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Country spreads and emerging countries: Who drives whom?

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Abstract

This paper attempts to disentangle the intricate relation linking the world interest rate, country spreads, and emerging-market fundamentals. It does so by using a methodology that combines empirical and theoretical elements. The main findings are: (1) US interest rate shocks explain about 20% of movements in aggregate activity in emerging economies. (2) Country spread shocks explain about 12% of business cycles in emerging economies. (3) In response to an increase in US interest rates, country spreads first fall and then display a large, delayed overshooting; (4) US-interest-rate shocks affect domestic variables mostly through their effects on country spreads; (5) The feedback from emerging-market fundamentals to country spreads significantly exacerbates business-cycle fluctuations.

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1. Introduction

Business cycles in emerging market economies are correlated with the cost of borrowing that these countries face in international financial markets. This observation is illustrated in Fig. 1, which depicts detrended output and the country interest rate for seven developing economies between 1994 and 2001. Periods of low interest rates are typically associated with economic expansions and times of high interest rates are often characterized by depressed levels of aggregate activity.¹

The countercyclical behavior of country interest rates has spurred researchers to investigate the role of movements in this variable in explaining business cycles in developing countries. In addressing this issue, an immediate natural question that emerges has to do with causality. Do country interest rates drive business cycles in emerging countries, or vice versa, or both? Different authors have approached this question in different ways.

One strand of the literature focuses primarily on stressing the effects of movements in domestic variables on country spreads. Specifically, a large empirical body of research has documented that country spreads respond systematically and countercyclically to business conditions in emerging economies. For instance, Edwards (1984), Cline (1995), and Cline and Barnes (1997) find that domestic variables such as GDP growth and export growth are significant determinants of country spreads in developing countries. Other studies have documented that higher credit ratings translate into lower country spreads (Cantor and Packer, 1996; Eichengreen and Mody, 2000). In turn, credit ratings have been found to respond strongly to domestic macroeconomic conditions. For example, Cantor and Packer (1996) estimate that about 80% of variations in credit ratings are explained by variations in per capita income, external debt burden, in ationary experience, default history, and the level of economic development. Cantor and Packer conclude, based on their own work and the related literature extant, that there exists significant information content of macroeconomic indicators in the pricing of sovereign risk. In this body of work little is said about the need to control for the fact that movements in domestic fundamentals may be caused in part by variations in country interest rates.

On the other extreme of the spectrum, a number of authors have assumed that country spreads are exogenous to domestic conditions in emerging countries. For instance, Neumeyer and Perri (2001) assume that the country spread and the US interest rate follow a bivariate, first-order, autoregressive process. They estimate such process and use it as a driving force of a theoretical model calibrated to Argentine data. In this way, Neumeyer and Perri assess the contribution of interest rates to explaining aggregate volatility in developing countries. They find that interest rate shocks explain 50% of output fluctuations in Argentina, and conclude, more generally, that interest rate shocks are an important factor for explaining business cycles in emerging countries.

If in reality country interest rates responded countercyclically to domestic conditions in emerging economies, then the findings of Neumeyer and Perri (2001) would be better

¹ The estimated correlations (p -values) are: Argentina -0.67 (0.00), Brazil -0.51 (0.00), Ecuador -0.80 (0.00), Mexico -0.58 (0.00), Peru -0.37 (0.12), the Philippines -0.02 (0.95), South Africa -0.07 (0.71).

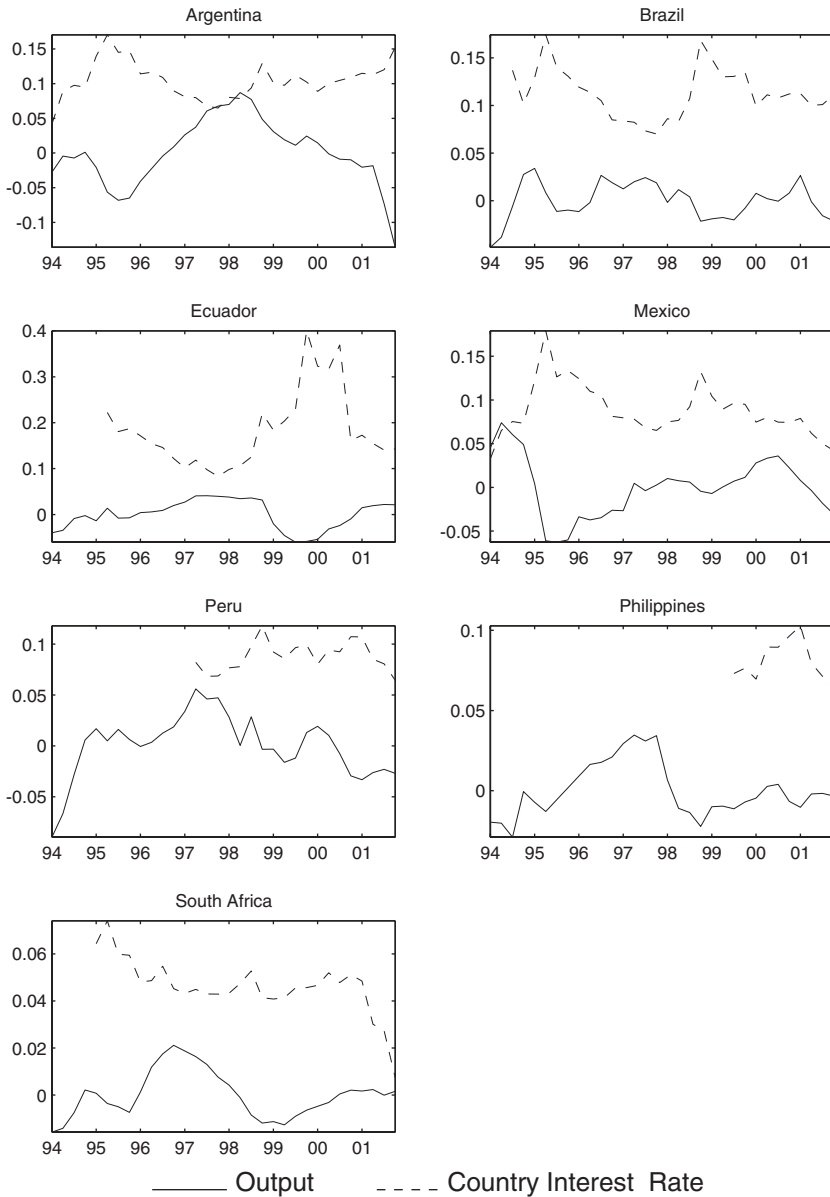


Fig. 1. Country interest rates and output in seven emerging countries. Note: Output is seasonally adjusted and detrended using a log-linear trend. country interest rates are real yields on dollar-denominated bonds of emerging countries issued in international financial markets. Data source: output, IFS; interest rates, EMBI+.

interpreted as an upper bound on the contribution of country interest rates to business cycle fluctuations in emerging countries. For they rely on the presumption that movements in country interest rates are completely exogenous to domestic economic conditions. To

illustrate how this exogeneity assumption can lead to an overestimation of the importance of country spreads in generating business cycle fluctuations, suppose that the (emerging) economy is hit by a positive productivity shock. In response to this innovation, output, investment, and consumption will tend to expand. Assume in addition that the country spread is a decreasing function of the level of economic activity. Then the productivity shock would also be associated with a decline in the spread. If in this economy one wrongly assumes that the spread is completely independent of domestic conditions, the change in the interest rate would be interpreted as an exogenous innovation, and therefore part of the accompanying expansion would be erroneously attributed to a spread shock, when in reality it was entirely caused by a domestic improvement in productivity.

Another important issue in understanding the macroeconomic effects of movements in country interest rates in emerging economies, is the role of world interest rates. Understanding the contribution of world interest rate shocks to aggregate fluctuations in developing countries is complicated by the fact that country interest rates do not respond one-for-one to movements in the world interest rate. In other words, emerging-country spreads respond to changes in the world interest rate. This fact has been documented in a number of studies (some of which are referenced above). Thus, country spreads serve as a transmission mechanism of world interest rates, capable of amplifying or dampening the effect of world-interest-rate shocks on the domestic economy. Both because spreads depend on the world interest rate itself and because they respond to domestic fundamentals.

In this paper, we attempt to disentangle the intricate interrelations between country spreads, the world interest rate, and business cycles in emerging countries. We do so using a methodology that combines empirical and theoretical analysis.

We begin by estimating a VAR system that includes measures of the world interest rate, the country interest rate, and a number of domestic macroeconomic variables. In estimating the model we use a panel data set with seven emerging countries covering the period 1994–2001 at a quarterly frequency. Over the period considered, both country spreads and capital flows display significant movements in the countries included in our sample. We use the estimated empirical model to extract information about three aspects of the data: First, we identify country-spread shocks and US-interest-rate shocks. The essence of our identification scheme is to assume that innovations in international financial markets take one quarter to affect real domestic variables, whereas innovations in domestic product markets are picked up by financial markets contemporaneously. Second, we uncover the business cycles implied by the identified shocks by producing estimated impulse response functions. Third, we measure the importance of the two identified shocks in explaining movements in aggregate variables by performing a variance decomposition of the variables included in the empirical model.

To assess the plausibility of the spread shocks and US-interest-rate shocks that we identify with the empirical model, we are guided by theory. Specifically, we develop a model of a small open economy with four special features: gestation lags in the production of capital, external habit formation (or catching up with the Joneses), a working-capital constraint that requires firms to hold non-interest-bearing liquid assets in an amount proportional to their wage bill, and an information structure according to which, in each period, output and absorption decisions are made before that period's international

financial conditions are revealed. The latter feature is consistent with the central assumption supporting the identification of our empirical model. We assign numerical values to the parameters of the model so as to fit a number of empirical regularities in developing countries. We then show that the model implies impulse response functions to country-spread shocks and to US-interest-rate shocks that are broadly consistent with those implied by the empirical model. It is in this precise sense that we conclude that the shocks identified in this study are plausible.

