Old and Modern Currency Crises:

Short-Term Liabilities, Speculative Attacks and Business Cycles

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Abstract

Today's level of financial integration and development of international capital markets is often compared to the pre-World War I Gold Standard. However, the propensity to currency crises seems higher today than in the past. Furthermore, the dynamics of crises has changed: In the most recent episodes of currency crises, output contractions have been large, but they have been followed by prompter recoveries than in the past.

This paper shows that high volatility in the demand for domestic currency, due to international investors buying short-term liquid assets, may increase the probability of currency crises and lead to large contractions followed by fast recoveries. Due to the "speculative" demand for currency, a small productivity shock can prompt a drop in the demand for domestic currency and the consequent exhaustion of international reserves. Therefore, crises can happen also when the fundamentals are relatively good: Investment drops temporarily due to the devaluation and recovers fast afterwards. In contrast, if the economy has smaller short-term liabilities, like during the pre-World War I Gold Standard, currency crises happen only when the real sector of the economy experiences a strong negative productivity shock. If productivity shocks have some degree of persistence, there are prolonged recessions.

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1. Introduction

Today's level of financial integration and development of international capital markets is often compared to the pre-World War I Gold Standard (Obstfeld and Taylor, 2003). Not only the magnitude of capital flows was very similar at the turn of the past century, but there were also no control to capital movements. However, the propensity to currency crises seems higher today than in the past: Bordo, Eichengreen and Irwin (1999) count 22 currency crises for the 1880-1913 period and 30 for the shorter period that goes from 1973 to 1998. In a related paper, Eichengreen and Bordo (2002) document a 7% increase in the probability that a randomly-selected country experiences a currency crisis.

Notwithstanding the magnitude of capital flows is similar, their role seems to have changed: In the aftermath of the currency crises of the nineties, globalization and the perfect mobility of capital movements have often been indicated as the culprit of financial instability. In striking contrast, economic historians notice the lack of "destabilizing capital movements" during the pre-World War I Gold Standard (Eichengreen, 1996 and Bordo, 1999).

The dynamics of currency crises also appears different: in the most recent episodes of currency crises output contractions are deeper, but are followed by prompt recoveries (Kamin, 1999; Bordo et al., 1999). Most notably, in much of East Asia recovery began soon after the crisis first struck. In Thailand GDP fell by more than 10% in 1998, but then grew by 4% the next year. In South Korea, output fell by 7% in the first year; over the next 12 months, it rose by 11% (The Economist, July 6, 2002). This contrasts, for instance, with the experience of Latin America in the early eighties, which definitively experienced less marked upswings and downswings.

This paper shows that the maturity and composition of capital flows can explain differences in business cycles and the frequency of currency crises. A somewhat neglected difference between the pre-World War I Gold Standard and the current times is that during the Gold Standard the most of capital flows were long-term and not easily redeemable (Baldwin and Martin, 1999; Obstfeld and Taylor, 2003). In contrast, today, foreign investments consist mostly of short-term financial assets, like tradable securities and banking operations (Chang and Velasco, 1998).

Investment in short-term assets increases the variability of money demand. If the economy is subject to productivity shocks, the propensity to currency crises increases, because even a small productivity shock can prompt a large decrease in the demand for currency and the consequent exhaustion of international reserves. As a result, the business cycles are amplified.

In the model, a devaluation has real effects because of a cash-in-advance constraint on consumption and investment, similarly to Calvo (1987). In the aftermath of the speculative attack, the effective cost of consumption and investment increases, because the devaluation acts as a tax on real money holdings, necessary to consume and invest. This causes a sharp contraction in the economy, which is driven by the devaluation, prompted by a minor real shock. To this extent, as several have noted before (Chang and Velasco, 1998), the punishment is much larger than the crime, since moderately weak fundamentals and small changes in exogenous circumstances cause large changes in prices and economic activity. However, since the production sector of the economy is not in a bad shape, the recovery is prompt, immediately after the currency crisis.

In contrast, if the speculative demand for money did not increase the liabilities of the government, the economy could exhaust the international reserves only as a consequence of a major productivity shock. Under the common assumption that productivity shocks have some persistence, the recession endures and the recovery is slow, as during the pre-World War I Gold Standard and the early eighties (Bordo et al., 1999 and Kamin, 1999).

This paper is related to a rich and growing literature on balance-of-payment crises. Among others, Calvo and Mendoza (1996), Kumhof (2000) and Corsetti and Mackowiak (2003) have considered the effect of short-term liabilities on the propensity to currency crises, on monetary aggregates, and on the rate of devaluation, but have overlooked the business cycles implications.

Like Mendoza and Uribe (2000), I analyze the business cycle implications of balance-of-payment crises. However, while they explicitly model the non-traded good sector and focus on the real exchange rate before the crisis, I assume that there is only a tradable consumption good and focus on the financial structure of the economy and the output recovery after the crisis. My model explicitly recognizes that agents hold domestic currency because they hold financial assets denominated in domestic currency, besides for consumption and investment.

The business cycle implications I aim to stress concern the speed of recovery of the economy, under different assumptions on the structure of domestic liabilities.

By introducing "speculative" demand for money, the model can explain why second (Obstfeld, 1996) and third-generation (Morris and Shin, 1998) models perform better in describing the most recent episodes of currency crises: If speculators hold liquid assets, the expectations of devaluation may cause the abandonment of the peg, even after minor productivity shocks, which would have had only minor consequences otherwise.

This paper also provides a contribution to the debate on the limitations that open capital markets place on exchange rate and monetary policy, often referred to as "inconsistent trinity" (Obstfeld and Taylor, 2002a and b; Eichengreen, 1996). According to dominant view, nowadays frequent currency crises would simply be a way of resolving this open-economy trilemma abandoning the fix exchange rate in favor of the freedom of monetary policy, in a world in which capital movements are perfect and the monetary authority is more concerned about unemployment and real activity than in the past. The alternative would be to forgive the freedom of the monetary policy in the sake of the fixed exchange rate, as during the pre-World War I Gold Standard, a period of freedom of capital movements and relative financial stability. This paper shows that, even if the central bank strongly commits to defend the fixed exchange rate, when the financial system allows speculators to hold short-term liabilities in domestic currency, the volatility of money demand increases and defending the peg becomes a more arduous task. Also minor productivity shocks may drive successful speculative attacks, followed by deep but short recessions. In this respect, the model provides an argument why financial structure and the composition of capital flows - rather than the magnitude of capital flows - may increase the frequency of currency crises.

The paper is organized as follows. Section 2 describes the model. Section 3 describes the dynamics of the main variables, under different assumptions on the demand for short-term domestic liabilities. Conclusions follow in Section 4.

2. The model

I consider a simple general equilibrium model of small open economy with a cash-in-advance constraint on consumption and investment and study the effects of an *unanticipated* negative productivity shock at *t=1*.

