International Financial Shocks in Emerging Markets*

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Abstract

In the present paper, we develop a two-sector general equilibrium model of a small open economy to explore the transmission mechanisms of external financial shocks. In particular, we use a cash-in-advance model with limited participation augmented with a financial friction in the form of a fundamentals-related risk premium on external funds. The friction amplifies the effects of external financial shocks, especially when the economy is highly indebted in foreign currency. For a set of Latin American economies, the theoretical model is calibrated to match the empirical impulse responses of output, investment, trade balance, and domestic credits in response to an adverse shock to the country risk premium. In addition, we analyze the role of monetary policy during the financial crisis.

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1 Introduction

Over the past two decades, several major emerging market (EM) economies have experienced serious financial crises. Many of these crises appear to have been triggered by systemic sudden stops in which massive capital outflows and substantial deteriorations in EM bond spreads affected a wide range of EM economies at approximately the same time. Many of these crises have been associated with large and persistent drops in investment and growth. These observations are illustrated in Figure 1 which plots country spreads and investments of five Latin American economies (LA-5).[1] Remarkably, the countries' external spreads (EMBI+ spreads) are highly correlated across countries and increase sharply during the major crisis periods of 1994-95, 1998, and 2001-02. The exception is Ecuador's currency crisis in 2000 which had no major impact on the other countries. Moreover, domestic investment drops in most cases with the onset of the financial shocks. Calvo, Izquierdo, and Talvi (2006) emphasize that such external shocks can be followed by a painful adjustment and sharp reduction in economic growth, or become a minor recession. The particular outcome depends ultimately on the structure of a country's balance sheet and income sources, and the credibility of fiscal and monetary policy.

In the present paper, we explore the associated adjustment mechanism in response to an unexpected, adverse shock to the costs of foreign funding in a dynamic stochastic general equilibrium model (DSGE) of a small open economy which faces financial market frictions. The initial shock is incorporated exogenously in the risk premium on foreign-currency denominated funds of the corporate sector and is amplified as the associated currency depreciation increases both the domestic value of outstanding debt (adverse balance sheet effect) and the fundamentals-related part of the risk premium (adverse interest rate effect). We simulate the model and match the theoretical impulse responses to the risk premium shock with the corresponding empirical impulse responses of output, investment, trade balance, and domestic credits resulting from a structural panel vector-autoregressive (VAR) model for the LA-5 economies.

The theoretical model can be applied to study the effects of systemic financial shocks originating in international capital markets on EM economies. Such systemic external shocks seem to have been at play during the Tequila crisis in 1994-95, the Asian crisis of 1997, the Russian crisis of 1998, the Argentine crisis of 2001-02, and the current global financial crisis (Calvo (1998), Kaminski, Reinhart, and Vegh (2003), Calvo, Izquierdo, and Talvi (2006), and World Bank (2008)). In all cases, a worse-than-expected crisis in one country spread out to a variety of economies in terms of exchange rate systems, capital controls, fiscal stance, growth performance, and balance sheet mismatches. The international contagion had different origins. Common creditor linkages seem to have been in the foreground during the Tequila, Russian, and current global financial crises, while pressures for competitive devaluations were present in Asia and Argentina after Thailand's devaluation of 1997 and Brazil's devaluation of 1999, respectively (Roubini and Setser (2004)). However, many EM economies are not innocent victims in this process. In many instances, domestic weaknesses such as currency mismatches on the economies' balance sheets and high levels of external short-term debt were the source of the underlying financial fragility and vulnerability to a financial crisis.

The theoretical literature on financial crises from the perspective of EM economies, typically,

[1] The countries are Brazil, Colombia, Ecuador, Mexico, and Peru.

incorporates financial market frictions in the form of borrowing constraints on external debt (Arellano and Mendoza (2003), Christiano, Gust, and Roldos (2004), and Mendoza (2006)). In these models, a crisis occurs when the economy is hit by an adverse shock which triggers the borrowing constraint to bind. As a result, the affected economy is forced to repay parts of its external debt (financial deleveraging). If liabilities are largely denominated in units of tradables and assets in units of non-tradables, the financial deleveraging causes a real depreciation which increases the economy's liabilities relative to its assets (balance sheet effect). The associated reduction in net worth increases in turn the real financial burden and worsens the economy's access to external finance, ending up in a circle of amplification.

The present model is most related to the limited participation model of Christiano, Gust, and Roldos (2004). The representative firm produces tradable and non-tradable goods subject to working capital constraints on labor and imports. In addition, the firm can borrow foreign-currency denominated funds on the global capital market to finance investment. There are, however, three important differences. First, we do not model the financial shock in the form of a binding borrowing constraint, rather we incorporate the shock in a debt-elastic risk premium on external debt. As in their model, the financial shock is amplified by a feed-back mechanism between the resulting currency depreciation and the adverse balance sheet effect. Second, not only the household is surprised by the financial shock, but also the firm which decides on production before the shock is realized. And third, we estimate a subset of the structural parameters by matching theoretical with empirical impulse responses resulting from a VAR model. The estimations show that the proposed model reproduces quantitatively and qualitatively the dynamics of the LA-5 countries in response to an adverse shock to the country risk premium. In addition, our framework highlights that initially small financial shocks are amplified and result in substantial sudden stops, especially when an economy is highly indebted in foreign currency. Moreover, we investigate the role of monetary policy during the financial crisis.

The remainder of the paper is organized as follows. In Section 2, we discuss the theoretical model. In Section 3, we present the estimation results of the VAR analysis, the implied empirical impulse responses, and the simulation results of the theoretical model using the estimated structural parameters. In addition, we investigate the role of monetary policy during the financial crisis, and the role of the level of external debt in amplifying the adverse effects of the financial shock. The final section concludes.

2 The theoretical model

This section describes an economic environment that is characteristic for emerging market economies: a small open economy (SOE) borrows on international capital markets in foreign currency subject to a risk premium that is related to its fundamentals. In our environment, unexpected financial shocks originating in international capital markets may occur and affect the domestic real economy. To analyze the transmission mechanism of these shocks, we consider a SOE version of a cash-in-advance (CIA) model with limited participation augmented with a financial friction in the form of a debt-elastic risk premium on external funds.[2] The SOE is

[2] For a detailed description of CIA models, see Christiano (1991), Christiano and Eichenbaum (1992), and Christiano, Eichenbaum, and Evans (1997).

inhabited by four types of agents: a representative household and firm, a financial intermediary, and a monetary authority. In the following, we describe the setup of our model in more detail.

2.1 Household

A representative household derives life-time utility from a composite consumption good C_t and disutility from labor L_t:

$$\mathbf{U} = E_t \sum_{j=0}^{\infty} \beta^j U(C_{t+j}, L_{t+j}), \tag{1}$$

where β denotes the household's time preference parameter. The instantaneous utility function takes the form:

$$U(C_t, L_t) = \frac{(C_t - \frac{L_t^\mu}{\mu} C_t^\gamma)^{1-\sigma} - 1}{1-\sigma}, \;\; \mu > 0, \;\; \sigma > 0, \;\; \sigma \neq 1, \;\; \gamma \geq 0,$$

where σ denotes the intertemporal elasticity of substitution, μ the intertemporal elasticity of substitution in labor supply, and E_t the expectations operator conditional on time t information. Note that the preferences include as a special case, for $\gamma = 0$, the preferences proposed by Greenwood, Hercowitz, and Huffman (1988) which rule out wealth effects on the labor supply. We incorporate this type of preferences to control for the strength of the wealth effect by choosing γ. The composite consumption good consists of a domestic tradable and a non-tradable good:

$$C_t = \left(n^{\frac{1}{\lambda}} C_{Tt}^{\frac{\lambda-1}{\lambda}} + (1-n)^{\frac{1}{\lambda}} C_{Nt}^{\frac{\lambda-1}{\lambda}} \right)^{\frac{\lambda}{\lambda-1}}, \;\; 0 < n < 1, \;\; \lambda > 0, \tag{2}$$

where n is the share of tradable goods in composite consumption and λ the constant elasticity of substitution between the consumption of tradable and non-tradable goods.