The main findings of the paper are: (1) US interest rate shocks explain about 20% of movements in aggregate activity in emerging countries at business-cycle frequency. (2) Country spread shocks explain about 12% of business-cycle movements in emerging economies. (3) About 60% of movements in country spreads are explained by country-spread shocks. (4) In response to an increase in US interest rates, country spreads first fall and then display a large, delayed overshooting. (5) US-interest-rate shocks affect domestic variables mostly through their effects on country spreads. Specifically, we find that when the country spread is assumed not to respond directly to variations in US interest rates, the standard deviation of output, investment, and the trade balance-to-output ratio explained by US-interest-rate shocks is about two thirds smaller. (6) The fact that country spreads respond to business conditions in emerging economies significantly exacerbates aggregate volatility in these countries. In particular, when the country spread is assumed to be independent of domestic conditions, the equilibrium volatility of output, investment, and the trade balance-to-output ratio explained jointly by US-interest-rate shocks and country-spread shocks falls by about one fourth. (7) The working-capital constraint appears to be an important feature determining the theoretical model's ability to replicate the observed output contractions in the aftermath of country-interest-rate shocks. Our estimate indicate that the working-capital constraint amounts to about 1.2 quarters of wage payments.

The remainder of the paper is organized in five sections. In Section 2, we present and estimate the empirical model, identify spread shocks and US-interest-rate shocks, and analyze the business cycles implied by these two sources of aggregate uncertainty. In Section 3, we develop and parameterize the theoretical model and compare theoretical and empirical impulse response functions. In Section 4, we investigate the business-cycle consequences of the fact that spreads respond to movements in both the US interest rate and domestic fundamentals. Section 5 contains a robustness check of the empirical model and a sensitivity analysis of the theoretical model. Section 6 closes the paper.

2. Empirical analysis

The goal of the empirical analysis presented here is to identify shocks to country spreads and the world interest rate and to assess their impact on aggregate activity in emerging economies. Our data set consists of quarterly data over the period 1994:1 to 2001:4, for seven developing countries, Argentina, Brazil, Ecuador, Mexico, Peru, Philippine, and South Africa. Our choice of countries and sample period is guided by data availability. The countries we consider belong to the set of countries included in J. P. Morgan's EMBI+ data set for emerging-country spreads. In the EMBI+database, time series for country spreads begin in 1994:1 or later. Of the 14 countries that were originally

included in the EMBI+ database, we eliminated from our sample Morocco, Nigeria, Panama, and Venezuela, because quarterly data on output and/or the components of aggregate demand are unavailable, and Bulgaria, Poland, and Russia, because their transition from a centrally planned to a market-based economic organization in the early 1990s complicates the task of identifying the effects of interest rates at business-cycle frequencies. Later In Section 5 we perform a robustness check of our empirical results by expanding the sample to include 6 additional countries from the EMBI Global data base. Because EMBI Global includes less liquid assets than EMBI+, in our baseline estimation presented here we restrict the sample to countries included in the latter data set.

2.1. The empirical model

Our empirical model takes the form of a first-order VAR system:

$$A \begin{bmatrix} \hat{y}_t \\ \hat{i}_t \\ tby_t \\ \hat{R}_t^{us} \\ \hat{R}_t \end{bmatrix} = B \begin{bmatrix} \hat{y}_{t-1} \\ \hat{i}_{t-1} \\ tby_{t-1} \\ \hat{R}_{t-1}^{us} \\ \hat{R}_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_t^y \\ \varepsilon_t^i \\ \varepsilon_t^{tby} \\ \varepsilon_t^{R^{us}} \\ \varepsilon_t^R \end{bmatrix} \quad (1)$$

where y_t denotes real gross domestic output, i_t denotes real gross domestic investment, tby_t denotes the trade balance to output ratio, R_t^{us} denotes the gross real US interest rate, and R_t denotes the gross real (emerging) country interest rate. A hat on y_t and i_t denotes log deviations from a log-linear trend. A hat on R_t^{us} and R_t denotes simply the log. We measure R_t^{us} as the 3-month gross Treasury bill rate divided by the average gross US inflation over the past four quarters.² We measure R_t as the sum of J. P. Morgan's EMBI+ stripped spread and the US real interest rate. Output, investment, and the trade balance are seasonally adjusted. More details on the data are provided in the working paper version of this paper (Uribe and Yue, 2003, Appendix). Our choice of domestic variables is governed by three objectives. First, the domestic variables included must provide a reasonable description of business cycles in emerging markets. Second, the domestic block must include variables that have been identified in the related literature as important determinants of emerging-country spreads. Third, we wish to keep the set of domestic variables in the VAR as small as possible to save degrees of freedom, given our relatively small data set.

A notable absence in our VAR system is some measure of country debt. A number of empirical studies (e.g., Edwards, 1984) have pointed out that country indebtedness, as measured, for instance, by the external-debt-to-GDP ratio, plays a significant role in explaining country spreads. We find that adding the external-debt-to-GDP ratio does not improve the overall fit of the model. Indeed, this variable enters insignificantly in the country-spread equation. We also find, however, that substituting the debt-to-GDP ratio for the trade-balance-to-GDP ratio in the VAR system restores the statistical

² Using a more forward looking measure of inflation expectations to compute the US real interest rate does not significantly alter our main results.

significance of the former. This is not surprising from an economic point of view. For intertemporal theories of current account determination predict a tight positive correlation between the trade balance and the level of external debt at least at low frequencies.

We identify our empirical model by imposing the restriction that the matrix \mathbf{A} be lower triangular with unit diagonal elements. Because R_t^{us} and R_t appear at the bottom of the system, our identification strategy presupposes that innovations in world interest rates ($\epsilon_t^{r^{us}}$) and innovations in country interest rates (ϵ_t^r) percolate into domestic real variables with a one-period lag. At the same time, the identification scheme implies that real domestic shocks ($\epsilon_t^d, \epsilon_t^i$, and ϵ_t^{tby}) affect financial markets contemporaneously. We believe our identification strategy is a natural one, for, conceivably, decisions such as employment and spending on durable consumption goods and investment goods take time to plan and implement. Also, it seems reasonable to assume that financial markets are able to react quickly to news about the state of the business cycle in emerging economies.

But alternative ways to identify $\epsilon_t^{r^{us}}$ and ϵ_t^r are also possible. In the working paper version of this paper (Uribe and Yue, 2003), we explore an identification scheme that allows for real domestic variables to react contemporaneously to innovations in the US interest rate or the country spread. Under this alternative identification strategy, the point estimate of the impact of a US-interest-rate shock on output and investment is slightly positive. For both variables, the two-standard-error intervals around the impact effect include zero. Because it would be difficult for most models of the open economy to predict an expansion in output and investment in response to an increase in the world interest rate, we conclude that our maintained identification assumption that real variables do not react contemporaneously to innovations in external financial variables is more plausible than the alternative described here.

An additional restriction we impose in estimating the VAR system is that R_t^{us} follows a simple univariate AR(1) process (i.e., we impose the restriction $A_{4i} = B_{4i} = 0$, for all $i \neq 4$). We adopt this restriction because it is reasonable to assume that disturbances in a particular (small) emerging country will not affect the real interest rate of a large country like the United States. In addition, the assumed AR(1) specification for R_t^{us} allows us to use a longer time series for R^{us} in estimating the fourth equation of the VAR system, which delivers a tighter estimate of the autoregressive coefficient B_{44} . (Note that R_t^{us} is the only variable in the VAR system that does not change from country to country.) We estimate the AR(1) process for R_t^{us} for the period 1987:Q3 to 2002:Q4. This sample period corresponds to the Greenspan era, which arguably ensures homogeneity in the monetary policy regime in place in the United States.

Note that the order of the first three variables in our VAR(\hat{y}_t, \hat{i}_t , and tby_t) does not affect either our estimates of the US-interest-rate and country-interest-rate shocks ($\epsilon_t^{r^{us}}$ and ϵ_t^r) or the impulse responses of output, investment, and the trade balance to innovations in these two sources of aggregate fluctuations.

We further note that the country-interest-rate shock, ϵ_t^r , can equivalently be interpreted as a country spread shock. To see this, consider substituting in Eq. (1) the country interest rate \hat{R}_t using the definition of country spread, $\hat{S}_t \equiv \hat{R}_t - \hat{R}_t^{us}$. Clearly, because R_t^{us} appears as a regressor in the bottom equation of the VAR system, the estimated residual of the

Table 1
Parameter estimates of the VAR system

Independent variable	Dependent variable				
	\hat{y}_t	\hat{i}_t	tby_t	\hat{R}_t^{us}	\hat{R}_t
\hat{y}_t	–	2.739 (10.28)	0.295 (2.18)	–	–0.791 (–3.72)
\hat{y}_{t-1}	.2820 (2.28)	–1.425 (–4.03)	–0.032 (–0.25)	–	0.617 (2.89)
\hat{i}_t	–	–	–0.228 (–6.89)	–	0.114 (1.74)
\hat{i}_{t-1}	0.162 (4.56)	0.537 (3.64)	0.040 (0.77)	–	–0.122 (–1.72)
tby_t	–	–	–	–	0.288 (1.86)
tby_{t-1}	0.267 (4.45)	–0.308 (–1.30)	0.317 (2.46)	–	–0.190 (–1.29)
\hat{R}_t^{us}	–	–	–	–	0.501 (1.55)
\hat{R}_{t-1}^{us}	0.0002 (0.00)	–0.269 (–0.47)	–0.063 (–0.28)	.830 (10.89)	0.355 (0.73)
\hat{R}_{t-1}	–0.170 (–3.93)	–0.026 (–0.21)	0.191 (3.54)	–	0.635 (4.25)
R^2	0.724	0.842	0.765	0.664	0.619
S.E.	0.018	0.043	0.019	0.007	0.031
No. of obs.	165	165	165	62	160

Note: t -statistics are shown in parenthesis. The system was estimated equation by equation. All equations except for the \hat{R}_t^{us} equation were estimated using instrumental variables with panel data from Argentina, Brazil, Ecuador, Mexico, Peru, Philippines, and South Africa, over the period 1994:1 to 2001:4. The \hat{R}_t^{us} equation was estimated by OLS over the period 1987:1–2002:4.

newly defined bottom equation, call it ϵ_t^s , is identical to ϵ_t^r . Moreover, it is obvious that the impulse response functions of \hat{y}_t , \hat{i}_t , and tby_t associated with ϵ_t^s are identical to those associated with ϵ_t^r . Therefore, throughout the paper we indistinctly refer to ϵ_t^r as a country interest rate shock or as a country spread shock.