There is a single good and no barriers to trade, so that purchasing power parity holds:

$$P_t = E_t P_t^* .$$

Here, P_t and P_t^* denote the domestic and foreign price levels, respectively, while E_t denotes the nominal exchange rate defined as units of domestic currency per unit of foreign currency. For convenience, I normalize the foreign price level to one: $P_t^*=1$ for all *t*.

The exchange rate is initially fixed at $E_t = 1$. It is abandoned if the government exhausts the international reserves.

2.1 The Household's Problem

The representative consumer maximizes lifetime utility over an infinite horizon:

$$\sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\sigma} - 1}{1-\sigma}$$

Utility depends on the consumption of the unique good, C_t. The parameters of the utility function are σ, which is the inverse of the intertemporal elasticity of substitution, and the intertemporal discount rate, β.

The representative agent is endowed with one unit of labor that offers inelastically receiving a wage, w_t, and owns the domestic firm receiving profits π_t. After receiving a lump-sum transfer, which can eventually be negative, τ_t, the consumer decides whether to consume or to save. She can allocate saving across domestic physical capital, k_{t+1}, foreign bonds, B_{t+1}, and domestic currency, M_{t+1}^C, whose rates of return in foreign currency are respectively: $r_{t+1} - 1, r^*$ and $\frac{E_t}{E_{t+1}} - 1$. Therefore, the consumer's budget constraint is:

$$C_t + k_{t+1} = r_t k_t + w_t + (1+r^*)B_t + \frac{M_t^C}{E_t} - B_{t+1} - \frac{M_{t+1}^C}{E_t} + \pi_t - \tau_t \,,$$

where the initial conditions, k_0, B_0 and M_0, are given.

There is a cash-in-advance constraint on consumption and investment:

$$E_t(C_t + k_{t+1}) \geq M_t^C \,,$$

which implies that households must hold money in order to consume and invest.

Since the nominal rate of return of domestic currency is zero (the real rate of return depends on the path of the nominal exchange rates and is negative after a depreciation), in equilibrium, the representative consumer holds money only for transaction purposes and the cash-in-advance constraint is always binding.

Combining the cash in advance constraint with the budget constraint one gets:

$$B_{t+1} = r_t k_t + w_t + (1+r^*)B_t - \frac{E_{t+1}}{E_t}(C_{t+1} + k_{t+2}) + \pi_t + \tau_t$$

The first order conditions of the maximization of the lifetime utility with respect to B_{t+1} and k_{t+2} under the above constraint are:

$$C_{t+1}^{-\sigma} \frac{E_t}{E_{t+1}} = \beta(1+r^*) C_{t+2}^{-\sigma} \frac{E_{t+1}}{E_{t+2}}$$

$$C_{t+1}^{-\sigma} = \beta r_{t+2} C_{t+3}^{-\sigma} \frac{E_{t+2}}{E_{t+3}} \,.$$

To have a well-defined steady state and to abstract from trends in the economy's current account, I make the common assumption that the intertemporal discount factor is equal to $\frac{1}{1+r^*}$. In this way, there are no incentives to borrow and lend from the rest of the world in steady state.

Combining the two first order conditions one gets that in equilibrium the following relation between the return on capital and the interest rate on foreign bonds must hold: $r_{t+2} = \frac{1}{\beta}\frac{E_{t+1}}{E_t}$. This implies that households want to receive a premium on the international interest rate to invest in domestic physical capital, if they expect a devaluation, because a devaluation acts as a tax on investment expenditures.

Without loss of generality, I assume that foreigners do not hold domestic capital. However, it is possible for domestic agents to borrow from world capital markets to finance investment projects.

2.2 Production side

The unique good can be used to consume and to invest and is produced using a Cobb Douglas production function:

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}.$$

which employs capital (K_t) and labor services (L_t). Total factor productivity is defined as $A_t = \mathrm{A}\exp(e_t)$, where e_t is an exogenous disturbance. It is assumed that there is some persistence in the productivity shock. I assume that $e_{t+1} = \rho e_t$, where the parameter ρ measures the degree of persistency of the shock.

The level of total factor productivity at *t+1*, A_{t+1}, is realized after the good market is closed and before assets markets at time *t* are opened, and is observed by all the agents.

In this context, a negative productivity shock may be represented by an exogenous decline in the price of the output[1], which lowers the value of total factor productivity or a catastrophic event (e.g. an earthquake, floods), which temporarily reduce the possibility of production of the economy.

For simplicity sake, I assume that capital goods completely depreciate in one period.

Firms maximize profits taking factor prices as given. The demand for capital and labor services are, respectively:

$$r_t = \alpha A_t K_t^{\alpha} L_t^{1-\alpha}$$

and

$$w_t = (1-\alpha) A_t K_t^{\alpha} L_t^{1-\alpha}.$$

[1] In the context of the Asian financial crisis, the emergence of China as a major low-wage exporter may have represented a negative productivity shock for the East Asian economies.

As usual with constant returns to scale production functions, profits are equal to zero in equilibrium.

2.3 Speculative Demand for Money

As I explain in the previous subsections, money is held by domestic consumers in order to consume and invest. This model departs from the existing literature by allowing international investors to hold short-term assets, denominated in *domestic currency*, such as bank deposits, short-term public debt, or similar domestic-currency-denominated assets. I do not model explicitly banks and other financial intermediaries, and instead assume that these assets are directly issued by the government. What is important here is not who issues the assets, but their currency of denomination and maturity. In particular, it is key for the results that international investors are able to redeem these assets and convert domestic currency in foreign currency, if they expect a currency crisis.

The interpretation of the model does not change if international investors are also able to build up liabilities in domestic currency through the domestic banking system: It is documented, for instance, that during crisis episodes domestic banks often lend to international investors the currency they have been provided by the central bank, in the attempt to maintain the banking system liquid.[2] This also affects the demand for domestic currency during a currency crisis, as domestic assets denominated in domestic currency do. My contribution is to analyze how this affects the probability of a currency crisis and especially how the structure of foreign currency liabilities is related to the business cycles of an economy.