At the beginning of period t, the household carries over its cash from the previous period M_{t-1}, gets prepaid paychecks $W_t L_t$, and deposits a cash amount D_t with the financial intermediary. The CIA constraint requires that all consumption expenditures must be paid with cash available at the beginning of period t:

$$P_t C_t \leq M_{t-1} - D_t + W_t L_t, \tag{3}$$

where P_t denotes the price index for the composite consumption good given by:

$$P_t = \left(n P_{Tt}^{1-\lambda} + (1-n) P_{Nt}^{1-\lambda} \right)^{\frac{1}{1-\lambda}}.$$

Maximizing composite consumption subject to total expenditures with respect to the consumption of tradable and non-tradable goods, we obtain the demand functions for tradables and non-tradables:

$$C_{Tt} = n \left(\frac{P_{Tt}}{P_t} \right)^{-\lambda} C_t,$$

$$C_{Nt} = (1-n) \left(\frac{P_{Nt}}{P_t} \right)^{-\lambda} C_t,$$

both are decreasing in the ratio of the good's price to the overall price index.

The budget constraint of the household, who owns the firm and bank, reflects the evolution of its assets: cash at the beginning of period $t+1$ is equal to the sum of net dividends that it receives from the firm (π_t^F) and the financial intermediary (π_t^B), interest earnings and repaid deposits loaned to the financial intermediary at the beginning of the period ($R_{Dt}D_t$), and any cash that is left from financing consumption expenditures:

$$M_t = \pi_t^F + \pi_t^B + R_{Dt}D_t + (M_{t-1} - D_t + W_tL_t - P_tC_t). \tag{4}$$

The household maximizes its life-time utility (1) subject to the CIA (3) and budget (4) constraints. A period's deposit decision is made before the financial shock occurs, while the decisions on consumption and labor supply are made afterwards.

The first-order condition associated with the employment decision implies that at the optimum the consumer chooses consumption and labor such that the marginal rate of substitution between consumption and leisure is equal to their relative price:

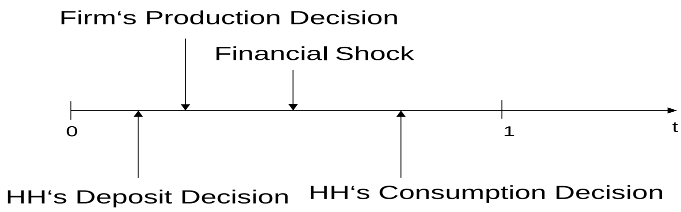
$$\frac{U_{C_t}}{U_{L_t}} = -\frac{P_t}{W_t}.$$

The intertemporal Euler equation associated with the deposit decision implies that marginal utility of a cash unit deposited with the financial intermediary at time t is equal to the expected marginal utility of the returns from that deposit to the time $t+1$:

$$R_{Dt}E_t\beta\frac{U_{C_{t+1}}}{P_{t+1}} = \frac{U_{C_t}}{P_t}. \tag{5}$$

2.2 Firm

The international financial shock affects the economy through the corporate sector. The representative firm produces two types of goods, tradables and non-tradables, using labor L_t, capital K_t, and imported materials IM_t as input factors. We assume that the firm has access to three types of credits. It borrows at the beginning of period t domestic short-term credits, BL_t, from the financial intermediary to hire labor (bank loans), and foreign short-term credits, SF_t, on the global capital market to prepay imported materials (trade credits). The firm repays these loans including interest payments at the end of the period. In addition, we assume that the firm can borrow foreign long-term credits, FL_t, on the global capital market which have to be repaid in the next period. These credits are used to finance investment. We assume that external debt is denominated in foreign currency, which is in line with the Original Sin theory (Eichengreen, Hausmann, and Panizza (2002)), and subject to a risk premium which depends on the firm's level of debt. As opposed to Christiano, Gust, and Roldos (2004), we assume that the firm decides on production at the beginning of period t, i.e. before the financial shock is realized, to capture that employment and investment decisions take time to plan. The timing in our model can be represented as follows:



It implies that the consumer decides on deposits and the firm on production before the financial shock occurs. After the financial shock is realized in the middle of period t, the household makes its consumption decision, and prices adjust such that all markets clear. Note that these timing assumptions ensure the consistency between the theoretical and empirical model discussed in Section 3.

The production functions of tradable and non-tradable goods are given by:

$$Y_{Tt} = A_{Tt}K_{Tt-1}^{\alpha_T}(IM_t^{\nu}L_{Tt}^{1-\nu})^{1-\alpha_T},\ 0<\alpha_T<1,\ 0<\nu<1, \tag{6}$$

$$Y_{Nt} = A_{Nt}K_{Nt-1}^{\alpha_N}L_{Nt}^{1-\alpha_N},\ 0<\alpha_N<1, \tag{7}$$

where technology levels in tradable and non-tradable good sectors, A_{Tt} and A_{Nt}, follow stationary AR(1) technology processes.[3] Note that α_i denotes the capital share in the production of each good and $\nu(1-\alpha_T)$ the import share in the production of tradable goods. The labor shares in the production of tradables and non-tradables are given by $(1-\nu)(1-\alpha_T)$ and $(1-\alpha_N)$, respectively. The firm accumulates two types of capital stocks:

$$K_{it} = I_{it} + (1-\delta)K_{it-1},\ i = T, N, \tag{8}$$

where I_{it} denotes investment in period t and $0<\delta<1$ the rate of capital depreciation. We assume that changes in the stock of capital are subject to quadratic capital adjustment costs:

$$AC(K_{it}, K_{it-1}) = \frac{\gamma_i}{2}\left(\frac{K_{it}-(1-\delta)K_{it-1}}{K_{it-1}}\right)^2 K_{it-1},\ i = T, N, \tag{9}$$

with an adjustment cost parameter denoted by $\gamma_i \geq 0$.

The firm starts each period with no cash, because all profits from the previous period are distributed to the household. Implied by the assumption of advance payments of labor and imports, the firm borrows domestic bank loans (BL_t) to hire labor, and foreign trade credits (SF_t) to prepay imported materials. In particular, the working capital constraints faced by the firm are given by:

$$BL_t \geq W_tL_{Tt} + W_tL_{Nt}, \tag{10}$$

$$SF_t \geq p^*_{IMt}IM_t, \tag{11}$$

where p^*_{IMt} denotes the price of imported materials expressed in foreign currency. Since domestic bank loans and foreign trade credits have to be repaid including interest payments at the end of each period, the effective costs of labor and imported materials in domestic currency are equal to $R_{Bt}W_tL_t$ and $e_tR_{St}p^*_{IMt}IM_t$, respectively. The nominal exchange rate e_t is denoted as the domestic price per unit of foreign currency. R_{Bt} denotes the gross interest rate on domestic bank loans and R_{St} that of trade credits. We assume that R_{St} is equal to the risk-free interest rate on external long-term credits, $1+r$, in the deterministic steady state, following a stationary AR(1) process. The gross interest rate on foreign long-term credits R_{Ft} is composed of a constant risk-free component and a variable risk premium:

$$R_{Ft} = (1+r) + \kappa exp(e_tFL_t - \bar{e}\overline{FL}) + RP_t,\ \kappa \geq 0. \tag{12}$$

[3] All stochastic shock processes are presented in Section 2.6.

In particular, it is assumed that the risk premium consists of a debt-related component, which increases when external long-term credits measured in domestic currency rise above their steady-state level, and of a stochastic component, RP_t, which is intended to capture aggregate risks. Note that we do not derive this risk premium explicitly from a debt contracting problem between borrowers and lenders, rather we use a reduced-form and assume that lenders charge additional interests when the firm's level of external debt expressed in domestic currency increases relative to its long-run average. We use this specification, because it summarizes the dynamics of the risk premium in two key variables (exchange rate and level of foreign currency debt) which have been highlighted in the empirical literature to be important determinants of emerging market risk premiums (Berganza, Chang, and Herrero (2004)). We believe that our choice is justified in the context of a general equilibrium model, however, other specifications of the risk premium could be introduced. Note that the strength of the financial friction can be controlled by the parameter κ. Moreover, our specification ensures stationarity of the equilibrium dynamics and is based on Schmitt-Grohé and Uribe (2003) with two modifications. First, it takes into account financial amplifier effects of exchange rate depreciations and, second, it prevents that the risk premium can turn negative during the equilibrium adjustment.[4] Note that we assume that the SOE is hit by the international financial shock in the form of an unexpected, adverse shock to RP_t.

