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Credit, Prices, and Crashes in Emerging Economies:
Sudden Stops Economics in an Equilibrium Framework

by

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1. Introduction

All of the capital-markets crises that hit emerging economies in the 1990s displayed the empirical regularities of a phenomenon that is now known as a "Sudden Stop" (see Calvo (1998)). The defining facts of a Sudden Stop are a sharp slowdown in capital inflows, or even a shift to large capital outflows, and a corresponding sharp reversal from large current-account and trade deficits into much smaller deficits or small surpluses. This "change of spirit" of external flows also features a sharp contraction of domestic production and private expenditures, collapses in the real exchange rate and in the relative price of nontradable goods in terms of tradables, and a sharp fall in credit to the private sector. In several cases, Sudden Stops followed extended periods during which the external accounts declined gradually, the relative price of nontradables and the real exchange rate appreciated, and economic activity boomed, often in tandem with stabilization policies anchored on managed exchange-rate regimes.

The features of a Sudden Stop resemble typical features of the balance-of-payments (BOP) crises that developing countries suffer regularly. Indeed, the literature on contractionary devaluations is based on the fact that in these countries devaluation is generally followed by recession (see Edwards (1986)). However, the evidence indicates that the changes in real and financial indicators observed in Sudden Stops largely exceeds those of typical BOP crises (see Calvo and Reinhart (1999)). Moreover, the economic collapses of Sudden Stops are deep, but the subsequent recoveries are quick and sharp -- an observation referred to as the "Mexican Wave" (see Martin Wolf's editorial in the August 8, 1999 *Financial Times*).

The characteristics of Sudden Stops described above suggest that the study of this phenomenon, and the analysis of policies aimed at dealing with it, needs to be undertaken in the context of a framework of "excess volatility." That is, a framework that distinguishes Sudden Stops from typical emerging-market business cycles, in a similar manner as theories of the Great Depression distinguish it from regular business cycles. There is a growing theoretical literature dealing with models of excess volatility in emerging markets from this perspective, based on elements that can be traced back to the Keynesian setup of price or wage stickiness or to the Fisherian analysis of debt deflations. However, progress has been much slower in developing a quantitative framework consistent with the theory. We need this quantitative framework to assess the extent to which particular approaches to model excess volatility can account for Sudden Stops, to evaluate the welfare effects of this phenomenon, and to explore the implications of policies that could be potentially useful to counter it.

The intent of this paper is to propose a basic general equilibrium framework for studying Sudden Stops. The aim is to design a framework that takes into account some of the financial frictions that have been identified in the theoretical literature on Sudden Stops (see Calvo (1988) and Calvo and Mendoza (2000b)), but that at the same time is suitable to be "put to test" with the quantitative tools of modern business cycle theory (see Cooley and Prescott (1995)). The approach followed in developing this framework sides with Fisher's in its emphasis on the credit-market effects of price shocks. In particular, it is shown that the optimal adjustment by rational economic agents in response to the distortions induced by financial frictions in a stochastic intertemporal general-equilibrium environment is consistent with key features of

Sudden Stops. This is the case even when credit frictions are stripped from their powerful debt-deflation intertemporal channel, and without recurring to the Keynesian assumption that prices or wages are inflexible or to the existence of multiple equilibria emphasized in some of the analytical work on Sudden Stops (e.g., Calvo (1998)).

The paper examines two models that highlight different aspects of the same basic equilibrium framework. First, a model for exploring a credit transmission channel triggered by endogenous changes in income and relative prices in a pure exchange economy. Second, a model for studying excess-volatility of equity prices and portfolio flows driven by financial frictions. The rest of this outline summarizes empirical evidence on financial transmission channels and Sudden Stops, sketches the two models, and provides preliminary results.

2. The Sudden Stops Phenomenon

The comprehensive cross-country analysis by Calvo and Reinhart (1999) documents 15 recent episodes of large reversals in net private capital flows for developing countries. The smallest reversal was equivalent to 4 percent of GDP (Argentina, 1994-1995). Reversals in excess of 10 percent of GDP were observed in 7 of the 15 cases. The implied adjustments in real GDP were also striking. Sudden Stops (which the authors report in Tables 8 and 9 of their paper under the label of "recent experiences") produced impact effects on output equivalent to an average decline of 13.3 percent for countries that experienced banking crises, and 12.3 percent for countries that experienced currency crises. These impact effects are much larger than those corresponding to 1970-1994 averages, which show declines of 3.2 and 2.7 percent for banking-crisis countries and currency-crisis countries respectively. In addition, Calvo and Reinhart show that Sudden Stops produced larger adjustments in reserves and real exchange rates, and higher bills for bailing out bankrupt banking systems, than those produced by previous BOP crises. They show that this is particularly the case for the recent crises in East Asia compared to other regions and to its own historical record.

Figures 1 and 2 illustrate Mexico's Sudden Stop triggered by the collapse of the peso in December, 1994. Figure 1 shows the Sudden Stop in private domestic absorption, the trade deficit as a share of GDP, and the output of tradables and nontradables (in terms of annual changes of quarterly data). The Figure also shows the period of gradual but sustained expansion and widening trade deficit that preceded the crash, and the relatively rapid recovery after 1995. Note in addition that the Sudden Stop in production was larger in the nontradables sector and that recovery in this sector was also more modest than in the tradables sector.