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[2] As vividly described by Eichengreen, Rose and Wyplosz (1996), currency speculation ultimately entails a loan in domestic currency originating in the home country. This is best put in the authors' words:

> *"…any speculative attack necessarily entails the following transactions. Speculators first obtain by banks the currency that is to be sold on the spot market. Banks then borrow that currency on the money market. The only agent buying the currency in such periods is the central bank, which, in so doing, drains liquidity from the market. If, to prevent interest rates to rise to politically unsupportable levels, the central bank sterilizes its exchange rate market operations and lends the domestic currency, it fuels additional speculation.*
> *Consolidating all these transactions (canceling among other items interbank loans) reveals that what is left is domestic currency lending by the banking system to the rest of the world. The central bank lends on domestic markets to resident commercial banks, which lend to nonresidents."*

International investors' holdings of short-term assets denominated in domestic currency generate what I call speculative demand for money and denote in nominal term as M_t^I. Obviously, the kind of monetary aggregate I consider here is a wide one, like M2 or M3, which, as Calvo and Mendoza (1996) show, are influenced by foreign capital flows,

For simplicity's sake, only international investors demand domestic currency for speculative purpose. This assumption allows me to separate the outcome of the speculation from the consumption decision. Hence, there is no need to account for the wealth effect on consumption deriving from speculation. This is without loss of generality as the business cycles implications of the model are driven by the effective cost of consumption and investment and not by wealth effects. Hence, they would not change if also domestic investors could hold short-term domestic assets.

International investors hold domestic short-term assets if the interest they yield, i^g, guarantees an expected foreign currency return at least equal to foreign bonds:

$$\frac{E_t}{E_{t+1}^e}(1+i^g) \geq 1+i^*,$$

where E_{t+1}^e the expected exchange rate at *t+1*. The interest rate on the short-term assets i^g is set by the government, like in Calvo and Végh (1995) and Lahiri and Végh (2003), which commit to provide any amount of short-term liabilities investors demand. Without loss of generality, I assume that, in the initial steady state, in which the exchange rate peg is believed to be sustainable (i.e., $\frac{E_t}{E_{t+1}^e}=1$), the government sets $i^g = i^*$. In this case, investors are indifferent between assets denominated in domestic and foreign currency.

In the current times, because of financial development and better technology for the transmission of information, there are more short-term assets that can be easily liquidated if a currency crisis seems likely. To capture this, I assume that in a modern economy $M_1^I > 0$, while in the pre-World War I Gold Standard $M_1^I = 0$. I show that this fundamental difference between the pre-World War I Gold Standard and the current time fixed exchange rate regimes affects the volatility in the demand for domestic currency and the probability of currency crises. The reason is very simple: In current times, investors can easily withdraw their deposits and sell their other financial assets. This generates a capital outflow, decreases the overall demand for domestic currency, and causes the abandonment of the fixed exchange rate.

In what follows, I model the behavior of international investors similarly to Morris and Shin (1998) and Botman and Jager (2002): Each international investor is too small, meaning that it has a limited amount of funds, to carry a successful attack on the international reserves alone. Hence, it subordinates her decision whether to attack or not to a private signal on the mass of the other speculators who will carry on an attack at a given point in time.

There is a continuum of risk neutral informed speculators with mass 1. They can either get indebted at the current interest rate, i^g, to short-sale the weak currency or sell liquid assets with return i^g that they already own. In either case, speculators can sell at most z unit of domestic currency. Their expected payoff from attacking the currency is: $\left(E^e_{t+1} - (1+i^g)\bar{E} - \tau\right)z$. A speculator attacks if her expected payoff is positive. This depends negatively on the interest rate on liquid assets, i^g, and on transaction costs, τ, and positively on the expected devaluation, E^e_{t+1}. A time t, speculators observe the realization of total factor productivity, A_{t+1}, and a private signal concerning the mass of the other speculators attacking the domestic currency. The signal observed by speculator i at time t is:

$$x_{it} = \max\{0, A - A_{t+1} + \varepsilon_{it}\}.$$

The signal is not precise and differs among speculators because of the noise, ε_i, which is identically and independently distributed across agents and has cumulative distribution function, F and mean $\bar{\varepsilon}$.

As in Morris and Shin (1998), the existence of this signal, which involves a small amount of private information for each speculator, allows to avoid multiplicity of equilibria and to focus on the difference between old and modern currency crises. Alternatively, I could allow for the existence of multiple equilibria. However, the main message of the model would not change: when speculators can sell large amounts of liquid assets, crises become possible also after minor productivity shocks, if speculators expect crises to happen.

The mass of speculators who receive a signal greater than x^* for a given realization of A_{t+1} is $1-F(x^* - A + A_{t+1})$. As Morris and Shin (1998) show, the optimal strategy is to attack if the signal x_{it} is larger than a certain threshold x^* to be determined below. For a given realization of the signal x_{it} the expected amount of speculation is $\left(1-F(x_{it}-A+A_{t+1})\right)z$. It is profitable to attack if $\left(1-F(x_{it}-A+A_{t+1})\right)z > \overline{M}^{I}(A_{t+1})$, where $\overline{M}^{I}$ is the minimum level of "speculation" which makes profitable a speculative attack when the next period level of productivity is A_{t+1}. The equality $\left(1-F(x^{*}-A+A_{t+1})\right)z = \overline{M}^{I}(A_{t+1})$ defines x^{*}. The amount of speculation for each realization of the productivity shock depends on the amount of funds that each speculator is able to move, z, on transaction costs, τ, on the interest rate on liquid assets denominated in domestic currency, i^{g}, and on the foreign reserves of the central bank. Interestingly, the larger is z, the smaller the negative productivity shock (i.e., the larger A_{t+1}), which can provoke a speculative attack.

The optimal strategy is to attack if $x_{it} > F^{-1}\left(1-\frac{\overline{M}^{I}(A_{t+1})}{z}\right)+A-A_{t+1}$. A successful attack happens if $\overline{x} > F^{-1}\left(1-\frac{\overline{M}^{I}(A_{t+1})}{z}\right)+A-A_{t+1}$, where $\overline{x} \equiv A-A_{t+1}+\overline{\varepsilon}$ is the average realization of the signal among the speculators.

For simplicity's sake, I assume that foreign investors do not hold any longer short-term domestic assets after a successful speculative attack for instance because the government does not adjust i^{g} to compensate investors for the expected depreciation of the currency. I will discuss later the implications of the volatility of money demand for interest rate policy.

2.4 The government

The government comprises the monetary and the fiscal authority. The monetary authority holds interest-bearing foreign exchange reserves, f_{t}, while the fiscal authority makes lump sum transfers τ_{t} to the public and spends a fixed amount g.

The government's dynamic budget constraint is:

$$f_{t+1} = (1+r^{*})f_{t} - g + \frac{M_{t+1}}{E_{t}} - \frac{M_{t}}{E_{t}} - \tau_{t}, \text{ if } f_{t} > 0.$$

The money aggregate, M_{t}, includes both currency held by domestic and foreign investors. The proceeds of the government derive from the revenues on international reserves and the increase in real money balances. I assume that $r^* f_t > g$ to study the effects of speculation and negative productivity shocks on an initially perfectly sustainable peg.[3]

Lump-sum transfers to the representative consumer consist of the central bank interest earnings on foreign exchange reserves and proceedings from the inflation taxes and real money balances which remain after funding the fixed level of fiscal expenditures, *g*: $\tau_t = r^* f_t + \frac{M_{t+1}}{E_t} - \frac{M_t}{E_t} - g$. Lump-sum transfers are determined residually: their role is to ensure the existence of an initial well-defined steady state. In fact, without this assumption, if $r^* f_{t-1} > g$, international reserves would be growing over time before the negative productivity shock is realized and the economy would not be in steady state.