We estimate the VAR system (1) equation by equation using an instrumental-variable method for dynamic panel data.³ The estimation results are shown in Table 1. The estimated system includes an intercept and country specific fixed effects (not shown in the table). We include a single lag in the VAR. In choosing the lag length of the VAR system, we perform the Akaike Information Criterion (AIC) and general-to-specific likelihood ratio tests. Both tests select a vector autoregression of first order.⁴

2.2. Country spreads, US interest rates, and business cycles

With an estimate of the VAR system (1) at hand, we can address four central questions: First, how do US-interest-rate shocks and country-spread shocks affect real domestic variables such as output, investment, and the trade balance? Second, how do country spreads respond to innovations in US interest rates? Third, how and by how much do

³ Our model is a dynamic panel data model with unbalanced long panels ($T > 30$). The model is estimated using the Anderson and Hsiao's (1981) procedure, with lagged levels serving as instrument variables. Judson and Owen (1999) find that compared to the GMM estimator proposed by Arellano and Bond (1991) or the least square estimator with (country specific) dummy variables, the Anderson-Hsiao estimator produces the lowest estimate bias for dynamic panel models with $T > 30$.

⁴ The AIC is –24.64 for the AR(1) specification, –24.48 for the AR(2) specification, –14.54 for the AR(3) specification, and –14.67 for the AR(4) specification. The likelihood ratio test of the hypothesis that the AR(1) specification is as good as the AR(i) specification delivers a p value of 0.34 for $i=2$, and 1.0 for $i=3$ and $i=4$.

country spreads move in response to innovations in emerging-country fundamentals? Fourth, how important are US-interest-rate shocks and country-spread shocks in explaining movements in aggregate activity in emerging countries? Fifth, how important are US-interest-rate shocks and country-spread shocks in accounting for movements in country spreads? We answer these questions with the help of impulse response functions and variance decompositions.

2.2.1. Impulse response functions

Fig. 2 displays with solid lines the impulse response function implied by the VAR system (1) to a unit innovation in the country spread shock, ϵ_t^c . Broken lines depict two-standard-deviation bands.⁵ In response to an unanticipated country-spread shock, the country spread itself increases and then quickly falls toward its steady-state level. The half life of the country spread response is about one year. Output, investment, and the trade balance-to-output ratio respond as one would expect. They are unchanged in the period of impact, because of our maintained assumption that external financial shocks take one quarter to affect production and absorption. In the two periods following the country-spread shock, output and investment fall, and subsequently recover gradually until they reach their pre-shock level. The adverse spread shock produces a larger contraction in aggregate domestic absorption than in aggregate output. This is reflected in the fact that the trade balance improves in the two periods following the shock.

Fig. 3 displays the response of the variables included in the VAR system (1) to a one percentage point increase in the US interest rate shock, ϵ_t^{rus} . The effects of US interest-rate shocks on domestic variables and country spreads are measured with significant uncertainty, as indicated by the width of the 2-standard-deviation error bands.

The point estimates of the response functions of output, investment, and the trade balance, however, are qualitatively similar to those associated with an innovation in the country spread. That is, aggregate activity and gross domestic investment contract, while net exports improve. However, the quantitative effects of an innovation in the US interest rate are much more pronounced than those caused by a country-spread disturbance of equal magnitude. For instance, the trough in the output response is twice as large under a US-interest-rate shock than under a country-spread shock.

A remarkable feature of this impulse response function is that the country spread displays a delayed overshooting. In effect, in the period of impact, the country interest rate increases but by less than the jump in the US interest rate. As a result, the country spread initially falls. However, the country spread recovers quickly and after a couple of quarters it is more than one percentage point above its pre-shock level. Thus, country spreads respond strongly to innovations in the US interest rate but with a short delay. The negative impact effect of an increase in the US interest rate on the country spread is in line with the findings of Eichengreen and Mody (2000) and Kamin and von Kleist (1999). We note, however, that because the models estimated in these studies are static in nature, by construction, they are unable to capture the rich dynamic

⁵ These bands are computed using the delta method.

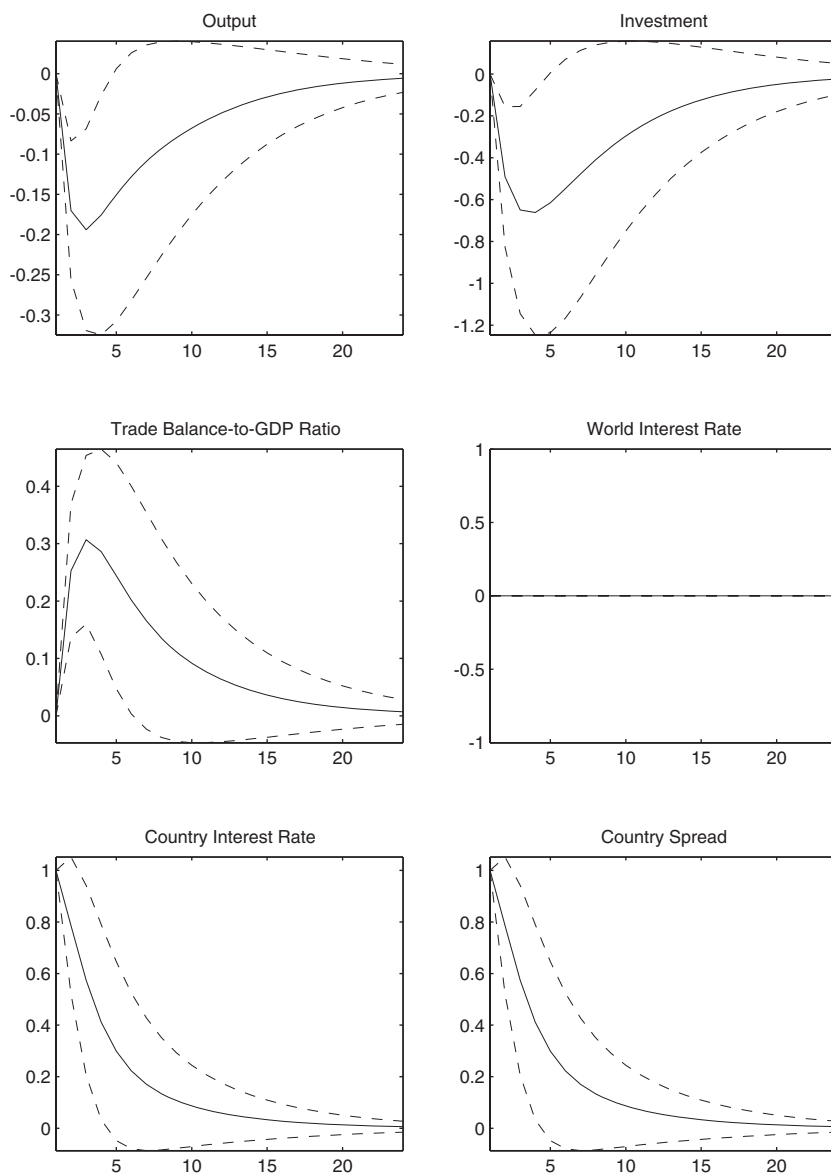


Fig. 2. Impulse response to a country-spread shock. Notes: (1) Solid lines depict point estimates of impulse responses, and broken lines depict two-standard-deviation error bands. (2) The responses of Output and Investment are expressed in percent deviations from their respective log-linear trends. The responses of the Trade Balance-to-GDP ratio, the country interest rate, the US interest rate, and the country spread are expressed in percentage points. The two-standard-error bands are computed using the delta method.

relation linking these two variables. The overshooting of country spreads is responsible for the much larger response of domestic variables to an innovation in the US interest rate than to an innovation in the country spread of equal magnitude.

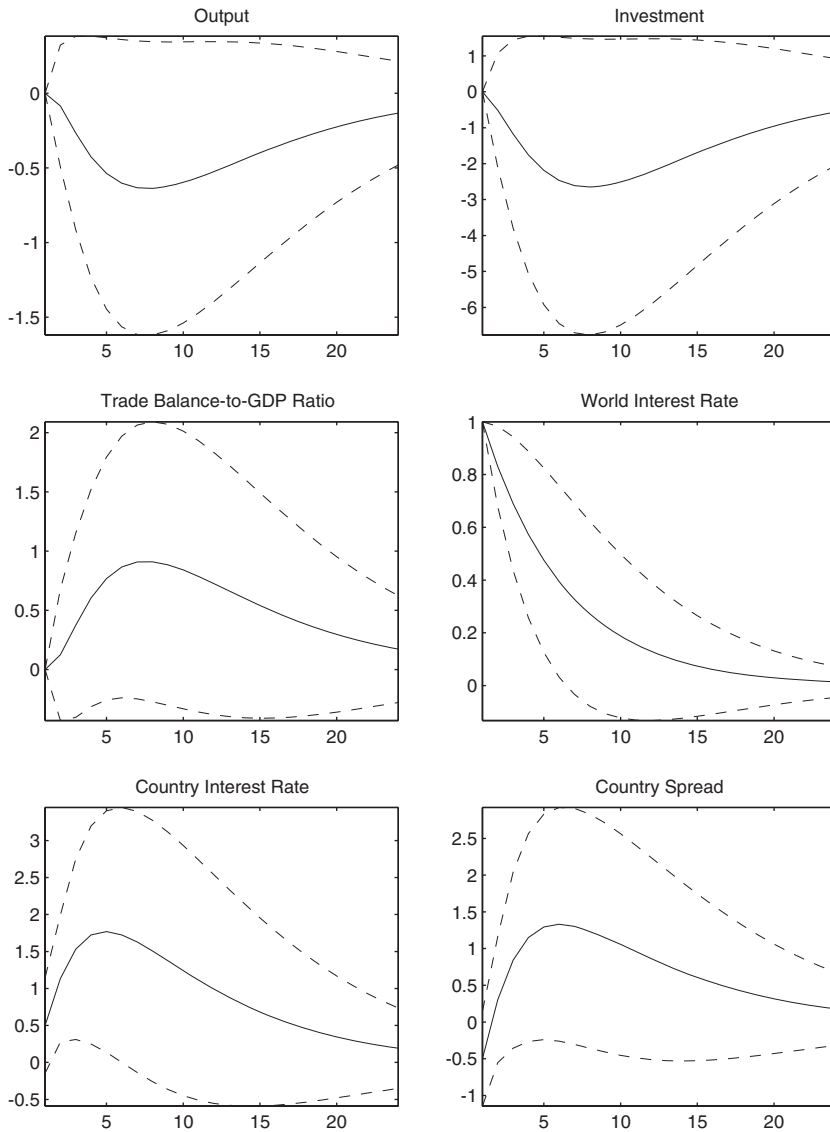


Fig. 3. Impulse response to a US-interest-rate shock. Notes: (1) Solid lines depict point estimates of impulse responses, and broken lines depict two-standard-deviation error bands. (2) The responses of Output and Investment are expressed in percent deviations from their respective log-linear trends. The responses of the Trade Balance-to-GDP ratio, the country interest rate, and the US interest rate are expressed in percentage points.