The firm's optimization problem is to maximize the expected discounted sum of future profits by the choice of L_{Tt}, L_{Nt}, K_{Tt}, K_{Nt}, IM_t, BL_t, SF_t, and FL_t. Assuming that the firm is surprised by the financial shock, it solves the following optimization problem based on the information set of period $t-1$:

$$\max_{L_{Tt},L_{Nt},K_{Tt},K_{Nt},IM_t,BL_t,SF_tFL_t} E_{t-1}\sum_{j=0}^{\infty}\rho_{t,t+j}\pi^F_{t+j},$$

where

$$\begin{aligned}\pi^F_t \quad = \quad & P_{Tt}Y_{Tt}+P_{Nt}Y_{Nt}-W_tL_{Tt}-W_tL_{Nt}-e_tp^*_{IMt}IM_t\\ & -P_{Tt}I_{Tt}-P_{Tt}AC(K_{Tt},K_{Tt-1})-P_{Nt}I_{Nt}\\ & -P_{Nt}AC(K_{Nt},K_{Nt-1})+BL_t-R_{Bt}BL_t\\ & +e_tSF_t-e_tR_{St}SF_t+e_tFL_t-e_tR_{Ft-1}FL_{t-1},\end{aligned}$$

subject to the working capital constraints (10) and (11). We assume that goods and labor markets are perfectly competitive which implies that the firm acts as a price taker.

The optimality conditions with respect to labor in the production of tradable and non-tradable goods imply that expected effective marginal costs of labor are equal to their expected marginal products:

$$E_{t-1}R_{Bt}W_t \quad = \quad (1-\alpha_T)(1-\nu)E_{t-1}\frac{P_{Tt}Y_{Tt}}{L_{Tt}}, \tag{13}$$

$$E_{t-1}R_{Bt}W_t \quad = \quad (1-\alpha_N)E_{t-1}\frac{P_{Nt}Y_{Nt}}{L_{Nt}}. \tag{14}$$

[4]The foreign interest rate with a debt-elastic risk premium as in Schmitt-Grohé and Uribe (2003) that incorporates an exchange rate would be: $R_{Ft}=(1+r)+\kappa(exp(e_tFL_t-\bar{e}\overline{FL})-1)$. This specification, however, does not restrict the lower bound of the gross foreign interest rate to be larger than 1 for $\kappa>r$.

The intertemporal optimality condition with respect to capital in the production of both types of goods equates the expected costs and expected benefits of an additional unit of capital:

$$E_{t-1}\left(1+\gamma\frac{I_{it}}{K_{it-1}}\right)=E_{t-1}\rho_{t,t+1}\left(\alpha_i\frac{Y_{it+1}}{K_{it}}+(1-\delta)-\gamma\frac{I_{it+1}}{K_{it}}\left[\frac{1}{2}\frac{I_{it+1}}{K_{it}}-\frac{K_{it+1}}{K_{it}}\right]\right),$$

for $i=T,N$. Expected benefits on the right side are equal to the expected marginal product of an additional unit of capital, its resale value after capital depreciation, and associated savings on future capital adjustment costs. The costs in the current period are given by the unit of investment and associated capital adjustment costs.

The optimality condition with respect to imported materials implies that expected effective marginal costs are equal to the expected marginal product:

$$E_{t-1}e_tR_{St}p^*_{IMt}=(1-\alpha_T)\nu E_{t-1}\frac{P_{Tt}Y_{Tt}}{IM_t}.$$

The intertemporal optimality condition with respect to external long-term credits equates expected benefits and expected costs of an additional unit of long-term foreign funds:

$$E_{t-1}e_t=E_{t-1}\rho_{t,t+1}e_{t+1}\left(R_{Ft}+\frac{\partial R_{Ft}}{\partial FL_t}FL_t\right), \tag{15}$$

$$\frac{\partial R_{Ft}}{\partial FL_t}=\kappa exp(e_tFL_t-\bar{e}\overline{FL})e_t.$$

Expected costs on the right side are equal to the sum of the repayment including interests of an additional unit of foreign credits and its effect on the risk premium.

Since firm profits are distributed to the household at the end of the period, the firm's discount factor is equal to the subjective discount factor of the household:

$$\rho_{t,t+j}=\beta^j\frac{P_t}{P_{t+j}}\frac{U_{C_{t+j}}}{U_{C_t}}. \tag{16}$$

Using the expression for the firm's discount factor and combining the household's and firm's intertemporal optimality conditions (5) and (15), we obtain the model's uncovered interest parity (UIP) condition:

$$E_{t-1}R_{Dt}=E_{t-1}\frac{e_{t+1}}{e_t}\left(R_{Ft}+\frac{\partial R_{Ft}}{\partial FL_t}FL_t\right). \tag{17}$$

This condition differs from the usual UIP condition in two aspects: it includes a risk premium term (the second term on the right side) and it holds only in expectations conditioned on information at the end of period $t-1$. This is consistent with Lewis (1995) who finds empirical evidence for the existence of predicted interest rate differentials between home and foreign bonds which can be explained by differences in country risks. Moreover, realized and predicted interest rate differentials can deviate due to expectation errors. In our model, the actual and predicted interest rate differentials coincide as long as there are no unexpected shocks in periods t and $t+1$. If an unexpected shock occurs, the model's UIP condition deviates from the usual UIP condition in the initial period. The risk premium term stems from the fact that the interest rate on external long-term credits incorporates the debt-elastic risk premium. Note that with a positive level of foreign long-term debt, the domestic interest rate exceeds the foreign interest rate in the deterministic steady state and is given by:

$$\bar{R}_D = \bar{R}_F + \kappa \bar{e}\overline{FL}.$$

The associated level of foreign debt in steady state is then equal to $\bar{e}\overline{FL} = \frac{1/\beta-(1+r)}{\kappa} - 1$.

2.3 Financial Intermediary and Monetary Authority

The financial intermediary receives deposits D_t at the beginning of each period, and repays $R_{Dt}D_t$ at the end of each period. Moreover, the financial intermediary lends at the beginning of the period bank loans BL_t to the firm, and receives $R_{Bt}BL_t$ at the end of the same period. It is assumed that the financial intermediary has a second source of funds given by the change in domestic liquidity, $M_t - M_{t-1}$. In the baseline case, we assume that domestic liquidity follows a stationary AR(1) process. The financial intermediary solves the following problem:

$$\max_{D_t, BL_t} = E_t \sum_{j=0}^{\infty} \rho_{t,t+j} \pi^B_{t+j},$$

s.t.

$$\begin{aligned} \pi^B_t &= M_t - M_{t-1} + D_t - R_{Dt}D_t - BL_t + R_{Bt}BL_t, \\ BL_t &= D_t + M_t - M_{t-1}, \end{aligned} \tag{18}$$

where (18) represents the bank's balance sheet identity that requires that assets (bank loans) are equal to liabilities (deposits and cash).

In equilibrium, the intermediation margin between bank loans and deposits is zero:

$$R_{Bt} - R_{Dt} = 0.$$

2.4 Rest of the World

The rest of the world supplies imports which are employed in the production of tradable goods. We assume that imports are producer-currency priced and that the supply is increasing in the price of imports p^*_{IMt}:

$$IM_t = Z_{IM}(p^*_{IMt})^{\phi_{IM}}, \; Z_{IM} > 0, \; \phi_{IM} > 0,$$

where Z_{IM} is a positive scaling parameter and ϕ_{IM} the price elasticity of supply.

Furthermore, the rest of the world imports tradable goods produced in the SOE. We assume that exports of the SOE are also producer-currency priced and that export demand is decreasing in the price of tradable goods:

$$C^*_t = Z_T \left(\frac{1}{e_t} p_{Tt}\right)^{-\phi_T}, \; Z_T > 0, \; \phi_T > 0,$$

where Z_T, analogously, is a positive scaling parameter and $-\phi_T$ the price elasticity of the foreign demand for tradables.[5]

2.5 Market Clearing Conditions

The market clearing condition for non-tradable goods is given by:

$$Y_{Nt} = C_{Nt} + I_{Nt} + AC_{Nt},$$

and that for tradable goods by:

$$Y_{Tt} = C_{Tt} + I_{Tt} + AC_{Tt} + C_t^*.$$

These two conditions equate production and absorption.

The market clearing condition for labor is:

$$L_{Tt} + L_{Nt} = L_t.$$

Combining the household's and firm's cash constraints with the financial intermediary's balance sheet identity, the money market clearing condition corresponds to:

$$M_t \geq P_t C_t. \tag{19}$$

This condition requires that actual cash balances equal desired cash balances.