Figure 2 shows the movements in relative prices and exchange rates using monthly data. The picture shows that the severe drop in the real exchange rate at the time of the December, 1994 devaluation reflected, in addition to the nominal devaluation, a collapse in the price of nontradables relative to tradables within Mexico. This occurred after the gradual but large increase in that relative price and in the real exchange rate that took place for the duration of the exchange-rate-based stabilization that started in 1988. Mendoza (2000) shows that the sharp real appreciation and increase in the price of nontradables resulted mainly from a major rise in the cost of use of housing. Guerra de Luna (1997) and (1998) shows in turn that the high inflation in housing resulted from a large increase in real estate and land prices which were closely related to the surge in inflows of foreign capital that preceded the Sudden Stop. Moreover, the Sudden Stop featured important corrections in house and land prices in 1995.

Studies from equity markets document further the effects of Sudden Stops on asset pricing. Although the extent of “true” contagion across equity markets is subject of debate (see Kaminsky and Reinhart (2000) and Forbes and Rigobon (2000)), stock market indexes fell sharply in each country that suffered a Sudden Stop. By the end of January 1995, nearly a month after the devaluation, Mexico’s stock market index had fallen by more than 50 percent in dollar terms relative to November 1, 1994. The indexes in Brazil and Argentina fell about 20 percent in the same period. In the East Asian crisis, the collapses of equity prices between September 1 and December 31, 1997 ranged from about 20 percent in Hong Kong to almost 70 percent in South Korea. Equity markets rose from these crash levels but compared to industrial-country markets continued to performed poorly (see Ch. III in International Monetary Fund (1999)). Periods of Sudden Stops are also associated with higher asset price volatility. The volatility of weekly emerging-market dollar returns doubled from 2 to 4 percent during the East Asian crisis in 1997 and the Russian collapse in 1998 (see Fig. 3.8 in International Monetary Fund (1999)).[1]

3. Credit, Income and Relative Prices in an Exchange Economy

Conventional models of current-account determination and business cycles in small open economies cannot account for Sudden Stops. In particular, they predict relatively smooth movements in foreign debt and the current account driven by consumption-smoothing and investment-augmenting effects that are inconsistent with the sudden reversal of capital flows of a Sudden Stop. One key element of these models behind this result is the assumption of perfect financial markets, in which agents borrow or lend at the world-determined real interest rate limited only by the reach of their wealth (as implied by the No-Ponzi-Game condition). The framework proposed here relaxes this assumption by considering financial frictions that link the agents’ ability to borrow to the dynamics of asset and goods prices and to the evolution of income and savings. These frictions are modeled abstracting from the existence of money because, as Calvo (1998) showed, Sudden Stops can be the outcome of the real-sector implications of frictions in credit markets even in a pure exchange economy.

Consider a small open economy with an exogenous endowment of tradable goods $\varepsilon_t^T Y^T$, where ε_t^T is a Markovian shock to the endowment or to its world value (i.e., the terms of trade). The economy produces nontradable goods using a Cobb-Douglas technology: $Y_t^N = \varepsilon_t^N K^{1-\alpha} L_t^{\alpha}$. K is a fixed capital stock with zero depreciation rate, ε_t^N is a Markovian shock to labor productivity, and L is labor input. Firms choose labor demand so as to maximize profits π_t in units of tradable goods (which are the model’s numeraire):

$$\pi_t = \varepsilon_t^T Y^T + p_t^N \varepsilon_t^N K^{1-\alpha} L_t^{\alpha} - w_t L_t \qquad \textbf{(1)}$$

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[1]These figures correspond to means of rolling 13-week standard deviations of equity price indexes in U.S. dollars for 16 emerging markets.

The price of nontradables in units of tradables is p_t^N and the real wage in units of tradables is w_t. At equilibrium, firms demand labor up to the point in which the value of the marginal product of labor equals the real wage. Since the value of the marginal product of labor depends on p_t^N, a collapse in the relative price of nontradables (i.e., a collapse in the real exchange rate since PPP in tradables is assumed to hold) induces a negative shock to labor demand.

Households consume tradable goods C_t^T, nontradable goods C_t^N, and supply labor to firms. They maximize a form of expected utility that incorporates an endogenous rate of time preference (see Epstein (1983)). Endogenous discounting is introduced here not only to provide the small open economy with well-defined dynamics (which is the standard motivation for preferences like these) but also to allow the model to support competitive equilibria in which credit frictions may bind or not, in the long run or in the short run, depending on the state of nature. The utility function is:

$$U = E_0\left[\sum_{t=0}^{\infty}\exp\left\{-\sum_{\tau=0}^{t-1} v\left[C(C_\tau^T, C_\tau^N) - G\left(L_\tau\right)\right]\right\}u\left[C(C_t^T, C_t^N) - G\left(L_t\right)\right]\right] \qquad \textbf{(2)}$$

In this expression, *U* is lifetime utility, *C* is a constant-elasticity-of-substitution (CES) aggregator of consumption of tradables and nontradables, *G* is a positive, concave function that measures the disutility of labor, *u(.)* is an isoelastic period utility function, and *v(.)* is the time preference function. The specification of the argument of the latter two in terms of *C-G* is borrowed from Greenwood, Hercowitz and Huffman, GHH, (1988). In their one-good model, this assumption eliminates the wealth effect on labor supply by making the marginal rate of substitution between consumption and labor supply depend on labor only. This is not the case in the two-sector model described here, but still the GHH specification simplifies the analysis.

