, because no subset of parameters can exactly match the targeted moments.

Table 3: Calibration of the Theoretical Model

Calibrated Structural Parameters												
σ	δ	r^*	α_m, α_x	α_n	$\omega_m, \omega_x, \omega_n$	μ_{mx}	$\mu_{\tau n}$	$\overline{tot}$	A^m, A^n	β	η	ρ
2	0.1	0.11	0.35	0.25	1.455	1	0.5	1	1	$1/(1+r^*)$	$*$	$*$
Moment Restrictions												
s_n	s_x	s_{tb}	$\frac{p^m y^m}{p^x y^x}$	$\frac{\sigma_{i_m+i_x}}{\sigma_{i_n}}$	$\frac{\sigma_i}{\sigma_y}$	$\frac{\sigma_{tb}}{\sigma_y}$						
0.5	0.2	0.01	1	1.5	$**$	$**$						
Implied Structural Parameter Values												
χ_m	χ_τ	$\overline{d}$	A^x	β	ϕ_m	ϕ_x	ϕ_n	ψ				
0.8980	0.4360	0.0078	1	0.9009	**	**	**	**				

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 values are given in table 1. **Country-specific values are given in table 4.

sector. We assume that this relationship also holds for emerging and poor countries and conditional on terms-of-trade shocks. Thus, one of the moment restrictions we impose is $\sigma_{i_m+i_x}/\sigma_{i_n} = 1.5$ conditional on terms-of-trade shocks. The other two moment restrictions are the country-by-country empirical estimates of the investment-output volatility ratio and the trade balance-output volatility ratio conditional on terms of trade shocks. The empirical estimates of these volatility ratios are those implied by the country-by-country estimates of the SVAR presented in section 2. Thus, this estimation procedure delivers one set of parameters ϕ_m, ϕ_x, ϕ_n, and ψ for each country.

Tables 3 and 4 summarize the calibration and estimation of of the parameters of the theoretical model. Table 4 shows that the parameter estimation yields a satisfactory match of the observed and predicted volatility of the trade balance relative to output conditional on terms of trade shocks. Both in the data and in the model the cross-country median of this volatility ratio is 0.64. The matching of the relative volatility of aggregate investment conditional on terms-of-trade shocks is less tight. In the data the median volatility of investment relative to that of output is 3.4 whereas its predicted counterpart is only 2.1. There is large cross-country dispersion in all four estimated parameter values, as reflected by median absolute deviations 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.

One may wonder why the estimated values of ϕ_j, for $j = m, x, n$ are not lower, given that

Table 4: Country-Specific Estimates of the Capital Adjustment Cost Parameters and the Debt Elasticity of the Interest Rate

					σ_i/σ_y		σ_{tb}/σ_y	
Country	ϕ_m	ϕ_x	ϕ_n	ψ	Data	Model	Data	Model
Algeria	0.01	60.49	32.27	0.01	2.79	2.38	2.10	2.09
Argentina	0.55	4.87	1.03	3.33	2.01	1.73	0.36	0.36
Bolivia	15.91	0.00	0.00	0.16	4.28	2.14	0.78	0.78
Botswana	11.55	0.00	0.00	0.02	5.93	2.43	1.62	1.62
Brazil	0.00	67.12	0.01	1.22	3.24	2.09	0.48	0.48
Burundi	15.36	0.00	0.04	0.09	2.52	2.14	0.90	0.89
Cameroon	0.98	1.07	9.33	84.41	2.14	2.44	0.10	0.10
Central African Republic	25.56	1.17	2.21	0.01	7.78	1.79	1.65	1.65
Colombia	0.00	26.96	0.00	7.38	3.09	2.04	0.39	0.39
Congo, Dem. Rep.	0.00	18.13	0.00	8.57	8.18	2.03	0.30	0.30
Costa Rica	13.90	0.00	0.00	0.02	3.05	2.42	1.50	1.50
Cote d'Ivoire	0.00	20.37	0.00	9.31	3.37	2.02	0.27	0.26
Dominican Republic	0.00	60.62	0.00	3.71	2.86	2.11	0.41	0.41
Egypt, Arab Rep.	43.20	0.00	27.93	0.05	5.74	2.22	0.97	0.97
El Salvador	0.00	59.19	0.00	1.59	3.35	2.22	0.60	0.60
Ghana	0.00	61.82	7.30	0.19	9.55	2.47	0.91	0.91
Guatemala	4.94	0.00	0.01	0.00	9.28	7.02	1.81	1.81
Honduras	14.46	0.00	0.00	0.06	6.02	2.31	1.09	1.08
India	0.30	2.05	0.76	0.97	1.49	1.29	0.27	0.27
Indonesia	0.00	27.60	0.00	4.28	4.26	2.01	0.30	0.30
Jordan	2.88	2.88	0.62	0.03	1.04	1.09	1.30	1.23
Kenya	66.73	0.00	54.54	0.11	5.17	2.19	0.71	0.70
Korea, Rep.	65.09	0.00	9.32	0.06	4.86	2.26	0.95	0.95
Madagascar	40.62	0.00	0.00	0.09	2.61	2.18	0.85	0.85
Malaysia	11.72	0.00	0.00	0.02	4.39	2.45	1.68	1.68
Mauritius	12.87	0.00	0.02	0.01	4.25	2.40	2.34	2.34
Mexico	7.56	1.01	0.61	0.24	1.58	1.36	0.40	0.40
Morocco	0.00	77.97	0.00	0.61	5.03	2.24	0.67	0.67
Pakistan	19.34	0.00	0.00	0.05	8.43	2.25	1.16	1.15
Paraguay	0.00	10.68	4.50	0.72	2.13	1.84	0.62	0.61
Peru	0.25	14.39	2.61	9.82	2.21	1.91	0.20	0.21
Philippines	0.10	8.17	1.11	1.12	1.78	1.66	0.44	0.41
Senegal	77.49	0.00	35.14	0.07	14.21	2.35	0.86	0.85
South Africa	122.76	0.01	56.35	0.68	2.47	2.11	0.28	0.28
Sudan	30.29	0.00	0.00	0.49	4.14	1.85	0.45	0.45
Thailand	1.74	1.74	1.32	0.30	0.74	0.78	0.61	0.56
Turkey	0.00	16.61	0.00	10.74	6.29	2.02	0.31	0.31
Uruguay	0.40	0.40	2.05	4.72	1.70	1.61	0.27	0.29
Median	2.31	1.12	0.03	0.27	3.36	2.13	0.64	0.64
Median Absolute Deviation	2.31	1.12	0.03	0.26	1.42	0.22	0.33	0.33

