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ON THE BENEFITS OF DOLLARIZATION WHEN STABILIZATION POLICY IS NOT CREDIBLE AND FINANCIAL MARKETS ARE IMPERFECT

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ABSTRACT

This paper examines two potential benefits that emerging economies may derive from dollarization. First, dollarization may eliminate distortions induced by the lack of credibility of monetary policy. Second, dollarization may weaken financial frictions that result in endogenous credit constraints. The analysis is based on numerical simulations of a two-sector dynamic, stochastic general equilibrium model calibrated to Mexican data. The results indicate that policy uncertainty and credit constraints are very costly distortions. The mean welfare gains of eliminating policy uncertainty range between 6.4 and 9 percent of the trend level of consumption per capita. The mean welfare gain of weakening credit frictions is about 4.6 percent.

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"Especially in emerging markets, exchange-rate regimes are the hemlines of macroeconomics– ideas about what looks best change all the time, at the whim of fashion." (The Economist, January 29, 2000, p. 88)

1. Introduction

The second half of the 1990s was a period of intense turbulence in international financial markets. This period witnessed the collapse of several managed exchange-rate regimes in "emerging" economies across the globe (including those of Brazil, Chile, Colombia, Ecuador, Korea, Indonesia, Malaysia, Mexico, Russia, and Thailand). There were also severe speculative attacks on currencies that escaped devaluation (such as those of Argentina, Hong Kong and Taiwan), and periods of systemic contagion in which even the financial markets of industrial nations suffered. This epidemic of financial crises, and the depth of the recessions that followed them, re-opened the protracted debate on exchange-rate regimes with a new sense of urgency.

For the most part, this renewed debate has been dominated by revisions of Mundell's (1960, 1961) classic arguments establishing conditions under which a fixed exchange rate, a flexible exchange rate or a currency union constitute the optimal regime in terms of its ability to smooth macroeconomic adjustment. While this approach has provided key insights in the past, there are two aspects central to the current situation that it does not address. First, the Mundellian approach abstracts from the financial frictions that played a key role in recent crises, and hence it does not provide policymakers with an understanding of how, or even whether, alternative exchange-rate regimes can address those frictions and thus prevent future crises. Second, the Mundellian approach conceives the choice of exchange-rate regime as if it were made in a vacuum. Any regime can be put in place instantaneously and maintained indefinitely. The Mundell-Fleming apparatus is used to study macroeconomic performance under alternative regimes, and the "winner" is the regime that yields smaller income fluctuations for a given environment of trade integration, factor mobility, and exogenous shocks.

The main issues confronting monetary authorities of emerging economies differ sharply from those emphasized in the Mundellian analysis in that they relate to the transition from one particular exchange-rate regime to another, the sustainability of a chosen regime, the adverse effects of severe financial volatility, and the distortions that result from the serious credibility problems they face.[1] The aim of this paper is to contribute to the debate on exchange-rate regimes by examining the implications of a macroeconomic model that incorporates some of these issues. In particular, the paper studies how dollarization (i.e., the policy by which domestic money is replaced with foreign money) can be beneficial because of its potential ability to deal with credibility distortions and weaken credit frictions.

The key role played by financial frictions and credibility problems in the emerging-markets crises of the 1990s is well-established and is a central theme of the large recent literature on the subject.[2] The emphasis that this literature places on the financial sector contrasts sharply with traditional theories that attribute currency crises to the trade implications of overvalued real exchange rates (driven by price rigidities) or to the monetization of fiscal deficits. This paper adds to the literature by exploring the quantitative implications of a financial transmission mechanism in which uncertain policy duration (i.e., lack of credibility) interacts with a financial friction represented by an endogenous borrowing constraint. This is done within the context of a dynamic, stochastic general-equilibrium setting suitable for the application of recursive numerical simulation methods.

The model shares basic features of models proposed in the literature on credibility and exchange-rate management initiated by Calvo (1986), Helpman and Razin (1987), and Drazen

[1]It is paradoxical that Mundell's work recognized that these issues were critical for the optimal choice of exchange-rate regime (see, for example, his analysis of business cycles driven by currency speculation in Mundell (1960)), but most of the literature that followed his work generally abstracted from them.

[2]See the November 1996 and June 2000 symposium issues of the *Journal of International Economics* or the NBER volume edited by Edwards (2000) for a short sample of this literature

and Helpman (1987). This literature showed that "lack of policy credibility" induces prices and wealth distortions that may contribute to explain some of the business-cycle facts typical of stabilization plans anchored on managed exchange rates. Similarly, the model's emphasis on credit constraints is shared by a growing recent literature studying the role of these constraints in emerging-markets crises.[3] These two literatures provide important background for the analysis conducted here, but until now the study of the connection between non-credible policy, credit-market imperfections, and economic fluctuations was largely unchartered territory (some insights on this issue are provided in Calvo and Mendoza (2000)).

The issues examined in this paper are also related to those studied in the ongoing research program on financial frictions in Macroeconomics, particularly the branch studying endogenous credit constraints driven by collateral or margin requirements.[4] Most studies in this literature consider borrowing constraints that are either always binding (as in Kiyotaki and Moore (1997) or Bernanke, Gertler and Girlchrist (1998)) or occasionally binding in the short run but never binding at steady state (as in Aiyagari and Gertler (1999)). The model of this paper differs in that it considers the dynamics of a small open economy in which borrowing constraints can be binding or non-binding (in the short run and in the long run) depending on the state of nature, and yet the competitive equilibrium can still be represented by a social planner's problem. These features of the model result from the adoption of Epstein's (1983) specification of expected utility with an endogenous rate of time preference.

The policy-credibility problem considered in this paper is that of a non-credible managed

[3]Most studies on this subject follow the influential closed-economy framework of credit cycles by Kiyotaki and Moore (1997). See, for example, Paasche (1999) and Caballero and Krishnamurty (1999).
[4]Another major branch of this literature (see Kehoe and Levine (1993), Kocherlakota (1996) and Alvarez and Jermann (2000)) studies models that incorporate explicitly participation constraints representing the risk of default implicit in postulating collateral constraints. Alvarez and Jermann showed that an *exact* decentralized credit-market representation of an efficient outcome in which participation constraints rule out default in equilibrium requires state-contingent solvency constraints.

exchange-rate regime. The government announces a currency peg as the anchor of a disinflation plan (as was done in several countries in Latin America during the late 1980s and early 1990s). However, agents expect with some probability a switch to a regime with a high rate of depreciation of the currency and the corresponding high inflation. The lack of credibility of the peg is measured by this probability. Thus, the credibility-enhancement that dollarization entails alters both the mean and variance of inflation and the distortions associated with each.

The credit friction present in the model is a liquidity requirement by which lenders require borrowers to meet a fraction of their current expenditures and tax and debt obligations out of current income and holdings of liquid financial assets. This sets an upper bound for the ratio of foreign debt to current income plus liquid-asset holdings which resembles common lending guidelines used in credit markets.[5] Whether the constraint binds or not in a particular state of nature is an endogenous outcome of the dynamics of income, money demand and relative prices. Moreover, this credit friction incorporates some of the adverse features resulting from the "liability dollarization" already present in the financial systems of emerging economies (see Calvo (2000)). In particular, the model considers traded and nontraded goods, but debt and the liquidity requirement are denominated in units of traded goods. Hence, a collapse in the relative price of nontradables (i.e., the real exchange rate) tightens credit severely and forces large adjustments in the current account and economic activity.

The interaction of the liquidity requirement and the non-credible currency peg can be summarized as follows. The stylized facts of exchange-rate-based stabilizations include a sharp real appreciation, large booms in output and absorption, a marked widening of external deficits, and a surge in money demand. Mendoza and Uribe (2000a) showed that the risk of devaluation

[5]In the United States the two institutions that anchor the mortgage market, *Fannie Mae* and *Freddie Mac*, set guidelines for lenders in terms of ratios of debt payments to income (net and gross of mortgage loans) of prospective borrowers which vary with interest rates and downpayments.

in a stochastic setting with incomplete markets produces large price and wealth distortions that can account for a fraction of these empirical regularities. In their model, however, credit markets are perfect and agents can borrow subject only to the standard no-Ponzi-game restriction.

The situation is very different with a binding liquidity requirement. As the country enters the exchange-rate-based stabilization plan, the associated economic expansion, real appreciation and surge in money demand may induce an endogenous relaxation of the borrowing limit (if the limit was binding initially), hence providing a channel for magnifying the real effects of the stabilization plan. Similarly, an exchange-rate collapse may tighten the borrowing limit to the point of making it binding, thus providing a mechanism for magnifying the recessive effects of the currency crash. Uncertainty plays a key role in this analysis because the shift in exchange-rate regime is a source of non-insurable risk that, in the presence of binding borrowing constraints, leads agents to engage in precautionary saving. General-equilibrium feedback effects are also critical. The collapse in the relative price of nontradables caused by a devaluation reduces the value of the marginal product of labor (and thus labor demand and output) in that sector. Falling output and prices in turn tighten further the borrowing constraint.

The borrowing constraint also introduces distortions that are likely to magnify those induced by lack of credibility. This occurs because the effective intertemporal relative price of consumption and the atemporal relative price of leisure rise in states of nature in which the constraint binds. Moreover, since money holdings influence the ability to borrow, the opportunity cost of holding money is also likely to rise in those states, leading to an increase in money velocity and in the monetary distortions that result from higher velocity. The model also features two endogenous persistence channels that result from distortions driven by the liquidity requirement. One operates through money demand dynamics: an increase in the date-t opportunity cost of holding money reduces money demand, which in turn induces a fall in initial holdings of liquid assets at $t+1$, thus making it more likely that the constraint will continue to bind. The second channel works through real-exchange-rate dynamics because the model's effective consumption-based real interest rate depends on the rate of change of the relative price of aggregate consumption in terms of tradables. The latter is a monotonic function of the relative price of nontradables and thus its dynamics depend on the evolution of the supply and demand of nontradable goods.

The paper proceeds as follows. Section 2 documents aspects of the recent Mexican experience that illustrate the role of credit frictions and their interaction with a managed exchange-rate regime. Section 3 develops the model. Section 4 uses a variant of the model to conduct quantitative experiments. Section 5 concludes and draws policy lessons.

2. Financial Frictions and the Mexican Economy

Several macroeconomic developments observed in Mexico during the period 1987-1994 provide suggestive evidence of the role of credit frictions in driving economic fluctuations. During this period, Mexico embarked on an exchange-rate-based stabilization plan and a far-reaching program of economic reforms (which included financial liberalization and the privatization of commercial banks).

One of the main features of this episode that highlights the role of financial frictions is the evolution of the real exchange rate. The sharp real appreciation of the Mexican peso was widely viewed as a leading indicator that signaled the country's external vulnerability. The real exchange rate, as measured by the exchange-rate-adjusted ratio of consumer price indexes (CPIs) of Mexico and the United States, rose by nearly 46 percent between February of 1988 (the month at the end of which exchange-rate management began) and November of 1994 (the month just before the devaluation). Given the nearly-fixed nominal exchange rate and the low U.S. inflation rate during this period, it is clear that the these two variables made a trivial contribution to the large real appreciation of the peso.[6] Changes in the prices of tradable goods in Mexico (proxied by the CPI for durables) also played a small role, as inflation in this category fell sharply after the stabilization plan began (in fact there were a few months of deflation in durable goods prices in 1989). Thus, by the definition of the real exchange rate, it follows that the real appreciation resulted from a sharp increase in the relative price of nontradables within Mexico.

Further examination of Mexican prices shows that by far the highest inflation rate in the nontradables sector corresponded to the cost of use of housing, and that this reflected large booms in real estate and land prices. Between Ferbuary, 1988 and November, 1999 the prices of tradables such as furniture and appliances rose by 88 percent, those of conventional nontradables had increases ranging from 171 percent for personal hygiene and health services to 289 percent for education and entertainment. In contrast, the cost of use of housing rose by *632* percent. This item also has the largest weight in the CPI at 15.7 percent.

The severe "housing-cost bias" of the real appreciation casts doubt on conventional accounts of the Mexican crisis. In particular, it is hard to associate this bias (and the associated asset-price boom) with either conventional arguments of price or wage stickiness or with a generalized rise in nontradables prices. In contrast, there is evidence connecting the real appreciation, the dynamics of the housing market, and financial frictions. Guerra de Luna (1997) describes in detail the tight connection between the rising housing costs and the sharp increase in the price of urban land in the Mexico City area. He documents how the rapid rise in real state prices was associated both with a boom in the mortgage market and with large inflows of foreign capital, and how commercial banks relaxed borrowing limits by lowering down-payments and by introducing high-risk mortgage loans known as "Mexican mortgages."[7]

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[6]See Mendoza (2000a) for details on variance decompositions of the peso-dollar real exchange rate.

[7]Mexican mortgages were similar to credit card contracts. They allowed payments with no amortization of principal and partial interest payments, capitalizing unpaid interest into the principal and extending their maturity if needed.