Households maximize utility subject to a standard budget constraint:

$$\left(1+\tau_t^T\right)C_t^T + \left(1+\tau_t^N\right)p_t^N C_t^N = \pi_t + w_t L_t - b_{t+1} + b_t R\varepsilon_t^R - T_t^T - p_t^N T_t^N \qquad \textbf{(3)}$$

Here, τ_t^T and τ_t^N are ad-valorem consumption taxes that apply to purchases of tradables and nontradables and T_t^T and T_t^N are lump-sum taxes levied in units of tradables and nontradables respectively. All these taxes may be stochastic and time-varying. *b* are holdings of one-period bonds that pay (if $b>0$) or charge (if $b<0$) the world-determined real interest rate $R\varepsilon^R_t$ in units of tradable goods (ε^R_t is a Markovian real-interest-rate shock). This is the only asset households exchange with the rest of the world, so markets of contingent claims are incomplete. Since we will be dealing with forms of *u* in the constant-relative-risk-aversion (CRRA) class, this implies that saving and consumption decisions respond to fluctuations in the marginal utility of wealth.

Households must satisfy a credit constraint that represents the model's financial-market friction. In particular, lenders require borrowers to finance a fraction φ, for $0 \le \varphi \le 1$, of their current expenses (i.e., consumption, taxes, and debt payments) out of current income:

$$w_t L_t + \pi_t \ge \varphi\left[\left(\left(1+\tau_t^T\right)C_t^T + \left(1+\tau_t^N\right)p_t^N C_t^N\right) - b_t R\varepsilon_t^R + T_t^T + p_t^N T_t^N\right] \qquad \textbf{(4)}$$

Given the budget constraint, this liquidity requirement is equivalent to a constraint that limits debt as a share of current income not to exceed *(1-φ)/φ*:

$$b_{t+1} \geq -\frac{1-\varphi}{\varphi}\left[w_t L_t + \pi_t\right] \qquad \textbf{(5)}$$

Note that $\varphi=1$ implies a no-borrowing constraint (i.e., $b_{t+1} \geq 0$ for all t) and as φ converges to 0 the economy approaches the case in which the liquidity constraint never binds.

Given incomplete markets, the above credit constraint gives households the incentive to engage in precautionary saving, storing away extra assets in the "good" states of nature for the "bad" states in which the constraint binds. This contrasts sharply with the outcome that would be obtained under perfect foresight. Under perfect foresight (and a constant discount factor) households would move to a corner and maximize their debt as long as the marginal utility of current consumption exceeds that of future consumption. Thus, uncertainty and risk aversion play a key role in the development of quantitative applications of models with credit frictions.

The form of the credit constraint is not formally derived as a feature of an optimal contract, but it resembles lending criteria commonly used in mortgage and consumer loans. The constraint also captures some of the potentially crippling effects of "liability dollarization" (as defined by Calvo (2000)) because debt is denominated in units of tradables but part of the income on which debt is "leveraged" originates in the nontradables sector. As a result, a sharp fall in the nontradables relative price could trigger a Sudden Stop.

The optimality conditions of the household's problem have straightforward interpretation, except that marginal lifetime utilities include the impatience effects by which changes to the arguments of period utility at any date *t* alter the rate at which all future period utilities are discounted. It is particularly important to note that when the credit constraint binds:

(a) The effective marginal reward to labor rises because the extra unit of labor enhances the household's ability to borrow (note that households care for the real wage in units of *C*, and that given the CES structure of *C* the relative price of *C* in units of tradables, p^C, is a standard CES price index that is monotonically increasing in p^N)

(b) The effective intertemporal relative price of current tradables consumption increases relative to the world real interest rate because the binding borrowing constraint forces households to reduce current tradables consumption relative to the optimal of an unconstrained economy.

(c) The distortions on aggregate consumption and on saving (i.e., changes in the current account since *b* is the only means of saving) resulting from the credit friction depend on the combined dynamic effects of (a) and (b). This is because the effective intertemporal relative price of aggregate consumption is determined by the consumption-based real interest rate, which depends on the inverse of the rate of change of the relative price of consumption (p_t^C/ p_{t+1}^C), which in turn depends on inverse of the rate of change of the relative price of nontradables or the real exchange rate (p_t^N/ p_{t+1}^N).

The specification of the model is completed with the description of the government sector. Ad-valorem consumption taxes were introduced with the aim of exploring the role of policy shocks or the lack of credibility of existing policies in triggering Sudden Stops. As in Mendoza (2000), tax rates can be assumed to follow a regime-switching process with exogenous and time-invariant transition probabilities. The government runs a balanced-budget policy and keeps constant its purchases of nontradable goods (financed by lump-sum taxes) at a level to be calibrated to the data. This is done so that the dynamics of the relative price of nontradables reflect only changes in demand and supply by the private sector of the economy. Fluctuations in tax revenue result in fluctuations in unproductive government purchases of tradable goods, given a constant amount of lump-sum taxes or transfers in units of tradables. This assumption introduces the Calvo-Drazen fiscal-induced wealth effect that Calvo and Drazen (1988) and Mendoza and Uribe (2000) found critical for explaining key features of economic fluctuations in developing countries exposed to the risk of uncertain duration of government policy. Under these assumptions, the government budget constraint is given by:

$$G_t^T + p_t^N G^N = t_t^T C_t^T + t_t^N C_t^N + T^T + p_t^N T^N \quad with\ G^N = T^N \tag{6}$$

The model was calibrated to Mexican data and initial simulations were conducted for the case of an economy in which the only source of uncertainty comes from tax shocks. Taxes are assumed to be uniform across tradable and nontradable goods, and they are modeled to follow a two-point regime-switching Markov chain. The low-tax state is 2.2 percent and the high- tax state is 15.5 percent. The probability of switching from the low tax to the high tax is 0.28.

