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Journal of Corporate Finance 11 (2005) 351–374
Journal of CORPORATE FINANCE
www.elsevier.com/locate/econbase

Financial liberalization and the stability of currency pegs ☆

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Received 10 April 2002; received in revised form 1 July 2003; accepted 20 October 2003
Available online 4 February 2004

Abstract

This paper analyzes how the strategies of domestic firms borrowing abroad complicate the interaction between central banks and foreign exchange short sellers. If we define financial liberalization as the degree of freedom given to domestic firms to borrow abroad, we find that, in the early stages of financial liberalization, foreign borrowing does not affect the stability of the currency peg, but, in the advanced stages of financial liberalization, foreign borrowing destabilizes currency pegs. When this happens, we show that policies to curb currency short sellers have no effect. The paper thus formalizes the critical juncture where financial liberalization and currency pegs become incompatible policy goals.

JEL classification: G15; F31; F34; D84
Keywords: Corporate borrowing; Currency short sellers; Central bank intervention; Exchange rate pegs

1. Financial liberalization and the stability of currency pegs

> At a casual glance, the IMF's attitude towards exchange rates seems extraordinarily erratic. In 1997 the Fund urged Asian countries to devalue or float their currencies. In 1998 it lent billions to Russia and Brazil to try to help them maintain their exchange rates. It has praised Hong Kong for its super-strict currency board, and feted Singapore for its flexible managed float. Economist, January 30, 1999

☆ This paper has benefitted from comments from Franklin Allen, Gary Gorton, Campbell Harvey, B. Ravikumar, Richard Rosen and S. Viswanathan, and from seminar participants at KAIST (Seoul, Korea), Indiana and Wharton.

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doi:10.1016/j.jcorpfin.2003.10.002

To fix or to float a currency? This question has not been answered even after a century of debate.[1] It has tormented a number of countries, the most recent being Argentina. The basic argument in favor of fixing the currency is to recognize that a fiat currency has value because its users believe it will have value. Governments need to bolster this confidence by anchoring the currency. Anchoring also makes the currency stable, which has real economic benefits. The basic argument in favor of floating the currency is that, like all tradeable assets, its value should be determined by supply and demand without distortions. A floating currency allows a country to absorb external shocks through the exchange rate, and it allows it to conduct an independent monetary policy.

A few countries have opted to float their currencies, more or less freely (e.g., the Unites States). A few countries have decided to fix their currencies. These have involved currency boards, where a law guarantees a parity with another currency (e.g., Bulgaria), or even tighter currency unions, where national currencies are abandoned in favor of a supranational currency (e.g., the Euro). Many countries, however, have tried to have the best of both worlds, loosely tying their exchange rate either to a single foreign currency, such as the dollar, or to a basket of currencies. They have allowed their central banks to intervene in the foreign exchange market to defend the currency peg as long as it is feasible (e.g., Singapore).[2]

The purpose of this paper is to show that if a country allows its domestic firms to borrow abroad, it may find it difficult to keep its currency peg. This means that if countries find it beneficial to embark on a policy of financial liberalization, currency pegs would probably have to be abandoned.[3] Countries would have to choose between floating their currencies or fixing their currencies; they cannot have it both ways.

This is not the first paper demonstrating the incompatibility of fixed exchange rates and international capital mobility. It has been widely known to macroeconomists that fixed exchange rates, independent monetary policy and international capital mobility cannot coexist. They refer to this as the "impossible trinity," following Robert Mundell's seminal work in the 1960s.[4] The contribution of this paper is to provide another justification for this insight, a justification that arises as a result of the complex game played between central banks, foreign exchange short sellers and domestic firms borrowing abroad. We

[1] See McKinnon (1993) for an excellent historical review of the changes in the rules of international financial systems over the last century.

[2] For some recent history of central bank interventions in the foreign exchange market, see Dominguez (2003). For empirical work on this subject, see Dominguez (1990, 1992) and Dominguez and Frankel (1993). For a model that captures the strategic interaction between foreign exchange short sellers and central banks, see Bhattacharya and Weller (1997), and Morris and Shin (1998).