Initially the exchange rate is fixed and equal to 1: $E_t = \overline{E} = 1$. If there is a speculative attack, speculators convert all their holdings of domestic currency in foreign currency. Moreover, domestic consumers decrease their real money balances according to their expectations of devaluation. As usual, the exchange rate peg is abandoned if the demand for international reserves due to the decrease in domestic demand for money is greater than the available international reserves. The speculative attack is successful if the following condition is satisfied: $(M_t^I(1+i_t^g) - M_{t+1}^I) + \left(M_t^D - M_{t+1}^D\right) > (1+r^*)f_t$.

In the devaluation period the government's flow budget constraint is:

$$0 = (1+r^*)f_t - g - \left(M_t^I(1+i_t^g) - \frac{M_{t+1}^I}{E_t} \right) + \frac{M_{t+1}^D}{E_t} - \frac{M_t^D}{E_t}.$$

At the time of the devaluation speculators redeem $\left(M_t^I(1+i_t^g) - M_{t+1}^I\right)$ units of local currency in exchange for foreign reserves, where $M_t^I - M_{t+1}^I > 0$.[4] This implicitly assumes that speculators redeem their cash before domestic investors and that they are never able to exhaust foreign reserves if there is no change in domestic demand for money. Only international investors who observe a signal lower than x^* continue to hold domestic short-term assets and suffer from the speculation.

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[3] This excludes first-generation currency crises models from the analysis. See Krugman (1979) on this point.

[4] Nothing would change if also the household redeemed a fixed amount of local currency in exchange for foreign reserves, as in Burnside, Eichenbaum and Rebelo (2003).

The extent of the devaluation at the time of the currency crisis is determined from the government budget constraint and the equilibrium demand for money. After foreign reserves are exhausted, seignorage revenues are used to finance the fiscal deficit, *g*. The devaluation is larger, the greater is the drop in money demand due to the expected devaluation and to the speculative demand for money.

After the devaluation period, the path of the exchange rate is determined for all the following periods by the government need to finance the fiscal deficit.

Since I want to focus on the link between productivity shocks, money demand and business cycles, I continue to assume that the monetary authority moves first by setting the path of nominal exchange rate E_t in order to allow the fixed amount of fiscal expenditures *g*. The fiscal authority passively accommodates such a path by letting transfers adjust.

Under these assumptions, after international reserves have been exhausted and the exchange rate peg has been abandoned, the budget constraint of the government determining the path of the exchange rate is:

$$g = m_{t+1} - m_t \frac{E_t}{E_{t+1}},$$

where $m_t \equiv \frac{M_t}{E_t}$ represents the holdings of real money balances at time *t*. This implies that transfers are set equal to zero after a currency crisis.

Note that the assumptions on the transfers and the monetary policy imply that if there is a small decrease in money demand, the transfers are adjusted accordingly. However, if the decrease in money demand is large to the point to exhaust the reserves, the monetary policy must be adjusted in order to fund the fiscal deficit. This captures the differences in the time of reaction of the monetary and the fiscal authority and ensures the existence of a well defined steady state at *t=0*.

2.5 The current account and the definition of equilibrium

Combining the consumer's and the government's dynamic budget constraints yields the current account of the economy:

(1) $$CA_t \equiv (B_{t+1} - B_t) + (f_{t+1} - f_t) = r^*(B_t + f_t) + y_t - C_t - g + \frac{M^I_{t+1}}{E_t} - \frac{M^I_t}{E_t}(1 + i^g_t)$$

Equation (1) implies that private and public consumption, C_t and g respectively, can be financed with the output, y_t, the interest earned on international assets by the households and the government, respectively, $r^*(B_t + f_t)$, and with the net purchases of short-term assets by the international investors, $\frac{M^I_{t+1}}{E_t} - \frac{M^I_t}{E_t}(1 + i^g_t)$. Any resources in excess are invested in international assets either by the households or by the government.

An equilibrium of the above economy is such that:

i. Consumers maximize their expected utility taking factor prices as given
ii. Firms maximize profits taking factors prices as given
iii. Capital and labor services are fully employed, i.e. $L_t = 1$ and $K_t = k_t$.
iv. The supply of money must be equal to the total demand for money: $M_t = M^C_t + M^I_t$.
v. The aggregate resource constraint is satisfied, i.e.:

$$k_0 + B_o + f_0 = \sum_{t=1}^{\infty} \frac{1}{(1 + r^*)^t} (C_t - A_t k^\alpha_t L^{1-\alpha}_t).$$

In what follows, I show that by introducing speculative money demand in the model (i.e., allowing *z>0*), the volatility of the economy increases and the exchange rate peg becomes vulnerable to small productivity shocks. These would have not provoked a speculative attack if demand for money derived only from the cash in advance constraint. The drop in demand for money at the time of the speculative attack causes a large devaluation, a sort of over-shooting, which causes a deep recession. The recession, however, is not persistent.

In contrast, without speculative demand for money, the exchange rate is abandoned only because of large negative productivity shocks. In this case, the recession can be as large, and there is no fast recovery, if productivity shocks are correlated over time.

3. Equilibrium implications

3.1 The initial steady state and the simulation of the model

Before the productivity shock is realized, the economy is in steady state. The exchange rate is fixed and perfectly sustainable, since $r^* f_0 > g$ by assumption. This implies the cost of consumption is constant and, therefore, consumption is also constant over time. Investment is also constant as total factor productivity equals *A* in steady state. Consequently, the path of the output and foreign assets is also constant over time.

Even if it is very simple to characterize the initial steady state of the model, the analysis of the response of the model economy to a temporary productivity shock with some degree of persistence involves the use of numeric methods, because the model presents non-linearities that do non permit to solve explicitly for the path of the nominal exchange rate.

The dynamics of the model can be described by a non-linear difference equation obtained by substituting equilibrium money demand into the government budget constraint. Since money demand depends on the path of consumption which in turn depends on present and future rate of devaluation through the lifetime budget constraint of the household, the model is not solvable analytically. The solution method involves the solution of a linearized version of this difference equation.

Some features of the equilibrium can, however, be determined by inspection of the first order conditions. Since there is a cash-in-advance constraint, a devaluation acts as a tax on investment expenditures. The first order conditions of the household's program imply that households require a higher rate of return on investment, if they expect a devaluation. As a consequence, capital accumulation decreases, as is clear from the expression of the equilibrium capital stock: $k_{t+1} = \left(\frac{\alpha A_t}{(1+r^*)} \frac{E_{t-1}}{E_t} \right)^{\frac{1}{1-\alpha}}$.