Real estate prices peaked in 1992 and then began to fall slowly, compromising the willingness of borrowers to service mortgages as loan values grew beyond that of home equity. Mexico also entered in recession in 1993, a year before the currency crash, and this combined with the rise in U.S. interest rates may have tigthened borrowing limits and contributed to precipitate both the banking crisis and the collapse of the currency. The international evidence reported by Guerra de Luna suggests that similar phenomena might have occurred in Chile before the 1982 crash, in Korea in the early 1990s, and in Uruguay in 1979-1980.

Additional evidence of the expansion of credit via relaxation of borrowing constraints in Mexico and in other emerging markets is provided by Copelman and Werner (1996). They show that credit from banks expanded rapidly in Mexico immediately after the introduction of the stabilization plan in1987, and also in Chile in 1978 and in Israel in 1985. They argue that these credit booms reduced the proportion of liquidity-constrained households and thus contributed to the economic expansions. In addition, they found that in Mexico the credit expansion was associated with the remonetization of the economy, the fall in the ratio of public debt to GDP held by banks, and the increase in foreign liabilities of commercial banks. A similar picture emerges from the analysis of Mexico's manufacturing firms by Gelos and Werner (1996).

Further analysis of the connection between real activity and financial indicators at the business cycle frequency is conducted by measuring the stylized facts of Mexican business cycles using standard detrending procedures. This is done using annual data on National Accounts and financial aggregates from the World Bank's *World Development Indicators*, price and exchange-rate data from the Bank of Mexico's *Indicadores Económicos*, and the index of the price of urban land in the Mexico City area used in Guerra de Luna (1997) -- which is also calculated by the Bank of Mexico. The sample is restricted to annual data for the period 1970-1995 because of the limited availability of the land price index.

Table 1 reports statistics summarizing the features of variability, co-movement and persistence of Mexico's business cycle. These stylized facts are qualitatively consistent with the typical stylized facts of business cycles observed in other countries. One striking feature of the table is the large cyclical variation of land prices, which is more than 6 times larger than that of GDP. Fluctuations in land prices are also more persistent than those of other variables, although their correlation with output is weaker. Table 2 is a matrix of correlation coefficients between real variables (GDP, private consumption, fixed investment, and the real exchange rate) and financial indicators (domestic bank credit to the private sector, private capital inflows, the price of land, the current account, and M2 money balances). With a few exceptions, the correlations are larger than 0.6 (smaller than -0.6 for the current account), indicating a strong tendency for financial indicators and real variables to move together over the business cycle.

The statistics in Tables 1 and 2 leave two important questions unanswered: (a) what is the pattern of statistical causality among the variables? and (b) how significant are financial shocks for business cycles and bank lending? To provide a rough approximation to the answers, a subset of the data were used to estimate a basic vector-autoregression model. The model was estimated with the ordering: private capital inflows, real exchange rate, fixed investment, and domestic bank credit (valued in dollars), with one lag of each variable and no intercept. Variance decompositions justified this ordering, with capital inflows as the most exogenous variable of the system. Impulse response functions for one-standard-deviation shocks to capital inflows and the real exchange rate (plotted in Figure 1) show strong and significant responses of investment and bank credit. The impact effect on fixed investment of a shock to either capital inflows or the exchange rate is equivalent to a 5-percent deviation from trend.

3. Liquidity Requirements, Credibility and Business Cycles in a Small Open Economy

The model proposed in this section has several features typical of two-sector models studied in the literature on non-credible exchange-rate-based stabilizations.[8] One important difference is in that preferences are represented by Epstein's (1983) Stationary Cardinal Utility, which is a time-recursive expected utility function with an endogenous rate of time preference. This utility function allows the model to support stationary states in which the liquidity requirement may or may not bind, and stochastic dynamics in which it may bind or not depending on the state of nature.[9]

3.1 Structure of the Model

The small open economy includes two competitive industries with a large number of identical firms. Firms in the tradables (T) and nontradables (N) sectors operate neoclassical technologies to produce output $Y_t^i = F(K^i, L_t^i)$, given a fixed capital stock K^i and a variable demand for labor L_t^i for $i=T,N$. Following Mendoza and Uribe (2000a), these technologies feature sector-specific factors of production. This increases the curvature of the sectoral production possibilities frontier, thereby enabling the model to yield large variations in the relative price of nontradables, p_t^N. In particular, labor supplied by households, L_t, is employed across sectors according to a linearly-homogeneous factor-transformation curve: $\Omega(L_t^T, L_t^N)$.

Firms choose sectoral output and labor allocations so as to maximize profits, π_t, in units of tradable goods (which are the model's numeraire) subject to the production technologies and the factor transformation curve. That is, firms choose (L_t^T, L_t^N) so as to maximize:

$$\pi_t = \varepsilon_t^T F(K^T, L_t^T) + p_t^N \varepsilon_t^N F(K^N, L_t^N) - w_t L_t \tag{1}$$

subject to $L_t = \Omega(L_t^T, L_t^N)$. In equation (1), ε_t^i, for $i=T,N$, are Markovian productivity shocks with

[8] The model is very similar to the one in Mendoza and Uribe (2000a), except that capital accumulation is ruled out for simplicity and money enters in utility instead of as a means to economize transactions costs.

[9] Preferences of this kind have been used to address the problems of steady-state dependency on initial conditions and state-contingent wealth typical of models of the small open economy (see Obstfeld (1981) and Mendoza (1991a)). Epstein's utility function also tackles these problems in the model examined here.

a known transition distribution function and w_t is the wage rate.[10]

Labor demand in each sector satisfies the following first-order conditions:

$$\varepsilon_t^T F_{L^T}(K^T, L_t^T) = w_t \Omega_{L^T}(L_t^T, L_t^N) \tag{2}$$

$$p_t^N \varepsilon_t^N F_{L^N}(K^N, L_t^N) = w_t \Omega_{L^N}(L_t^T, L_t^N) \tag{3}$$

Since the production functions and the factor transformation curve are homogeneous of degree one, profits equal the rents on capital and factor payments exhaust output: $w_t L_t + \pi_t = Y_t^T + p_t^N Y_t^N$.

The utility function of the representative household is:

$$U = E_0\left[\sum_{t=0}^{\infty} \exp\left\{-\sum_{\tau=0}^{t-1} v\left[H\left(C(C_\tau^T, C_\tau^N), m_\tau\right), \ell_\tau\right]\right\} u\left[H\left(C(C_t^T, C_t^N), m_t\right), \ell_t\right]\right] \tag{4}$$

U is lifetime utility, C is a constant-elasticity-of-substitution (CES) aggregator of consumption of tradables (C_t^T) and nontradables (C_t^N) , m are real balances *in units of* C, H is a CES function of aggregate consumption and real balances, ℓ is labor supply, $u(.)$ is a CES period utility function, and $v(.)$ is the time preference function. The functions $u(.)$ and $v(.)$ must satisfy a set of conditions in order to ensure that U displays standard properties of concavity and time-recursiveness with a declining intertemporal marginal rate of substitution (see Epstein (1983)). Note that money enters the model as an argument of utility via the H function. As shown below, this specification implies that uncertain duration of a currency peg distorts saving and labor supply. The implications of the model are similar if money enters instead as a means to economize transactions costs (see Mendoza and Uribe (2000a)).

Households maximize lifetime utility subject to the following period budget constraint:

$$C_t^T + p_t^N C_t^N = \pi_t + w_t L_t - b_{t+1} + b_t R \varepsilon_t^R + \frac{m_{t-1}^T}{1+e_t} - m_t^T - T_t^T - p_t^N T_t^N \tag{5}$$

and to the standard normalized time constraint:

[10] The tradables industry can be interpreted as producing exportable goods sold in world markets at a world-determined relative price. In this case, shocks to the terms of trade (i.e., the relative price of exports in terms of imports) are similar to productivity shocks.

$$L_t + \ell_t = 1 \tag{6}$$

In the budget constraint (5), b are holdings of non-state-contingent, one-period international bonds that pay the gross real interest rate $R\varepsilon^R_t$ in units of tradable goods, m^T are real balances *in units of tradable goods*, e_t is the government-determined rate of depreciation of the currency (which is equal to the domestic tradables inflation rate since Purchasing Power Parity is assumed to hold and world inflation is assumed to be zero), and T^T and T^N are lump-sum taxes levied by the government. ε^R_t and e_t follow Markov processes with known transition functions. The process describing e_t is specified in more detail later.

The literature on the real effects of exchange rate management typically assumes that money is a nominal asset denominated in units of domestic tradable goods. Instead, money in this model is valued in terms of its purchasing power over the entire consumption basket (i.e., the composite good C). This makes the model consistent with standard definitions of velocity and money in the data and in empirical studies of money demand. In particular, the expenditures velocity of circulation of money is $V_t \equiv (P_t^T C_t^T + P_t^N C_t^N)/M_t$, where M represents nominal money balances and P^T and P^N are prices of tradables and nontradables in units of domestic currency. Velocity can then be expressed as $V_t = (C_t^T + p_t^N C_t^N)/m_t^T$. Moreover, given that C is a CES composite good, standard duality results apply and hence the relative price of C in terms of tradables, p^C, is given by a CES price index (which is increasing in p^N).[11] Thus, velocity can also be expressed as $V_t = p_t^C C_t / m_t^T$. This result is used later to interpret the equilibrium of the model.

In addition to the constraints in (5) and (6), households face the liquidity requirement that constraints their ability to borrow. They are required to pay for a fraction φ, for $0 \le \varphi \le 1$, of their current expenses and obligations (i.e., consumption, taxes, debt repayment and accumulation of

[11]Note that since money balances entering in utility can be rewritten as $m = m^T/p^C$, monetary distortions induced by fluctuations in the purchasing power of money are not only driven by changes in the prices of tradable goods, as in standard models of exchange-rate-management, but also by changes in nontradables prices.

money balances) out of current income and current money holdings:

$$w_t L_t + \pi_t + \frac{m_{t-1}^{\ T}}{1+e_t} \geq \varphi\left[\left(C_t^T + p_t^N C_t^N\right) - b_t R \varepsilon_t^R + m_t^{\ T} + T_t^T + p_t^N T_t^N\right] \tag{7}$$

Given the budget constraint (5), this liquidity requirement is equivalent to a constraint that limits debt as a share of current income plus current money holdings not to exceed *(1-*φ*)/*φ:

$$b_{t+1} \geq -\frac{1-\varphi}{\varphi}\left[w_t L_t + \pi_t + \frac{m_{t-1}^{\ T}}{1+e_t}\right] \tag{8}$$

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 standard non-negativity constraints on the variables in the left-hand-side of (7)).

The above borrowing constraint is not formally derived as a feature of an optimal credit contract, but, as noted in the introduction, it resembles lending criteria commonly used in mortgage and consumer loans. This borrowing constraint can also capture some of the potentially crippling effects of "liability dollarization" because debt is denominated in units of tradables but part of the income on which debt is "leveraged" originates in the nontradables sector. Hence, a sharp fall in the nontradables relative price, as induced by a devaluation, can trigger a "sudden stop" to capital inflows by making the constraint in (8) suddenly binding.

Given the CES forms of u and C and the structure of the utility function, it is easy, though lengthy, to show that the first-order conditions for the households' optimization problem reduce to the following expressions:

$$U_C(t)\left(1-\frac{\mu_t}{\lambda_t}\right) = \exp(-v(t))E\left[\frac{R\varepsilon_{t+1}^R p_t^c}{p_{t+1}^c} U_C(t+1)\right] \tag{9}$$

$$\frac{C_{C^N}(t)}{C_{C^T}(t)} = p_t^N \tag{10}$$

$$h(V_t) = E_t\left\{\left(\frac{(1+e_{t+1})R\varepsilon^R_{t+1} - 1 - \frac{1-\varphi}{\varphi}\frac{\mu_{t+1}}{\lambda_{t+1}}}{(1+e_{t+1})}\right)\left(\frac{p^c_t \exp(-v(t))U_C(t+1)}{p^c_{t+1}U_C(t)}\right) + \frac{\mu_t}{\lambda_t}\right\} \tag{11}$$

$$\frac{u_\ell(t)}{u_C(t)} = \frac{1}{1+h(V_t)V_t^{-1}}\left(\frac{w_t}{p_t^C}\right)\left[1+\frac{\mu_t}{\lambda_t}\frac{1-\varphi}{\varphi}\right] \tag{12}$$

In these expressions, $h(V_t)$ denotes the marginal rate of substitution between C and m in the period-utility function u. Using the assumptions that u and H are CES functions, it can be shown that h is nonnegative and increasing in V. The terms in U_C in equations (9) and (11) are derivatives of *lifetime* utility with respect to C. These include "impatience effects" by which changes in consumption at any date t alter the rate at which all period utilities after t are discounted. λ and μ are the nonnegative multipliers of the budget constraint and the liquidity requirement respectively.