Figures 3 and 4 report the impact effects of a switch from the low to the high tax as a function of the foreign asset positions included in the discretized state space used to solve the model. Impact effects are reported for the case of an economy that faces a credit constraint that limits foreign debt to 40 percent of GDP and for an economy without credit constraints. For high foreign asset positions (i.e., low debt) the constraint does not bind and the impact effects are the same in the two economies. For very low foreign asset positions (i.e., high debt) the constraint is binding regardless of the tax state, hence the debt-to-output ratio cannot change across tax regimes. Still, the constraint is not equally binding in each state so the other impact effects in Figures 3-4 are different from zero. There is also a range of foreign asset positions in which the credit constraint is not binding in the low tax state but shifts to become binding when the tax increases. In this case, the adjustment in the debt-to-output ratio is smaller than in the unconstrained economy. At the high end of this range, the model yields Sudden Stop dynamics: large collapses in domestic absorption, the output of nontradables (and aggregate GDP), the relative price of nontradables and large reversals in the current account and trade deficits.

The model is also consistent with the notion that Sudden Stops are unusual. In contrast with the sharp differences in impact effects shown in Figure 3 across constrained and unconstrained ecnomies, the long-run business cycle moments of the credit-constrained economy (calculated using the corresponding ergodic distribution) do not differ significantly from those of the unconstrained economy (except for obvious major differences in foreign asset accumulation and the current account).

4. Margin Requirements, Adjustment Costs and Excess Volatility of Portfolio Flows

The framework developed in Section 3 is now modified to explore the role of financial frictions in accounting for excess volatility of portfolio flows and equity prices in emerging economies. In particular, the model considers agents in the domestic small open economy that are subject to margin requirements and trade shares of their capital stock with foreign securities firms. These foreign firms face portfolio adjustment costs that result from their disadvantaged position in trading equity of the small open economy (in terms of information or institutional features). Frankel and Schmukler (1996) provide empirical evidence suggesting that indeed foreign traders are at a disadvantage relative to traders in the domestic equity markets of emerging economies.

Given the large nonlinearities that result from the feedback between income, the price of nontradables, and the credit constraint in the model of Section 3 (see Figure 3), the model is simplified to consider only a single, homogeneous tradable good. This has two important additional advantages. First, it implies that the GHH specification of the argument of utility eliminates completely the wealth effect of labor supply, thereby isolating the labor supply decision from the dynamics of consumption, saving and portfolio choices (and hence from the distortions due to credit frictions). Second, since the optimal labor demand and profits of firms are also unaffected by credit frictions, the one-good model features a supply-side that corresponds exactly to that of a frictionless model. In particular, the "fundamentals" equity price corresponds to the present value of the stream of dividends discounted at the exogenous world real interest rate, and dividends and the labor-market equilibrium are independent of saving decisions and credit frictions. As a result, credit frictions in this setting do not induce output collapses, even if Sudden Stops to capital flows and collapses of domestic demand occur.

Production of the single, homogeneous tradable good is undertaken with the same Cobb-Douglas technology used before: $Y_t = \varepsilon_t K^{1-\alpha} L_t^{\alpha}$. Firms choose labor demand so as to maximize the present discounted value of dividends, discounting them at the world-determined risk-free real interest rate. Thus, firms do not face frictions in the credit market. At each date t, labor demand is given by the standard marginal-product condition:

$$\varepsilon_t \alpha K^{1-\alpha} L_t^{\alpha-1} = w_t \qquad \textbf{(7)}$$

Dividend payments are given by:

$$d_t = \varepsilon_t (1-\alpha) K^{-\alpha} L_t^{\alpha} \qquad \textbf{(8)}$$

Expected lifetime utility is specified as before (except that C is now made of a single consumption good). Households maximize utility subject to the following budget constraint:

$$(1+\tau_t)C_t = a_t K d_t + w_t L_t + q_t(a_t - a_{t+1})K - b_{t+1} + b_t R \varepsilon_t^R \qquad \textbf{(9)}$$

where τ_t is a time-varying consumption tax (which can also be interpreted as an import tariff), a_t and a_{t+1} are beginning- and end-of-period shares of the domestic capital stock owned by domestic households, d_t are dividends paid by domestic firms and q_t is the price of equity.

Households also face a *margin requirement* according to which they must finance a fraction κ of their equity holdings out of current saving:

$$a_t K d_t + w_t L_t + q_t a_t K + b_t R \varepsilon_t^R - (1+\tau_t) C_t \geq \kappa q_t a_{t+1} K \qquad \textbf{(10)}$$

Given the budget constraint, the margin requirement imposes a constraint on foreign borrowing of the form:

$$b_{t+1} \geq -(1-\kappa) q_t a_{t+1} K \qquad \textbf{(11)}$$

This constraint differs sharply from the liquidity requirement because it depends on the price of equity, which is a forward-looking variable. Note that the constraint can also be interpreted as restricting the stock of savings (i.e., $q_t a_{t+1} K + b_{t+1}$) to be larger than $\kappa q_t a_{t+1} K$.

The optimality conditions of the household's problem have similar features as before, except that, because of the simplification to a one-good model, a binding borrowing constraint does not distort the labor supply choice and does induce distortions via the dynamics of the relative prices of aggregate consumption and nontradables in terms of tradables. A binding borrowing constraint still increases the expected effective real interest rate of the small open economy relative to the world real interest rate.