[3] In this paper, the phrase 'financial liberalization' would mean liberalization of the regulatory environment with respect to the first dimension of the six dimensions identified by Mahar and Williamson (1999)—allowing residents to borrow abroad, abolishing credit controls, deregulating interest rates, allowing free entry into the financial services industry, making banks autonomous and privatizing banks. Mahar and Williamson (1999) find that between 1973 and 1996 there has been dramatic financial liberalization in the world. It has increased efficiency in the allocation of capital, but its effect on savings has been ambiguous. Bekaert and Harvey (1995) argue convincingly that liberalization could also be nonregulatory. Markets may be segmented in laissez-faire regimes, and markets may be integrated in restrictive regimes. We will not discuss this type of liberalization in this paper.

[4] See Obstfeld and Rogoff (1995) for a lucid exposition of the issues.

formalize this game in a simple model, and use the model to pinpoint the critical juncture where financial liberalization and currency pegs become incompatible policy goals.

The model consists of a central bank, a foreign exchange short seller, and a domestic firm borrowing abroad. The central bank pegs its currency, which means that it commits itself to defending the currency.[5] The central bank enjoys a benefit from maintaining the peg (which we do not model), but bears a cost of defense, a cost that is increasing in the amount of local currency it has to purchase for defending it, and is decreasing in the strength of the economy. As would be intuitively expected, the equilibrium outcome is that the short seller attacks if and only if the fundamentals of the economy fall below a critical level.

The introduction of the third agent—the domestic firm borrowing abroad—complicates the interaction between the central bank and the foreign exchange short seller. The key insight of our paper is that corporate borrowers are the first movers in the game between them, foreign exchange short sellers and the central bank. They make foreign borrowing decisions based on their expectations of future exchange rate pegging policies, and these expectations are upheld in equilibrium. This leads to the main result of this paper: the foreign exchange short seller is the marginal agent in the early stages of financial liberalization, but the corporate borrower is the marginal agent in the later stages of financial liberalization. The intuition for this main result in our paper is as follows.

In the early stages of financial liberalization, the tax on foreign borrowing is high. To compensate for this, the firm will only borrow abroad if it expects the central bank to defend the local currency in all but the weakest states of the economy. The firm knows that the central bank can fulfil this expectation if the volume of currency sales by the other agents is below a low number. The firm also knows that, unfortunately, the currency sales by the foreign exchange short sellers is higher than this low number. Expectations of the firm are not fulfilled, and, in a Nash equilibrium, the firm will not borrow abroad. In turn, the only participant will be the foreign exchange short seller. He becomes the marginal agent. Therefore, the central bank's fight is only with foreign exchange short sellers, and these short sellers have to be curbed to strengthen the hand of the central bank.

In the later stages of financial liberalization, the tax on foreign borrowing is low. Therefore, the firm will not need as much compensation for borrowing abroad as before. This implies that it will borrow abroad even if it expects the central bank not to defend the local currency in all but the strongest states of the economy. The firm knows that the central bank can fulfil this expectation if the volume of currency sales by the other agents is below a high number. The firm also knows that the currency sales by the foreign exchange short seller is lower than this high number. Currency sales from the corporate

[5] There has been considerable policy debate, both in the policy area and among academics, about whether pegging a currency is wise (see, e.g., Adams and Henderson, 1983, The Jurgenson Report (1983) and Obstfeld, 1990). In this paper, we do not address the question as to whether central banks should or should not intervene in the foreign exchange market. Instead, we take central bank intervention as an established fact, and we go on to analyze how the strategies of domestic corporate borrowers complicate the interaction between central banks and foreign exchange short sellers.

borrower repaying his foreign loan, therefore, will make up the difference. Expectations of the firm will be fulfilled, and we will have a Nash equilibrium where the firm will borrow abroad. It is important to note here that if the currency sales of the foreign exchange short seller are decreased (increased) by regulatory action, the corporate borrower, knowing this, will borrow more (less) to keep his expectation of the total currency sales unchanged. It is in this sense that the corporate borrower becomes the marginal agent. This means that, if the central bank wants to strengthen its hand in its defense of the local currency, the agent it needs to curb is the domestic corporate borrower and not the foreign exchange short seller. This could be achieved by raising the tax on domestic borrowing abroad, or by any other regulatory means that makes borrowing abroad more difficult. It cannot be achieved by "bashing" foreign exchange short sellers.