The optimality conditions have a straightforward interpretation. Equation (9) is the consumption Euler equation that equates the marginal utility cost of sacrificing a unit of C at date t with the marginal benefit that the extra saving yields at $t+1$. The effective return on saving is evaluated at the "consumer-based" real interest rate, $(R\varepsilon^R_{t+1})p^C_t/p^C_{t+1}$, which incorporates the rate of change of the real exchange rate implicit in the ratio p^C_t/p^C_{t+1}. Equation (10) equates the marginal rate of substitution in consumption of tradable and nontradable goods with the corresponding relative price. Equation (11) is the optimality condition for money demand that equates the marginal rate of substitution between consumption and money balances with the opportunity cost of holding money. Equation (12) is the labor supply condition that equates the marginal rate of substitution between aggregate consumption and leisure with the real wage. The relevant real wage for labor supply (i.e., w_t/p_t^C) is in units of C.

The conditions in (9)-(12) capture the distortions emphasized in the credibility literature on exchange-rate management. In particular, *if* $\mu=0$, the following standard results follow:

(a) At equilibrium, V and $h(V)$ are increasing functions of the opportunity cost of holding money (i.e., the ratio $i_t/(1+i_t)$, where i_t is the nominal interest rate). This follows from equation (11) taking into account the CES form of H and noting that the opportunity cost of holding money is given by the expression in the right-hand-side of the equation. This expression measures the rate of return on a one-period nominal bond (see Mendoza and Uribe (2000a)).

(b) The domestic nominal interest rate carries a state-contingent currency risk premium relative to the world's nominal interest rate (the latter is given by $R\varepsilon^R_{t+1}$ since world inflation is zero). This risk premium exists because insurance markets are incomplete and households are risk averse. Its magnitude is determined by the properties of the equilibrium stochastic process of the intertemporal marginal rate of substitution in aggregate consumption that enters in the determination of the opportunity cost of holding money, which is influenced by the equilibrium dynamics of the real exchange rate.

(c) Fluctuations in velocity induce a stochastic tax-like distortion on saving. This can be seen by manipulating equation (9) to show that the effective rate of return on saving in the right-hand side of the expression equals the consumer-based real interest rate multiplied by a term that depends on the wedge $[1+h(V_t)V_t^{-1}]\,/\,[1+h(V_{t+1})V_{t+1}^{-1}]$.

(d) Velocity induces also a monetary distortion on labor supply because the effective real wage faced by households is reduced by the wedge $1/[1+h(V_t)V_t^{-1}]$, as shown in equation (12).

These credibility distortions on prices are the central element of the transmission mechanism by which devaluation risk affects the competitive equilibrium. These distortions affect stochastic dynamics as well as the stationary equilibrium. For instance, if the government fixes the exchange rate permanently, it reduces permanently the nominal interest rate and hence the implicit labor tax identified in (d). This increases steady-state labor, output and consumption. If the currency peg is expected to be temporary, the cut in the nominal interest rate is also expected to be temporary. This triggers a stochastic distortion on the consumption-labor margin similar to the permanent cut, and it also distorts the consumption-saving margin as indicated in (c). These distortions operate regardless of whether ex post the currency is devalued or not. Thus, they reflect *primarily* the lack of credibility of the policy.

A binding liquidity requirement adds to and modifies the price distortions driven by devaluation risk. Consider first labor supply. A binding liquidity requirement distorts labor supply by increasing the effective wage on the marginal unit of labor (since extra labor income enhances the households' ability to borrow). This distortion is larger the smaller is φ and the larger is the ratio μ_t/λ_t. Everything else constant, this distortion would yield smaller booms (recessions) if the introduction (abandonment) of an exchange-rate-based stabilization plan leads to a situation in which the liquidity requirement becomes nonbinding (binding).[12] However, the net response of labor supply to a switch in exchange rate regime depends also on the magnitude of the credibility distortion, on the response of the real exchange rate (since the relevant real wage is deflated by p^C) and on a fiscal-induced wealth effect to be described later.

A binding liquidity requirement also has an indirect distortion on labor supply working in the opposite direction from the one identified above. This indirect distortion results from the fact that, as explained below, a binding liquidity requirement is likely to increase the opportunity cost of holding money, thereby increasing the labor tax imposed by the credibility distortion.

The liquidity constraint distorts saving by altering the intertemporal relative price of consumption. When the constraint binds, it tilts consumption toward the future by preventing households to borrow as much they like. Taking as given the consumption-based real interest rate, the expected intertemporal price of C_t in terms of C_{t+1} increases from $E[R\varepsilon^R_{t+1}p^C_t/p^C_{t+1}]$ to

[12]Notice, however, that the effect of this distortion is nonmonotonic: the distortion is zero for both a value of φ so low that μ=0 or for φ=1. In both cases changes to current income have no effect on the ability to borrow.

$E[R\varepsilon^R_{t+1}p^C_t/p^C_{t+1}]/[1-\mu_t/\lambda_t]$.[13] Thus, a binding liquidity requirement can be interpreted as imposing an endogenous interest rate premium in the households' use of foreign debt over income and domestic liquid assets to finance consumption. This is analogous to the "external financing premium" faced by firms in closed-economy studies on the financial accelerator (as in Bernanke et al. (1998)).

The above rise in the effective real interest rate implies that a binding liquidity constraint *increases* the effective opportunity cost of holding money. Since the real interest rate is higher for given expectations of devaluation, risk-adjusted interest parity implies a higher nominal interest rate. However, a binding liquidity constraint (if expected to bind in the future) also features an effect that *reduces* the opportunity cost of holding money. This is because the date-t choice of real balances affects the date-$t+1$ initial liquid-asset position, and hence the future ability to borrow. The net effect of these opposing effects of the liquidity constraint on the real interest rate feeds back into the credibility distortions identified in (a)-(d) depending on how they alter the nominal interest rate, and hence V and $h(V)$. If the net effect is to magnify the early fall and late increase of the nominal interest rate associated with an exchange-rate-based stabilization, the liquidity requirement will magnify the credibility distortions.

The two opposing effects of the liquidity requirement on the opportunity cost of holding money are captured by the terms in the numerator of the right-hand-side of (11) that include the Lagrange multipliers. The ratio μ_t/λ_t represents the increase in the opportunity cost of holding money driven by the effect of the binding liquidity requirement on the effective real interest rate facing the economy between dates t and $t+1$. If the constraint were not expected to bind in the future (or if the liquidity requirement set by lenders did not include money holdings), this would

[13]In equilibrium, the rate of change of p^C is endogenous and is determined together with μ_t/λ_t. Hence, a binding credit constraint is necessary but not sufficient to ensure that the consumption-based real interest rate of the credit-constrained economy is higher than that of an unconstrained economy for the same state variables.

be the only effect at work and the liquidity constraint would always increase the nominal interest rate. However, if the constraint is expected to bind in the future, the term $-[(1-\varphi)/\varphi](\mu_{t+1}/\lambda_{t+1})$ lowers the opportunity cost of holding money. The expression for this second effect is similar to the one for the wage distortion, but dated at $t+1$.[14] Note that the rise in the real interest rate due to a *date-t* binding liquidity constraint reduces the discounted value of the marginal benefit of holding extra real balances to meet the *date-t+1* liquidity requirement. Hence, a higher μ_t/λ_t strengthens the effect that rises the nominal interest rate and weakens the effect that lowers it.

The model is completed with the specification of the government sector and the nature of the lack of credibility of government policy. The government implements a managed exchange-rate regime by setting the rate of depreciation of the currency to a publicly-announced value. For simplicity, this regime implies a constant, low rate of depreciation of the currency $e_t=e^L$. The aim of this policy is to bring inflation down from the higher level that prevailed before the regime was introduced, which is given by e^H. The policy lacks credibility in the sense that agents assign an exogenous, time-invariant conditional probability $z=Pr[e_{t+1}=e^H|e_t=e_t^L]$ to the collapse of the regime. The stochastic process describing the evolution of e is a Markovian regime-switching process, instead of the symmetric processes typical of real-business-cycle models. The post-collapse value of e is identical to its pre-stabilization value, in line with the standard assumption of credibility models of exchange-rate-based stabilization (in which "at collapse" the rate of depreciation of the currency return to its pre-stabilization value).[15]

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[14]As with the wage distortion, the effect of this distortion is non-monotonic: the marginal benefit of holding extra real balances in helping agents meet the $t+1$ liquidity requirement is zero for both the case in which φ is so low that the constraint is not binding or for $\varphi=1$.

[15]These assumptions are not innocuous. As explained in Mendoza and Uribe (2000b), a model in which the devaluation date and the post-collapse rate of depreciation of the currency are endogenous yields post-collapse values of the nominal interest rate that vary with the timing of the collapse. Moreover, Mendoza and Uribe (2000a) show that time-varying transition probabilities induce different time paths of distortions and hence different equilibrium outcomes than time-invariant transition probabilities. However, their setup considers a once-and-for-all stochastic transition in between deterministic long-run equilibria, and thus is not suitable for an analysis of the ergodic distributions followed by macroeconomic variables in a regime-switching environment.

For simplicity, the probabilistic process driving the rate of depreciation of the currency follows a basic regime-switching specification for discrete-valued random variables with time-invariant transition probabilities governed by an irreducible, ergodic Markov chain. This process is assumed to be independent of the Markov processes driving the other shocks in the model. The transition matrix Π and the corresponding Vector Autoregression representation are:

$$\Pi = \begin{bmatrix} \varsigma & z \\ 1-\varsigma & 1-z \end{bmatrix}, \qquad \zeta_{t+1} = \Pi\zeta_t + i_{t+1}, \tag{13}$$

where $\varsigma = Pr[e_{t+1} = e^H | e_t = e_t^H]$, ζ is a 2x1 random vector such that $\zeta_t = (1,0)'$ when $e_t = e_t^H$ and $\zeta_t = (0,1)'$ when $e_t = e_t^L$, and $i_{t+1} \equiv \zeta_{t+1} - E(\zeta_{t+1} | \zeta_t, \zeta_{t-1}, \ldots)$. The limiting probabilities of the two states of e are $P(e_t = e_t^H) = z/(1+z-\varsigma)$ and $P(e_t = e_t^L) = 1-[z/(1+z-\varsigma)]$ and the AR(1) representation of the process is: $\zeta_{j,t+1} = z + (\varsigma - z)\zeta_{j,t} + i_{j,t+1}$ for $j=1,2$. The average duration of the "high depreciation" regime is $1/(1-\varsigma)$ and that of the "low depreciation" regime is $1/z$.

In addition to managing the exchange rate, the government makes unproductive purchases of goods. The pre-stabilization levels of government purchases of tradables and nontradables (G^T and G^N) are paid for using lump-sum taxes (or transfers) levied in tradable and nontradable goods (T^T and T^N) and seigniorage revenue. When the managed exchange-rate regime is in place, government purchases of nontradables and all lump-sum taxes are kept constant, and any fluctuations in seigniorage are used to purchase tradable goods. The government's budget constraint can thus be written as follows:

$$G_t^T + p_t^N G^N = m_t^T - \frac{m_{t-1}^T}{1+e_t} + T^T + p_t^N T^N \quad \text{with} \quad G^N = T^N \tag{14}$$

Hence, the risk of a surge in government absorption that accompanies the switch to e^h is the source of an adverse, non-insurable wealth effect (given that insurance markets are incomplete). This is the same assumption used by Calvo and Drazen (1998) and Mendoza and Uribe (2000a) to introduce fiscal-induced wealth effects under incomplete markets in their studies of policy uncertainty. They showed that these wealth effects are necessary for models of uncertain policy duration to account for key features of emerging-markets business cycles. The magnitude of these effects is limited here to fluctuations in government purchases financed by short-run changes in seigniorage around a fixed level of expenditures paid for by constant lump-sum taxes.

3.2 Competitive Equilibrium

Given the probabilistic processes for $(\varepsilon_t^T, \varepsilon_t^N, \varepsilon_t^R, e_t)$ and the initial conditions (b_0, m_{-1}), a competitive equilibrium for the model is defined by sequences of state-contingent allocations $[C_t^T, C_t^N, L_t^T, L_t^N, L_t, \ell_t, b_{t+1}, m_t, V_t, G_t^T]$ and prices $[w_t, p_t^N, p_t^C, i_t]$ for $t=0,\ldots,\infty$ such that (a) firms maximize profits subject to production technologies and the labor transformation curve, (b) households maximize expected lifetime utility subject to the budget constraint, the time constraint, and the liquidity constraint, (c) the government budget constraint holds and (d) the following market-clearing conditions hold:

$$C_t^T + G_t^T = \varepsilon_t^T F(K^T, L_t^T) - b_{t+1} + b_t R \varepsilon_t^R \tag{15}$$

$$C_t^N + G^N = \varepsilon_t^N F(K^N, L_t^N) \tag{16}$$

$$\Omega(L_t^T, L_t^N) = 1 - \ell_t \tag{17}$$

Despite the distortions present in the model, it is possible to characterize the competitive equilibrium as the solution of a planning problem in which $[C_t^T, C_t^N, L_t^T, L_t^N, L_t, b_{t+1}, m_t, V_t]_{t=0}^{\infty}$ are chosen so as to maximize the stationary cardinal utility function in (1) subject to the market clearing constraints and the equilibrium representation of the liquidity requirement:

$$b_{t+1} \geq -\left(\frac{1-\varphi}{\varphi}\right)\left(\varepsilon_t^T F(K^T, L_t^T) + p_t^N \varepsilon_t^N F(K^N, L_t^N) + \frac{m_{t-1}}{1+e_t}\right) \tag{18}$$

Since the planning problem is time-recursive, it can also be characterized as a stochastic dynamic programing problem (an Appendix available from the author provides more details).