We now ask how innovations in the output shock ϵ_t^y impinge upon the variables of our empirical model. The model is vague about the precise nature of output shocks. They can reflect variations in total factor productivity, terms-of-trade movements, etc. Fig. 4 depicts the impulse response function to a one-percent increase in the output shock. The response

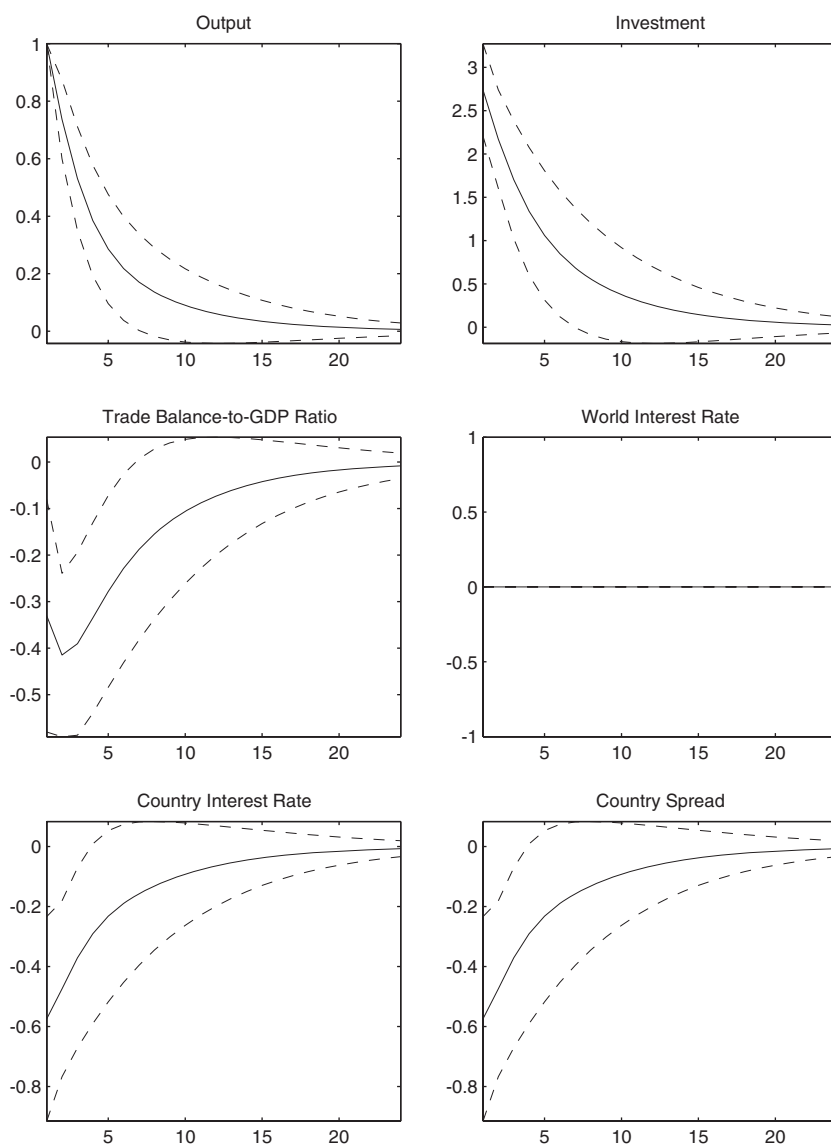


Fig. 4. Impulse response to an output shock. Notes: (1) Solid lines depict point estimates of impulse response functions, and broken lines depict two-standard-deviation error bands. (2) The responses of Output and Investment are expressed in percent deviations from their respective log-linear trends. The responses of the Trade Balance-to-GDP ratio, the country interest rate, and the US interest rate are expressed in percentage points.

of output, investment, and the trade balance is very much in line with the impulse response to a positive productivity shock implied by the small open economy RBC model (see e.g., Schmitt-Grohé and Uribe, 2003). The response of investment is about three times as large as that of output. At the same time, the trade balance deteriorates significantly for two

periods by about 0.4% and then converges gradually to its steady-state level. More interestingly, the increase in output produces a significant reduction in the country spread of about 0.6%. The half life of the country spread response is about five quarters. The countercyclical behavior of the country spread in response to output shocks suggests that country interest rates behave in ways that exacerbates the business-cycle effects of output shocks.

2.2.2. Variance decompositions

To understand the contribution of the various shocks in the empirical model, we perform a variance decomposition of the variables contained in the VAR system (1) at different horizons. Specifically, we focus on the the fraction of the variance of the forecasting error explained by each shock.⁶ Note that as the forecasting horizon approaches infinity, the decomposition of the variance of the forecasting error coincides with the decomposition of the unconditional variance of the series in question.

For the purpose of the present discussion, we associate business-cycle fluctuations with the variance of the forecasting error at a horizon of about five years. Researchers typically define business cycles as movements in time series of frequencies ranging from 6 quarters to 32 quarters (Stock and Watson, 1999). Our choice of horizon falls in the middle of this window.

According to our estimate of the VAR system given in Eq. (1), innovations in the US interest rate, ϵ_t^{us} explain about 20% of movements in aggregate activity in emerging countries at business cycle frequency. At the same time, country-spread shocks, ϵ_t^r , account for about 12% of aggregate fluctuations in these countries. Thus, around one third of business cycles in emerging economies is explained by disturbances in external financial variables. These disturbances play an even stronger role in explaining movements in international transactions. In effect, US-interest-rate shocks and country-spread shocks are responsible for about 43% of movements in the trade balance-to-output ratio in the countries included in our panel.

Variations in country spreads are largely explained by innovations in US interest rates and innovations in country-spreads themselves. Jointly, these two sources of uncertainty account for about 85% of fluctuations in country spreads. Most of this fraction, about 60% points, is attributed to country-spread shocks. This last result concurs with Eichengreen and Mody (2000), who interpret this finding as suggesting that arbitrary revisions in investors sentiments play a significant role in explaining the behavior of country spreads.

The impulse response functions shown in Fig. 4 establish empirically that country spreads respond significantly and systematically to domestic macroeconomic variables. At the same time, the variance de-composition performed in this section indicates that

⁶ We observe that the estimates of $\epsilon_t^y, \epsilon_t^i, \epsilon_t^{thy}$, and ϵ_t^r (i.e., the sample residuals of the first, second, third, and fifth equations of the VAR system) are orthogonal to each other. But because \hat{y}_t, \hat{l}_t , and thy_t are excluded from the R_t^{us} equation, we have that the estimates of ϵ_t^{us} will in general not be orthogonal to the estimates of $\epsilon_t^y, \epsilon_t^i$, or ϵ_t^{thy} . However, under our maintained specification assumption that the US real interest rate does not systematically respond to the state of the business cycle in emerging countries, this lack of orthogonality should disappear as the sample size increases.

Table 2
Aggregate volatility with and without feedback of spreads from domestic variables model

Variable	Feedback	No Feedback
	Std. Dev.	Std. Dev.
\hat{y}	3.6450	3.0674
\hat{l}	14.1060	11.9260
tby	4.3846	3.5198
R	6.495	4.7696

domestic variables are responsible for about 15% of the variance of country spreads at business-cycle frequency. A natural question raised by these findings is whether the feedback from endogenous domestic variables to country spreads exacerbates domestic volatility. Here we make a first step at answering this question. Specifically, we modify the \hat{R}_t equation of the VAR system by setting to zero the coefficients on \hat{y}_{t-i} , \hat{l}_{t-i} , and tby_{t-i} for $i=0, 1$. We then compute the implied volatility of \hat{y}_t , \hat{l}_t , tby_t and \hat{R}_t in the modified VAR system at business-cycle frequency (20 quarters). We compare these volatilities to those emerging from the original VAR model. Table 2 shows that the presence of feedback from domestic variables to country spreads significantly increases domestic volatility. In particular, when we shut off the endogenous feedback, the volatility of output falls by 16% whereas the volatility of investment and the trade balance-to-GDP ratio falls by about 20%. The effect of feedback on the cyclical behavior of the country spread itself is even stronger. In effect, when feedback is negated, the volatility of the country interest rate falls by about one third.

Of course, this counterfactual exercise is subject to Lucas' (1976) celebrated critique. For one should not expect that in response to changes in the coefficients defining the spread process all other coefficients of the VAR system will remain unaltered. As such, the results of Table 2 serve solely as a way to motivate a more adequate approach to the question they aim to address. This more satisfactory approach necessarily involves the use of a theoretical model economy where private decisions change in response to alterations in the country-spread process. We follow this route later on.

3. Plausibility of the identified shocks

The process of identifying country-spread shocks and US-interest-rate shocks involves a number of restrictions on the matrices defining the VAR system (1). To assess the plausibility of these restrictions, it is necessary to use the predictions of some theory of the business cycle as a metric. If the estimated shocks imply similar business cycle fluctuations in the empirical as in theoretical models, we conclude that according to the proposed theory, the identified shocks are plausible.

Accordingly, we will assess the plausibility of our estimated shocks in four steps: First, we develop a standard model of the business cycle in small open economies. Second, we estimate the deep structural parameters of the model. Third, we feed into the model the estimated version of the fourth and fifth equations of the VAR system (1), describing the

stochastic laws of motion of the US interest rate and the country spread. Finally, we compare estimated impulse responses (i.e., those shown in Figs. 2 and 3) with those implied by the proposed theoretical framework.

3.1. The theoretical model

The basis of the theoretical model presented here is the standard neoclassical growth model of the small open economy (e.g., Mendoza, 1991). We depart from the canonical version of the model in four important dimensions. First, as in the empirical model, we assume that in each period, production and absorption decisions are made prior to the realization of that period's world interest rate and country spread. Thus, innovations in the world interest rate or the country spread are assumed to have allocative effects with a one-period lag. Second, preferences are assumed to feature external habit formation, or catching up with the Joneses as in Abel (1990). This feature improves the predictions of the standard model by preventing an excessive contraction in private non-business absorption in response to external financial shocks. Habit formation has been shown to help explain asset prices and business fluctuations in both developed economies (e.g., Boldrin et al., 2001) and emerging countries (e.g., Uribe, 2002). Third, firms are assumed to be subject to a working-capital-in-advance constraint. This element introduces a direct supply side effect of changes in the cost of borrowing in international financial markets. This working capital constraint allows the model to predict a more realistic response of domestic output to external financial shocks. Fourth, the process of capital accumulation is assumed to be subject to gestation lags and convex adjustment costs. In combination, these frictions prevent excessive investment volatility, induce persistence, and allow for the observed nonmonotonic (hump-shaped) response of investment in response to a variety of shocks (see Uribe, 1997).