The consolidated budget constraint of the whole economy results from combining the household's budget constraint with those of the firm and the financial intermediary:

$$\begin{aligned} (P_{Tt}Y_{Tt} - P_{Tt}C_{Tt} - P_{Tt}I_{Tt} - P_{Tt}AC_{Tt}) + (P_{Nt}Y_{Nt} - P_{Nt}C_{Nt} \\ -P_{Nt}I_{Nt} - P_{Nt}AC_{Nt}) + (W_tL_t - W_tL_{Tt} - W_tL_{Nt}) \\ -e_t p_{IMt}^* IM_t - e_t(R_{St} - 1)SF_t - e_t(R_{Ft-1} - 1)FL_{t-1} = -e_t(FL_t - FL_{t-1}). \end{aligned}$$

Using the market clearing conditions for goods and labor, the consolidated budget constraint reduces to:

$$P_{Tt}C_{Tt}^* - e_t p_{IMt}^* IM_t - e_t(R_{St} - 1)SF_t - e_t(R_{Ft-1} - 1)FL_{t-1} = -e_t(FL_t - FL_{t-1}).$$

The economy's trade balance is given by:

$$TB_t = \underbrace{P_{Tt}C_{Tt}^*}_{\text{Exports}} - \underbrace{e_t p_{IMt}^* IM_t}_{\text{Imports}}.$$

Using the definition of the trade balance, the consolidated budget constraint can be expressed as:

$$\underbrace{TB_t - e_t(R_{St} - 1)SF_t - e_t(R_{Ft-1} - 1)FL_{t-1}}_{\text{Current Account}} = \underbrace{-e_t(FL_t - FL_{t-1})}_{-\text{Capital Account}}.$$

This condition represents the economy's balance of payments condition, which requires that the current account (sum of the trade balance and net foreign interest payments) is equal to the negative of the capital account (change in net foreign assets).

[5] The assumption of producer-currency pricing implies that the firm sells tradable goods for the same price on the domestic and foreign market, and that foreign demand increases with an exchange rate depreciation depending on the demand elasticity.

2.6 Stochastic Shocks

The economy faces two real and three financial shocks, however, our main focus is set on the transmission mechanism of the shock to the risk premium on external long-term credits, RP_t. The assumptions on the stochastic shocks can be represented as follows:

$$z_t = z_c + \rho_z z_{t-1} + \varepsilon_{zt}, \qquad \varepsilon_{zt} \sim N(0, \Sigma), \tag{20}$$
$$z_t = \begin{bmatrix} RP_t \\ R_{St} \\ lnM_t \\ lnA_{Tt} \\ lnA_{Nt} \end{bmatrix}, z_c = \begin{bmatrix} 0 \\ (1-\rho_S)(1+r) \\ 0 \\ 0 \\ 0 \end{bmatrix}, \varepsilon_{zt} = \begin{bmatrix} \varepsilon_{RPt} \\ \varepsilon_{St} \\ \varepsilon_{Mt} \\ \varepsilon_{ATt} \\ \varepsilon_{ANt} \end{bmatrix},$$

where ρ_z denotes a diagonal matrix with the autoregressive coefficients $\rho_{RP}, \rho_S, \rho_M, \rho_{AT}, \rho_{AN}$ of the stochastic processes on its diagonal. The stationarity assumptions imply that all autoregressive coefficients are smaller than 1 in modulus. Note also that the financial shocks could be correlated, however, we restrict our attention to the case in which Σ is diagonal.

2.7 Equilibrium

A rational expectations equilibrium of the whole economy is a set of processes for $\{C_{Tt}$,C_{Nt},C_t, L_{Tt},L_{Nt},L_t,IM_t,K_{Tt},K_{Nt},I_{Tt},I_{Nt},Y_{Tt},Y_{Nt}, $\rho_{t,t+1}$,P_{Tt},P_{Nt},P_t,p^*_{IMt},W_t,C^*_t,D_t,BL_t,SF_t,FL_t, R_{Dt},R_{Bt},R_{St},$R_{Ft}\}_{t=0}^{\infty}$, having the following properties: (1) for each time period and given prices, the quantities solve the optimization problems of the household, firm, and the financial intermediary, and (2) all markets clear. We solve the model by linearizing the equilibrium conditions around the deterministic steady state and solve numerically the linearized system.

2.8 Transmission mechanisms of the financial shock

In the following, we describe qualitatively the transmission of the international financial shock for the set of structural parameters which is shown in Table 3 and discussed in Section 3.

Initially, the firm faces an unexpected rise in the costs of borrowing new external long-term credits by the magnitude of the exogenous shock to the risk premium. The assumption that the household's deposit and firm's production decisions are made before the shock occurs implies that all other variables are unaffected in the initial period. In particular, the domestic interest rate does not react, because the household's deposit decision and the firm's demand for domestic bank loans are predetermined. Moreover, as the model's UIP condition holds only in expectations, see (17), there is no predicted interest rate differential. This implies that the exchange rate is expected to remain constant and no currency depreciation occurs. Overall, only the foreign interest rate changes in the initial period without affecting other prices and quantities.

In the next period, the firm reduces cet. par. external borrowing in response to the adverse financial shock. Given that the domestic interest rate rises less than the foreign interest rate, the UIP condition implies a currency depreciation which is followed by an expected appreciation. The currency depreciation in turn results in an adverse balance sheet effect by increasing the domestic value of external debt. For a given level of external debt, the depreciation leads to an increase in the risk premium on long-term credits and strengthens the reduction in foreign borrowing. The firm faces contrasting effects on operating profits in the form of increasing costs of imports and increasing earnings from exports. In combination with the increased costs of investment, this translates into a higher labor demand in the tradable good sector. Given the higher demand for tradables caused by the increase in the demand for exports, the firm finds it optimal to reallocate resources from the non-tradable to the tradable good sector. For the household, the financial shock translates into a negative wealth effect as dividend payments from the firm decrease. To compensate this effect, the household increases its labor supply if $\gamma > 0$. In our case with $\gamma = 0$, however, employment is fully determined by labor demand. For our set of parameters, production drops persistently in both sectors associated with increasing prices.

3 Econometric and calibration results

In this section, we investigate the empirical impulse response functions (IRFs) of particular emerging-market fundamentals resulting from a country risk premium shock in a structural panel VAR model. Moreover, the empirical IRFs are matched with the theoretical IRFs by minimizing their weighted distance as a function of particular structural parameters of the theoretical model.

3.1 Econometric results

The quarterly data covers the period from 1994 to 2007 and includes the LA-5 countries: Brazil, Colombia, Ecuador, Mexico, and Peru. The VAR system consists of 5 variables including GDP, investment, trade balance, domestic bank credits, and a measure for the country risk premium.[6] Note that the estimation strategy is similar to Uribe and Yue (2006) who analyze the effects of country risk premium shocks on business cycles in EM economies. The differences are the choice of variables and the estimation method.[7]

The empirical model can be represented as follows:

$$\mathbf{A_0} x_t = \sum_{i=1}^{p} \mathbf{A_i} x_{t-i} + \varepsilon_t, \tag{21}$$

$$\mathbf{A_0} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{pmatrix}, x_t = \begin{bmatrix} y_{jt} \\ i_{jt} \\ tb_{jt} \\ c_{jt} \\ r_{jt} \end{bmatrix}, \varepsilon_t = \begin{bmatrix} \varepsilon^y_{jt} \\ \varepsilon^i_{jt} \\ \varepsilon^{tb}_{jt} \\ \varepsilon^c_{jt} \\ \varepsilon^r_{jt} \end{bmatrix},$$

where t refers to the time dimension, j to countries, and p to the lag length. Moreover, y_{jt} denotes real GDP, i_{jt} real investment, tb_{jt} the trade balance to GDP ratio, c_{jt} real domestic

[6] A more detailed description of the data sources and definitions can be found in Table 1.

[7] As Uribe and Yue (2006), we use a five-variable VAR system, however, we include domestic credits instead of the US interest rate. As the authors, we estimate the system equation-by-equation, but we use the system GMM estimator instead of the Anderson-Hsiao estimator.

credits, and r_{jt} the country spread.[8] Output, investment, and domestic credits are expressed in log-deviations from a log-linear trend. All variables except for domestic credits and the country spread are seasonally adjusted. The included variables represent important macroeconomic aggregates that describe EM-fundamentals, and they have been identified in the literature as being highly related to EM country spreads (Tornell and Westermann (2003) and Uribe and Yue (2006)). Our key interest hereby is to investigate whether our theoretical model is able to reproduce the economies' trajectory in response to a country risk premium shock of 5 percentage points per quarter (p.q.).