A quick look at the model's deterministic stationary equilibrium sheds light on the role of the Stationary Cardinal Utility function in supporting steady states in which the liquidity requirement is binding. From this perspective, the key steady-state condition is the one that represents the consumption Euler equation (eq. (9)). At steady state this condition becomes:

$$1-\frac{\mu}{\lambda}=\exp\left(-v(C,m,\ell)\right)R \tag{19}$$

where variables without time subscripts are steady-state levels. The exponential term in the right-hand-side of this expression represents the endogenous subjective discount rate.

If the utility function featured the conventional exogenous discount factor β, the corresponding version of the above condition, $1-\mu/\lambda=\beta R$, would imply that the model could either feature a steady state in which the liquidity requirement always binds (when $0<\beta R<1$ and thus $\mu/\lambda>0$) or a steady state in which the liquidity requirement cannot be binding (when $\beta R=1$, which implies $\mu/\lambda=0$). Hence, with standard preferences, whether the liquidity requirement binds or not in the long-run is an assumption that depends on the exogenous values of β and R. In contrast, with the endogenous discount factor, whether the constraint is binding or not in the long run is determined within the model. Given preference, technology, and policy parameters, there are values of φ low enough so that the liquidity requirement does not bind at steady state. In these cases the stationary equilibrium is the same for all such φ's, as can be inferred from (19). There is also a critical φ above which the constraint binds and for which the steady state varies with φ. In these cases, the rate of time preference increases to support the steady state equilibrium with a binding borrowing limit.

4. Quantitative Insights and the Case for Dollarization in Mexico

This section of the paper conducts a series of numerical simulations based on a calibration to Mexican data. The simulations assess the effects of the two aspects of dollarization noted in the Introduction: (a) the enhanced credibility of stabilization policy, reflected in a fall in z, and (b) the potential improvements in the functioning of credit markets, approximated by a fall in φ.[16] A detailed analysis of the macroeconomics effects of the credit friction is left for further research (see Mendoza (2000b)).

4.1 Functional Forms and Calibration

The following functions are used to characterize preferences and technology:

$$u(C_t, \ell_t) = \frac{\left[\left[\gamma C_t^{-\theta} + (1-\gamma) m_t^{-\theta}\right]^{-\frac{1}{\theta}} \ell_t^{\rho}\right]^{1-\sigma} - 1}{1-\sigma} \quad (20)$$

$$v(C_t, \ell_t) = \beta\left[Ln\left(1 + \left[\gamma C_t^{-\theta} + (1-\gamma) m_t^{-\theta}\right]^{-\frac{1}{\theta}} \ell_t^{\rho}\right)\right] \quad (21)$$

$$C_t = \left[\omega\left(C_t^T\right)^{-\eta} + (1-\omega)\left(C_t^N\right)^{-\eta}\right]^{-\frac{1}{\eta}} \quad (22)$$

$$Y_t^T = \varepsilon_t^T\left(K^T\right)^{1-\alpha T}\left(L_t^T\right)^{\alpha T} \quad (23)$$

$$Y_t^N = \varepsilon_t^N\left(K^N\right)^{1-\alpha N}\left(L_t^N\right)^{\alpha N} \quad (24)$$

$$\Omega(L_t^T, L_t^N) = \left[\left(L_t^T\right)^{-\xi} + \left(L_t^N\right)^{-\xi}\right]^{-1/\xi} \quad (25)$$

The parameters θ and γ characterize velocity and money demand. The optimality condition for money holdings (eq. (11)) implies that velocity follows a log-linear equation $ln(V_t) = [1/(1+\theta)]ln(\gamma/(1-\gamma)) + [1/(1+\theta)]ln(i_t/(1+i_t))$. Thus, the model predicts a unitary expenditures elasticity of money demand and a constant interest elasticity given by $-[1/(1+\theta)]$. This equation was estimated by Ordinary Least Squares (correcting for serial autocorrelation) using cyclical

[16]The intuition is that dollarization would weaken financial frictions attributed to imperfect and costly information about exchange-rate and monetary policy regimes, to asset-liability mismatches in the financial system, and to moral-hazard and adverse-selection incentives pervasive in other exchange-rate regimes.

components of quadratic time trends applied to quarterly Mexican data for the period 1987:1-1994:4. Velocity was measured as the ratio of private consumption over M2 money balances and the opportunity cost of holding money ($i/(1+i)$) was measured using the nominal interest rate on 28-day Treasury Certificates (Cetes). The implied estimates of θ and γ were $\theta=6.77$ and $\gamma=0.85$. The regression coefficients were statistically significant at the 5 percent level, and the adjusted R^2 indicated that the regression explains 76 percent of the fluctuations in velocity.[17]

The elasticity of substitution between C^T and C^N, $1/(1+\eta)$, is set to the value estimated by Ostry and Reinhart (1992). Their estimate of η for developing countries is $\eta=0.316$. Lacking precise econometric evidence on the rest of the model's parameters, their values were set to yield a baseline scenario in which the model's deterministic steady state with a nonbinding liquidity requirement mimics the following features of Mexican data:[18]

(a) The average labor shares in sectoral GDP over the period 1988-1996 were $\alpha T=0.284$ and $\alpha N=0.364$. These values follow from defining the tradables (nontradables) sector as the set of industries for which the average ratio of exports plus imports was more (less) than 5 percent of gross production (see Mendoza and Uribe (2000a) for further details).

(b) The average 1988-1998 ratio of traded to nontraded GDP at current prices was 0.648.

(c) The average ratio of paid employees in the nontradables sector relative to the tradables sector over the period 1988-1996 was 0.715.

(d) The average trade deficit-GDP ratio over the period 1970-1995 was -0.1 percent.

(e) The average annual interest rate on 28-day Cetes was 0.248 in the sample used to estimate the money-demand equation (1987:1-1994:4). Thus, $i/(1+i)$ equals 0.2.

(f) The average share of total government purchases allocated to the nontradables sector during 1988-1996 was 0.928.

The calibration is normalized by setting $K^T=1$ and by setting the ratio K^T/K^N to a value such that the steady-state relative price of nontradables equals 1. This implies $K^T/K^N=2.142$.

[17]These estimates are virtually the same as those reported by Calvo and Mendoza (1996) and Kamin and Rogers (1996). These authors also found evidence in support of an unitary elasticity of money demand with respect to the scale of transactions, including a co-integration relationship between M2 and GDP.

[18]Sample periods over which various averages were computed differ due to limitations on the availability of a detailed consistent sectoral database in the National Income Accounts (see Mendoza and Uribe (2000a)).

The model is also calibrated to match the average GDP shares of private consumption, investment, and government purchases over the 1970-1995 period (68.4, 21.7 and 9.2 percent respectively) by introducing "autonomous" levels of investment and government expenditures that are kept constant throughout the simulations. These autonomous expenditures are allocated across sectors according to the observed average shares of total investment and total government purchases allocated to the nontradables sector during 1988-1996 (42.4 and 92.8 percent respectively). The calibration is completed by setting $R=1.065$ per year, $\ell=0.2$, and $\sigma=2$, which are standard values in real-business-cycle theory.

The calibrated values of the parameters ξ, ω, ρ, and β and the values of V, C^T, C^N, L^T, L^N, m and b in the baseline scenario are jointly determined by solving the steady-state equilibrium conditions imposing the calibration criteria described in the previous paragraphs. The solution reduces to a system of twelve recursive linear equations. In general, however, the model's stationary equilibrium for a fixed set of preference and technology parameters is the solution of a nonlinear simultaneous equation system.

4.2. Deterministic Steady States for Alternative Policy Regimes

Table 3 compares deterministic long-run equilibria for alternative policy regimes. The Table reports percent changes in the allocations of consumption, labor, GDP (valued in tradables), the trade balance-GDP ratio (*TBY*), real money balances, and sectoral output relative to the corresponding values in the baseline scenario. Also listed are the relative price of nontradables and the domestic real interest rate. Results are reported for economies with and without binding liquidity requirements, and in each instance the Table lists four inflation scenarios. The first scenario corresponds to a fully-credible, permanent peg of the Mexican peso to the dollar, which *in the model* is equivalent to the replacement of the domestic currency by the foreign currency implied by dollarization. In this scenario, Mexico's tradables inflation rate falls permanently to zero, as a proxy for the U.S. inflation rate, and the nominal interest rate falls to the world's level of 6.5 percent per year. The other three inflation scenarios correspond to policy regimes that settle into long-run tradables inflation rates (or rates of currency depreciation) of 12.5, 46.4 and 406.3 percent per year -- quarterly rates of 3, 10 and 50 percent respectively. These cases can be thought of as long-run outcomes of managed exchange-rate regimes or inflation-targeting regimes under a floating exchange rate. Treating these alternative regimes as deterministic helps their case by limiting the analysis to steady-state efficiency gains of permanent changes in inflation-tax distortions.

Two important caveats apply to the comparison of deterministic steady states. First, the results are likely to differ sharply in a stochastic setting because credit frictions and incomplete markets imply that equilibrium allocations are influenced by effects absent from the perfect-foresight setup. In particular, agents engage in precautionary saving in the stochastic case seeking self-insurance against non-diversifiable risks (mainly those resulting from sudden surges in government absorption when seigniorage increases and from the fluctuating nature of the borrowing constraint). Second, comparisons of steady-state utility levels are not useful for assessing the welfare implications of alternative policies because (a) when the credit friction is non-binding, steady-state utility is the same regardless of the inflation rate (as explained below), and (b) when the credit constraint binds, steady state-utility is always *higher* than when the constraint is not binding. The latter occurs because a binding credit friction reduces steady-state debt and the net exports-output ratio, which in turn imply higher steady-state consumption and money demand (recall that a binding borrowing constraint tilts consumption toward the future). Yet, for common initial conditions, lifetime utility for a credit-constrained economy cannot exceed that of an unconstrained economy.

Consider the steady-state effects of policies that deliver different inflation rates when the liquidity requirement never binds (the top panel of Table 3). Ensuring that this is the case in the zero-inflation scenario requires setting $\varphi \leq 0.406$. Thus, the economy can borrow up to 146 percent of its income plus liquid asset holdings (since $(1-\varphi)/\varphi=1.46$). Note that steady-state debt increases as inflation falls because the increase in wealth resulting from efficiency gains of reduced inflation-tax distortions leads households to increase their borrowing.[19] Thus, 0.406 represents the maximum φ such that the borrowing constraint does not bind *with any nonnegative steady-state inflation rate*.

Compared to the baseline scenario, which featured 5.7-percent quarterly inflation, a permanent peg with non-binding credit frictions increases C, L, m, Y^T, Y^N, and TBY, and causes a slight decline in p^n. With sectoral output levels increasing but the real exchange rate falling, output valued at tradables-goods prices remains nearly unchanged. Despite these real effects, which reflect the fact that money is not superneutral in the model, the permanent peg *cannot* alter steady-state utility. This is because, as long as the credit friction is not binding, the steady-state value of the mix of C, m and ℓ that enters as the argument of the utility and time-preference functions must remain unaltered, so that the endogenous rate of time preference equals the unchanged value of R (see eq. (19)). This *does not* imply, however, that welfare (i.e., lifetime utility) is invariant to inflation. Higher inflation increases inflation-tax distortions and reduces welfare. What it implies is that welfare effects accrue only during the transitional dynamics.

The long-run effects of reducing inflation differ markedly when credit frictions bind. The middle panel of Table 3 considers the case in which $\varphi=0.75$. In this case, foreign debt cannot exceed 33 percent of the value of income plus holdings of liquid assets. This value of φ was set so that the credit constraint is marginally binding in the baseline scenario. Therefore, if

[19]The smaller distortion on labor increases long-run tradables production by more than consumption, resulting in a larger lung-run trade surplus, which reflects larger steady-state foreign debt (i.e.,a perpetual trade surplus pays for perpetual foreign interest outlays).

dollarization cuts inflation permanently and improves credit-market efficiency by lowering φ to 0.406, the steady-state effects would be identical to those shown in the top panel of the Table. However, if dollarization cuts inflation but leaves φ unchanged, the dollarized regime runs into the borrowing constraint. The same occurs with the regime that lowers inflation to 3 percent. In these two cases, the domestic real interest rate becomes endogenous and rises as inflation falls. In the currency-peg scenario, the real interest rate increases by 41 basis points relative to the baseline level. The net exports-output ratio increases by 1.1 percentage points, instead of 4.6 percentage points when the constraint was not binding, because a smaller steady-state trade surplus services a smaller stock of foreign debt. Consumption increases nearly 6 times as much, labor changes only marginally, the demand for money increases more, and output at tradables prices increases nearly 11 percent instead of remaining almost constant. The larger output increase reflects the fact that the relative price of nontradables rises by nearly 18 percent instead of falling 2.7 percent. Thus, the model predicts that sharp real appreciations are consistent with the long-run equilibria that stabilizing economies attain if credit frictions are binding.