The important addition to the optimality conditions is the condition that determines changes in equity holdings by equating the cost and benefit of sacrificing a unit of current consumption to accumulate an extra unit of equity. Using the standard forward solution procedure, it follows that arbitrage of the expected, risk-adjusted returns on equity and bonds requires the equity price to satisfy:

$$q_t = E_t \left(\sum_{i=0}^{\infty} \left[\prod_{j=0}^{i} \tilde{R}_{t+1+j} - (1-\kappa) \frac{\eta_t}{\lambda_{t+1}} \right]^{-1} d_{t+i} \right), \qquad \tilde{R}_{t+1+j} = R \varepsilon_{t+1+j}^R + \frac{\eta_t}{\lambda_{t+1}} \qquad \textbf{(12)}$$

Here, η is the Lagrange multiplier on the margin constraint and λ is the multiplier on the budget constraint (i.e., the marginal utility of wealth). If the margin requirement *never* binds, this expression yields the conventional *"fundamentals"* price of equity q_t^f as the present discounted value of the expected stream of dividends discounted at the exogenous risk-free rate. Clearly, since a binding margin requirement implies an effective real interest rate that exceeds the risk-free rate, the price of equity under a binding margin requirement is always lower than the fundamentals price. This is because in this situation households sell equity to meet the margin requirement, but selling "under duress" requires them to sell at a discount. Moreover, the date-t equity price is lower than the date-t fundamentals price whenever the margin requirement is expected to bind in the future, *even if it were not binding at date t* (i.e., all what is required for $q_t < q_t^f$ is that $\eta_{t+j} > 0$ for some $j > t$).

Foreign securities firms are specialized in holding equity of the small open economy. These firms maximize the present discounted value of dividends D to their global share-holders, facing a quadratic adjustment cost in adjusting equity positions in the small open economy. This adjustment cost is similar to the one in Aiyagari and Gertler (1999), except that here it is imposed on foreign securities firms rather than on households. The adjustment cost specification also differs from Aiyagari and Gertler's in that it does not require an arbitrary time-varying partial adjustment coefficient to support the equilibrium determination of equity prices, and in that it allows for a fixed cost to support stationary equilibria in which margin requirements bind and equity prices permanently deviate from fundamentals. Foreign securities firms choose a^*_{t+1} for t=0,...,∞ so as to maximize:

$$D = E_0\left[\sum_{t=0}^{\infty} M_t\left(a_t^* K(d_t + q_t) - q_t a_{t+1}^* K - q_t\left(\frac{s}{2}\right)\left(\left(a_{t+1}^* - a_t^*\right)K + \theta\right)^2\right)\right] \qquad \textbf{(13)}$$

where $M_0 \equiv 1$, $M_t \equiv R^t \varepsilon_1^R \varepsilon_2^R \ldots \varepsilon_t^R$ for t=1,...,∞ is the discount rate that applies to date-t dividends (i.e., the marginal rate of substitution between date-t consumption and date-0 consumption for the world's representative consumer with a perfectly-diversified portfolio), s is a "speed-of-adjustment" coefficient and θ is the fixed cost of holding a time-invariant equity position in the small open economy. The fixed cost is assumed to be zero if the long-run equity price equals its "fundamentals" level, otherwise the fixed cost is a positive constant. Thus, if "excess volatility" of equity prices is expected to be a feature of the long-run equilibrium, securities firms will incur fixed costs to remain able to trade in emerging markets, even if their portfolios remain constant.

The first-order condition for the optimization problem of securities firms implies a partial-adjustment rule for their portfolio of the form:

$$\left(a_{t+1}^* - a_t^*\right)K = s^{-1}\left(\frac{q_t^f}{q_t} - 1\right) - \theta \qquad \textbf{(14)}$$

According to this rule, when households face a binding margin requirement and thus are forced to sell equity at a price below the fundamentals price, they trade with foreign securities firms that are willing to adjust their demand for equity but by a magnitude that is inversely related to the value of s. Note that the informational friction behind the partial-adjustment behavior of these firms is key to support equilibrium equity prices below the fundamentals levels. If securities firms could adjust their portfolios costlessly, households could liquidate the shares they need to meet their margin calls at an infinitesimal discount.

The government sets the value of τ_t and uses tax revenue to finance unproductive government expenditures G_t maintaining a balanced-budget policy:

$$G_t = \tau_t C_t \qquad \textbf{(15)}$$

Thus, sudden changes in taxes introduce the same wealth effects driven by endogenous changes in unproductive government absorption present in the model examined earlier.

The model's deterministic steady state offers interesting insights regarding the long-run implications of the margin constraint for asset prices. If the margin constraint is not binding at steady state (and hence the fixed portfolio adjustment cost vanishes), the steady-state equity price equals the fundamentals price: $\bar{q} = \bar{q}^f = \bar{d} / (\bar{R} - 1)$. Implicit in this equality is the result that the return on equity, $(\bar{q} + \bar{d}) / \bar{q}$, equals the gross rate of return on foreign assets (i.e., there is no equity premium). Note, however, that the steady-state equity and debt positions depend on initial conditions even though savings have a unique steady state independent of initial conditions. Portfolio holdings in place when the margin requirement becomes permanently nonbinding are never altered. Hence, these portfolio holdings are also the steady-state holdings, while foreign bonds adjust gradually to converge to the unique steady-state level of savings that yields a steady-state rate of time preference equal to the world interest rate.