I simulate the model under two alternative assumptions on the amount of speculative demand for money. In the simulation of the old economy, I assume that the level of transaction costs makes prohibitive short-term speculation. To put it differently, no short-term assets denominated in domestic currency exists. In the modern economy case, the assumptions on the amount of funds speculators are able to move in case of speculative attack imply that speculative demand for money is approximately 1/3 of households demand for domestic currency.

Following a negative productivity shock the dynamics of the economy is not very sensible to preferences and technology parameters values and depends only on whether foreign reserves are exhausted or not. This in turn depends on the amount of speculation and on the magnitude of the negative productivity shock.

The parameters values used in the simulation I report are the following: $\sigma = 5$, $\alpha = 0.42$, $r^* = 0.02$, $\rho = 0.99$, *A=5* and $f_0 = 2$. A small productivity shock involves a 10% drop of total factor productivity on impact, while a major productivity shock implies a 40% decrease in total factor productivity. Finally, I assume that the distribution of the signal, the level of transaction costs, and the return on short-term assets are such that all international investors participate to the speculative attack, even after a small productivity shock.

3.2 The "old" economy

Let's assume first that transaction costs are high enough to rule out speculative demand for money: $M_t^I = 0$. Under this condition, I analyze the behavior of the economy in response to a negative productivity shock. I show that in this context the monetary authority is forced to abandon the parity only after major shocks. This fits well the empirical evidence on the Gold Standard period: the monetary authority maintained the peg except in the event of a well understood emergency such as a major war (Bordo, 1999).

In *t=0*, before agents make saving decisions, it is known that a negative productivity shock will materialize at date *t=1*. In particular, I assume: $e_0 = 0$, which implies $A_0 = A$, and $e_1 < 0$. Negative productivity shocks always imply that the domestic demand for money deriving from the cash-in-advance constraint on consumption and investment goes down. Depending on the extent of the productivity shocks and the size of the reduction in money demand, this may provoke or not a balance-of-payments crisis.

There is no currency crisis and the shock has only a negative income effect if: $m_0 - m_1 < (1 + r^*) f_0 - g$.

Proposition 1. Small productivity shock.

Productivity shocks are absorbed without a balance-of-payments crisis, if the decrease in money demand does not deplete foreign reserves (that is, if the following condition is satisfied: $m_0 - m_1 < (1 + r^*) f_0 - g$ *).*

If the condition in Proposition 1 is satisfied, international reserves decrease, but remain positive. The drop in money demand implies only a reduction in the lump-sum transfers to the representative consumer. However, the peg can be maintained as the reserves remain positive at *t=0*.

Figure 1 shows the reaction of the main variables of the economy to a small temporary productivity shock, which was unanticipated at *t=0*. Under the assumption that there is a fiscal adjustment and the peg is maintained, international reserves decrease but remain positive. The effect of the productivity shock on output and investment is only temporary as the productivity comes back at its old level. Consumption, however, decreases permanently as the negative productivity shock has a permanent effect on the life-time income.

Two assumptions ensure that after a productivity shock that does not completely deplete the foreign reserves there cannot be balance-of payments-crises with foreign reserves that are gradually depleted over time, like in Krugman (1979) or Flood and Garber (1984). These assumptions are:

1. The monetary authority abandons the exchange rate if the drop in money demand is such to completely exhaust foreign reserves
2. The monetary authority sets the exchange rate first and transfers to the private sector are determined residually.

Under these assumptions, if international reserves are not depleted on impact, when the negative productivity shock is realized, the transfers to the public adjust and become eventually negative. Therefore, the peg remains sustainable. This timing of events captures the fact that when there is a speculative attack the monetary authority is alone to defend the peg, but in the long run whether there is a fiscal adjustment or not is important to decree the durability of a fixed exchange rate regime.

To the extent that fiscal adjustments are not feasible, small productivity shocks – which do not provoke an immediate abandonment of the peg – may cause a gradual loss of international reserves and currency crises that unfold, like in Krugman (1979). In this respect, the model suggests that first generation currency crises are more likely to happen in economies with small amount of short-term liabilities.

Major productivity shocks, however, can determine an immediate currency crisis also in an economy without speculators.

Proposition 2. Large productivity shock.

If $m_0 - m_1 > (1+r^*)f_0 - g$ *the currency crisis happens in t=1.*

When the drop in money demand is such to exhaust foreign reserves, the peg is abandoned. However, this happens only for very large productivity shocks: If the economy has no short-term liabilities denominated in domestic currencies, productivity must decrease by 40% in order to observe a currency crisis.

As Figure 2 shows, the devaluation is higher on impact than in the long run, because the productivity shock has no permanent effects. Investment demand (and, therefore, the demand for domestic currency due to the cash-in-advance constraint on investment) drops in the short run, but not in the long run as total factor productivity recovers. The overshooting in the devaluation rate, due to the temporary drop in investment, increases the effective cost of consumption and investment (the devaluation acts as a tax on real money balances, necessary to consume and invest) and this contributes to decrease domestic money demand further.

After the initial devaluation, the currency appreciates and consumption recovers, although not at the pre-shock level. Households increase real money holdings based on the expectation of a lower long run devaluation rate. During the transition to the new steady state, the increase in households' real money holdings partially funds the fixed component of the budget deficit, *g*. This explains why the devaluation rate is lower during the transition than in the long run. In the new steady state there is a constant depreciation rate and consequently output and investment are lower than in the initial steady state even if total factor productivity completely recovered. The depreciating currency permanently increases the effective cost of consumption and investment. Of course, this is due to the existence of a fixed component of the fiscal deficit, *g*. If at some point there is a fiscal adjustment and the fiscal deficit is driven to zero, the economy is able to come back to the initial steady state after the effects of the temporary productivity shock vanish.

To summarize, in an economy where money is held only for transactions, the peg is vulnerable only to major negative shocks. Such an economy may well represent the situation of the pre-World War I Gold Standard. The experiences of Australia and Canada confirm the scarce propensity to currency crises (Bordo, 1999): these two countries experienced respectively severe banking problems and a sharp cyclical downturn, but, surprisingly for current times, they did not suspend the convertibility to the gold. Only major shocks, such as bad crops, political unrest, wars and fiscal improvidence, caused frequent currency crises in Latin America in that period.

3.3 The "modern" economy

The effect of the speculative demand for money, as it has been introduced in Section 2.3, is to change the financial structure of the economy. Capital inflows include not only foreign bonds issued by domestic investors, but also short-term assets denominated in domestic currency, issued by the government. This increases the level of transfers to the domestic consumer when the currency is still pegged, and the domestic currency liabilities of the government in case of a speculative attack.