That move raises a paradox. Why would the government want to curb its domestic firms from borrowing abroad if the country has embarked on a course of financial liberalization that, among other things, was intended to encourage, not discourage, its domestic firms from borrowing abroad? The only resolution to this paradox is to realize that currency pegs and financial liberalization may be incompatible policy objectives after a point. One of them has to go after this critical juncture is reached.

There is some evidence supporting our prediction that, in the advanced stages of financial liberalization, the instability of currency pegs may be a consequence of foreign borrowing by domestic corporations. Since late 1992, Finland, Sweden, Norway, Britain, Italy, Spain, Portugal, Mexico, the Czech Republic, Thailand, Indonesia, Malaysia, the Philippines, South Korea, Taiwan, Vietnam, Russia, Brazil, Turkey have been forced to abandon currency pegs. Argentina, recently, was forced to abandon its currency board, which is "harder" than a currency peg. The devaluations in Southeast Asia in 1997 were particularly dramatic.[6] Equally remarkable was the level of foreign borrowing by domestic firms in these countries.[7] In a recent paper, Henn (2003), in an examination of the currency crises in Latin America—Mexico (1994–1995), Brazil (1998–1999) and Argentina (2000–2002), finds that all of them had foreign exchange anchors that became unsustainable due, among other reasons, to excessive debt.

Many observers, both in academia and in the financial press, singled out this foreign borrowing binge on the part of domestic firms as a significant contributor to the crisis. In academia, a partial list of papers that did this would include Aghion et al. (2001), Allen and Gale (2003), Bris and Koskinen (2002), Burnside et al. (1999), Caballero and Krishnamurthy (2003), Chang and Valasco (1998), Chan-Lau and Chen (1998), Corsetti et al. (1999), Dornbusch (1998), Edison et al. (1998), Gande et al. (1999), Harvey and Roper (1999), Krugman (1998), Kumhof (1997), McKinnon and Pill (1996), Pomerleano (2003), and Sachs et al. (1996).

[6] Indonesia's currency fell 80%; South Korea, Malaysia, Philippines and Thailand currencies fell 35–50%.

[7] In Korea, debt maturing within a year exceeded US$100 billion, which was more than 10 times its foreign exchange reserves. The top 30 chaebol had an average debt–equity ratio of 400% (compared with 70% in the United States). In Thailand, the debt to foreign banks jumped from US$29 billion in 1993 to US$69 billion by mid-1997, 70% of which had a maturity of less than a year. In Indonesia, the ratio of foreign bank debt to GDP after the devaluation was 140%; most Indonesian banks and firms became technically bankrupt. (Economist, March 7, 1998, and the Oxford Analytica Brief (1997)).

Our paper fits in the above literature. What differentiates our paper from the above literature is that we focus on the effect the domestic firms have on the relationship between the central bank and the foreign exchange short sellers. Because the defense of a currency peg is essentially a noncooperative game between a central bank and foreign exchange short sellers, where short sellers base their strategies on their estimation of the strength of the economy and their conjecture of central bank policy, and central banks formulate their intervention policy taking into account the anticipated reactions of short sellers, we think it is important to model how this game and its results change when an important third agent—the domestic firm borrowing abroad—enters. To the best of our knowledge, this is the first paper which has analyzed this particular role of the domestic borrower.

The paper is organized as follows. In Section 2, we lay out the rules of the game between the three important players determining the stability of currency pegs—the central bank, the foreign exchange short seller and the domestic firm borrowing abroad. In Section 3, we invoke no-arbitrage arguments to show the relationships between certain economic variables. The interactions between the central bank and the foreign exchange short seller, and between the central bank and the domestic firm borrowing abroad, are analyzed in Section 4. We bring all the agents together in Section 5, where the main results of our paper are presented. Section 6 concludes with a discussion on future avenues for research.