4.3 Dynamic Implications: Welfare Gains of Dollarization and "Sudden Stops"

To facilitate the numerical simulations in the presence of the "occasionally- binding" credit constraint, the number of endogenous state variables is reduced by examining the case of a non-monetary economy. Labor is supplied inelastically to the tradable goods industry and period utility adopts the form proposed by Greenwood, Hercowitz and Huffman (1988), in which the argument of utility is $C\text{-}L^{\omega}/\omega$. The price distortions in this non-monetary economy are made comparable to those of the monetary economy by introducing an ad-valorem consumption tax τ uniform across tradable and nontradable goods. It is straightforward to show that for a given nominal interest rate, a tax set at $\tau_t = [(1\text{-}\gamma)/\gamma]V(i_t)^{\theta}$ captures identical price distortions on labor supply and very similar price distortions on saving as those resulting from credibility-induced changes in the nominal interest rate.[20] Hence, the exchange-rate-management experiment is approximated by a cut in τ_t that follows a regime-switching Markov process.

In the non-monetary model the liquidity requirement reduces to a borrowing constraint of the form: $b_{t+1} \geq -[(1-\varphi)/\varphi][Y^T+p_t^N Y^N(L_t)]$. With $\varphi=1$, this setup becomes a variant of the canonical precautionary-saving model with a no-borrowing constraint (see, for example, Aiyagari (1993)). Since money no longer enters into the constraint, the persistence effect resulting from the dynamics of money demand is lost. This is a shortcoming of the exercise, but the reduced number of state variables is exploited to use exact-solution methods in solving the model under the "occasionally binding" constraint. Moreover, as shown below, the critical dynamic effects that result from the feedback effects of the dynamics of the relative price of nontradables on the borrowing constraint are still present.

The baseline calibration is adjusted to take into account the features of the non-monetary model. The calibration is normalized assuming a unit endowment of tradable goods and a unitary relative price of nontradables. The parameters of the CES composite good C and the labor share in nontradables are the same as before, and the model is set to mimic the same averages taken from Mexican data for sectoral ratios of consumption, investment and government absorption, and the ratios of net exports to tradables output and tradables to nontradables output. The labor exponent in utility $\omega=1.455$ is taken from Mendoza (1991a).

The parameters describing the regime-switching process of taxes are set as follows. The low-tax regime is: $\tau^L = [(1-\gamma)/\gamma]V(i^*)^\theta = 0.0214$, which mimics the price distortions of the calibrated monetary model with $e=0$. The high tax is: $\tau^H = 0.15$, which corresponds to $e=0.75$

[20]The distortion on saving differs depending on the intertemporal elasticity of substitution in consumption. If $\sigma=1$ the saving distortion is identical in both models. With elasticities higher than unitary the saving distortions differ, but for small perturbations around the steady state the differences are negligible (since at steady state the saving distortion vanishes in both models). This equivalence of tax and monetary distortions is similar to those explored by Coleman (1996).

per year. Following Mendoza and Uribe (2000a), the time-invariant probability of reversal of the tax cut is set to $z=0.28$, which implies an average duration of 3.6 years for τ^L. The mean duration of τ^H is set at 6 years, which implies $\varsigma=0.833$. Given these parameters, the ergodic probabilities of τ^H and τ^L are 0.627 and 0.373 respectively. The unconditional mean of the tax rate is 10.2 percent, with a standard deviation of 60.9 percent, and the coefficient of persistence of tax shocks is 0.55.

Figure 2 compares the effects of changes in φ brought about by dollarization on the ergodic distribution that characterizes the model's stochastic steady state, assuming that the credibility problem remains unaltered. The figure shows the limiting distributions for the case in which the credit constraint is not binding at any point in the state space, which requires $\varphi\leq 0.52$, and for a credit constraint that keeps debt at a maximum of 40 percent of GDP at tradables prices (i.e., $(1-\varphi)/\varphi=0.4$, or $\varphi=0.714$). The state space of foreign assets is given by an evenly-spaced grid with 1200 elements that spans the interval [-2.137,-0.698].

The limiting distribution of the credit-constrained economy is shifted to the right of the limiting distribution of the unconstrained economy because of the binding limit on external debt. The average debt-to-GDP ratio in the unconstrained economy is 56.3 percent, compared to 35.8 percent in the constrained economy. Note that in a deterministic version of this model with $\varphi=0.714$ binding at steady state, steady-state debt is a corner solution that corresponds to the largest allowable debt for which the credit constraint binds. In contrast, the ergodic distribution of the stochastic debt-constrained economy has a mean debt-output ratio *lower* than that mandated by the credit constraint, and only a fraction of the mass of that distribution is concentrated at the lower bound of its support b^{min} (where b^{min} is the smallest value of foreign assets with positive long-run probability, which is given by the lowest b such that for the state (b,τ^L) the credit constraint is binding). Thus, in the limiting distribution of the stochastic credit-constrained economy, the credit constraint binds with the probability attached to b^{min} (9.7 percent in Figure 2). "Excess" holdings of foreign assets relative to b^{min}, which result from precautionary saving, correspond to states in which the credit constraint is not binding. It follows, therefore, that while the credit constraint has major effects on the limiting distribution of foreign debt, most of the mass of that distribution corresponds to states in which the constraint is not binding.

Table 4 lists unconditional business-cycle moments computed using the ergodic distributions of foreign assets and taxes in credit-constrained and -unconstrained economies. The stylized facts of business cycles in both cases are roughly consistent with those reported for Mexican data in Table 1.[21] The variability of GDP and expenditures in units of tradables, and the variability of CES consumption, labor, and the price of nontradables are slightly higher in the presence of the credit friction. This increased volatility reflects the extra difficulties for smoothing consumption and utility flows faced by credit-constrained households. The fact that these effects are small suggests that precautionary saving is an effective means of self-insurance. Precautionary saving is also evidenced by the lower correlation between the tax rate and foreign assets in the debt-constrained economy, which falls from -0.2 to -0.46 (i.e., realizations of the low-tax state are more likely to result in an increase in foreign asset holdings in the debt-constrained economy than in the unconstrained economy). In addition, output valued in tradables, labor, and the price of nontradables are strongly negatively correlated with the tax rate, so in the high-tax state the economy tends to borrow more but the debt constraint also tends to be tighter because nontradables output and its unit price in terms of tradables are both falling.

A comparison across the two panels of Table 4 suggests that the credit friction has small effects on the real economy, even though the moments describing foreign assets and the limiting

[21]The variability of GDP and expenditures in the model is larger than in the data, but the ratio of the standard deviation of expenditures relative to that of GDP is similar in the model and in the data -- consumption in Table 1 is valued in dollars so it corresponds to "Expenditures" in Table 4.

distributions in Figure 2 change dramatically. However, the moments of ergodic distributions in that Table misrepresent the potentially large real effects of the credit constraint because the constraint binds only with 0.097 long-run probability, and in states in which the constraint does not bind the behavior of real variables does not differ markedly across simulations with $\varphi \leq 0.52$ or $\varphi = 0.714$. In contrast, the impact effects of a shift from τ^L to τ^H, summarized in Figure 3, show that a binding credit friction has important macroeconomic consequences.

Figure 3 shows the percent change in the debt-output ratio, consumption, non-tradables output, and the relative price of nontradables that occurs on impact when the tax shifts from low to high. Each plot presents impact effects for the economy with a non-binding credit friction ($\varphi \leq 0.52$) and for the economy with debt constrained at 40 percent of GDP ($\varphi = 0.714$). Consider first the economy with non-binding credit constraints. The current debt position matters little for the impact effects of a tax hike. The effects are in the direction predicted by uncertain-policy-duration models (e.g., Calvo and Drazen (1998) and Mendoza and Uribe (2000a)). The realization of the high-tax state reduces labor supply, output in the nontradables sector, and consumption, and it induces a fall in the relative price of nontradables. These effects reflect the credibility distortions described in Section 3 and the fiscal-induced wealth effects triggered by the sudden surge in government absorption that follows the tax hike. Note that the regime-switching process attaches some probability to a return to the low-tax state, so agents always expected the future tax rate to be lower than the currently-observed high tax.

The impact effects of the tax shock differ significantly in the debt-constrained economy. In particular, impact effects vary widely depending on the initial debt position. The effects are particularly striking in the region of the state space in which the credit constraint is not binding when the tax is low but becomes suddenly binding when the tax increases (coordinates 824 to 965 in the foreign asset grid). For the part of this range in which foreign assets are relatively high (between coordinates 900 and 965), the model produces dynamics that display several features of what Calvo (1999) refers to as a "sudden stop to capital inflows," and these result from the credit contraction that follows the severe relative price and output collapses induced by the tax shock. There is a large fall in the relative price of nontradable goods that exceeds the fall observed in the absence of credit frictions. Associated with the price collapse, there are sharp declines in labor and output of nontradable goods and in aggregate consumption, as well as a severe reversal in the current account (of about 7 percentage points of GDP). There is still a fall in debt to output ratio (i.e., $b_{t+1}/[Y^T+p_t^N Y^N(L_t)]$), as in the case without credit constraints, but it is smaller the lower b_t was before the tax hike.

For coordinates in the foreign asset grid below 824, the constraint always binds regardless of the tax rate, so there is no adjustment in the debt-to-GDP ratio across tax states. Output, consumption, and the price of nontradables still fall significantly because of the distortions driven by the dynamics of the debt-constraint multiplier μ_t. For high values in the foreign asset grid (i.e., coordinates 966 to 1200) the credit constraint does not bind and the impact effects of the tax hike are similar to those observed in the unconstrained economy.

The welfare gains that dollarization would yield by lowering φ from 0.714 to 0.52 are measured by calculating compensating variations in stationary consumption levels that render households indifferent, in terms of lifetime utility, between the two environments. This calculation is made for each coordinate in the state space. Using the ergodic distribution of the economy with non-binding credit constraints, the mean welfare gain is 4.6 percent. This welfare gain exceeds by a large margin the welfare gains from business cycle stabilization, international asset trading, and radical tax reforms calculated for industrial countries (see Lucas (1990), Mendoza (1991b), Tesar (1995), Cooley and Hansen (1992), and Mendoza and Tesar (1998)). The state-contingent welfare gains for each coordinate under the low- and high-tax states are plotted in Figure 4. Welfare gains are as large as 24 percent for the high-tax state and 18 percent for the low-tax state. These are associated with large initial debt positions which have zero steady-state probability but may be relevant to consider depending on how far off the ergodic distribution are the initial conditions of the economy. The gains become negligible as foreign asset holdings reach values for which the credit constraint with $\varphi=0.714$ is not binding.

Consider next the gains of dollarization that result from eliminating the credibility problem. For this purpose, "dollarization" is a once-and-for-all shift from the stochastic regime-switching setting of noncredible tax cuts to a deterministic setting with a tax set at τ^L forever.[22] When "dollarization" is introduced, the economy takes off on the transitional dynamics to the low-tax deterministic steady state from the initial conditions set at the end of the last period in which the stochastic environment was in place. The welfare gain of dollarization depends on these initial conditions, and on whether the credit constraint binds at any point during the transition and in the long run. Note that while $\varphi \leq 0.52$ ensured that the credit friction did not bind in the stochastic environment, it may still yield a binding credit constraint for the low-tax deterministic economy. This is because the debt-output ratio of the "dollarized" regime is larger than that of the regime-switching economy -- the mean tax in the regime-switching economy is nearly 5 times higher than in the "dollarized" economy and steady-state debt is a negative function of the tax rate. For the credit constraint to be non-binding in the "dollarized" economy, it is necessary to set $\varphi \leq 0.416$. Thus, values of φ between 0.416 and 0.52 produce transitional dynamics in which the credit constraint is not binding at the outset but becomes eventually binding as the economy converges to the low-tax steady state.

Figures 5 and 6 and Table 5 summarize the welfare effects of different scenarios dealing

[22]Since dollarization yields the model deterministic, it does not have interesting business-cycle effects. Less than fully-credible dollarization can be considered by lowering z but keeping it positive.

with the elimination of the credibility problem. Some of these scenarios combine changes in credibility and in credit frictions. Figure 5 considers the case in which the credit constraint in the deterministic economy is nonbinding (i.e., $\varphi \leq 0.416$), and plots welfare gains measured as compensating variations in consumption that equalize lifetime utility in the "dollarized" economy with that of the originating regime-switching economy for each point in the state space. The regime-switching economy can be *credit constrained* ($\varphi=0.714$) or *unconstrained* ($\varphi \leq 0.52$). Thus, in these comparisons dollarization eliminates policy uncertainty and reduces φ.