Under these conditions, balance-of payments crises become more frequent. By introducing a small amount of speculative demand for money, a balance-of-payment crisis can happen at $t=1$, even if a small productivity shock hits the economy. If the short-term liabilities denominated in foreign currency are approximately 70% of international reserves, even a negative productivity shock that temporarily decreases productivity by 5% can provoke a currency crisis. As a consequence the output decreases temporarily by approximately 10%.

In Figure 3, I assume that the short-term assets denominated in domestic currency are approximately 1/4 of GDP. Under these assumptions, a negative shock that decreases productivity by slightly less than 10% provokes a currency crisis, which decreases the output nearly as much as a large productivity shock in the old economy.

In this case, the exchange rate overshoots and a sharp recession hits the economy even if the productivity shock was minor. There is a devaluation on impact because of the decrease on money demand, which in turn depends on how large are the short-term liabilities held by foreign investors. For given strength of the productivity shock, the drop in consumption and investment is more severe in an economy where speculators have easier access to funds (z larger).

The aftermath of the currency crisis seems indistinguishable from the case in which the drop in money demand has been caused by a large productivity shock that reduces life-time income and, therefore, consumption and especially the productivity of investment.

However, there is an important difference in the timing of the crisis: Old-time currency crises happen simultaneously with a deep recession. In modern times, currency crises, when the peg is abandoned, only a minor decrease in the output is observed. The recession follows the crisis and reaches its peak when the distortions due to the devaluation have effects on the economy. Moreover, as is evident from Table 1, the speed of recovery is different depending on the determinants of the crisis (i.e., large negative productivity shock vs. decrease in the demand for currency due to international investors). When the recession is mostly due to the devaluation the output recovers fast, even if its contraction is comparable or even deeper.

Additionally, in accordance to the empirical evidence (Bordo et al., 2001) the current account reversal appears more sudden in the modern than in the old economy. This is intuitive: Real shocks are the cause of crises in the latter. The abrupt cessation of capital inflows in the modern economy, instead, requires the compression of consumption and investment and is therefore at the origin of the devaluation.

This description of the dynamics of the crisis driven by the volatility of money demand fits well the experiences of Mexico in 1994-95 and the East Asian economies in 1998 (Kamin, 1999). In both cases, the currency crisis led subsequently to sharp declines in economic activity, followed by a fast rebound. This contrasts the experience of the Latin America debt crisis. In the 1980s the Latin American countries, affected by the debt crisis, exhibited less marked upswings and downswings, also because the world economy and especially the industrial countries were already in a very sharp recession. According to the model, the origins of the 1980s crisis and the most recent ones should be very different: the 1980s debt crisis would still be an example of "old" currency crisis driven by a negative shock, while the latest two would have been driven by speculation.

In general, the model predicts that larger short-term liabilities denominated in domestic currency increase the probability of sudden stops (i.e., currency crises that hit the economy even if fundamentals are quite good) as opposed to first generation currency crises, provoked by mounting fiscal imbalances. These are instead more frequent in economies with small amounts of short-term liabilities denominated in domestic currency, when the fiscal policy does not adjust to accommodate small productivity shocks.

Interestingly, in the contest of this model, short-term assets denominated in domestic currency make the economy worse off: On the one hand, the holdings of domestic short-term assets of speculators do not perform any desirable risk sharing function, but just substitute foreign bonds. On the other hand, these assets make crises more likely and consumption more variable. This obviously decreases the utility of the representative consumer.

3.4 Active interest rate policy

So far I have assumed that following a productivity shock, the government does not try to defend the exchange rate increasing the interest rate on the short-term assets denominated in foreign currency, i^g . Doing so, the government could certainly make more costly speculation and reduce the set of speculators who find it optimal to attack the exchange rate parity. However, similarly to Lahiri and Végh (2003), an increase in i^g would have a negative effect on the international reserves as the interest rate burden of the existing short-term assets would increase. Depending on the amount of outstanding liabilities and the expected devaluation, the interest rate policy may not be able to avert the currency crisis: If the expected devaluation is large or the government has a large amount of outstanding short-term liabilities, the increase in interest rate would cause a large drop in international reserves. These are exhausted if their residual amount is smaller than the drop in demand from domestic consumers and speculators who persist in their activity.

To the extent that an increase in interest rate can prevent the speculative attack, however, it is desirable that the central bank uses this policy instrument, as this limits the temporary drop in consumption and maximizes welfare.

The model also suggests that interest rate policy becomes an increasingly less effective (or more costly) instrument to maintain the exchange rate parity as the speculative demand for money increases. This is also compatible with the empirical evidence showing that small changes in the interest rate could easily revert capital flows in the pre-World War I Gold Standard (Eichengreen, 1996; Bordo, 1999), but no longer nowadays.

4. Conclusions

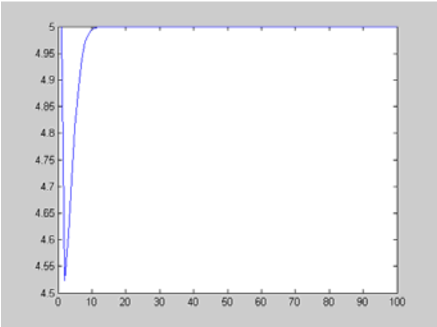
This paper shows that a decrease in transaction costs may increase volatility of money demand by allowing speculators to hold short-term liquid assets that can be sold during a speculative attack in exchange for international reserves. This increases the probability of currency crises that otherwise would be possible in the model only after major real shocks.

As a consequence of balance-of-payments crises, the business cycles of the model economy are amplified and sharp contractions are followed by fast recoveries. Additionally, interest rate policy becomes a less effective (or more costly) instrument to maintain the exchange rate parity as the speculative demand for money increase. This is also compatible with the empirical evidence showing that small changes in the interest rate could easily revert capital flows in the pre-World War I Gold Standard (Eichengreen, 1996; Bordo, 1999), but no longer nowadays.

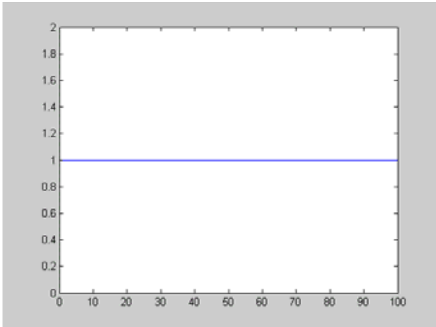
The paper also suggests that the persistence of the real effects of a currency crisis can be used to distinguish the causes of the crisis. If the origins of the balance-of-payment crises are on the real side of the economy, the effects are likely to be persistent and the recovery sluggish. In contrast, when the drop in international reserves is mainly due to speculation, the recovery is likely to be fast, as the drop in economic activity is due to the distortion caused by the expected devaluation at the time of the attack and not by persistent real shocks.