the model underpredicts the relative volatility of investment. The reason is that, although reducing the values of the ϕs raises all sectoral investment volatilities, it need not result in higher aggregate investment volatility. For as the ϕs go down in value, sectoral investments become increasingly negatively correlated, conspiring against the volatility of aggregate investment. This negative correlation among sectoral investments is intuitive, because when the relative price of exportables in terms of importables rises (i.e., when the terms of trade appreciate) the value of the marginal product of capital increases in the exportable sector and declines in the importable sector. Thus, an improvement in the terms of trade acts like a positive productivity shock in the exportable sector and a negative productivity shock in the importable sector.

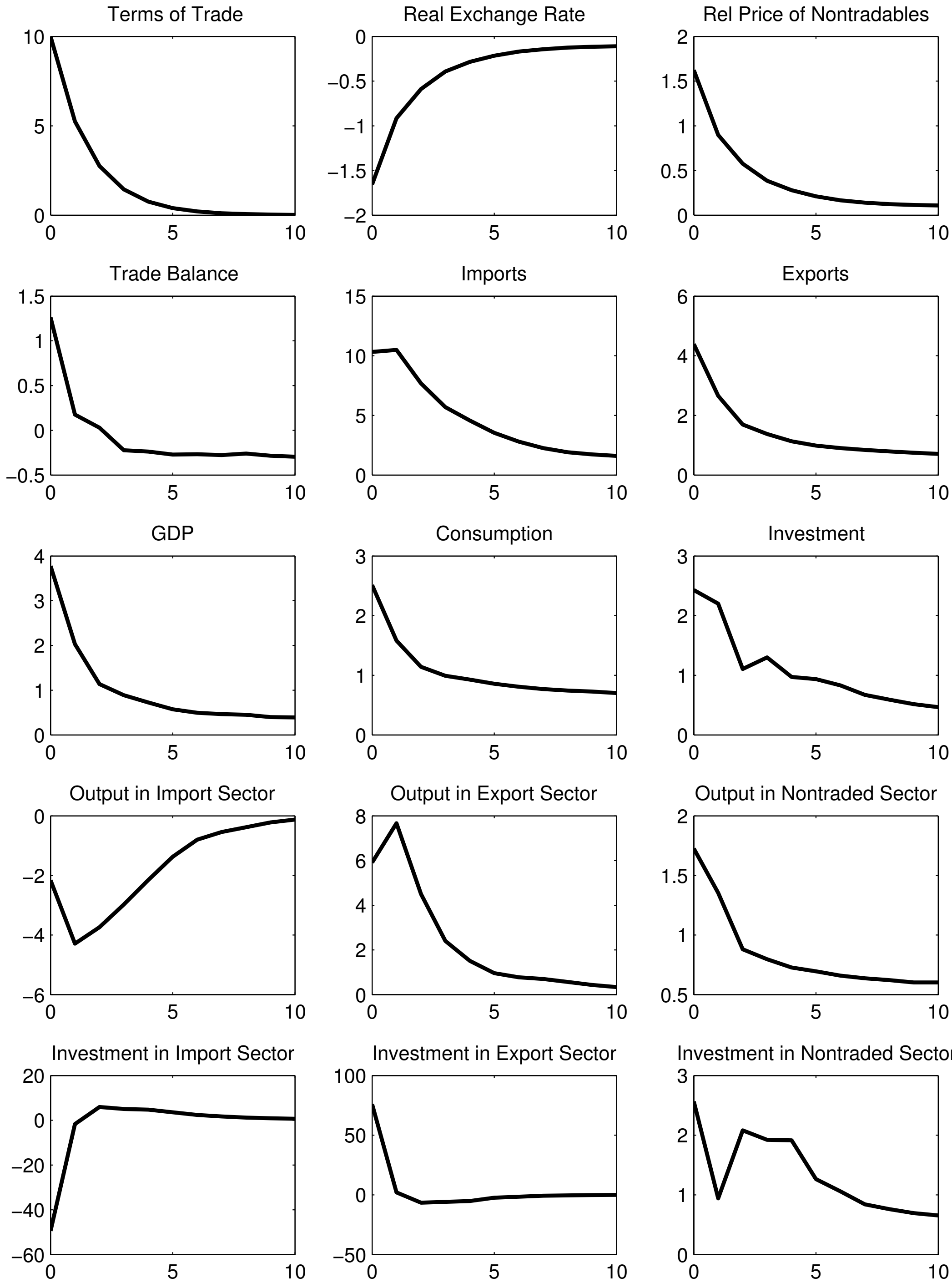
5 The Terms-of-Trade Disconnect

Figure 2 displays the response of the theoretical economy to a ten-percent increase in the terms of trade. The impulse responses shown in the figure are medians across the impulse responses implied by country-specific calibrations of the theoretical model. The model does a good job at capturing the response of the real exchange rate to a terms-of-trade shock. Comparing figures 1 and 2 shows that in both the SVAR and the theoretical models an improvement in the terms of trade appreciates the real exchange rate. The explanation behind this result 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 2 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 good relative to the price of the tradable composite good, that is, p_t^τ falls.

Intuitively, the increase in the terms of trade produces an expansion in exports. Imports also 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 theoretical model is in line with the Harberger-Laursen-Metzler effect present in the SVAR model.

In line with the predictions of the SVAR model, the theoretical model implies that output expands in response to an improvement in the terms of trade (panel (3,1) of figure 2). This