Figure 6 considers the case in which the credit constraint binds in the dollarized economy by a large margin ($\varphi=0.714$). The Figure plots again welfare gains relative to constrained ($\varphi=0.714$) and unconstrained ($\varphi \leq 0.52$) regime-switching economies. The former captures the case in which policy uncertainty vanishes but credit-market inefficiencies, as measured by φ, are unaltered, while the latter is a perverse case in which the end to policy uncertainty is associated with a sudden *increase* in φ. Table 5 combines the data of Figures 5 and 6 with the ergodic distributions of Figure 2 and reports mean welfare gains.

The mean welfare gains of Table 5 suggest that the credibility gains of dollarization are very large regardless of the outcome with respect to φ. The gains range from 5.5 to 9.7 percent. Figures 5 and 6 show that state-by-state welfare gains are also generally large and that they vary widely as the initial state in the pre-dollarization regime varies. The wide differences in welfare gains reflect the interaction of the credit friction with policy uncertainty.

Table 5 shows that, if at the time policy uncertainty ends φ increases to 0.714, so that the economy runs into a sharply binding credit constraint as it converges to the steady state of the "dollarized" regime, the mean welfare gain of dollarization falls from 8.98 to 6.44 percent.[23]

[23]Recall that values in the range $0.416 \leq \varphi \leq 0.52$ are enough to yield outcomes in which the credit friction is not binding for the regime-switching economy but binding for the deterministic, low-tax economy. Hence, the sharp increase to $\varphi = 0.714$ is much larger than needed to make the constraint binding in the "dollarized" economy. The

Figure 6 shows there can even be non-trivial welfare losses rather than a gain if debt was high on the date of dollarization. In contrast, if the credit constraint was binding under policy uncertainty and the switch to credible policy coincides with a fall in φ that renders the constraint nonbinding, Table 5 shows a trivial increase in the mean welfare gains from 8.98 to 9 percent (relative to the case in which the constraint was not binding before dollarization). This result reflects again the shortcomings of comparisons based on ergodic distributions to assess the effects of the credit friction. As Figure 5 shows, welfare gains of dollarization are as high as 36 percent when the economy switches from a high-tax, debt-constrained setting under policy uncertainty to an unconstrained deterministic environment. The mean welfare gains in Table 5 do not reflect these large gains because the limiting distribution of the credit-constrained economy has virtually zero mass for the states in Figure 5 in which welfare gains across the credit constrained and unconstrained scenarios differ by non-trivial amounts. The same reasoning explains why, starting from a credit-constrained regime-switching setting, the mean welfare gains of eliminating policy uncertainty are nearly the same whether $\varphi \leq 0.416$ or $\varphi = 0.714$ in the deterministic economy, even though welfare gains in Figures 5 and 6 vary widely.

Leaving aside changes in φ, the welfare gains of eliminating policy uncertainty (i.e., setting $z=0$) have two components: one relates to efficiency gains that result from a lower mean tax rate, which reduce permanently price and wealth distortions, the other is due to the reduction in the variance of the tax (i.e., a reduction in a mean-preserving spread of the tax rate process). Of these two, the former is quantitatively the most important for producing the large welfare gains of dollarization. The welfare gain of eliminating the variance of τ while keeping a constant tax equal to the 10.2-percent mean tax of the regime-switching process is only 0.11 percent.

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welfare gains in the other scenarios would always be *larger* than the to 6.44 percent obtained with $\varphi=0.714$ because the values of φ would be smaller and would yield weaker credit constraints.

This reflects the well-known result that stabilization of mean-preserving fluctuations of the arguments of utility with constant-relative-risk-aversion utility functions yields negligible welfare gains (see Lucas (1987)).

The large efficiency gains of the mean tax cut have an important component driven by the fiscal-induced wealth effect. This accounts for the larger welfare gains obtained in this exercise relative to other existing studies of efficiency gains of tax reforms in deterministic economies (see Cooley and Hansen (1992) and Mendoza and Tesar (1998)). The results are in line with the estimates of Mendoza and Uribe (2000a) showing that in the presence of this fiscal-induced wealth effect the welfare of an economy facing a time-invariant probability of devaluation for six years increases by 4.5 percentage points by switching to a perfect foresight economy, and that this gain increases with the horizon of devaluation risk.

5. Concluding Remarks

This paper examines the potential benefits of dollarization from the perspective of a framework in which credit-market frictions and the lack of credibility of economic policy are large distortions. The analysis focuses on a dynamic, stochastic general equilibrium model of a small open economy with a managed exchange-rate regime and in which agents face a liquidity requirement that sets a limit on the stock of foreign debt as a ratio of GDP plus liquid money balances. The model adopts Epstein's (1983) Stationary Cardinal Utility function so as to produce a tractable quantitative framework in which credit constraints may or may not bind in the short run and in the long run.

The credit-market friction amplifies the distortions introduced by a non-credible managed-exchange-rate regime and it also introduces distortions of its own. In particular, the liquidity requirement distorts the labor-consumption and saving margins and the demand for liquid assets. Trough these mechanisms, the interaction of non-credible policies and credit-market frictions offers a potential explanation for the large and costly economic collapses observed in emerging-markets crises.

Numerical simulations based on a calibration to Mexican data suggest that dollarization can produce large social welfare gains, in terms of the trend level of consumption per capita. The mean welfare gains that dollarization can yield by enhancing the credibility of stabilization policy range between 6.4 and 9.7 percent. The mean welfare gain that can result from the weakening of financial frictions and improved access to global capital markets for a dollarized economy, even if policy credibility remained weak, reaches 4.6 percent.

These findings lend support to radical strategies to address financial frictions and the lack of policy credibility affecting emerging economies. Dollarization, the internationalization of the financial system, the creation of strong-currency areas, and the strengthening of institutional and legal arrangements to counter the governments' temptation to display time-inconsistency, could do away both with the risk of collapse of managed exchange rates and with the negative shocks caused by credit constraints that become acutely binding precisely when currencies collapse.

The numerical analysis of this paper assumes that dollarization is the only regime that yields a permanent zero-inflation outcome. This is a strong assumption based on the notion that the alternatives (exchange rate management or inflation targeting) suffer from chronic credibility problems that prevent them from delivering that result. In turn, lack of credibility is seen as deriving from two sources. First, the agents' misgivings regarding the actions of policymakers, justified by the recurrent collapses of stabilization plans.[24] Second, time inconsistency: in models like the one proposed here, it is optimal for well-intentioned, fully-rational policymakers to deviate from pre-announced policies. Hence, as long as a *domestic* currency exists, even the

[24]The Mexican experience during the post-war period in this regard includes the collapse of five managed exchange-rate regimes (see Gomez-Oliver (1981) and Mendoza and Uribe (2000a)).

best-intentioned *domestic* monetary authority has an incentive to surprise the private sector. Dollarization eliminates this possibility by replacing the domestic currency with a foreign currency and thus transferring the control of the currency to a foreign authority. The country runs the risk that the foreign authority may ignore the welfare of domestic agents in its policy decisions, but it is precisely the fear that the domestic authority may do "too good a job" at this that drives the time-inconsistency problem. Moreover, while in theory the foreign authority faces a time-inconsistency problem with regard to its constituency, so that dollarization cannot guarantee zero inflation, the Federal Reserve has a strong reputation at avoiding high inflation.

An important shortcoming of this analysis is that it abstracted from the connection between capital flows, asset prices and credit frictions evident in the data. Mendoza (2000b) shows how a variation of the setup proposed here could address some of these issues. Consider a global capital market in which residents of a small open economy trade equity with foreign securities firms. If these firms face informational or institutional frictions that put them at a disadvantage in trading the equity of the small open economy, and if domestic residents face margin requirements in their equity holdings, equilibrium asset prices may fall below their "fundamentals" level and display excess volatility. International capital flows will also display higher volatility than in an environment free of financial frictions. Further research is needed to assess the quantitative significance of credit frictions in this context.

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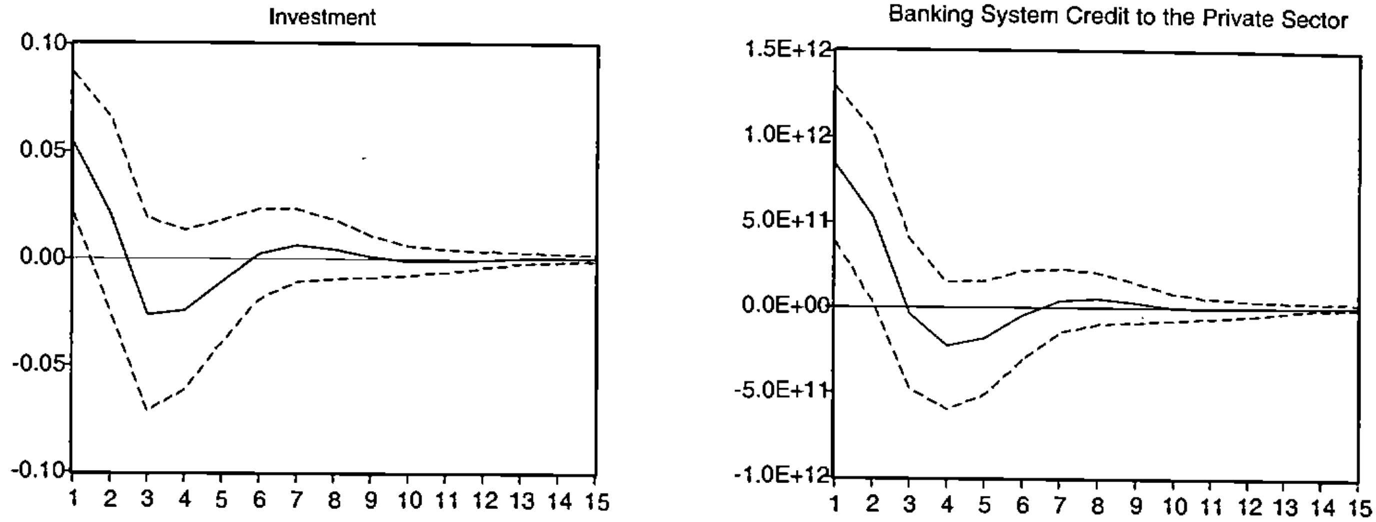
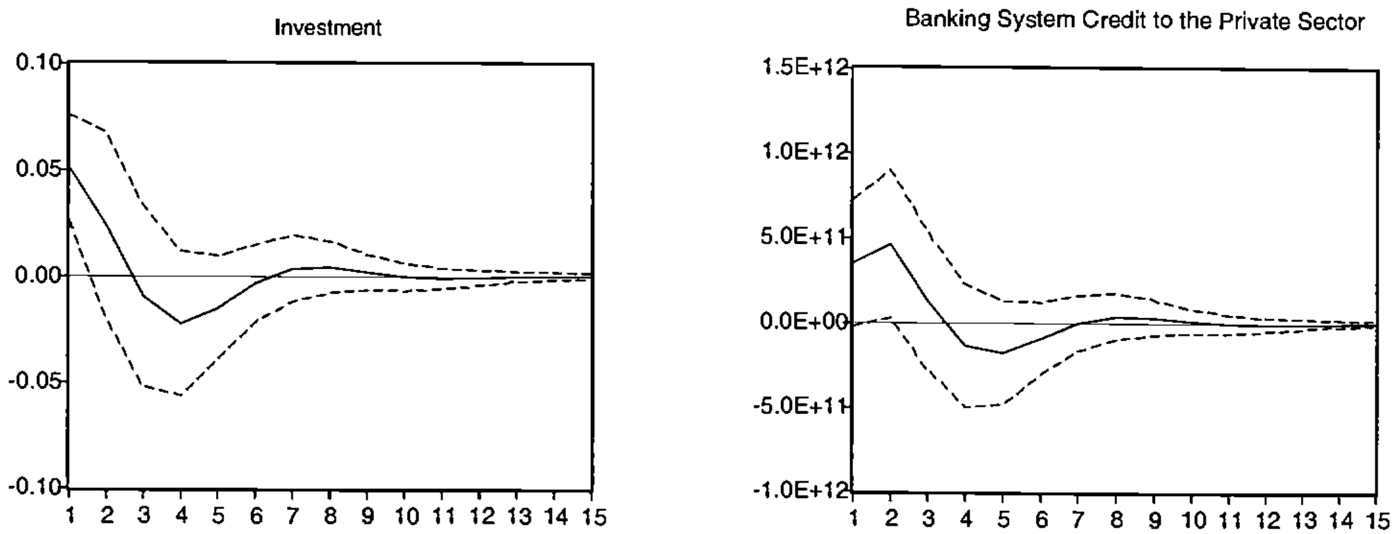
Figure 1.
Impulse Response Functions for One Standard Deviation Shocks to Capital Inflows and the Real Exchange Rate

A) Shock to Private Capital Inflows



B) Shock to Real Exchange Rate



Note: Unrestricted VAR using HP-filtered cyclical components, one lag and no intercept.