FIGURE 1

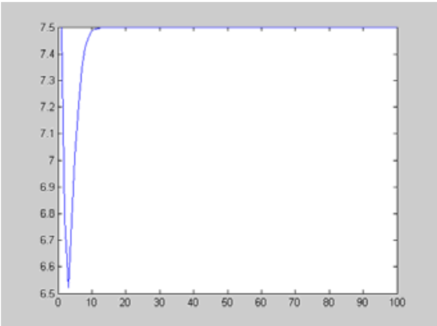
Small temporary productivity shock without speculation



Total Factor Productivity



Depreciation Rate



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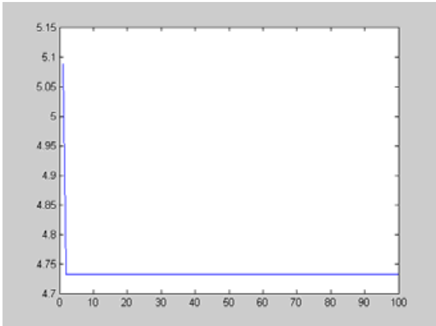
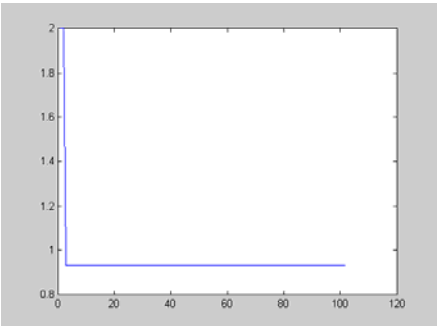
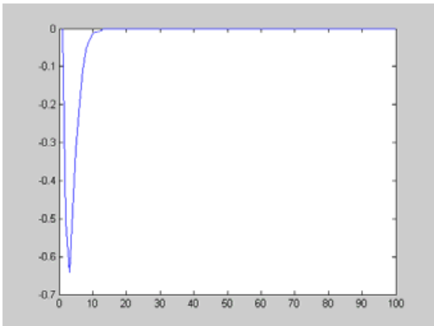


Consumption



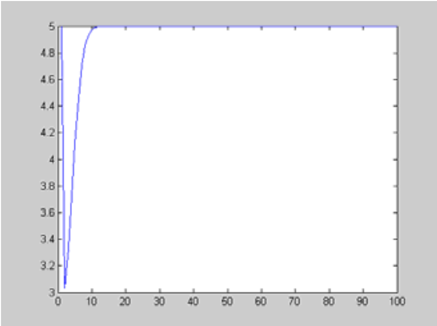
International Reserves



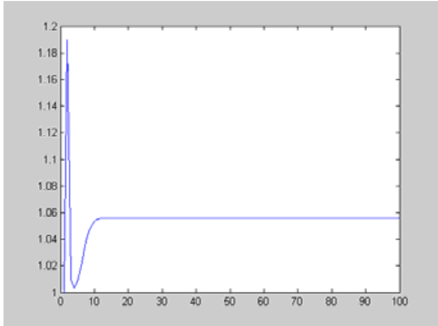
Current Account

FIGURE 2

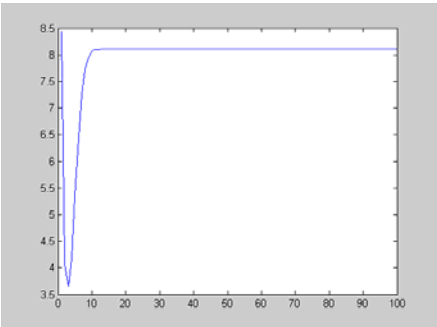
Large temporary productivity shock without speculation



Total factor Productivity



Depreciation Rate



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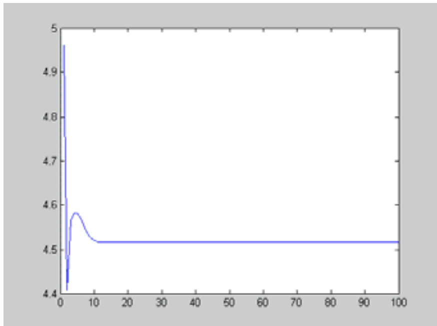
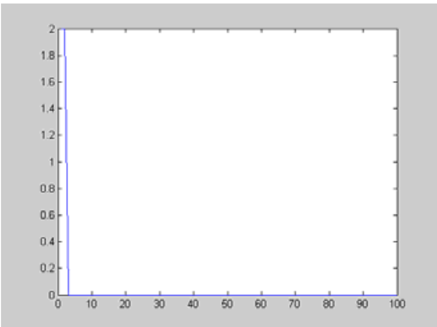
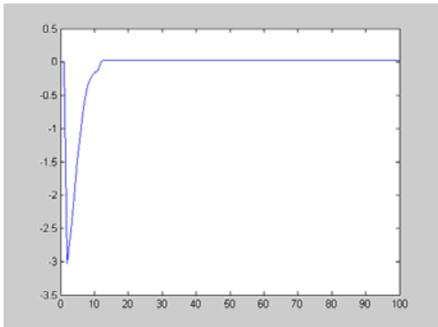


Consumption



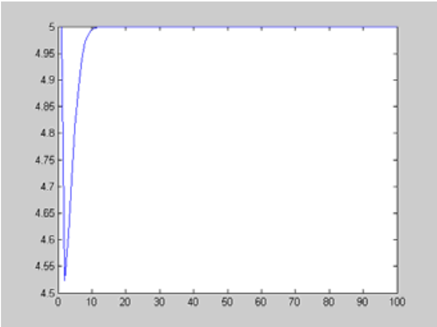
International Reserves



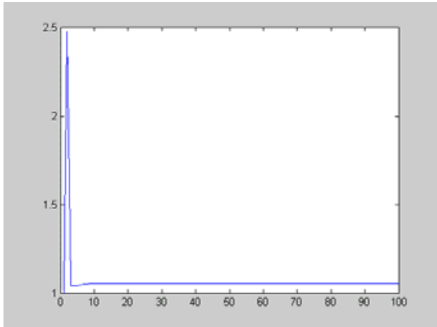
Current Account

FIGURE 3

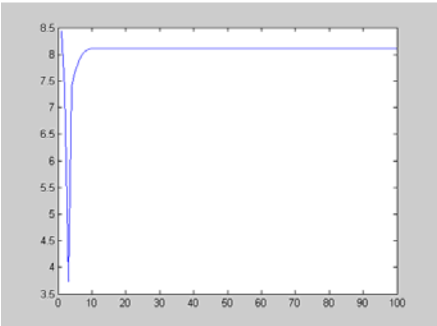
Small temporary productivity shock with speculation