The structural shock to the country risk premium is identified by imposing restrictions on the matrix $\mathbf{A_0}$, that is, by restrictions on its contemporaneous effects. The identification assumes that innovations in the country risk affect the real variables with one-period lag, and that innovations in the real variables affect the country risk contemporaneously. As Uribe and Yue (2006), we are convinced that these assumptions are reasonable since decisions on employment, consumption, and investment take time to plan and to be implemented. Equally, it seems reasonable to assume that financial markets react more rapidly to changes in the state of the economy. Note that these restrictions reflect the relation between the considered variables implied by the theoretical model. As we are only interested in identifying the structural shock to the country risk premium, the order of the real variables is arbitrary. There are no restrictions on the coefficient matrices $\mathbf{A_i}$.

A difficulty that arises from the specification is an endogeneity problem between the lags of the dependent variables and the error terms. To account for this problem, we estimate the VAR system equation-by-equation using the Generalized Method of Moments (GMM) estimator for dynamic panel data (Arellano and Bover (1995)). Based on the Schwarz information criterion which is equal to $\{-34.69, -34.98, -34.68, -34.31\}$ for the lag lengths $p = 1, 2, 3, 4$, we choose a lag length of $p = 2$. The estimation results are reported in Table 2. The AR(2) tests indicate that there is no incidence of autocorrelation of the error terms. Moreover, the Sargan tests on overidentification indicate that the instruments are valid except for the GDP equation. Most of the estimated coefficients show the expected signs. In particular, the variables are positively autocorrelated. With a lag, output and investment decrease significantly in response to an increase in the country spread, while the trade balance increases. Domestic credits decrease, however, the coefficient is statistically not significant.

Based on the moving average representation, we calculate the IRFs to a country spread shock of 5% (p.q.). The graphs are shown in Figure 2. The dotted lines indicate the 10% and 90% bootstrap intervals based on 1000 replications of estimation.[9] In response to the country risk shock, the country risk increases and reverses steadily towards zero. The half life of the response is approximately one year. Output, investment, and credits respond negatively with a lag. The trade balance improves after one quarter indicating that domestic absorption deteriorates more than output. Another interesting finding is that the trade balance and domestic credits recover faster than output and investment. Investment decreases by approximately 15% and output by

[8] Real variables are calculated by dividing the particular variable by the GDP deflator.

[9] More precisely, in each replication we generate artificial data using the estimated coefficients and resampled residuals, and reestimate the VAR and the corresponding IRFs. The bootstrap intervals are then the 10th and 90th percentiles of the resulting distribution of IRFs.

5% from trend after 1 year. The trade balance improves by 4% of GDP, and domestic credits decrease by 15% from trend. While the trade balance, domestic credits, and the country risk premium recover after about 5 years, the recovery of output and investment takes much longer.

3.2 Calibration results

In the next step, we match the empirical IRFs with those implied by the theoretical model as a function of a subset of the structural parameters. Two groups of model parameters have to be distinguished.

The first group contains parameters for which values are chosen such that our economy satisfies certain long-run characteristics in the steady state that are in line with the empirical evidence on EMs and the related literature. We restrict the parameters $\{n, \alpha_T, \nu, \alpha_N, \delta\}$ such that the tradable goods sector makes up about 38% of overall production in line with Arellano and Mendoza (2003) and Kehoe and Ruhl (2007). The share of tradable goods in composite consumption is set to $n = 0.3$ and the rate of capital depreciation to $\delta = 0.026$ which implies an annual depreciation rate of 10%. As Christiano, Gust, and Roldos (2004), we assume that tradable production is more capital intensive and set $\alpha_T = 0.4$ and $\alpha_N = 0.3$. Moreover, we set the import parameter in tradable production to be equal to $\nu = 0.3$, which implies a share of imports in overall production of 7% and a share of wage income of 54%. Following Mendoza (1991) and Uribe and Yue (2006), we set the household's intertemporal elasticity of substitution of consumption to $\sigma = 1.001$ and its intertemporal elasticity of substitution in labor supply to 2 which implies that $\mu = 1.455$. The risk-free foreign interest rate is set to 0.01 implying an annualized interest rate of 4%. Moreover, we set the parameter κ, which measures the importance of the financial friction, to 0.04, and the annual steady-state ratio of external long-term debt to GDP to 20%. By the relation $\bar{e}\overline{FL} = \frac{1/\beta-(1+r)}{\kappa} - 1$, the economy's time preference parameter β equals 0.92 resulting in $\bar{R}_D = 1.087$. Overall, this set of parameters implies that the trade balance to GDP ratio is equal to 4% in the steady state.

The second group of parameters includes the remaining structural parameters and those describing the stochastic processes. These parameters are allowed to vary on a fixed interval and are estimated by matching the IRFs. The structural parameters include the capital adjustment cost parameters γ_T and γ_N, the elasticities of imports and exports ϕ_{IM} and ϕ_T, the elasticity of substitution between tradables and non-tradables λ, and the preference parameter γ which controls for wealth effects on labor supply. The parameters of the stochastic processes consist of the autoregressive coefficients $(\rho_{RP}, \rho_S, \rho_M, \rho_{AT}, \rho_{AN})$ and the variances and covariances of the stochastic shocks. In the baseline case, however, we estimate only the parameters of the exogenous financial shock process of long-term credits (ρ_{RP}, σ_{RP}) and set the other stochastic parameters to zero.

The empirical and theoretical IRFs are matched by minimizing a measure of the distance between the empirical IRFs, IR^e, and the corresponding theoretical IRFs, IR^t. The theoretical counterparts of the VAR variables are the log-deviations from steady state of real output $(P_TY_T + P_NY_N)/P$, real investment $(P_TI_T + P_NI_N)/P$, trade balance over production TB/PY, real domestic bank loans BL/P, and the risk premium of foreign long-term credits expressed in percentage points. In particular, we match 5 years of the impulse responses of each variable by minimizing the following distance function with respect to $\xi = (\phi_{IM}, \phi_T, \gamma_T, \gamma_N, \lambda, \gamma, \rho_{RP}, \sigma_{RP})$:

$$\min_{\xi}[IR^e - IR^t(\xi)]'W[IR^e - IR^t(\xi)], \tag{22}$$

subject to $\underline{\xi} \leq \xi \leq \overline{\xi}$. The positive-definite weighting matrix W is calculated as the inverse of a diagonal matrix with variances of the corresponding IRFs resulting from the 1000 bootstrap replications on its diagonal.

The starting values of the parameters ξ are set according to the related literature and empirical evidence. In particular, we set the export and import elasticities to be in the range between 0.4 and 1.5 as suggested by empirical trade studies (Goldstein and Khan (1985) and Bahmani-Oskooee and Kara (2005)). The adjustment costs parameters are restricted to be in the interval between 0 and 20. Moreover, we restrict the elasticity of substitution between the consumption of tradables and non-tradables to range from 0.1 to 0.5 and the wealth parameter from 0 to 0.5. Finally, the autoregressive parameter of the exogenous financial shock is allowed to be between 0.5 and 0.9 and the standard deviation between 0.001 and 0.05. Table 3 shows the starting values, interval bands, and the resulting parameters. All estimated parameters lie inside the interval band except for the wealth parameter which converges to $\gamma = 0$. This estimate implies that the labor supply decision is independent of consumption and wealth.

Figure 3 compares the empirical IRFs with those resulting from the model. Most of the points belonging to the theoretical IRFs lie inside the bootstrapped confidence intervals. Although we estimate only 8 parameters to match 100 points of impulse responses, the theoretical model reproduces the empirical IRFs reasonably well: output, investment, and domestic credits drop, while the trade balance improves. The initial response of investment is slightly overestimated, while output and domestic credits do not react as much as in the VAR model. Over time, the theoretical and empirical IRFs get closer.

Finally, we investigate the responses of other particularly important model variables, see Figure 4. Interest rates are shown in percentage points and the other variables in percentage deviations from steady state. All model variables respond as expected. In response to the financial shock, the interest rate R_{Ft} increases to 2.5 percentage points in the second quarter driven by the fundamentals-related component. The associated currency depreciation amounts to 40% and external long-term credits decrease by approximately 1.2%. Moreover, real imports drop by 12% and exports increase by 30%. The capital stocks in the tradable and non-tradable sectors drop by 4% and 3%, respectively. Labor is shifted from the non-tradable (-8%) to the tradable goods sector (+10%) as earnings from exports increase. Overall, the financial shock leads to a decline in total output of 2% explained by an important drop in the non-tradable goods sector (-6%) which is partly offset by an increase in the tradable goods sector (3%). Total consumption drops by 5.5% dominated by a more pronounced decrease in the consumption of tradable goods (-6%).