Figure 2
Limiting Distribution of Foreign Assets

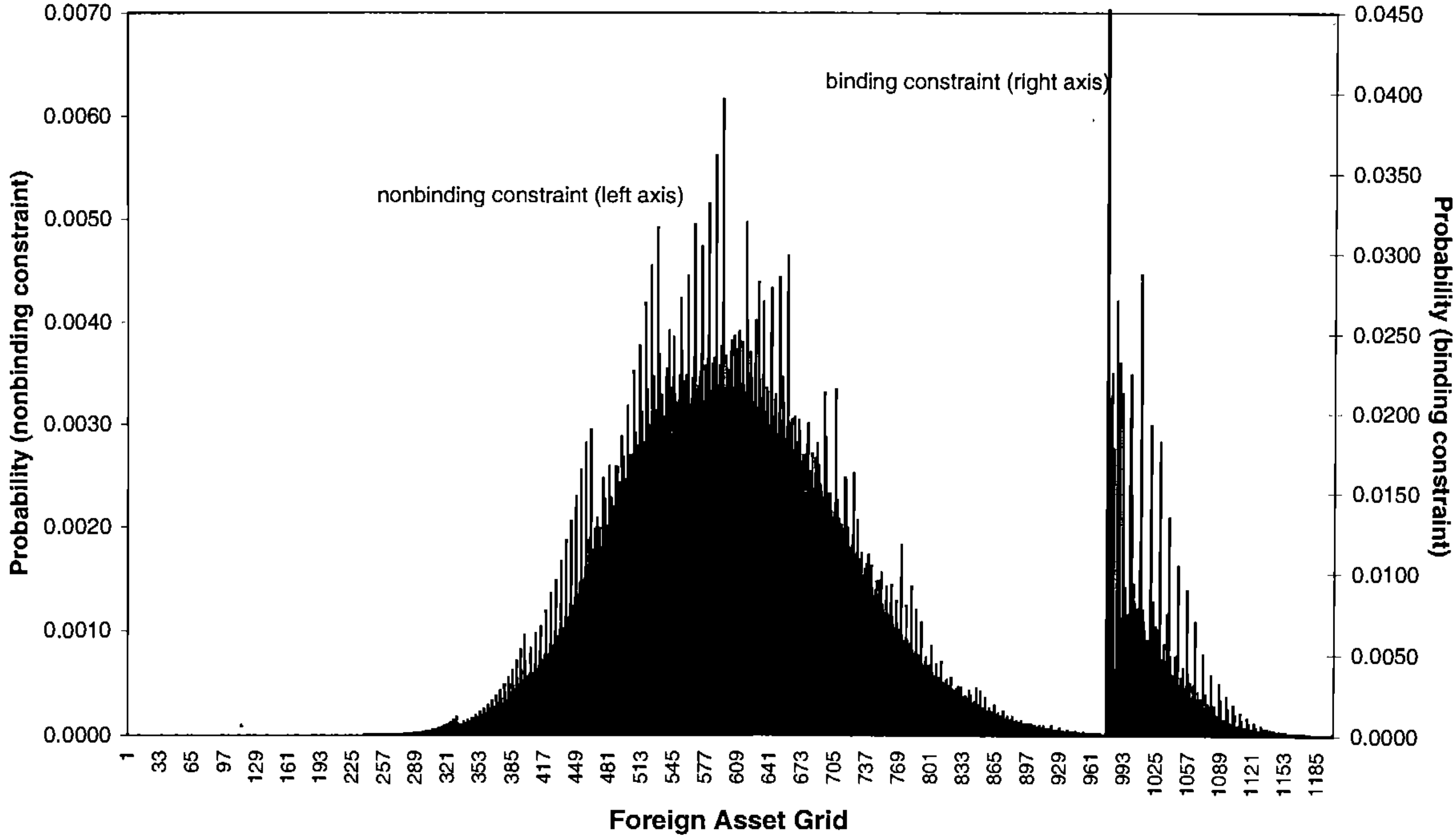


Figure 3. Impact Effects of Tax Increase
(percent changes relative to low-tax state)

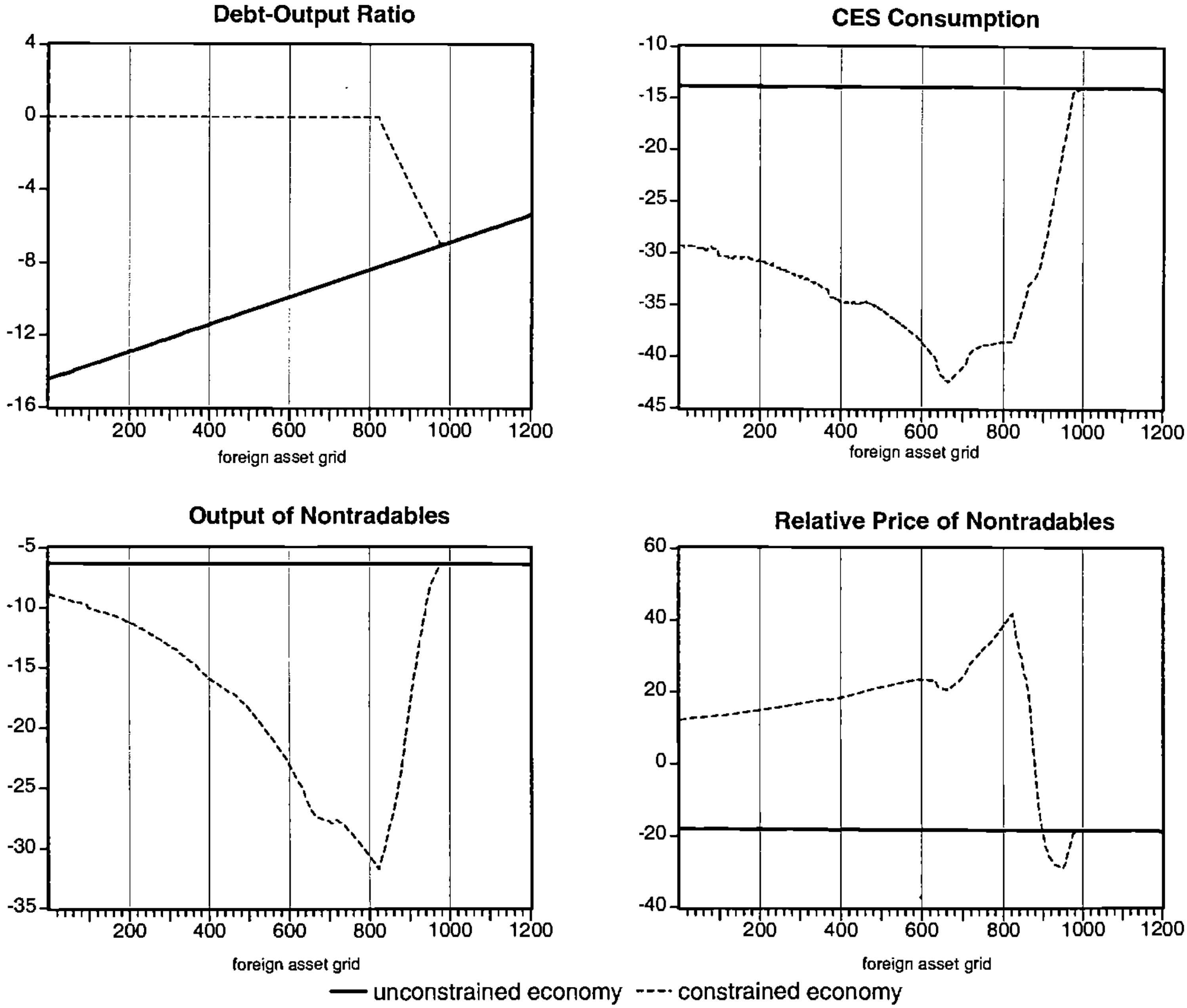


Figure 4
State-Contingent Welfare Losses Induced by Credit Constraints

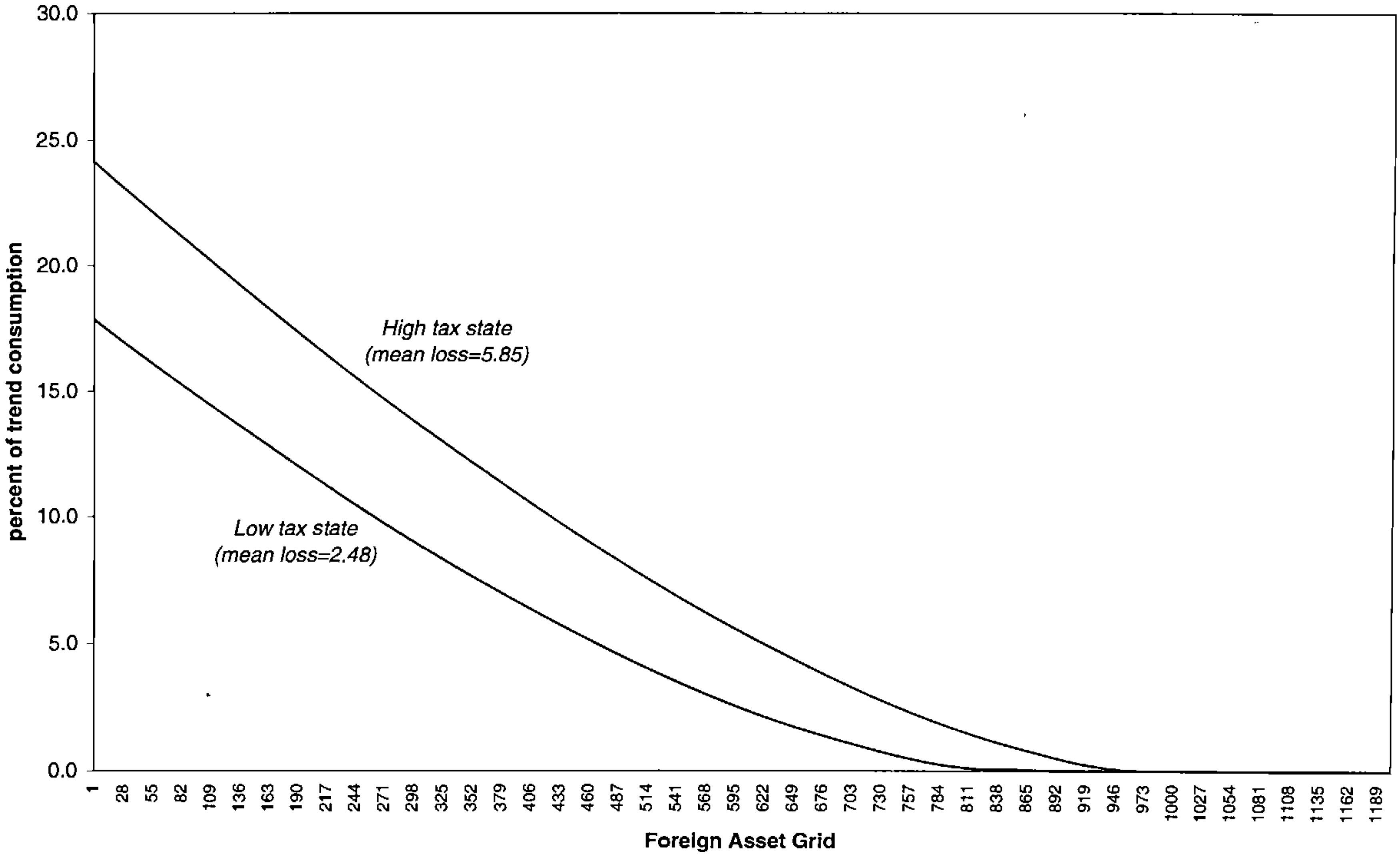


Figure 5
Welfare Gains of a Permanent Tax Cut (Dollarization): Nonbinding Credit Friction

(gains as a function of state-contingent initial conditions in the stochastic environment indicated in italics)