If the margin requirement is binding at steady state (and hence θ>0), the partial-adjustment portfolio rule of securities firms implies that the steady-state equity price satisfies: $\bar{q} = \bar{q}^f / (1 + sq) < \bar{q}^f$. This price is supported as an equilibrium price from the household's side because the margin requirement and the endogenous rate of time preference result in a long-run equity premium: the steady-state rate of return on equity exceeds the world risk-free rate of return by the amount $\kappa(\eta/\lambda)$. Thus, under the assumed specification of preferences, the financial and informational frictions implied by the margin constraint and the portfolio adjustment cost combine to yield a stationary equilibrium in which equity prices can deviate permanently from their fundamentals value and the margin constraint is always binding. Moreover, in this case the steady-state holdings of foreign bonds and equity are uniquely determined.

Numerical simulations of this model will be used to examine Sudden Stop effects on porftolio capital flows, asset prices, domestic demand and the current account. Exogenous shocks driving the volatility of global capital flows, such as shocks to the world real interest rate, can be examined in an analogous manner as the "liquidity shocks" examined by Aiyagari and Gertler (1999). The effects of productivity shocks, policy shocks, and exogenous shocks to the marging coefficient κ can also be studied. These experiments would capture some of the features of the episode of waves of margin calls observed in the aftermath of the Russian default in 1998. During this episode, margin calls were triggered by increasing estimates of potential portfolio losses produced by the value-at-risk models of investment banks that leveraged the operations of hedge funds like Long Term Capital Management. As market volatility increased and asset prices plummeted, value-at-risk estimates worsened thereby mandating even larger margin calls. Similarly, in the model, shocks that make equity prices fall below fundamentals trigger an endogenous increase in the level of the margin requirement (even if κ remains unchanged). The sharper the decline in equity prices, the larger the size of the margin call.

5. Conclusions and Policy Implications

The quantitative analysis of financial frictions in the general equilibrium framework proposed here illustrates the potential for these frictions to account for the Sudden Stops phenomenon. In addition, the welfare analysis of these effects shows that the social costs of Sudden Stops are substantial. These findings suggest that policy intervention is worth considering. Alternatives considered so far in the literature can be classified as siding with two approaches: an *isolationist* approach that seeks to avoid Sudden Stops using capital controls and limiting currency trading and an *internationalist* approach that aims to minimize Sudden Stops by strengthening the global integration of domestic financial institutions and by abandoning the issuance of weak domestic currencies with the adoption of hard currencies (i.e., dollarization).

The policies advocated by internationalists counter two important sources of Sudden Stops: the lack of credibility of economic policies in emerging-markets countries and the perverse combination of heavy need-weak incentives for gathering costly information about these countries by global investors and lenders (see Calvo and Mendoza (2000a)). Dollarization, for example, does away with the need to keep track of monetary and exchange rate policies, which have proven extremely volatile and hard to predict in periods of capital-markets turbulence. A similar principle applies to fiscal and trade policies that follow regimes with uncertain duration, but which are harder to make credible. The benefits of increased policy credibility for the management of Sudden Stops can be explored by studying the effects of varying the transition probabilities of the regime switching process of tax rates as in Mendoza (2000). The potential gains of policies that improve the efficiency of credit markets can be approximated by studying the effects of lowering the values of the coefficients that control the liquidity and margin requirements.

The effects of capital controls can also be quantified with the framework provided here. The dynamic general-equilibrium nature of the analysis fleshes out the tension between the short-term aim of using capital controls to prevent a Sudden Stop's reversal of capital flows and the dynamic implications of this policy. For capital controls to effectively remove the risk of Sudden Stops, they must ensure that exposure to large outflows is fully avoided, but this can only be guaranteed if the stock of foreign liabilities is never allowed to be "too large." However, relative to the environments with occasionally-binding credit constraints, this is a worst-case scenario equivalent to one in which borrowing constraints are very tight. Sudden Stops are avoided, domestic saving is high and long-run private consumption is high, but this is all the result of very costly distortions on the structure of intertemporal relative prices. Policies related to capital controls but seemingly less stringent, such as short-selling constraints, margin requirements, and collateral constraints linked to value-at-risk estimates also have negative features. Short selling constraints exacerbate the loss of incentives to gather costly information, as Calvo and Mendoza (2000a) showed, while margin requirements and collateral constraints strengthen the mechanisms driving "excess volatility" of asset prices and international capital flows examined in this paper.

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Figure 1. Mexico's Sudden Stop
(annual percent changes of quarterly data)