2. The model

There are three players in our model: a central bank, a foreign exchange short seller and a domestic firm borrowing abroad. There are two time points, $t=0$ and $t=1$. Our model is adapted from Morris and Shin (1998). We introduce a third agent in their model—the domestic firm borrowing abroad—and we reduce the number of short sellers in their model to one. This is because the focus in our paper is to study the strategic interactions between three different types of agents, whereas the focus in Morris and Shin (1988) is to study the coordination problem between many foreign exchange short sellers.

We explain below what each of these three agents do at each time point.

2.1. The central bank and its economic environment

The central bank strives to defend a pegged currency at each of the two time points. The external environment of the economy at each time point is characterized by a set of fundamentals, θ, which is assumed to be independently drawn from a uniform distribution, whose support is the interval [0,1]. If θ turns out to be high, we interpret this to mean that the fundamentals of this economy relative to the world are strong, and the central bank finds it easy to defend its currency; if θ turns out to be low, we interpret this to mean that the fundamentals of this economy with respect to the world are weak, and the central bank finds it difficult to defend its currency. Therefore, θ is a summary statistic of every macroeconomic variable that has been known to help central banks defend their currencies—current account surpluses, foreign exchange reserves, low

government debt, domestic budget surpluses, low inflation and expectations of monetary tightening.[8]

The exchange rate is defined as the price of one unit of domestic currency in units of foreign currency. It is conjectured that if $\theta \leq \theta^*$, the government cannot defend its currency. At time $t=0$, $\theta_0 > \theta^*$, and exchange rate is pegged at e_0. At time $t=1$, θ_1 is realized. If $\theta_1 > \theta^*$, the central bank is successful in keeping the local currency pegged. Therefore, $e_1 = e_0$. If $\theta_1 \leq \theta^*$, the central bank is unsuccessful in its defense of the local currency, and the local currency depreciates to an exchange rate of $e_1(\theta_1) < e_0$. Here, $e_1(\theta_1) = g(\theta_1)\ \forall\ \theta_1 \in [0,\theta^*)$. The function $g(\theta_1)$ is monotonically increasing in θ_1. This means that when the central bank surrenders, the depreciation of the local currency is positively correlated to the underlying weakness of the economy. The parameter θ^* is endogenous; it is a conjecture that satisfies rational expectations and will be determined later in our analysis.

The objective of the central bank is to decide whether to intervene or not to intervene at $t=1$. If it decides not to intervene, its payoff is normalized to 0. If the central bank decides to intervene, its payoff is $v-c$. The central bank only intervenes if its payoff is positive. The benefit, v, aggregates all the benefits the government derives from fixing its currency, and we discussed these in the beginning of this paper. The cost, c, is the cost of defense. This cost of defense depends on the quantity of local currency that is purchased by the central bank to defend the exchange rate, m. This includes the local currency that is purchased by the central bank at time $t=0$ from potential currency short sellers and at time $t=1$ from corporate borrowers paying back their foreign loans. The cost of defense also depends on the fundamentals of the economy at time $t=1$, θ_1. Here, $m \in [0,\infty)$ and $\theta_1 \in [0,1]$. We make the reasonable assumption that c increases as m increases, and c decreases as θ_1 increases.

As in Morris and Shin (1998), we assume that $c(m,\theta_1=0) > v$ and $c(m,\theta_1=1) < v$. The former assumption implies that, in the worst state of the economy, the cost of defense always exceeds its benefits, whereas the latter assumption implies that, in the best state of the economy, the benefit of defense always exceeds its costs. Given these assumptions, it is easy to see that there exists a θ_L where $c(m=0,\theta_1=\theta_L)=v$, and there exists a θ_H where $c(m\rightarrow\infty,\theta_1=\theta_H)=v$. Assuming $\theta_L < \theta_H$, fundamentals can be classified into three zones:

[8] The equilibrium determination of exchange rates is a vast and controversial literature. See pages 345–437 in Sercu and Uppal (1995) for a lucid description of the various approaches that have been used to model the supply and demand of currencies. A particular attractive feature of Morris and Shin (1998) is that they skirt these controversies by summarizing the effect of all primitive parameters that are supposed to affect exchange rates in one summary statistic—θ. This allows them to tell their story without needless distractions. Similarly, we interpret θ in this paper as a summary statistic of the economic fundamentals of a country that affects its exchange rates. We, however, can broaden the interpretation of θ to include factors outside the country that also affects its exchange rates. This means that our model can accommodate contagion, a phenomenon where the local economy suffers a crisis because of a crisis outside its borders (e.g., the Mexican "tequila" crisis of 1994, the Asian "flu" of 1997 or the Russian "virus" of 1998). Contagion could be rational (see Kaminsky and Reinhart, 2000, for a careful analysis of the rational determinants of contagion in foreign exchange markets) or irrational (see Daouk and Trivedi, 2003, who could not detect any plausible reason for the EMS crisis of 1992–1993). As long as θ affects exchange rates and as long as θ is observable to the central bank and to the currency short sellers, our model can accommodate both domestic and foreign factors that affect θ, whether the factors are rational or behavioral.

(1) $\theta_1 \in [0, \theta_L]$, the zone where the currency is not defensible; (2) $\theta_1 \in (\theta_L, \theta_H]$, the interesting zone where the outcome depends on the realization of the fundamental θ_1; and (3) $\theta_1 \in (\theta, 1]$, the zone where the currency is not attackable.

Finally, let $m(\theta_1)$ be the value of m, which solves $c(m,\theta_1) = v \ \forall \ \theta_1 \in (\theta_L, \theta]$. $m(\theta_1)$ is interpreted as the maximum currency purchase that the central bank can make to defend its currency or, equivalently, the minimum currency sales needed to "defeat" the central bank. It is a function of the fundamentals of the economy θ_1. Fig. 1—which is a simplified version of Fig. 3 in Morris and Shin (1998)—depicts this function. As one would expect, $m(\theta_1)$ is zero in the zone where the currency is not defensible, $m(\theta_1)$ is continuous and strictly increasing in fundamentals in the zone where the outcome depends on the realization of the fundamental, and $m(\theta_1)$ is infinite in the zone where the currency is not attackable.

Fig. 1 tells us that in economies with stronger fundamentals, more currency sales by others is needed to defeat the central bank in its objective of maintaining the currency peg. Note that, if the fundamental $\theta_1 \leq \theta_L$, no currency sales by others is needed because, as the economy is so weak, the central bank will devalue its currency immediately. Note also that, if the fundamental $\theta_1 > \theta_H$, the economy is so strong that the central bank will win however large the currency sales against it are.

2.2. The foreign exchange short seller

The foreign exchange short seller, at time $t = 0$, discovers what θ_1 is going to be the next period. Based on this information, he decides on whether he should short sell the domestic

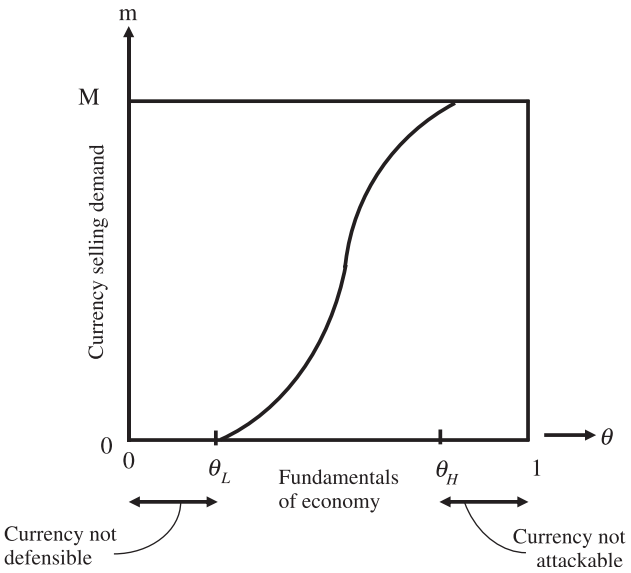

Fig. 1. Minimum currency sales needed to "defeat" the central bank as a function of the fundamentals of economy.