Summing up, the model reproduces the qualitative and quantitative features of the empirical IRFs. The initial risk premium shock is amplified by the currency depreciation and results in important contractions in economic activity and domestic absorption. Most of the 100 points belonging to the theoretical impulse responses of output, investment, trade balance, domestic credits, and country risk premium lie inside the bootstrapped confidence interval, except for some short periods.

3.3 Monetary Policy Response

In this section, we compare the impulse responses of the theoretical model using the estimated structural and stochastic parameters for different responses of monetary policy. We assume that the monetary authority, such as the firm, is surprised by the exogenous financial shock in the initial period.

In our framework, the monetary authority has two possibilities to respond. On the one hand, it can expand the domestic money supply and provide additional liquidity to the financial intermediary. This would reduce cet. par. the domestic interest rate and the firm's effective wage costs, but increase the currency depreciation which would amplify the adverse balance sheet effect. On the other hand, the monetary authority can reduce the domestic money supply which would increase effective wage costs, but counteract the exchange rate depreciation and adverse balance sheet effect. Figure 5 shows selected impulse responses for expansionary and contractionary monetary policy, along with the baseline scenario of passive monetary policy. Note that we assume that the monetary authority increases/decreases domestic liquidity by 10%. In the expansionary case, the exchange rate depreciation reaches 54% as opposed to 40% in the baseline case. The associated adverse balance sheet effect, implied by the increased domestic-currency level of external debt, causes a more pronounced financial amplification. As a result, the foreign interest rate increases to 3% (p.q.), external long-term credits decrease by 1.7%, and investment drops by 15%. The adverse effect of the financial shock on output, however, is mitigated due to the improvement in the international price competitiveness of domestic tradable goods and due to the decreased effective wage costs. As the stock of money increases and output drops, the overall price level rises by more than the percentage change in the money supply. In the contractionary case, the exchange rate depreciates only by 23%, which mitigates the adverse balance sheet effect and the financial amplification. As a result, the foreign interest rate increases only to 2% (p.q.), external long-term credits drop by 0.5%, and investment by 11%. The output collapse, however, is more pronounced since the improvement in the international price competitiveness of domestic tradable goods is smaller and effective wage costs are higher. The overall price level decreases in the case of contractionary monetary policy. In sum, if output stabilization and unemployment are the main objectives of monetary policy, it would be advisable to follow an expansionary monetary policy in our economy in response to the financial shock. However, if the monetary authority targets price stability, it would be successful by following a contractionary monetary policy.

3.4 Sensitivity analysis

In this section, we compare the impulse responses of the theoretical model using the estimated structural and stochastic parameters for different values of the steady-state level of external debt, $\bar{e}\overline{FL} = [1/\beta - (1+r)]/\kappa - 1$. For this purpose we vary the time preference parameter β which determines the impatience of the economy and, therewith, the steady-state level of external debt and the gross domestic interest rate $\bar{R}_D = 1/\beta$. The risk-free foreign interest rate remains unaffected, however, interest payments on foreign debt in the steady state increase with a higher debt stock and therewith the associated trade surplus. Figure 6 shows the results for $\beta = 0.924$ and 0.935 which imply a stock of foreign debt relative to quarterly GDP of 90% and 50%, respectively. In the high-debt economy, the financial amplification leads to a rise in the foreign interest rate of about 3.5 percentage points (p.q.), opposed to about 2 percentage points (p.q.) in the medium-debt economy, and the resulting recession is deeper and more persistent. For instance, the exchange rate depreciates by about 60% and output drops by around 3% in the high-debt economy compared to 20% and 1% in the medium-debt economy.

The intuition is the following. Given the same exogenous financial shock, interest payments of the high-debt economy increase by more than in the medium-debt economy which results in a higher reduction in wealth. In order to compensate the adverse wealth effect, the high-debt economy finds it optimal to reduce external borrowing by more than the medium-debt economy. This implies that the associated currency depreciation and improvement in the trade balance are higher in the high-debt economy. The higher depreciation in the high-debt economy in turn results in a more pronounced balance sheet effect and sets in motion a circle of financial amplification. Note that although the high-debt economy reduces foreign borrowing by more than the medium-debt economy, the increase in the risk premium is higher.

4 Conclusion

The aim of this paper was to explain how an emerging market economy is affected when it suddenly faces a higher risk premium in international financial markets. We study this question empirically for five Latin American economies and analyze theoretically the transmission of risk premium shocks in a dynamic general equilibrium model. In particular, we developed a cash-in-advance model of a two-sector small open economy with limited participation. The financial shock hits initially the corporate sector of the economy which has access to three types of capital: domestic bank loans to hire labor, foreign trade credits to prepay imported materials, and foreign credits of longer maturity to finance investment. We assume that foreign credits are supplied by the global capital market in foreign currency and that the interest rate depends on the firm's level of debt. In particular, the financial shock is modeled as a rise in the risk premium of foreign currency credits and is amplified by a feed-back mechanism between currency depreciation, adverse balance sheet effect, and the debt-related risk premium.

In our model, the financial shock causes the economy to run a current account surplus and to reduce external borrowing. In the transition, the debt-elastic risk premium limits the economy's ability to smooth out the adverse effects and leads to a fall in output and employment. In addition, the nominal exchange rates depreciates and overshoots. The transition corresponds to what has been observed during many emerging market crises: an initial shock sets in motion a financial amplifier mechanism and leads to a broader crisis. Our framework shows that initially small shocks can culminate in prolonged recessions depending on the economy's real and financial structure, most importantly, on the level of foreign currency debt, the size of the tradable goods sector, and the share of imports in production.

By calibration and estimation of a subset of structural parameters, the theoretical model is able to reproduce quantitatively the empirical impulse responses of output, investment, trade balance, and domestic credits resulting from a shock in the country risk premium of five Latin American economies. We think that, although we use a reduced-form risk premium in the theoretical model, this justifies that our framework can be taken seriously to analyze monetary policy and the transmission mechanism of international financial shocks. An interesting extension of our work would be to derive a risk premium explicitly from a contracting problem between lenders and borrowers. Regarding the policy implications, we find that a monetary authority which targets output stabilization would follow an expansionary policy, while an inflation-targeting authority would prefer a contractionary policy.

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5 Appendix

Table 1: Description of the data

The data consists of quarterly data for 5 Latin American economies: Brazil, Colombia, Ecuador, Mexico, and Peru. The sample periods vary from country to country: Brazil 1995:1-2007:4, Colombia 1994:1-2007:4, Ecuador 1995:2-2002:1, Mexico 1994:1-2007:4, and Peru 1994:1-2007:4. In total, the data set includes 198 observations.
Quarterly series for GDP (series 99B), gross domestic investment (series 93E), trade balance (series 90C minus series 98C), and domestic credits (series 52 and 32) are from IMF's International Financial Statistics. GDP, investment, and the trade balance are seasonally adjusted. GDP, investment, and domestic credits are deflated using the GDP deflator (series 99BIP). Because the GDP deflator for Brazil is not available, we use the consumer price index (series 64). As a measure for the country spread, we use J.P. Morgan EMBI+ stripped spread from the database Datastream. The EMBI+ is a composite index of different liquid dollar-denominated debt instruments such as Brady bonds, Eurobonds, and traded loans by sovereign entities. We express GDP, investment, and domestic credits as log deviations from a log-linear trend, and the trade balance as a ratio of the nominal trade balance to nominal GDP.

Table 2: Results of the panel VAR estimation

Estimation method: System GMM					
Independent variable	Dependent variables				
	y_t	i_t	tb_t	c_t	r_t
y_t	–	1.43***	0.09	0.19	-0.29***
y_{t-1}	0.69***	-0.47**	0.03	-0.43**	0.20***
y_{t-2}	0.13	-0.76***	-0.06*	-0.09	0.08
i_t	–	–	-0.12***	-0.06	0.04
i_{t-1}	0.07*	0.73***	0.09***	0.08	-0.05
i_{t-2}	-0.01	0.14	0.01	0.09	0.00
tb_t	–	–	–	0.45	0.32**
tb_{t-1}	-0.06	-0.90**	1.28***	-0.57	-0.35
tb_{t-2}	0.36**	0.99**	-0.41***	0.26	0.10
c_t	–	–	–	–	0.07
c_{t-1}	0.02	-0.03	-0.01	1.01***	-0.03
c_{t-2}	-0.03	0.05	0.01	-0.12***	-0.01
r_t	–	–	–	–	–
r_{t-1}	-0.16**	-0.15**	0.11**	-0.14	0.62***
r_{t-2}	0.04	0.08	-0.10***	-0.15	0.17
Observations	198	198	198	198	198
AR(2) test	0.700	0.117	0.535	0.186	0.212
Sargan test	0.011	0.808	0.914	0.899	0.791

Note: The included countries are Brazil, Colombia, Ecuador, Mexico, and Peru.