Figure 2: Response of the Theoretical Economy to a Ten-Percent Terms-of-Trade Shock



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 calibrations of ϕ_m, ϕ_x, ϕ_n, ψ, and ρ.

Table 5: Share of Variances Explained by Terms-of-Trade Shocks: Theoretical Versus Empirical Models

Variable	Theoretical Model	SVAR Model
Terms of Trade	100	100
Trade Balance	31	12
Output	34	10
Consumption	31	9
Investment	13	10
Real Exchange Rate	1	14

Note. Each entry is the cross-country median of the variance explained by terms of trade shocks expressed as a percentage of the corresponding unconditional variance implied by the SVAR model.

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 2).

The theoretical model predicts that both consumption and investment increase in response to the improvement in the terms of trade. This prediction is partly supported by the data. The SVAR predicts that the expansion in consumption and investment is delayed by one period, whereas the theoretical model predicts that both variables increase on impact.

The similarity between model and data ends at the qualitative level, however. For the increase in output predicted by the theoretical model is 10 times larger than that implied by the empirical SVAR model. In addition, the magnitudes of the theoretical responses of consumption and investment are much larger than their empirical counterparts.

Finally, earlier we pointed out that in the theoretical model lowering the adjustment cost parameters ϕ_j, for $j = m, x, n$ does not necessarily result in an increase in aggregate investment volatility because of a negative cross sectoral correlation of investment with soaks up the volatility of each individual component. This effect is patently displayed in the bottom row of figure 2. The 10-percent improvement in the terms of trade causes aggregate investment to increase by 2 percent. However, investment in the exportable sector increase by 80 percent while in the importable sector it decreases by 60 percent. It would be of interest to see whether this prediction of the theoretical model is borne out in the data.