3.1.1. Households

Consider a small open economy populated by a large number of infinitely lived households with preferences described by the following utility function

$$E_0 \sum_{t=0}^{\infty} \beta^t U(c_t - \mu \tilde{c}_{t-1}, h_t), \quad (2)$$

where c_t denotes consumption in period t , \tilde{c}_t denotes the cross-sectional average level of consumption in period $t - 1$, and h_t denotes the fraction of time devoted to work in period t . Households take as given the process for \tilde{c}_t . The single-period utility index u is assumed to be increasing in its first argument, decreasing in its second argument, concave, and smooth. The parameter $\beta \in (0, 1)$ denotes the subjective discount factor. The parameter μ measures the degree of external habit formation. The case $\mu=0$ corresponds to time separability in preferences. The larger is μ , the stronger is the degree of external habit formation.

Households have access to two types of asset, physical capital and an internationally traded bond. The capital stock is assumed to be owned entirely by

domestic residents. Households have three sources of income: wages, capital rents, and interest income on financial asset holdings. Each period, households allocate their wealth to purchases of consumption goods, purchases of investment goods, and purchases of financial assets. The household's period-by-period budget constraint is given by

$$d_t = R_{t-1}d_{t-1} + \Psi(d_t) - w_t h_t - u_t k_t + c_t + i_t, \quad (3)$$

where d_t denotes the household's debt position in period t , R_t denotes the gross interest rate faced by domestic residents in financial markets, w_t denotes the wage rate, u_t denotes the rental rate of capital, k_t denotes the stock of physical capital, and i_t denotes gross domestic investment. We assume that households face costs of adjusting their foreign asset position. We introduce these adjustment costs with the sole purpose of eliminating the familiar unit root built in the dynamics of standard formulations of the small open economy model. The debt-adjustment cost function $\Psi(\cdot)$ is assumed to be convex and to satisfy $\Psi(\bar{d}) = \Psi'(\bar{d}) = 0$, for some $\bar{d} > 0$ Schmitt-Grohé and Uribe (2003) compare a number of standard alternative ways to induce stationarity in the small open economy framework and conclude that they all produce virtually identical implications for business fluctuations.

The debt adjustment cost can be decentralized as follows. Suppose that financial transactions between domestic and foreign residents require financial intermediation by domestic institutions (banks). Suppose there is a continuum of banks of measure one that behave competitively. They capture funds from foreign investors at the country rate R_t and lend to domestic agents at the rate R_t^d . In addition, banks face operational costs, $\Psi(d_t)$, that are increasing and convex in the volume of intermediation, d_t . The problem of domestic banks is then to choose the volume d_t so as to maximize profits, which are given by $R_t^d [d_t - \Psi(d_t)] - R_t d_t$, taking as given R_t^d and R_t . It follows from the first-order condition associated with this problem that the interest rate charged to domestic residents is given by

$$R_t^d = \frac{R_t}{1 - \Psi'(d_t)}, \quad (4)$$

which is precisely the shadow interest rate faced by domestic agents in the centralized problem. Bank profits are assumed to be distributed to domestic households in a lump-sum fashion. This digression will be of use later in the paper when we analyze the firm's problem.

The process of capital accumulation displays adjustment costs in the form of gestation lags and convex costs of installing new capital goods. To produce one unit of capital good requires investing 1/4 units of goods for four consecutive periods. Let s_{it} denote the number of investment projects started in $t-i$ for $i=0, 1, 2, 3$. Then investment in period t is given by

$$i_t = \frac{1}{4} \sum_{i=0}^3 s_{it}. \quad (5)$$

In turn, the evolution of s_{it} is given by

$$s_{i+1,t+1} = s_{it}, \tag{6}$$

For $i=0, 1, 2$. The stock of capital obeys the following law of motion:

$$k_{t+1} = (1 - \delta)k_t + k_t \Phi\left(\frac{s_{3t}}{k_t}\right), \tag{7}$$

where $\delta \in (0, 1)$ denotes the rate of depreciation of physical capital. The process of capital accumulation is assumed to be subject to adjustment costs, as defined by the function Φ , which is assumed to be strictly increasing, concave, and to satisfy $\Phi(\delta) = \delta$ and $\Phi'(\delta) = 1$. These last two assumptions ensure the absence of adjustment costs in the steady state. The introduction of capital adjustment costs is commonplace in models of the small open economy. They are a convenient and plausible way to avoid excessive investment volatility in response to changes in the interest rate faced by the country in international markets.

Households choose contingent plans $\{c_{t+1}, h_{t+1}, s_{0,t+1}, d_{t+1}\}_{t=0}^{\infty}$ so as to maximize the utility function (2) subject to the budget constraint (3), the laws of motion of total investment, investment projects, and the capital stock given by Eqs. (5)–(7), and a borrowing constraint of the form

$$\lim_{j \rightarrow \infty} E_t \frac{d_{t+j+1}}{\prod_{s=0}^j R_{t+s}} \leq 0 \tag{8}$$

that prevents the possibility of Ponzi schemes. The household takes as given the processes $\{\hat{c}_{t-1}, R_t, w_t, u_t\}_{t=0}^{\infty}$ as well as $c_0, h_0, k_0, R_{-1}d_{-1}$, and s_{it} for $i=0, 1, 2, 3$. Uribe and Yue (2003) present the associated first- order conditions. These optimality conditions are fairly standard, except for the fact that, because of our assumed information structure, they take into account that the variables c_{t+1}, h_{t+1} , and $s_{0,t+1}$ all reside in the information set of period t .

3.1.2. Firms

Output is produced by means of a production function that takes labor services and physical capital as inputs,

$$y_t = F(k_t, h_t), \tag{9}$$

where the function F is assumed to be homogeneous of degree one, increasing in both arguments, and concave. Firms hire labor and capital services from perfectly competitive markets. The production process is subject to a working-capital constraint that requires firms to hold non-interest-bearing assets to finance a fraction of the wage bill each period. Formally, the working-capital constraint takes the form

$$\kappa_t \geq \eta w_t h_t; \quad n \geq 0,$$

where κ_t denotes the amount of working capital held by the representative firm in period t .

The debt position of the firm, denoted by d_t^f , evolves according to the following expression

$$d_t^f = R_{t-1}^d d_{t-1}^f - F(k_t, h_t) + w_t h_t + u_t k_t + \pi_t - \kappa_{t-1} + \kappa_t,$$

where π_t denotes distributed profits in period t , and R_t^d is the shadow interest rate at which domestic residents borrow and is given by Eq. (4). As shown by the discussion around Eq. (4), R_t^d is indeed the interest rate at which all nonfinancial domestic residents borrow and differs in general from the country interest rate R_t due to the presence of debt-adjustment costs. Define the firm’s total net liabilities at the end of period t as $a_t = R_t^d d_t^f - \kappa_t$. Then, we can rewrite the above expression as

$$\frac{a_t}{R_t^d} = a_{t-1} - F(k_t, h_t) + w_t h_t + u_t k_t + \pi_t + \left(\frac{R_t^d - 1}{R_t^d} \right) \kappa_t.$$

We will limit attention to the case in which the interest rate is positive at all times. This implies that the working-capital constraint will always bind, for otherwise the firm would incur in unnecessary financial costs, which would be suboptimal. So we can use the working-capital constraint holding with equality to eliminate κ_t from the above expression to get

$$\frac{a_t}{R_t^d} = a_{t-1} - F(k_t, h_t) + w_t h_t \left[1 + \eta \left(\frac{R_t^d - 1}{R_t^d} \right) \right] + u_t k_t + \pi_t. \tag{10}$$

It is clear from this expression that the assumed working-capital constraint increases the unit labor cost by a fraction $\eta(R_t^d - 1)/R_t^d$, which is increasing in the interest rate R_t^d .

The firm’s objective is to maximize the present discounted value of the stream of profits distributed to its owners, the domestic residents. That is,

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \pi_t.$$

We use the household’s marginal utility of wealth as the stochastic discount factor because households own domestic firms. Using constraint (10) to eliminate π_t from the firm’s objective function the firm’s problem can be stated as choosing processes for a_t , h_t , and k_t so as to maximize

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \left\{ \frac{a_t}{R_t^d} - a_{t-1} + F(k_t, h_t) - w_t h_t \left[1 + \eta \left(\frac{R_t^d - 1}{R_t^d} \right) \right] - u_t k_t \right\},$$

subject to a no-Ponzi-game borrowing constraint of the form

$$\lim_{j \rightarrow \infty} E_t \frac{a_{t+j}}{j \prod_{s=0}^j R_{t+s}^d} \leq 0.$$

The first-order conditions associated with this problem are (10), the no-Ponzi-game constraint holding with equality, and Eq. (11) in Uribe and Yue (2003), and

$$F_h(k_t, h_t) = w_t \left[1 + \eta \left(\frac{R_t^d - 1}{R_t^d} \right) \right] \quad (11)$$

$$F_k(k_t, h_t) = u_t. \quad (12)$$

It is clear from the first of these two efficiency conditions that the working-capital constraint distorts the labor market by introducing a wedge between the marginal product of labor and the real wage rate. This distortion is larger the larger the opportunity cost of holding working capital, $(R_t^d - 1)/R_t^d$, or the higher the intensity of the working capital constraint, η^7 . We also observe that any process at satisfying Eq. (10) and the firm's no-Ponzi-game constraint is optimal. We assume that firms start out with no liabilities. Then, an optimal plan consists in holding no liabilities at all times ($a_t = 0$ for all $t \geq 0$), with distributed profits given by

$$\pi_t = F(k_t, h_t) - w_t h_t \left[1 + \eta \left(\frac{R_t^d - 1}{R_t^d} \right) \right] - u_t k_t.$$

In this case, d_t represents the country's net debt position, as well as the amount of debt intermediated by local banks. We also note that the above three equations together with the assumption that the production technology is homogeneous of degree one imply that profits are zero at all times ($\pi_t = 0 \forall t$).