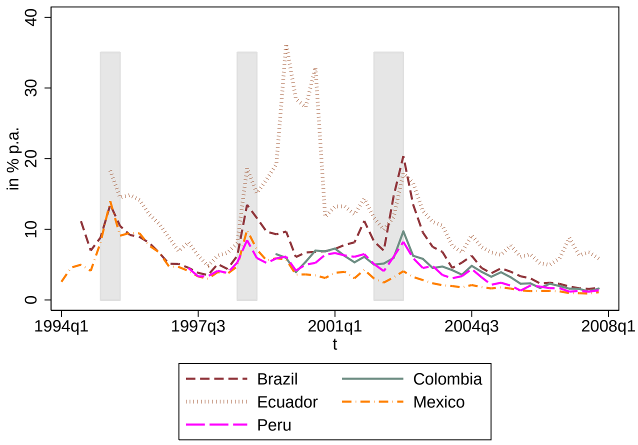
***,**, and * indicate, respectively, significance at the 1%, 5%, and 10% level.

For the Arellano-Bond test for autocorrelation in the residuals (AR(2)) and the Sargan test of overidentifying restrictions p-values are reported. The constant is not reported.

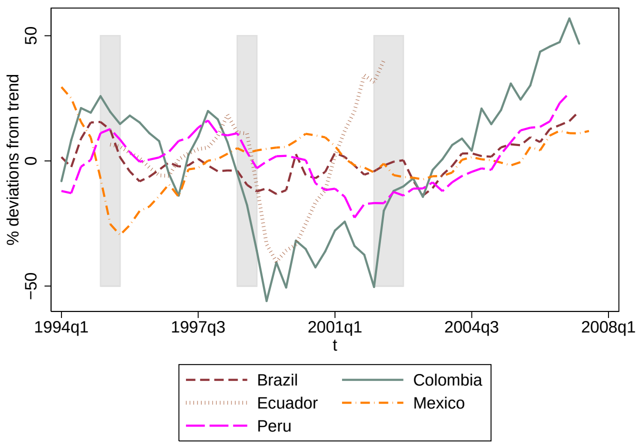
Table 3: Structural parameters

Parameter	Starting Value	Interval	Estimation Result	Description
β	0.92			time preference
μ	1.455			intertemporal EoS of labor
σ	1.001			intertemporal EoS of consumption
n	0.3			share of C_T in C
λ	0.14	[0.1,0.5]	0.12	EoS between C_N and C_T
γ	0	[0,0.5]	0	disutility of labor
α_T	0.3			capital share in Y_T
α_N	0.4			capital share in Y_N
δ	0.026			capital depreciation
r	0.01			risk-free interest rate
κ	0.04			risk premium parameter
ν	0.3			share of imports in Y_T
γ_T	0	[0,20]	13.11	K_T adjustment costs
γ_N	0	[0,20]	11.79	K_N adjustment costs
Z_{IM}	0.1			import supply parameter
Z_T	0.1			export demand parameter
ϕ_{IM}	0.7	[0.4,1.5]	1.31	price elasticity of import supply
ϕ_T	0.8	[0.5,1.5]	1.20	price elasticity of export demand
σ_{RP}	0.03	[0.001,0.05]	0.015	std. deviation of ε_{RP}
ρ_{RP}	0.7	[0.5,0.9]	0.88	persistence of ε_{RP}

Figure 1: EMBI spreads and investments for the LA-5 countries



(a) Country spreads in percent p.a.