currency or not at time $t=0$. He is risk-neutral. His objective is to maximize his profits at time $t=1$. His payoff at time $t=1$ is modeled in the following way. If a short seller decides not to participate in the foreign exchange market, his payoff is normalized to zero. If a short seller decides to short sell the domestic currency at $t=0$, his payoff at $t=1$ depends on whether the central bank is successful in its defense of the currency. If the short seller short sells, and he loses against the central bank, his payoff is a loss. On the other hand, if the short seller short sells, and he wins against the central bank, his payoff is a profit. We detail below how to calculate the foreign exchange short seller's loss if the central bank wins, and the foreign exchange short seller's profit if the central bank loses.

Let r (r^*) be the domestic (foreign) risk-free interest rate. If the foreign exchange short seller borrows one unit of the local currency from the local market for short selling at time $t=0$, his borrowing cost is $(1+r)$ in local currency. He converts this local currency to foreign currency at time $t=0$, invests it for one period in foreign risk-free bonds, and obtains $(1+r^*)$ in foreign currency at time $t=1$. He reconverts it back to local currency at time $t=1$. His revenue at time $t=1$, is $(1+r^*)e_0/e_1(\theta_1))$, where e_0 and $e_1(\theta_1)$ are the exchange rate at time $t=0$ and the exchange rate at time $t=1$ respectively. Therefore, the cost of carry of the short in local currency is $[(1+r)-(1+r^*)e_0/(e_1(\theta_1))]$. In foreign currency, which is the numeraire currency of the foreign exchange short seller, the cost of carry of the short is $[(1+r)/e_0-(1+r^*)/(e_1(\theta_1))]$. If the central bank wins, $e_0=e_1(\theta_1)$, and so the foreign exchange short seller's loss is $(r-r^*)/e_0$ in units of foreign currency at time $t=1$. If the central bank loses, $e_0>e_1(\theta_1)$, and so the foreign exchange short seller's profit is $[(1+r^*)/(e_1(\theta_1))-(1+r)/e_0]$ in units of foreign currency at time $t=1$. Eq. (8) will show that $r>r^*$. This implies that the foreign exchange short seller's loss at time $t=1$ if the central bank wins is always positive. This means that the foreign exchange short seller will not take a short position at time $t=0$ if he discovers that $\theta_1>\theta^*$ because, if this is the case, the central bank will win for sure and the foreign exchange short seller will lose for sure at time $t=1$. We will now assume that the maximum value of $e_1(\theta_1)$, when θ_1 is in the region $0\le\theta_1\le\theta^*$, is lower than $(1+r^*)e_0/(1+r)$. This ensures that the foreign exchange short seller's profit at time $t=1$ when the central bank loses—$[(1+r^*)/(e_1(\theta_1))-(1+r)/e_0]$—is always positive. This will ensure that the foreign exchange short seller will always take a short position at time $t=0$ if he discovers that $\theta_1\le\theta^*$ because, if this is the case, the central bank will lose for sure and the foreign exchange short seller will win for sure at time $t=1$. The above assumption thus captures the notion that foreign exchange short sellers attack only after they detect a vulnerability of the central bank when the economy is weak.

The above formulation of short seller payoffs assumes that the foreign currency is the numeraire currency for the short seller, an assumption that could easily be changed, but that would make the algebra more tedious without adding any economic insight. We now need an assumption to restrict trade sizes. This assumption is needed because, if we do not restrict trade sizes, risk-neutral agents will either not short sell or short sell infinite amounts.[9] Therefore, with some loss of generality, we assume that the currency short sellers will short sell 0 or short sell S.

[9] A similar argument is made in market microstructure models to restrict agents to buy or sell just one share (see Glosten and Milgrom, 1985).

2.3. The domestic firm

The domestic firm has a domestic project that requires an investment of one unit local currency at $t = 0$. If undertaken, these projects return R in local currency at $t = 1$. The domestic firm is risk-neutral. Its objective is to maximize its expected profits at $t = 1$. The numeraire currency for the domestic firm is the local currency.