A comparison of the empirical and theoretical impulse responses displayed in figures 1 and 2, respectively, reveals that the response of the main macro indicators, like output, consumption, and the trade balance, are many times larger in the theoretical model than in the SVAR model. This suggests that the theoretical and SVAR models differ in their assessments

Table 6: Share of Variance Explained by Terms of Trade Shocks: Country-Level Predictions of the Theoretical and SVAR Models

	tb		y		c		i		rer	
Country	Theory	SVAR	Theory	SVAR	Theory	SVAR	Theory	SVAR	Theory	SVAR
Algeria	633	67	80	8	442	58	65	10	3	25
Argentina	17	28	14	22	10	14	7	16	0	33
Bolivia	30	6	29	6	51	8	15	11	1	6
Botswana	7	20	19	50	4	32	2	32	2	8
Brazil	87	47	30	16	20	4	22	28	0	57
Burundi	65	4	36	2	54	4	6	1	6	9
Cameroon	2	9	4	14	4	13	5	13	2	16
Central African Republic	1848	37	302	6	586	14	34	13	11	53
Colombia	17	7	43	18	53	7	14	13	0	13
Congo, Dem. Rep.	20	3	7	1	6	1	3	7	1	12
Costa Rica	190	17	36	3	97	1	15	2	3	2
Cote d'Ivoire	30	30	42	43	44	36	15	43	2	70
Dominican Republic	18	20	15	17	12	16	14	28	0	14
Egypt, Arab Rep.	72	62	69	58	119	46	11	65	1	48
El Salvador	189	8	49	2	39	4	42	4	1	22
Ghana	32	4	26	4	14	3	2	3	0	4
Guatemala	887	5	98	1	186	2	261	2	1	13
Honduras	124	7	96	5	48	1	19	7	1	15
India	105	4	341	13	389	19	26	1	1	1
Indonesia	34	13	58	22	30	17	14	23	0	14
Jordan	23	31	10	13	13	32	3	4	2	5
Kenya	63	6	40	4	62	9	21	12	2	2
Korea, Rep.	49	17	5	2	8	3	17	28	1	36
Madagascar	65	7	68	8	165	1	16	3	3	6
Malaysia	19	6	14	5	36	3	5	5	1	1
Mauritius	147	9	33	2	278	6	9	2	3	4
Mexico	84	12	126	17	299	12	58	10	7	28
Morocco	16	2	15	2	9	2	5	3	0	10
Pakistan	11	2	41	7	32	2	1	1	2	3
Paraguay	59	12	37	7	25	8	39	10	0	1
Peru	8	16	10	19	16	14	9	23	0	15
Philippines	27	19	22	13	31	17	12	8	1	38
Senegal	119	4	271	8	478	3	17	19	3	57
South Africa	13	12	12	11	29	9	7	8	1	23
Sudan	26	20	49	38	28	10	5	21	0	18
Thailand	2	14	2	13	3	15	0	2	0	25
Turkey	7	4	26	14	11	19	6	31	0	3
Uruguay	12	20	18	36	10	37	7	15	0	30
Median	31	12	34	10	31	9	13	10	1	14
Median Absolute Deviation	24	7	20	7	22	6	7	7	1	11

Note. Each entry is the variance explained by terms of trade shocks expressed as a percentage of the corresponding unconditional variance implied by the SVAR model. Theoretical conditional variances are computed using country-specific estimates of ϕ_m, ϕ_x, ϕ_n, ψ, $\rho(=a_{11})$, and $\eta(=\pi_{11})$ reported in tables 1 and 4.

of the importance of terms-of-trade shocks as drivers of business cycles in poor and emerging countries. Table 5 confirms this suggestion. It presents the variance of variables of interest explained by terms-of-trade shocks according to the theoretical and the SVAR models. Each variance is expressed as a fraction of its corresponding unconditional variance predicted by the SVAR model. The table shows that in the theoretical model, terms of trade shocks explain one third of the variances of the trade balance, output and consumption, whereas in the SVAR model they explain only one tenth. That is, the theoretical model predicts that terms of trade shocks are three times as important as implied by the empirical model.[9] It is in this precise sense that we say that there is a terms-of-trade disconnect between the theory that gave rise to the conventional wisdom and the data. Table 6 documents the terms-of-trade disconnect country by country.

6 Conclusion

In this paper, we argue that when one looks at the data through the lens of SVAR models, terms-of-trade shocks play a minor 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 about 10 percent. This result is at odds with the standard view, built on the predictions of calibrated microfounded dynamic business-cycle models, according to which terms-of-trade disturbances explain at least 30 percent of movements in aggregate activity.

Explaining the aforementioned disconnect between empirical and theoretical models is an important item in the research agenda that lies ahead. 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. This is likely to be the case especially for countries whose exports or imports are concentrated in a small number of commodities. 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 why fluctuations in the terms of trade may not have large domestic effects could be the presence of nominal rigidities that introduce a wedge between domestic and

[9]The disconnect is even stronger when the cyclical components of the time series are computed by HP filtering with a smoothing parameter of 100.

world prices.

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