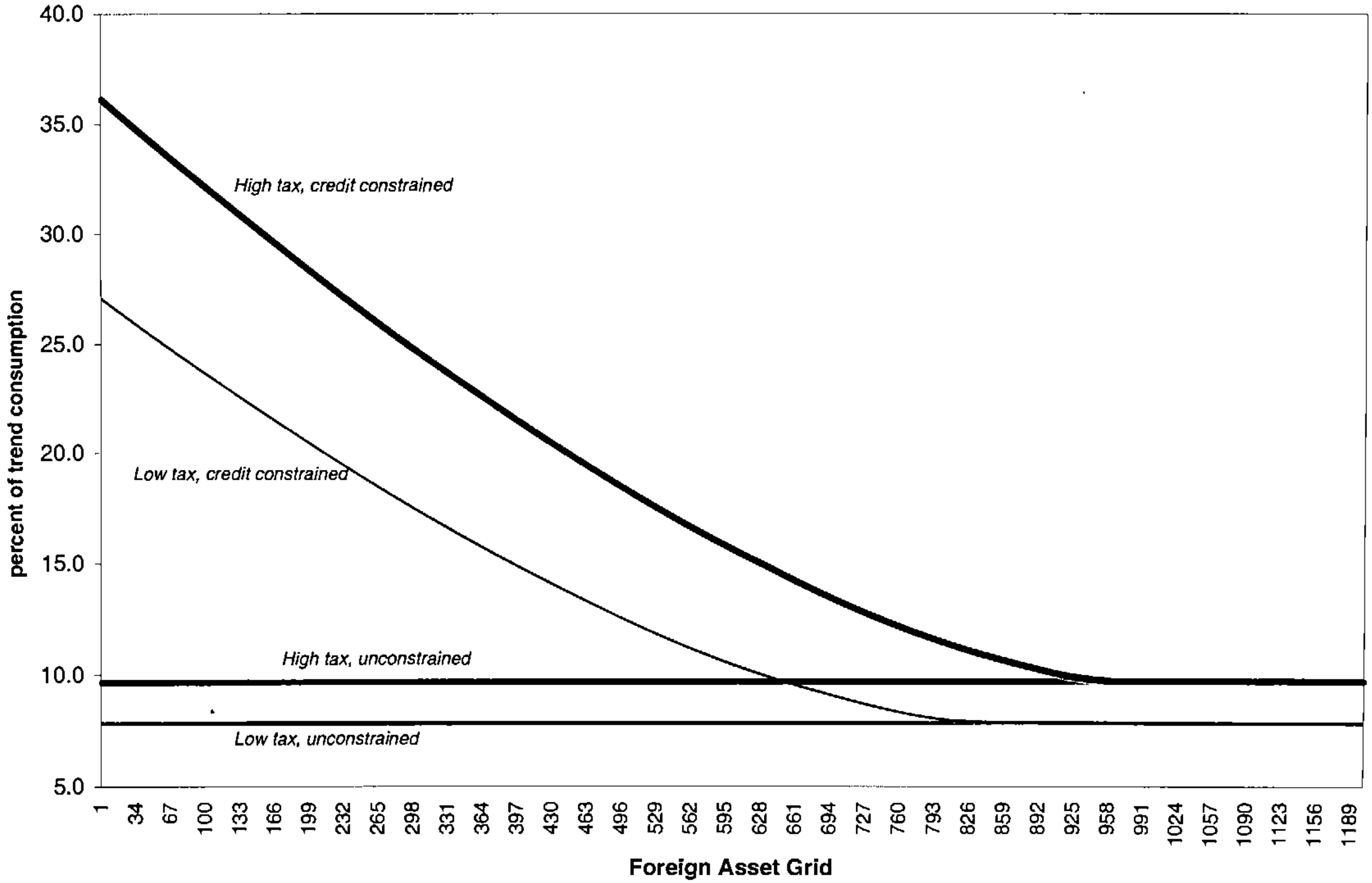


Figure 6.

Welfare Gains of a Permanent Tax Cut (Dollarization): Binding Credit Friction

(gains as a function of state-contingent initial conditions in the stochastic environment indicated in italics)

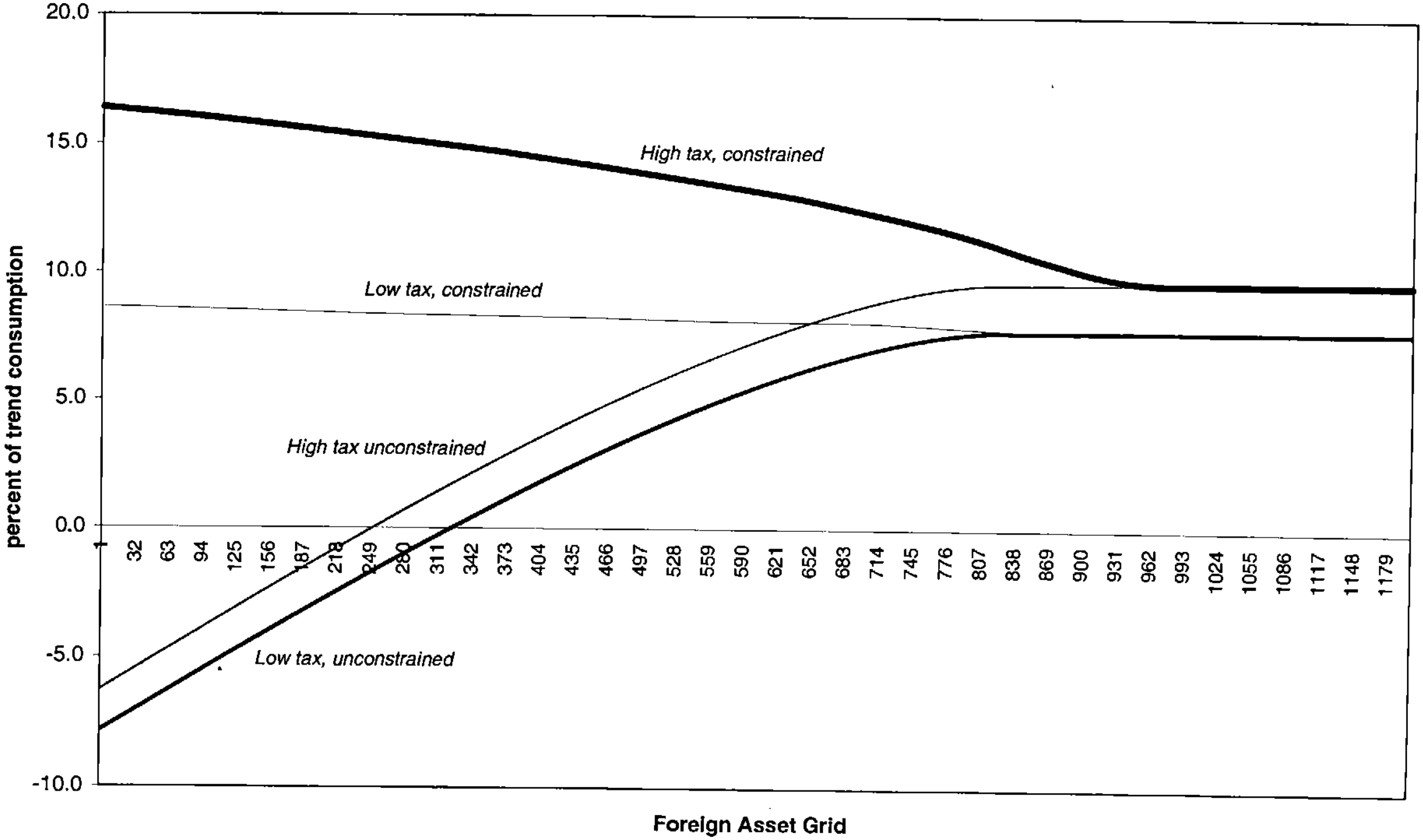


Table 1. Mexico: Stylized Facts of Business Cycles

	Std. Dev.	Std. Dev. relative to GDP	Persistence	Correlation with GDP	Correlation with RER
GDP	4.005	1.000	0.512	1.000	0.717
Consumption	5.807	1.450	0.490	0.925	0.860
Investment	15.504	3.871	0.438	0.875	0.884
Real Exchange Rate	13.966	3.487	0.354	0.717	1.000
Land Price	25.417	6.346	0.704	0.648	0.472

Note: Cyclical components were derived using the Hodrick-Prescott filter with the smoothing parameter set at 100. The real exchange rate is the exchange-rate-adjusted ratio of consumer price indexes for Mexico and the United States. GDP, consumption and investment are measured at1987 prices and expressed in U.S. dollars. The land price is the price of land in the metropolitan Mexico City area as reported by Guerra (1997).

Table 2. Cyclical Correlations of Macroeconomic Aggregates

	GDP	Consumption	Investment	Credit	Private Capital Flows	Real Exchange Rate	Land Price	Current Account	M2 money balances
GDP	1.000								
Consumption	0.925	1.000							
Investment	0.875	0.966	1.000						
Credit	0.866	0.784	0.761	1.000					
Private Capital Flows	0.701	0.691	0.697	0.761	1.000				
Real Exchange Rate	0.717	0.860	0.884	0.578	0.535	1.000			
Land Price	0.648	0.642	0.526	0.503	0.419	0.472	1.000		
Current Account	-0.794	-0.875	-0.882	-0.788	-0.643	-0.828	-0.409	1.000	
M2 money balances	0.888	0.820	0.816	0.771	0.552	0.780	0.396	-0.848	1.000

Note: All data, except land prices and the real exchange rate, are expressed in U.S. dollars. Cyclical components were derived using the Hodrick-Prescott filter with the smoothing parameter set at 100. The real exchange rate is the exchange-rate-adjusted ratio of consumer price indexes of Mexico and the United States. Land price is the real price of land in the Mexico City metropolitan area as reported in Guerra (1997). GDP, consumption and investment are measured at 1987 prices.

Table 3. Deterministic Steady-State Effects of Alternative Stabilization Policies
(percent changes with respect to baseline scenario without credit friction)

	C	L	Y	TBY 2/	m	YT	YN	Pn	Rd 3/
Without credit frictions ($\varphi \leq 0.406$)									
Dollarization	1.22	4.49	-0.20	4.61	22.48	1.52	1.44	-2.71	0.00
3 percent inflation 1/	0.52	1.93	-0.11	1.99	6.38	0.66	0.62	-1.23	0.00
10 percent inflation	-0.69	-2.60	0.21	-2.77	-5.95	-0.92	-0.85	1.81	0.00
50 percent inflation	-3.86	-15.77	2.68	-19.17	-21.83	-6.02	-5.29	14.36	0.00
With credit frictions ($\varphi = 0.75$)									
Dollarization (binding)	6.46	0.24	10.87	1.12	28.16	-1.75	1.17	17.66	0.41
3 percent inflation (binding)	1.82	0.80	2.51	1.03	7.71	-0.18	0.55	3.69	0.11
10 percent inflation (nonbinding)	-0.69	-2.60	0.21	-2.77	-5.95	-0.92	-0.85	1.81	0.00
50 percent inflation (nonbinding)	-3.86	-15.77	2.68	-19.17	-21.83	-6.02	-5.29	14.36	0.00
Levels in baseline scenario with nonbinding credit friction ($\varphi \leq 1.044$)									
5.7 percent inflation	0.498	0.200	1.385	-0.110	0.564	0.544	0.840	1.000	1.065

1/ All inflation rates are quarterly rates.
2/ Percentage points difference with respect to baseline
3/ Percentage point change in the domestic real interest rate in annual terms.

Table 4. Stylized Facts of Business Cycles in Model Economies

	Mean	Std. Dev.	Std. Dev. relative to GDP	Persistence	Correlation with GDP	Correlation with Pn	Correlation with tax rate
	(A) Non-binding liquidity requirement φ≤0.52						
GDP 1/	2.540	8.214	1.000	0.573	1.000	1.000	-0.994
Expenditures 1/	1.767	13.928	1.696	0.571	1.000	1.000	-0.995
Consumption	0.925	7.437	0.905	0.567	1.000	0.999	-0.997
Price of nontradables	0.982	10.235	1.246	0.577	1.000	1.000	-0.992
Net foreign assets	-1.417	8.960	1.091	0.996	0.301	0.319	-0.201
Labor	0.404	8.886	1.082	0.561	0.998	0.997	-0.999
Tax rate	0.102	60.944	7.420	0.553	-0.994	-0.992	1.000
	(B) Occasionally binding liquidity requirement, φ=0.714						
GDP 1/	2.610	8.628	1.000	0.577	1.000	1.000	-0.998
Expenditures 1/	1.844	14.348	1.663	0.575	1.000	1.000	-0.998
Consumption	0.942	7.585	0.879	0.571	1.000	1.000	-0.999
Price of nontradables	1.021	10.622	1.231	0.581	1.000	1.000	-0.997
Net foreign assets	-0.926	4.652	0.539	0.973	0.514	0.522	-0.464
Labor	0.410	9.008	1.044	0.564	0.999	0.999	-1.000
Tax rate	0.102	60.944	7.064	0.553	-0.998	-0.997	1.000

1/ GDP and expenditures are measured in units of tradables goods prices. Expenditures are the sum of tradables consumption and nontradables consumption valued at tradables goods prices.

Table 5. Mean Welfare Gains of Permanent Tax Cut for Alternative Transition Scenarios
(means computed using the ergodic distribution of the corresponding regime-switching scenario)

Originating Regime-Switching Scenario	Deterministic Economy with Permanently Lower Tax	
	Nonbinding Credit Constraint ($\varphi \leq 0.416$)	Binding Credit Constraint ($\varphi = 0.714$)
Nonbinding Credit Constraint ($\varphi \leq 0.52$)		
Conditional on high tax	9.68	6.98
Conditional on low tax	7.82	5.53
Unconditional mean	8.98	6.44
Binding Credit Constraint ($\varphi = 0.714$)		
Conditional on high tax	9.70	9.66
Conditional on low tax	7.82	7.78
Unconditional mean	9.00	8.96