The domestic firm has no money of its own. It can finance the project by either borrowing from domestic banks at an interest rate r_d (which is endogenous and would be determined later) or by borrowing from foreign banks at an interest rate r_f (which is also endogenous and would be determined later). It has to make its investment and borrowing decision at $t = 0$; so, unlike the short sellers and the central bank, its decision *cannot be contingent* on the realization of the fundamental θ_1 at $t = 1$.

As the domestic firm faces the choice of whether to borrow locally or borrow abroad at $t = 0$, it seems natural for us to define the existing government policy of financial liberalization as the degree of freedom given to domestic firms to borrow abroad. In particular, assume that the government can tax the local currency profits of the domestic firm if it borrows abroad.[10] Let the tax rate be t_B. The lower the tax is, the higher the level of financial liberalization achieved by this country would be.

If the domestic firm borrows from the foreign bank at time $t = 0$, it may choose to hedge at $t = 0$ the currency risk it will face at $t = 1$, but, because it is risk-neutral, this is not an issue.[11]

2.4. Other players

Foreign banks are risk-neutral, and they operate in a competitive environment. Therefore, they make zero expected profits. They can offer an interest rate, r_f, to the domestic firm. This interest rate, r_f, is influenced by the risk-free interest rate that the

[10] Any policies that curb the inflow and/or outflow of foreign capital to and from a country are capital control policies. These regulations include, but are not limited to, prohibitions or tax on local institutions raising money abroad, prohibitions or tax on foreigners selling foreign financial assets locally or buying local financial assets, prohibitions or tax on interest and dividends earned by locals investing abroad or foreigners investing locally, reserve requirements and time-intensive approval requirements. As all these regulations are "sand-in-the-wheel" regulations, they can be modeled, with some loss of generality, as a tax on the profits of the local firm that borrows abroad.

[11] In our model, because the domestic firm is risk-neutral, and because default has no costs like loss of tax shelters or loss of managerial reputation, the firm has no incentive to hedge. In the real world, however, firms do hedge. In our model, if the firms hedge at time $t = 0$, the provider of the hedge will insure the firm against default in the event of a currency devaluation at time $t = 1$. However, now, instead of the firm selling local currency to buy foreign currency to repay its loan at time $t = 1$, it will be the provider of the hedge who will be doing this. Therefore, although default has been averted, the selling of local currency at time $t = 1$ by an agent other than the foreign exchange short seller has not been averted. The results of our model will still go through. The results of our model will not go through if the provider of the hedge does not sell local currency to provide foreign currency at time $t = 1$, but does it, if at all, at a future time. In that case, we appeal to a recent paper by Caballero and Krishnamurthy (2003), who explain that agents always undervalue insuring against exchange rate depreciation because of financing constraints in emerging markets. Therefore, although they may be risk-averse, firms in reality choose to hedge very little at time $t = 0$.

foreign bank can obtain by lending its funds in the foreign market itself. Let this rate be r^*, which is exogenous. The numeraire currency for the foreign banks is the foreign currency.

Domestic banks are risk-neutral, and they operate in a competitive environment. Therefore, they also make zero expected profits. They can offer an interest rate, r_d to the domestic firm. This interest rate, r_d, is influenced by the risk-free interest rate that the domestic bank can obtain by lending its funds in the domestic market itself. Let this rate be r. The numeraire currency for the domestic banks is the local currency.

Domestic banks can also borrow from foreign banks and lend this money out to the domestic firm. As a matter of fact, domestic banks are significant borrowers from abroad in emerging markets. However, because domestic banks do not have a comparative advantage over the domestic firm with regards to interactions with the foreign banks in our model, we assume, for simplification, that the domestic firm interacts directly with the foreign banks or just uses the domestic banks as intermediaries.

The domestic firm can approach domestic banks for a loan, and, because the project is riskless in the domestic currency unit and the market for domestic lending is competitive, the loan rate r_d would not be more nor less than the domestic riskless interest rate r. Therefore,

$$r_d = r \tag{1}$$

2.5. The time line

We summarize below the main events at the two time points, $t = 0$ and $t = 1$.