3.1.3. Driving forces

One advantage of our method to assess the plausibility of the identified US-interest-rate shocks and country-spread shocks is that one need not feed into the model shocks other than those whose effects one is interested in studying. This is because we empirically identified not only the distribution of the two shocks we wish to study, but also their contribution to business cycles in emerging economies. In formal terms, we produced empirical estimates of the coefficients associated with ϵ_t^r and ϵ_t^{rUS} in the MA(∞) representation of the endogenous variables of interest (output, investment, etc.). So using the calibrated model, we can generate the corresponding theoretical objects and compare them. It turns out that up to first order, one need not know anything about the distribution of shocks other than ϵ_t^r and ϵ_t^{rUS} to construct the coefficients associated with these shocks in the MA(∞) representation of endogenous variables implied by the model. We therefore close our model by introducing the law of motion of the country interest rate R_t . This

⁷ The precise form taken by this wedge depends on the particular timing assumed in modeling the use of working capital. Here we adopt the shopping-time timing. Alternative assumptions give rise to different specifications of the wedge. For instance, under a cash-in-advance timing the wedge takes the form $1 + \eta(R_t^d - 1)$.

process is given by our estimate of the bottom equation of the VAR system (1), which is shown in the last columns of Table 1. That is, \hat{R}_t is given by

$$\begin{aligned} \hat{R}_t = & 0.63\hat{R}_{t-1} + 0.50\hat{R}_t^{us} + 0.35\hat{R}_{t-1}^{us} - 0.79\hat{y}_t + 0.61\hat{y}_{t-1} + 0.11\hat{i}_t \\ & - 0.12\hat{i}_{t-1} + 0.29tby_t - 0.19tby_{t-1} + \epsilon_t^r, \end{aligned} \tag{13}$$

where ϵ^r is an i.i.d. disturbance with mean zero and standard deviation 0.031. As indicated earlier, the variable tby_t stands for the trade balance-to-GDP ratio and is given by:⁸

$$tby_t = \frac{y_t - c_t - i_t - \Psi(d_t)}{y_t}. \tag{14}$$

Because the process for the country interest rate defined by Eq. (13) involves the world interest rate R_t^{us} , which is assumed to be an exogenous random variable, we must also include this variable’s law of motion as part of the set of equations defining the equilibrium behavior of the theoretical model. Accordingly, we stipulate that R_t^{us} follows the AR (1) process shown in the fourth column of Table 1. Specifically,

$$\hat{R}_t^{us} = 0.83\hat{R}_{t-1}^{us} + \epsilon_t^{rus}, \tag{15}$$

where ϵ_t^{rus} is an i.i.d. innovation with mean zero and standard deviation 0.007.

3.1.4. Equilibrium, functional forms, and parameter values

In equilibrium all households consume identical quantities. Thus, individual consumption equals average consumption across households, or

$$c_t = \tilde{c}_t; \quad t \geq -1. \tag{16}$$

An equilibrium is a set of processes $c_{t+1}, \tilde{c}_{t+1}, h_{t+1}, d_t, i_t, k_{t+1}, s_{it+1}$ for $i=0, 1, 2, 3, R_t, R_t^d, w_t, u_t, y_t, tby_t, \lambda_t, q_t,$ and v_{it} for $i=0, 1, 2$ satisfying conditions (3)–(9), (11)–(14), (16), and the optimality conditions associated with the household’s problem (Eqs. (9)–(16)) in Uribe and Yue, 2003), all holding with equality, given $c_0, c_{-1}, y_{-1}, i_{-1}, i_0, h_0,$ the processes for the exogenous innovations ϵ_t^{rus} and $\epsilon_t^r,$ and Eq. (15) describing the evolution of the world interest rate.

We adopt the following standard functional forms for preferences, technology, capital adjustment costs, and debt adjustment costs,

$$U(c - \mu\tilde{c}, h) = \frac{[c - \mu\tilde{c} - \omega^{-1}h^\omega]^{1-\gamma} - 1}{1 - \gamma}$$

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

$$\Phi(x) = x - \frac{\phi}{2}(x - \delta)^2; \quad \phi > 0$$

⁸ In an economy like the one described by our theoretical model, where the debt-adjustment cost $\Psi(d_t)$ are incurred by households, the national income and product accounts would measure private consumption as $c_t + \Psi(d_t)$ and not simply as c_t . However, because of our maintained assumption that $\Psi'(\bar{d})=0$, it follows that both measures of private consumption are identical up to first order.

$$\Psi(d) = \frac{\psi}{2} (d - \bar{d})^2.$$

In calibrating the model, the time unit is meant to be one quarter. Following [Mendoza \(1991\)](#), we set $\gamma=2$, $w=1.455$, and $\alpha=.32$. We set the steady-state real interest rate faced by the small economy in international financial markets at 11% per year. This value is consistent with an average US interest rate of about 4% and an average country premium of 7%, both of which are in line with actual data. We set the depreciation rate at 10% per year, a standard value in business-cycle studies.

There remain four parameters to assign values to, ψ , ϕ , η , and μ . There is no readily available estimates for these parameters for emerging economies. We therefore proceed to estimate them. Our estimation procedure follows [Christiano et al. \(2001\)](#) and consists of choosing values for the four parameters so as to minimize the distance between the estimated impulse response functions shown in [Fig. 2](#) and the corresponding impulse responses implied by the model.⁹ In our exercise we consider the first 24 quarters of the impulse response functions of 4 variables (output, investment, the trade balance, and the country interest rate), to 2 shocks (the US-interest-rate shock and the country-spread shock). Thus, we are setting 4 parameter values to match 192 points. Specifically, let IR^e denote the 192×1 vector of estimated impulse response functions and $IR^m(\psi, \phi, \eta, \mu)$ the corresponding vector of impulse responses implied by the theoretical model, which is a function of the four parameters we seek to estimate. Then our estimate of (ψ, ϕ, η, μ) and the associated distance between the empirical and the theoretical models, which we denote by Δ , satisfy

$$\Delta \equiv \min_{\{\psi, \phi, \eta, \mu\}} [IR^e - IR^m(\psi, \phi, \eta, \mu)]' \sum_{IR^e}^{-1} [IR^e - IR^m(\psi, \phi, \eta, \mu)], \quad (17)$$

where \sum_{IR^e} is a 192×192 diagonal matrix containing the variance of the impulse response function along the diagonal. This matrix penalizes those elements of the estimated impulse response functions associated with large error intervals. The resulting parameter estimates are $\psi=0.00042$, $\phi=72.8$, $\eta=1.2$, and $\mu=0.2$. The implied debt adjustment costs are small. For example, a 10% increase in d_t over its steady-state value \bar{d} maintained over one year has a resource cost of 4×10^{-6} percent of annual GDP. On the other hand, capital adjustment costs appear as more significant. For instance, starting in a steady-state situation, a 10% increase in investment for one year produces an increase in the capital stock of 0.88%. In the absence of capital adjustment costs, the capital stock increases by 0.96%. The estimated value of η implies that firms maintain a level of working capital equivalent to about 3.6 months of wage payments. Finally, the estimated degree of habit formation is modest compared to the values typically used to explain asset-price regularities in closed economies (e.g., [Constantinides, 1990](#)). [Table 3](#) summarizes the parameterization of the model.

⁹ A key difference between the exercise presented here and that in [Christiano et al.](#) is that here the estimation procedure requires fitting impulse responses to multiple sources of uncertainty (i.e., country-interest-rate shocks and world-interest-rate shocks, whereas in [Christiano et al.](#) the set of estimated impulse responses used in the estimation procedure are originated by a single shock.

Table 3
Parameter values

Symbol	Value	Description
β	0.973	Subjective discount factor
γ	2	Inverse of intertemporal elasticity of substitution
μ	0.204	Habit formation parameter
ω	1.455	$1/(\omega - 1)$ =Labor supply elasticity
α	0.32	Capital elasticity of output
ϕ	72.8	Capital adjustment cost parameter
ψ	0.00042	Debt adjustment cost parameter
δ	0.025	Depreciation rate (quarterly)
η	1.2	Fraction of wage bill subject to working-capital constraint
R	2.77%	Steady-state real country interest rate (quarterly)

3.2. Estimated and theoretical impulse response functions

We are now ready to produce the response functions implied by the theoretical model and to compare them to those stemming from the empirical model given by the VAR system (1). Fig. 5 depicts the impulse response functions of output, investment, the trade balance-to-GDP ratio, and the country interest rate. The left column shows impulse responses to a US-interest-rate shock (ϵ_t^{us}), and the right column shows impulse responses to a country-spread shock (ϵ_t^c).

The model replicates the data relatively well. All 192 points belonging to the theoretical impulse responses except for three lie inside the estimated two-standard-error bands. Furthermore, the model replicates three key qualitative features of the estimated impulse responses: First, output and investment contract in response to either a US-interest-rate shock or a country-spread shock. Second, the trade balance improves in response to either shock. Third, the country interest rate displays a hump-shaped response to an innovation in the US interest rate. Fourth, the country interest rate displays a monotonic response to a country-spread shock. We therefore conclude that the scheme used to identify the parameters of the VAR system (1) is indeed successful in isolating country-spread shocks and US-interest-rate shocks from the data.

4. The endogeneity of country spreads: business cycle implications

The estimated process for the country interest rate given in Eq. (13) implies that the country spread, $\hat{S}_t \equiv \hat{R}_t - \hat{R}_t^{us}$, moves in response to four types of variable: lagged values of itself (or the autoregressive component, S_{t-1}), the exogenous country-spread shock (or, in Eichengreen's and Mody's, 2000, terminology, the sentiment component, ϵ_t^c), current and past US interest rates (R_t^{us} and R_{t-1}^{us}), and current and past values of a set of domestic endogenous variables ($\hat{y}_t, \hat{y}_{t-1}, \hat{i}_t, \hat{i}_{t-1}, \hat{tby}_t, \hat{tby}_{t-1}$). A natural question is to what extent the endogeneity of country spreads contributes to exacerbating aggregate fluctuations in emerging countries.