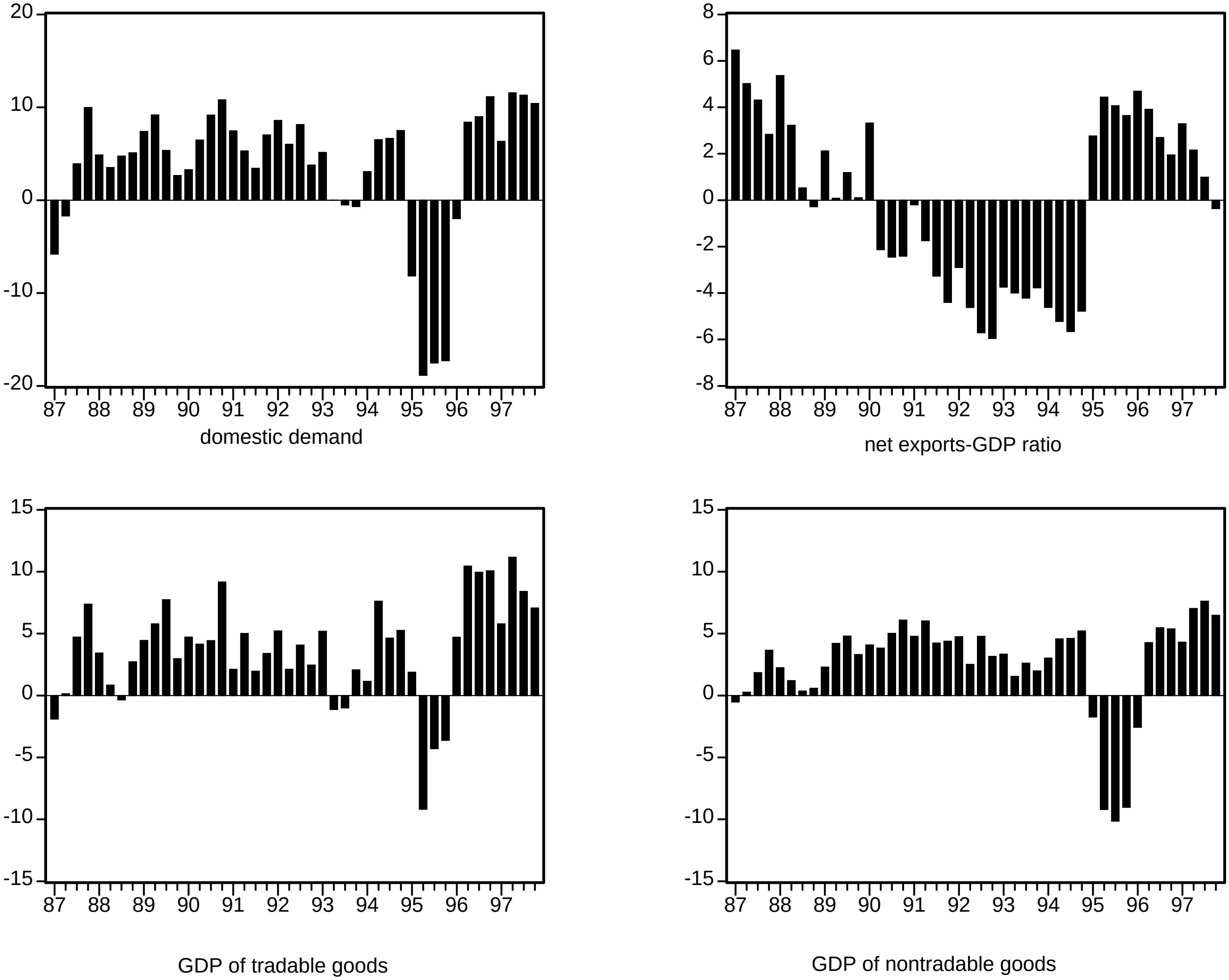

Figure 2. Mexico-U.S.: Relative Prices and the Real Exchange Rate
(consumer price indexes rebased at 1988:02=100)