Total Factor Productivity



Depreciation Rate



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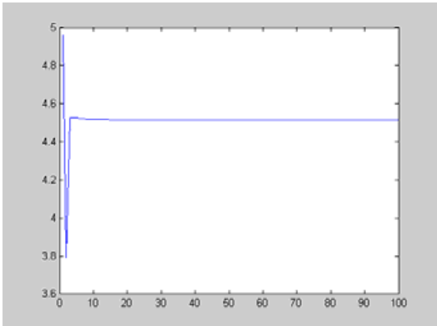
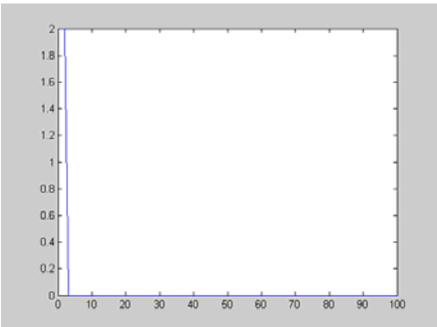
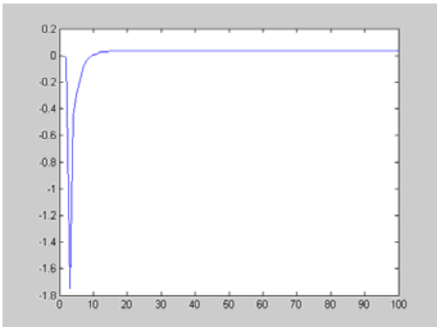


Consumption



International Reserves



Current Account

TABLE 1

The speed of the recovery

	Old Economy **Large Productivity Shock**	**Modern Economy** **Small Productivity shock**
$\frac{y_{crisis} - y_1}{y_1}$	-0.42	-0.13
$\frac{y_3 - y_1}{y_1}$	-0.56	-0.56
$\frac{y_4 - y_1}{y_1}$	-0.40	-0.12
$\frac{y_5 - y_1}{y_1}$	-0.29	-0.09
$\frac{y_6 - y_1}{y_1}$	-0.18	-0.07
$\frac{y_7 - y_1}{y_1}$	-0.11	-0.05
$\frac{y_8 - y_1}{y_1}$	-0.07	-0.04
$\frac{y_9 - y_1}{y_1}$	-0.05	-0.04
$\frac{y_{10} - y_1}{y_1}$	-0.04	-0.04

References

Baldwin, R. E. and Philippe M. (1999), Two Waves of Globalization: Superficial Similarities, Fundamental Differences, NBER W.P. #6904.

Bordo, M. D., B. Eichengreen, and D. A. Irwin (1999), Is Globalization Today Really Different than Globalization a Hundred Years Ago?, NBER W.P. # 7195.

Bordo, M. D. (1999), *The Gold Standard & Related Regimes: Collected Essays*, Cambridge UK, Cambridge University Press.

Bordo, M. D., B. Eichengreen, D. Kilngebiel, and M. S. Martinez-Peria (2001), Is the Crisis Problem Growing More Severe?, *Economic Policy*, Vol. 32, pp. 53-82.

Botman, D. P. J. and H. Jager (2002), Coordination of speculation, *Journal of International Economics*, Vol. 58, pp. 159-175.

Burnside, C., M. Eichenbaum and S. Rebelo (2003), Government Guarantees and Self-Fulfilling Speculative Attacks, forthcoming *Journal of Economic Theory*.

Calvo, G. A. (1987), Balance of Payments Crises in a Cash-in-Advance Economy, *Journal of Money, Credit, and Banking* Vol. 19, pp. 19-31.

Calvo, G. A. and C. A. Végh (1995), Fighting Inflation with High Interest Rates:The Small Open Economy Case under Flexible Prices, *Journal of Money, Credit, and Banking* Vol. 27, pp. 49-56.

Calvo, G. and E. Mendoza (1996), Mexico's balance-of-payments crisis: a chronicle of a death foretold, *Journal of International Economics*, Vol. 41, pp. 235-64.

Chang, R. and A. Velasco (1998), The Asian Liquidity Crisis, NBER W.P. #6796.

Cole, H. L. and T. J. Kehoe (1996), A self-fullfilling model of Mexico's 1994-1995 debt crisis, *Journal of International Economics,* Vol. 41, pp. 309-330.

Corsetti, G. and B. Mackowiak (2003), Fiscal Imbalances and the Dynamics of Currency Crises, mimeo, European University Institute.

Economist (2002), Five years on, p.13, July 6.

Eichengreen, B. J. (1996), *Globalizing Capital: A History of the International Monetary System*, Princeton, Princeton University Press.

Eichengreen, B. J., A. K. Rose and C. Wyplosz (1996), Is There a Safe Passage to EMU? Evidence on Capital Controls and a Proposal, in *The Microstructure of Foreign*

Exchange Market, Jeffrey A. Frankel, Giampaolo Galli and Alberto Giovannini, eds., Cambridge MA, National Bureau of Economic Research.

Eichengreen, B. and M. D Bordo (2002), Crises Now and Then: What Lessons from the Last Era of Financial Globalization?, NBER W.P. #8716.

Flood, R.P. and P.M. Garber (1984), Collapsing exchange-rate regimes: some linear examples, *Journal of International Economics*, Vol. 17, pp. 1-14.

Kamin, S. B. (1999), The Current International Financial Crisis: How much is New?, *Journal of International Money and Finance*, Vol. 18, pp.501-514.

Krugman, P. (1979), A Model of Balance of Payment Crises, *Journal of Money, Credit and Banking*, Vol. 11, pp. 311-325.

Kumhof, M. (2000), A Quantitative Exploration of the Role of Short-Term Domestic Debt in Balance of Payments Crises, *Journal of International Economics*, Vol. 51, pp. 195-215.

Lahiri, A. and C. A. Végh (2003), Delaying the Inevitable: Interest Rate Defense and Balance of Payments Crises, *Journal of Political Economy*, Vol. 111, pp. 404-424.

Mendoza, E. G. and M. Uribe (2000), The Business Cycles of Balance-of-Payments Crises: A Revision of A Mundellian Framework in *Money, Capital Mobility, and Trade: Essays in Honor of Robert A. Mundell*, ed. by G. Calvo, R. Dornbusch and M. Obstfeld, MIT Press, Cambridge:MA.

Morris, S. and H. S. Shin (1998), Unique Equilibrium in a Model of Self-Fullfilling Currency Attacks, *American Economic Review*, Vol.88, pp. 587-597.

Obstfeld, M. and A. M. Taylor (2003), *World Capital Markets: Integration, Crisis and Growth*, Cambridge, Cambridge University Press.

Obstfeld, M. and Alan M. Taylor (2002), Globalization and Capital Markets, NBER WP #8846.

Obstfeld, M. (1996), Models of Currency Crises with Self-Fulfilling Features, *European Economic Review*, Vol. 40, pp. 1037-1047.