We address this question by means of two counterfactual exercises. The first exercise aims at gauging the degree to which country spreads amplify the effects of world-interest-

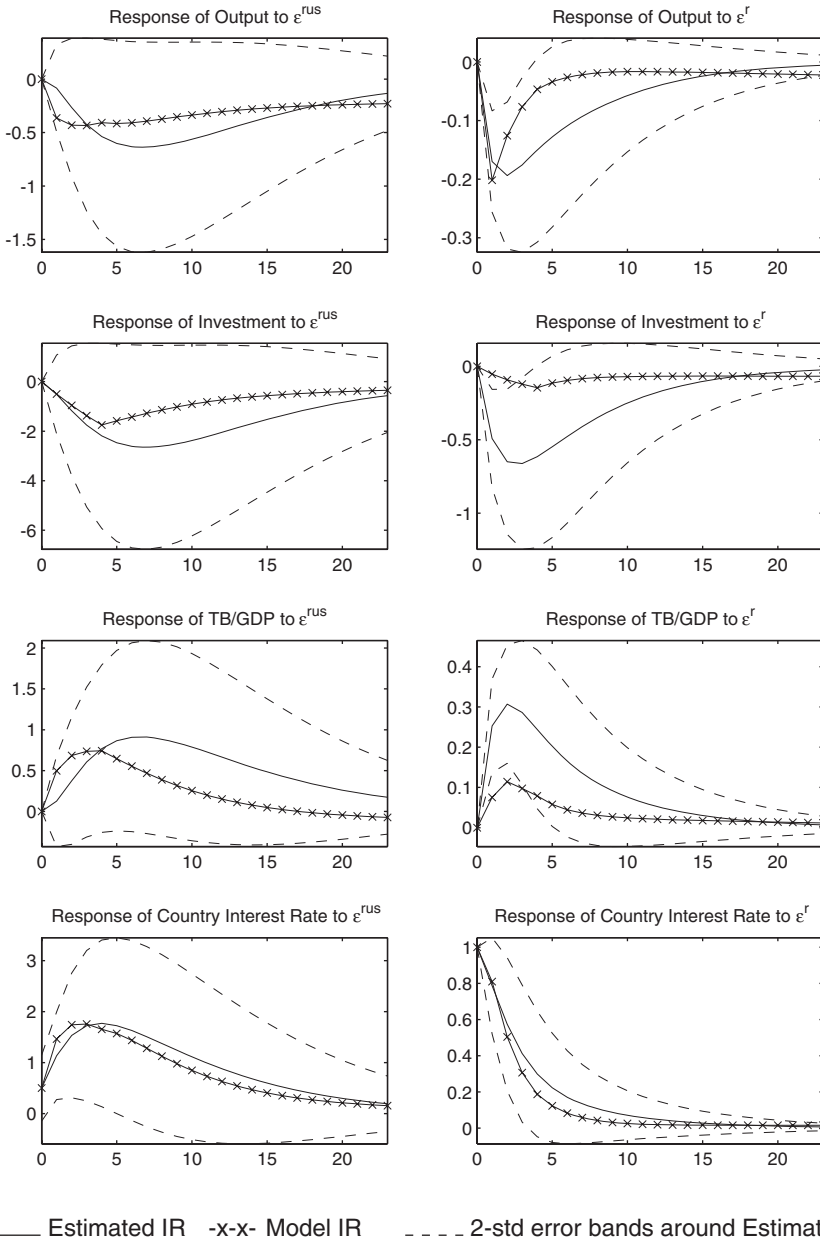


Fig. 5. Theoretical and estimated impulse response functions. Note: The first column displays impulse responses to a US interest rate shock ($\epsilon^{r^{US}}$), and the second column displays impulse responses to a country-spread shock (ϵ^r).

rate shocks. To this end, we calculate the volatility of endogenous macroeconomic variables due to US-interest-rate shocks in a world where the country spread does not directly depend on the US interest rate. Specifically, we assume that the process for the country interest rate is given by

$$\begin{aligned} \hat{R}_t = & 0.63\hat{R}_{t-1} + \hat{R}_t^{us} - 0.63\hat{R}_{t-1}^{us} - 0.79\hat{y}_t + 0.61\hat{y}_{t-1} + 0.11\hat{t}_t - 0.12\hat{t}_{t-1} \\ & + 0.29tby_t - 0.19tby_{t-1} + \epsilon'_t. \end{aligned} \quad (18)$$

This process differs from the one shown in Eq. (13) only in that the coefficient on the contemporaneous US interest rate is unity and the coefficient on the lagged US interest rate equals -0.63 , which is the negative of the coefficient on the lagged country interest rate. This parameterization has two properties of interest. First, it implies that, given the past value of the country spread, $\hat{S}_{t-1} = \hat{R}_{t-1}\hat{R}_{t-1}^{us}$, the current country spread, S_t , does not directly depend upon current or past values of the US interest rate. Second, the above specification of the country-interest-rate process preserves the dynamics of the model in response to country-spread shocks. The process for the US interest rate is assumed to be unchanged (see Eq. (15)). We note that in conducting this and the next counterfactual exercises we do not reestimate the VAR system (equivalently, we do not reestimate Eq. (13)). The reason is that doing so would alter the estimated process of the country spread shock ϵ'_t . This would amount to introducing two changes at the same time. Namely, changes in the endogenous and the sentiment components of the country spread process.

The precise question we wish to answer is: what process for \hat{R}_t induces higher volatility in macroeconomic variables in response to US-interest-rate shocks, the one given in Eq. (13) or the one given in Eq. (18)? As pointed out earlier in the paper, to address this counterfactual question one cannot simply resort to replacing line five in the VAR system (1) with Eq. (18) and then recomputing the variance decomposition. For this procedure would be subject to Lucas' (1976) critique on the use of estimated models to evaluate changes in regime. Instead, we appeal to the theoretical model developed in the previous section. The answer stemming from our theoretical model is meaningful for two reasons: First, it is not vulnerable to the Lucas critique, because the theoretical equilibrium is recomputed taking into account the effects of parameter changes on decision rules. Second, we showed earlier in this paper that the theoretical model is capable of capturing the observed macroeconomic dynamics induced by US-interest-rate shocks. This is important because obviously the exercise would be meaningless if conducted within a theoretical framework that fails to provide an adequate account of basic business-cycle stylized facts.

The result of the exercise is shown in Table 4. We find that when the country spread is assumed not to respond directly to variations in the US interest rate (i.e., under the process for R_t given in Eq. (18)) the standard deviation of output and the trade balance-to-output ratio explained by US-interest-rate shocks is about two thirds smaller than in the baseline scenario (i.e., when R_t follows the process given in Eq. (13)). This indicates that the aggregate effects of US-interest-rate shocks are strongly amplified by the dependence of country spreads on US interest rates.

A second counterfactual experiment we wish to conduct aims to assess the macroeconomic consequences of the fact that country spreads move in response to

Table 4
Endogeneity of country spreads and aggregate instability

Variable	Std. Dev. due to ϵ^{rus}			Std. Dev. due to ϵ^r		
	Baseline model	S_t independent of R^{rus}	S_t independent of \hat{y} , \hat{i} , or tby	Baseline model	S_t independent of R^{rus}	S_t independent of \hat{y} , \hat{i} , or tby
\hat{y}	1.110	0.420	0.784	0.819	0.819	0.639
\hat{i}	2.245	0.866	1.580	1.547	1.547	1.175
tby	1.319	0.469	0.885	0.663	0.663	0.446
R	3.509	1.622	2.623	4.429	4.429	3.983
S	2.515	0.347	1.640	4.429	4.429	3.983

Note: the variable S denotes the country spread and is defined as $S=R/R^{rus}$. A hat on a variable denotes log-deviation from its non-stochastic steady-state value.

changes in domestic variables such as output and the external accounts. To this end, we use our theoretical model to compute the volatility of endogenous domestic variables in an environment where country spreads do not respond to domestic variables. Specifically, we replace the process for the country interest rate given in Eq. (13) with the process

$$\hat{R}_t = 0.63\hat{R}_{t-1} + 0.50\hat{R}_t^{rus} + 0.35\hat{R}_{t-1}^{rus} + \epsilon_t^r. \quad (19)$$

Table 4 displays the outcome of this exercise. We find that the equilibrium volatility of output, investment, and the trade balance-to-output ratio explained jointly by US-interest-rate shocks and country-spread shocks (ϵ_t^{rus} and ϵ_t^r) falls by about one fourth when the country spread is independent of domestic conditions with respect to the baseline scenario.¹⁰ Thus, the fact that country spreads respond to the state of business conditions in emerging countries seems to significantly accentuate the degree of aggregate instability in the region.

5. Robustness and sensitivity

In this section, we perform a robustness check on our empirical model and a sensitivity analysis on the theoretical model.

To gauge the robustness of our VAR results, we augment our sample by adding 6 countries from the EMBI Global data base. Namely, Chile, Colombia, Korea, Malaysia, Thailand, and Turkey. Because the EMBI Global data base allows for less liquid assets than the EMBI+ data set, our baseline estimation excludes data from the former source. We also deepen our sample in the temporal dimension by enlarging the Argentine sample to the period 1983:1 to 2001:4. The results of estimating the VAR system (1) using the expanded sample are shown in Fig. 6. The estimated impulse response functions are similar to those obtained using the smaller data set. In particular, output and domestic absorption contract in response to an innovation in the country spread or the world interest rate. Also, the decline in domestic absorption is more severe than the

¹⁰ Ideally, this particular exercise should be conducted in an environment with a richer battery of shocks capable of explaining a larger fraction of observed business cycles than that accounted by ϵ_t^{rus} and ϵ_t^r alone.