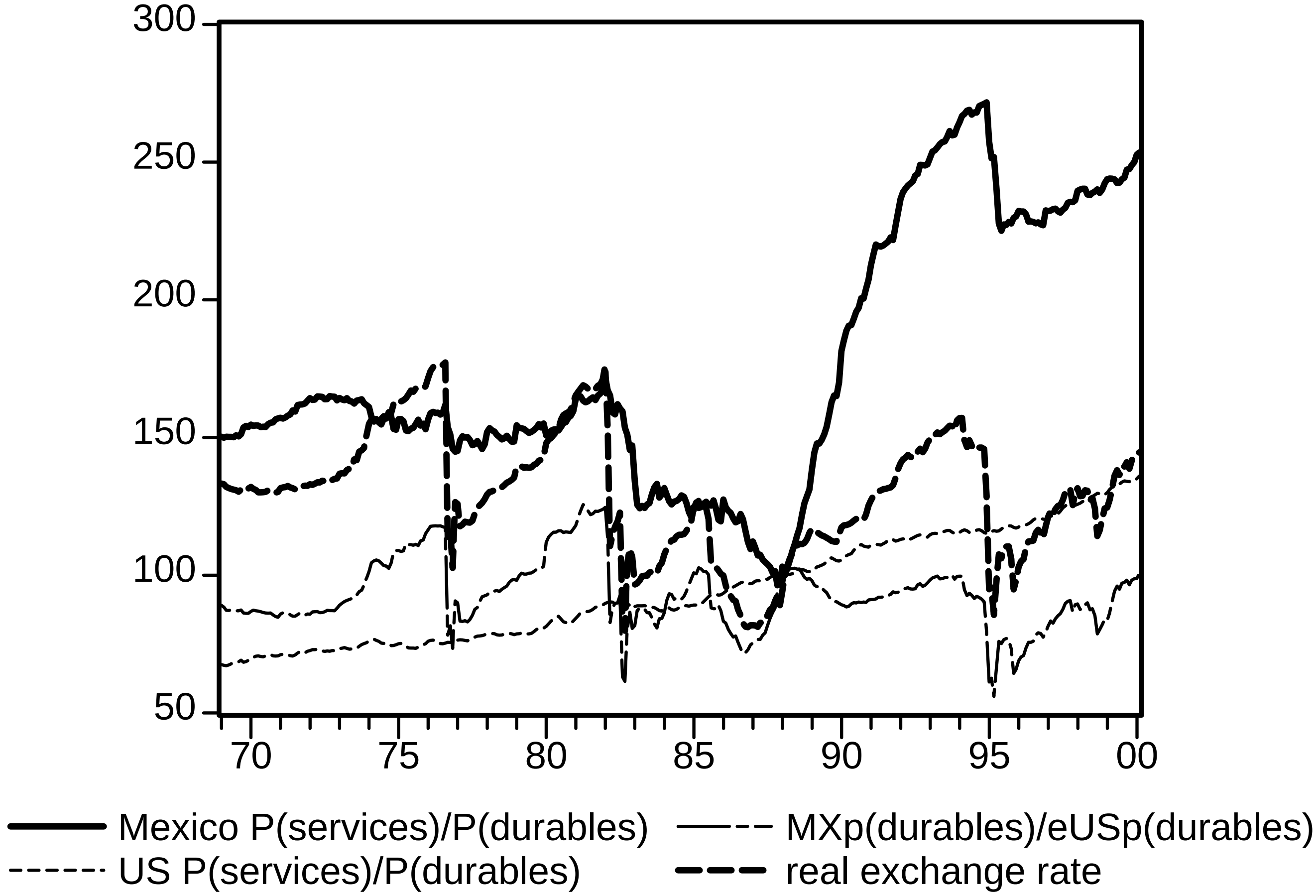

Figure 3. Impact Effects of Tax Increase
(percent changes relative to low-tax state)

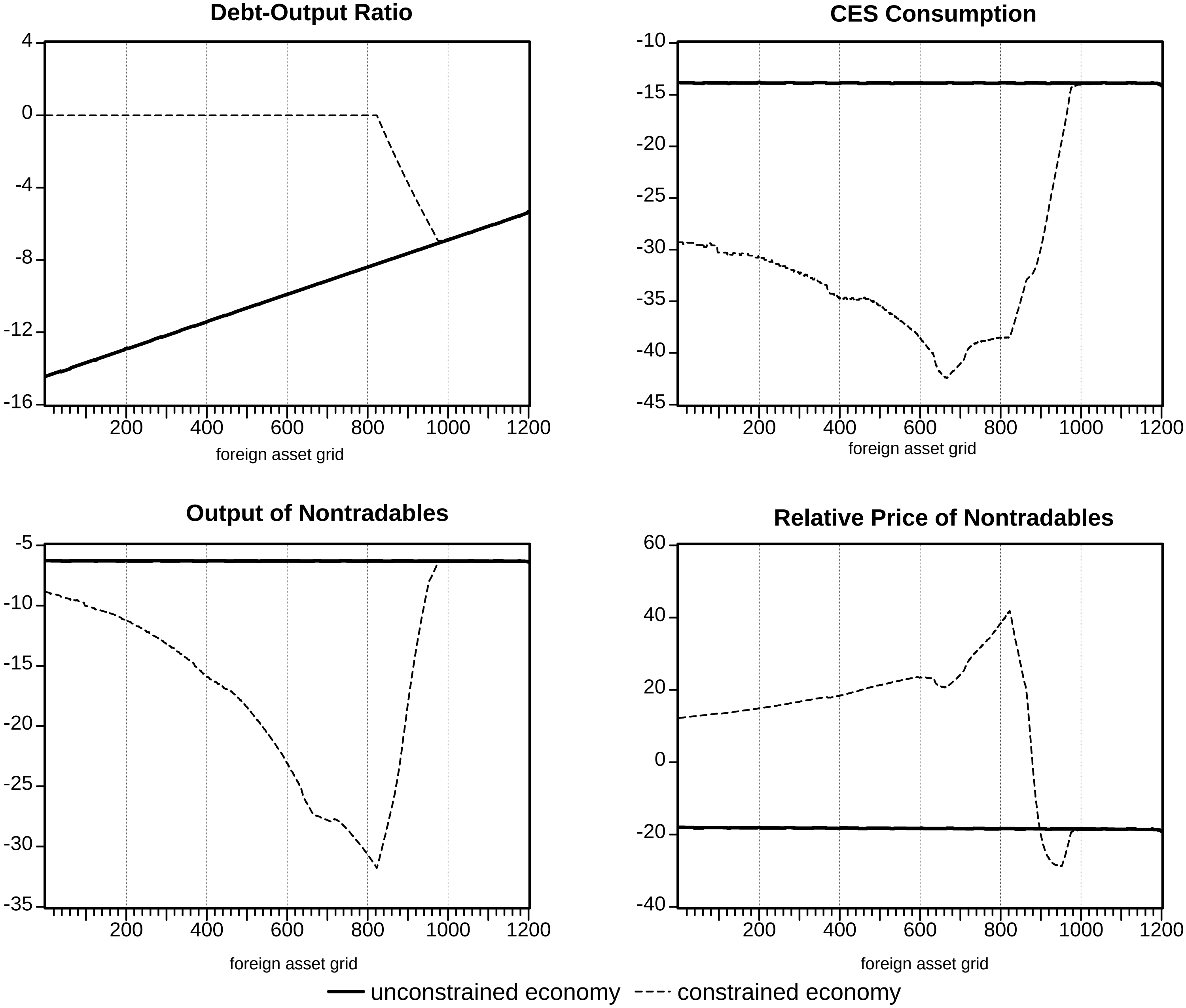

Figure 4. Impact Effects of Tax Increase on the External Accounts
(percentage points changes relative to low-tax state)