(b) Investments in percent deviations from trend

Figure 2: Empirical impulse responses to the country spread shock

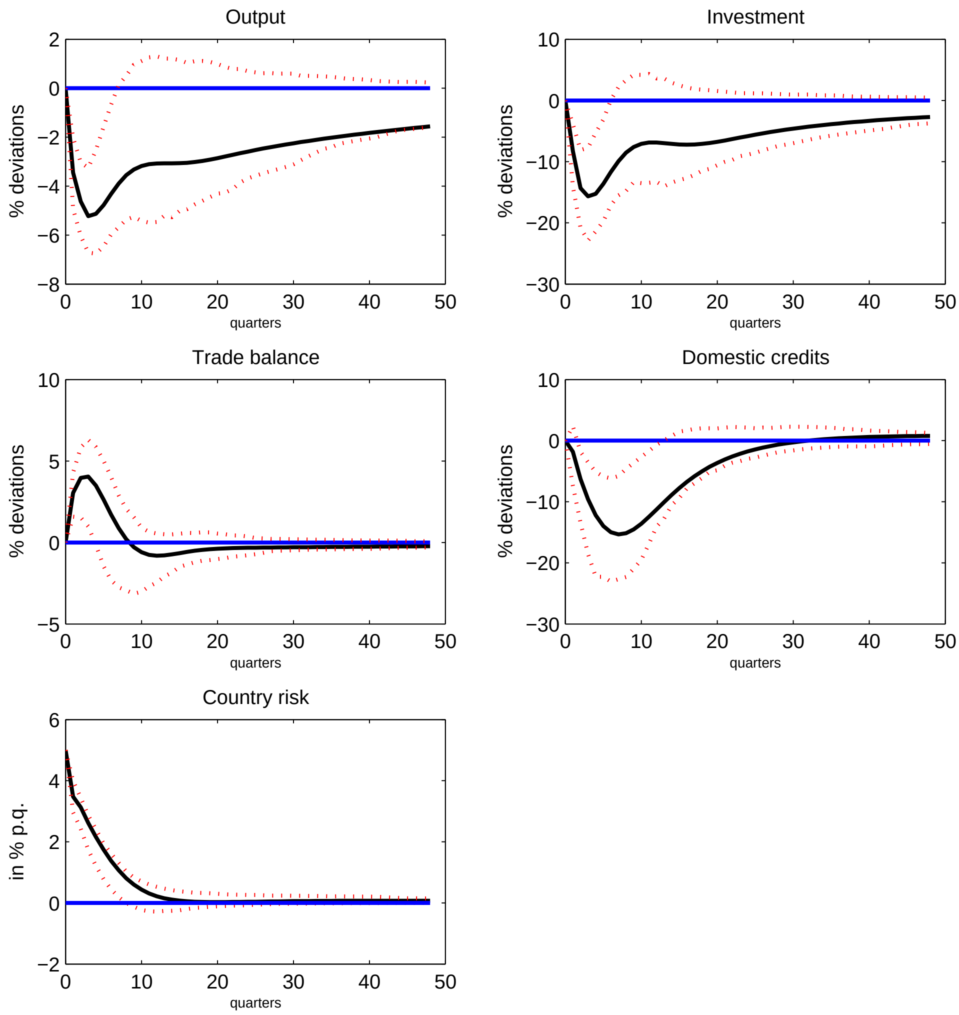


Figure 3: Empirical and theoretical impulse responses

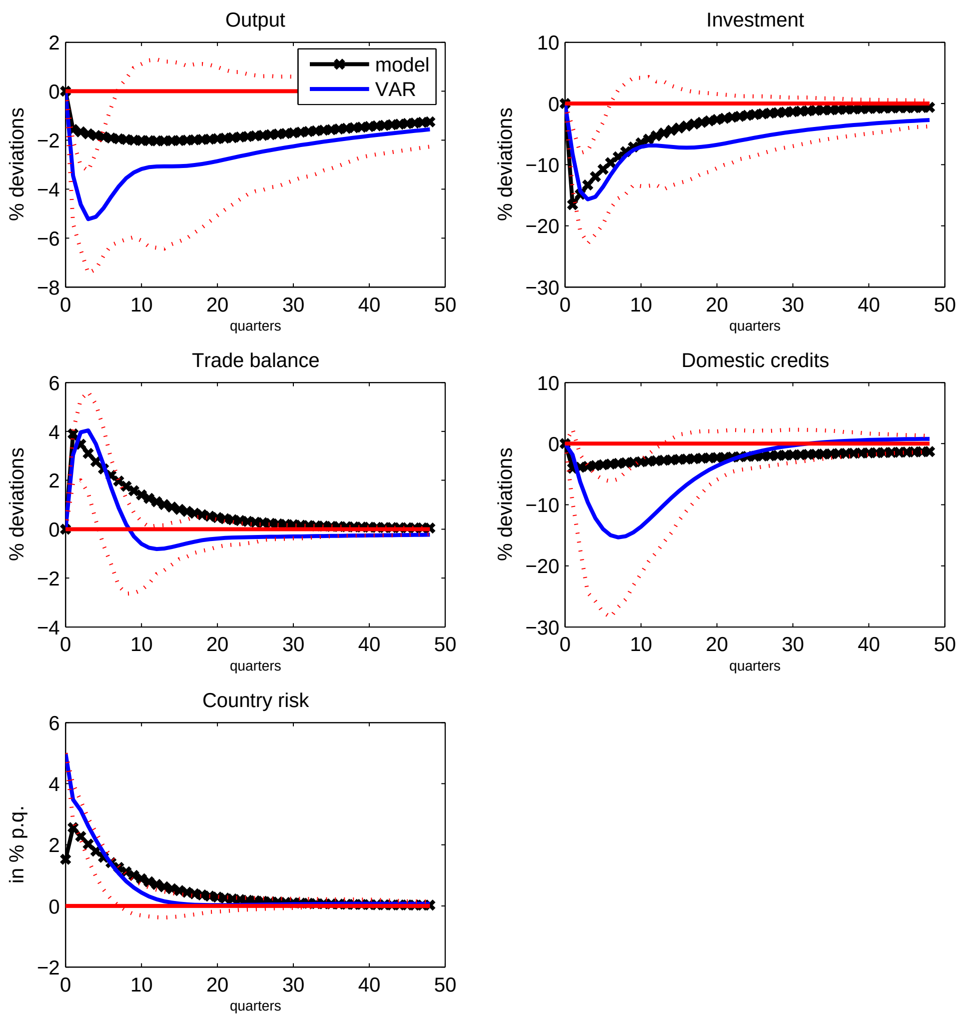


Figure 4: Selected theoretical impulses responses

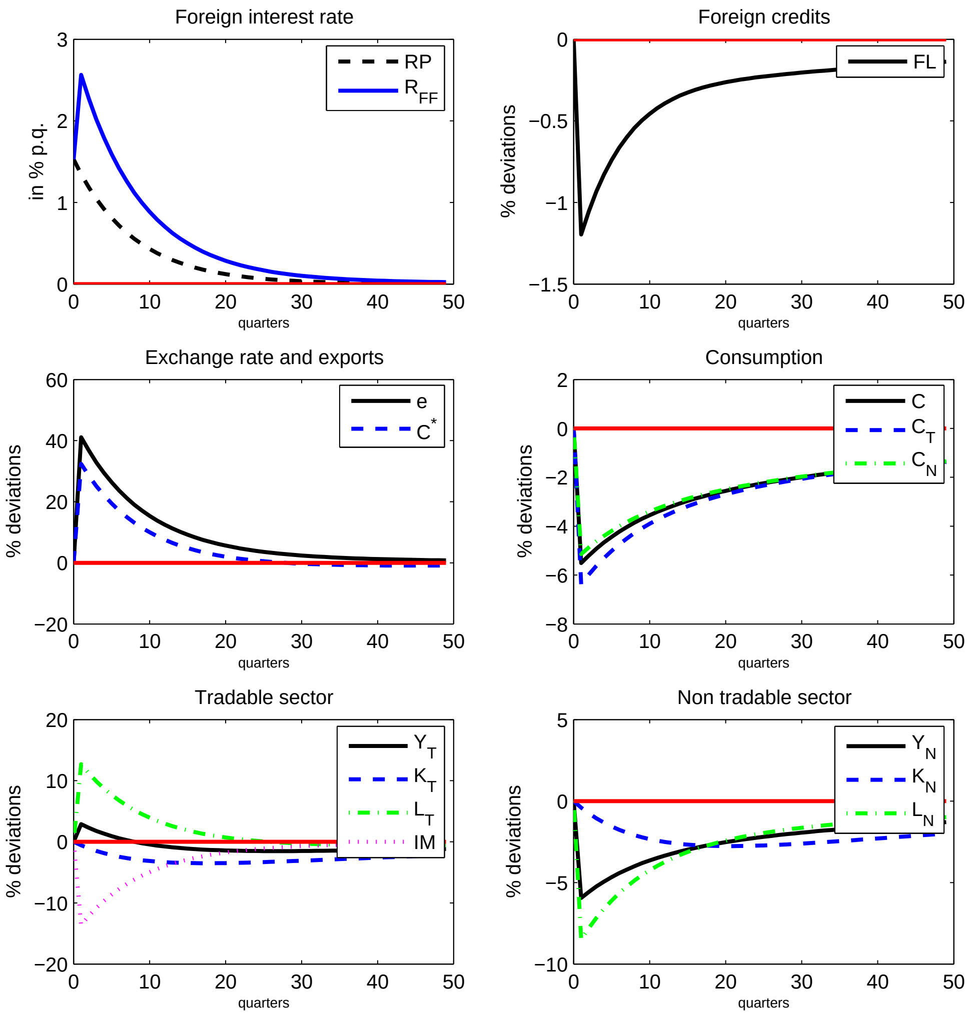


Figure 5: Selected theoretical impulses responses for different monetary policies

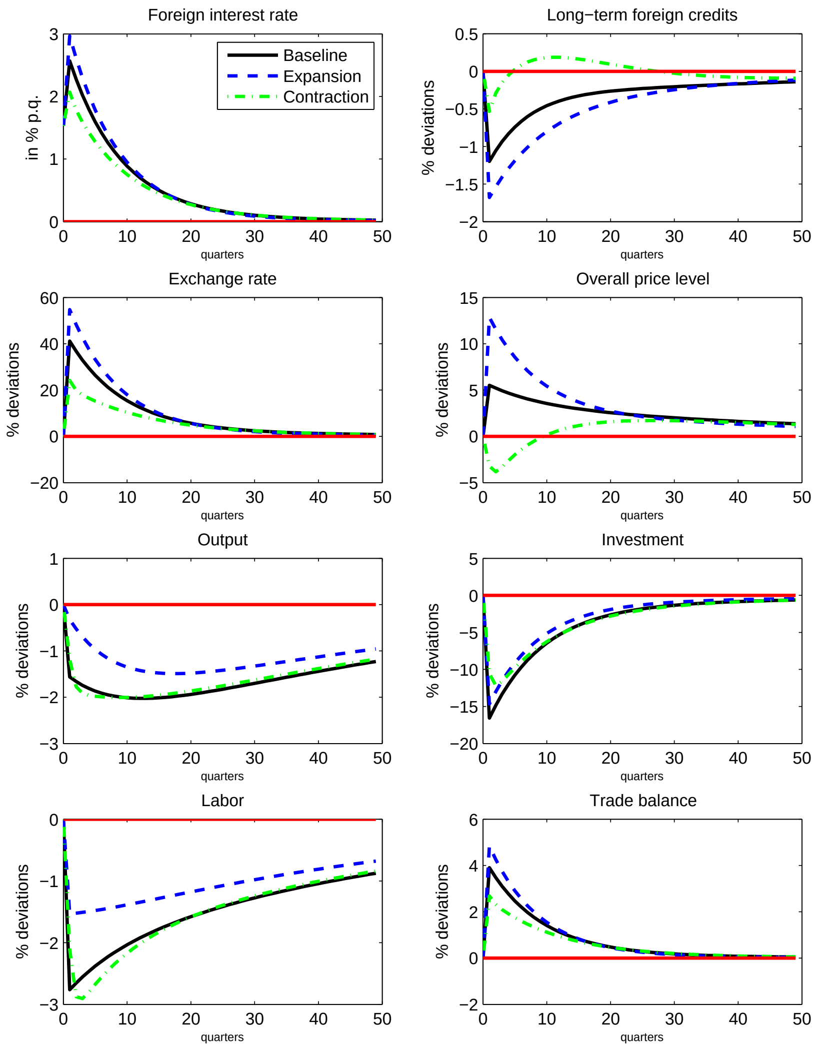


Figure 6: Selected theoretical impulses responses for different debt levels