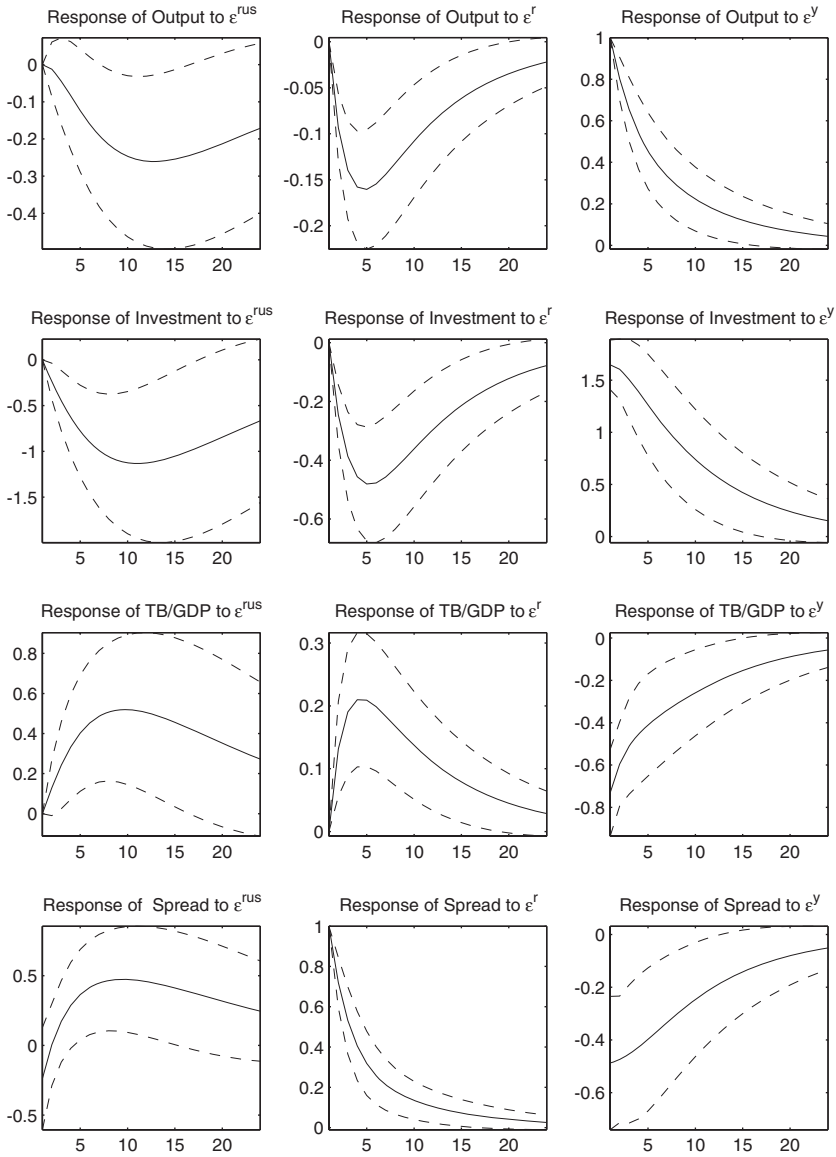


Fig. 6. Robustness of empirical estimates. Notes: (1) Solid lines depict point estimates of impulse responses, and broken lines depict two-standard-deviation error bands. (2) The responses of Output and Investment are expressed in percent deviations from their respective log-linear trends. The responses of the Trade Balance-to-GDP ratio and the country spread are expressed in percentage points. The two-standard-error bands are computed using the delta method.

fall in output, which causes the trade balance to improve. In response to an unexpected increase in the world interest rate, the country spread initially falls, but then overshoots with a delay of about 6 quarters. Finally, as in the baseline estimation, a positive output

Table 5
Sensitivity analysis

Model specification	ψ	ϕ	η	μ	Δ
Baseline	0.0004	72.8	1.20	0.20	125.2
No habits	0.0002	72.8	1.06	0	129.9
Low adjustment costs	0.9582	7.2	0.17	0.15	148.9
No working capital	0.0003	52.9	0	0.00	163.7

Note: ψ is the parameter defining the debt adjustment cost function, ϕ is the parameter defining the capital adjustment cost function, η denotes the fraction of the wage bill subject to a working capital constraint, μ is the habit formation parameter, and Δ denotes the distance between empirical and theoretical models as defined in Eq. (17).

shock produces a significant decline in country spreads and a deterioration in the trade balance.

We perform a sensitivity analysis by studying three alternative specifications of the theoretical model: a model without habit formation ($\mu=0$), a model with no working capital constraint ($\eta=0$), and a model with adjustment costs 10 times smaller than in the baseline specification ($\phi=7.2$). In each case, we reestimate the remaining 3 parameters. Table 5 displays estimation results and the associated distance between the empirical and the theoretical model, denoted by Δ and defined in Eq. (17).

The most important of the estimated parameters appears to be η , the one defining the size of the working capital constraint. Fig. 7 displays impulse responses to country-spread and world interest rate shocks in a model featuring no working capital constraints. In the absence of working capital constraints, the model fails to reproduce the observed contraction in output in response to unexpected increases in country spreads or the world interest rate. The intuition behind this result is clear. The working capital constraint implies that the cost of labor is increasing in the interest rate, which is opportunity cost of holding working capital. The importance of working capital constraints in explaining output contractions in emerging countries has been emphasized by a number of authors. See, for instance, Neumeyer and Perri (2001), Mendoza (2004), and Oviedo (2004).

Taken together, the sensitivity analysis performed here and the two counterfactual experiments presented earlier in the paper point at the importance of country spreads—particularly their dependence on domestic fundamentals and the world interest rate—in understanding business cycles in emerging economies.

6. Conclusion

Country spreads, the world interest rate, and business conditions in emerging markets are interrelated in complicated ways. Country spreads affect aggregate activity but at the same time respond to domestic macroeconomic fundamentals. The world interest rate has an effect on the country interest rates not only through the familiar no-arbitrage condition but also through country spreads. This paper aims at making a step forward in disentangling these interconnections.

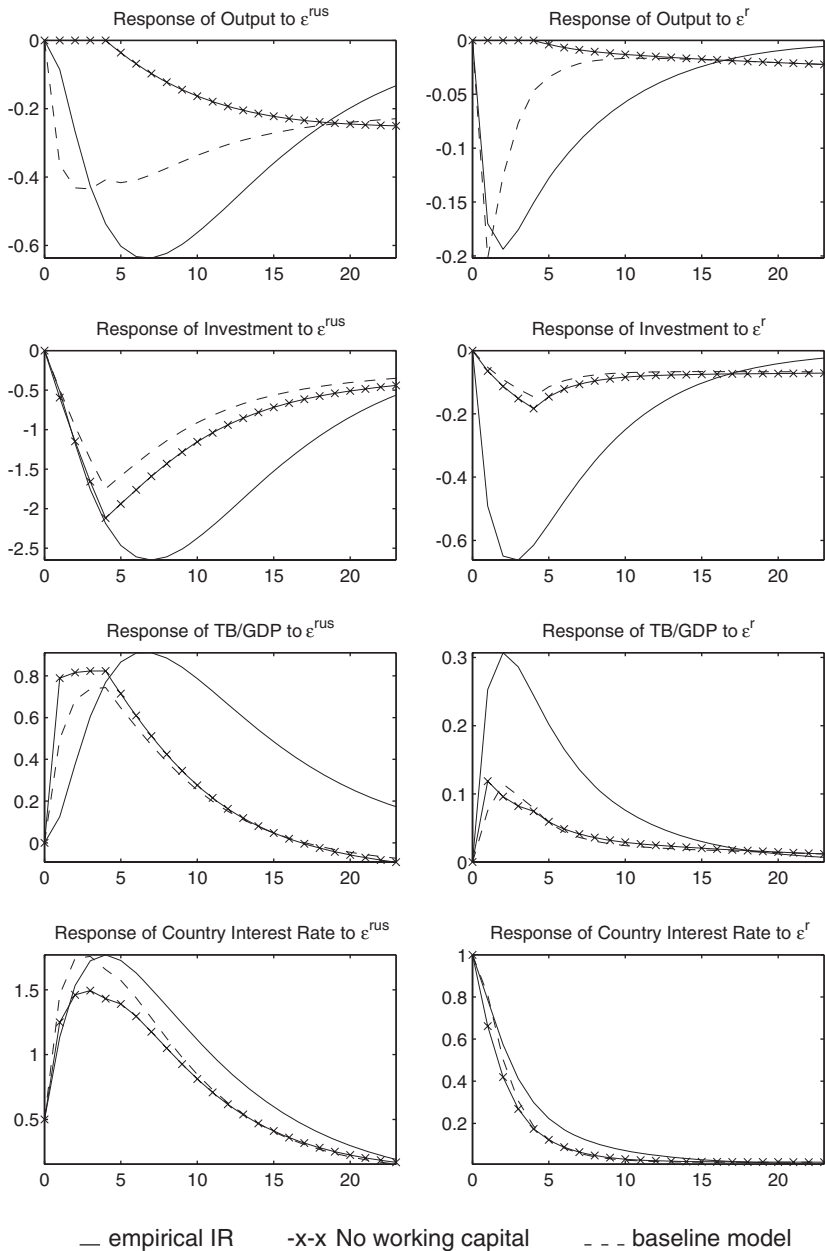


Fig. 7. Sensitivity analysis: no working capital. Note: the first column displays impulse responses to a US interest rate shock ($\epsilon^{r^{US}}$), and the second column displays impulse responses to a country-spread shock (ϵ^r).

We find that the answer to the question posed in the title of this paper is that country spreads drive business cycles in emerging economies and vice versa. But the effects are not overwhelmingly large. Country spread shocks explain about 12% of

movements in domestic economic activity, and, in turn, innovations in macroeconomic fundamentals in emerging markets explain about 12% of movements in country spreads.

However, country spreads play a significant role in propagating shocks. For instance, we find that US-interest-rate shocks explain about 20% of movements in output. This is a large number. But most of the contribution of US interest rates to business cycles in emerging markets is due to the fact that country spreads respond systematically to variations in this variable. Specifically, if country spreads were independent of the US interest rate, then the variance of emerging countries' output explained by US interest rates would fall by about two thirds. Similarly, a significant fraction of the variability in domestic activity that is explained jointly by world-interest-rate shocks and country-spread shocks is due to the fact that country spreads respond to the state of developing countries' business cycles (as measured by variables such as aggregate output). If country spreads did not respond to variations in emerging countries' domestic fundamentals, then the magnitude of aggregate fluctuations due to US interest-rate shocks and country-spread shocks would fall by around one fourth.

This paper can be extended in a number of directions. First, a key relative price whose behavior any model of emerging market economies should aspire to explain is the real exchange rate. Both the theoretical and empirical models studied here are completely silent on this. Extending the analysis to allow for a nontradable sector is therefore in order.

Perhaps a more important issue to address concerns the microfoundations of country-spread behavior. In this paper the theoretical analysis is limited to the case in which the law of motion of the country spread is given. Nothing is said about why the country premium depends upon variables such as output or the world interest rate. Enriching the theoretical model by providing a more microfounded specification of country spreads is desirable. The improved framework is likely to deal explicitly with issues of debt default, as it seems reasonable to expect that the probability that a country will honor its external obligations is higher the higher are variables such as output, investment, or the trade balance, and the lower is the world interest rate. The existing literature on sovereign debt developed in the 1980s is a natural starting point. But this body of work still remains to be integrated into a dynamic business-cycle framework of the open economy. A recent paper by [Arellano \(2003\)](#) is a step in this direction. An important challenge that the resulting theoretical framework will face has to do with replicating the delayed overshooting in the response of country spreads to world-interest-rate shocks identified in this paper. In effect, our empirical findings suggest that an increase in the world interest rate causes an initial decline in country spreads. After the initial period, the country spread grows rapidly, reaching in a few quarters a level higher than the pre-shock value.

More generally, a central methodological theme of this paper is the combined use of time series analysis and theoretical general equilibrium modeling. Most of the literature extant limits attention to only one of these analytical tools. It is our belief that bringing the prediction of empirical and theoretical models closer together will further enhance our understanding of the forces driving business cycles in the emerging market world.

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