Time $t = 0$. θ_0 is above θ^*, and so, exchange rate is pegged at e_0. Corporate borrowers make their decisions about borrowing in foreign currency from foreign banks. They know the distribution of θ_1 next period, and they have conjectures about the strategies of the other players. Foreign exchange short sellers know what θ_1 is going to be next period. Based on this information, they decide whether to short sell or not.

Time $t = 1$. θ_1 is realized. If θ_1 is above θ^*, the central bank is successful in keeping the local currency pegged. Therefore, $e_1 = e_0$. If θ_1 is below or equal to θ^*, the central bank is unsuccessful in its defense of the local currency, and the local currency depreciates to an exchange rate of $e_1(\theta_1) < e_0$. Foreign exchange short sellers close their positions and realize profits, if any. Corporate borrowers pay off their loans, if they can. Banks realize their profits, if any. The central bank realizes its utility.

We are now in a position to invoke no-arbitrage arguments to show the relationships between some economic variables.

3. Some parity conditions

If the domestic firm borrows from the domestic bank at $t = 0$, its after-tax profits after paying off the loan at $t = 1$ would be

$$R - (1 + r_d) = R - (1 + r) \tag{2}$$

An implicit assumption in Eq. (2) is that $R \geq (1 + r)$. This assumption is needed because, if $R < (1 + r)$, no domestic bank will lend to the domestic firm.

If the domestic firm approaches the foreign bank for a loan, the loan rate it will receive is r_f. It will borrow one unit of local currency for the project at $t=0$ which is equivalent to borrowing e_0 units of foreign currency from the foreign bank. As r_f is the loan rate, the payment due at $t=1$ is $e_0(1+r_f)$ units of foreign currency or, equivalently, $[e_0(1+r_f)]/e_1$ units of local currency. However, R is the maximum (in units of local currency) that it can pay back. This implies that if $[e_0(1+r_f)]/e_1]>R$, devaluation will lead to default.[12] To ensure that this always happens, a sufficient condition is: the maximum value of $e_1(\theta_1)$, when θ_1 is in the region $0\le\theta_1\le\theta^*$, is lower than e_0/R.

The above discussion implies that if the central bank is able to defend its currency —e_1 remains at e_0—at time $t=1$, the probability of which occurring is conjectured to be $1-\theta^*$, the domestic firm can repay from its revenue its obligations to the foreign bank as well as pay a foreign borrowing tax to its government. Therefore, its after-tax profits at time $t=1$, in units of the local currency, is $[R-\{[e_0(1+r_f)]/e_1\}][1-t_B]=[R-(1+r_f)][1-t_B]$. If, on the other hand, the central bank is not able to defend its currency at time $t=1$, the probability of which occurring is conjectured to be θ^*, the domestic firm defaults. In that case, the domestic firm has no profits, and so, it does not have to pay any tax. Therefore, in units of local currency, the expected profits of the domestic firm at time $t=1$ is

$$[R-(1+r_f)][1-\theta^*][1-t_B] \tag{3}$$

Eq. (3) assumes that there is no direct or indirect cost of bankruptcy when the domestic firm fails to pay its foreign bank.[13] For both local borrowing and foreign borrowing to coexist, the domestic borrower has to be indifferent between borrowing locally and borrowing abroad. Therefore, Eq. (2) equals Eq. (3). This gives us

$$[R-(1+r)]=[R-(1+r_f)][1-\theta^*][1-t_B] \tag{4}$$

From Eq. (4), it is apparent that the local borrowing rate obtained by the domestic firm, $r_d=r$, is greater than the foreign borrowing rate it obtains, r_f. The intuition for Eq. (4) is as follows. From the point of view of the domestic borrower, local borrowing, compared to foreign borrowing, has a tax advantage as well as no possibility of default. Therefore, the domestic borrower will be indifferent between local borrowing and foreign borrowing only if foreign borrowing rates are lower; that is $r_f<r=r_d$.

The foreign bank can lend e_0 in foreign currency to foreign riskless borrowers at $t=0$, and, as r^* is the foreign riskless rate, it would get back at $t=1$ in units of foreign currency

$$e_0[1+r^*] \tag{5}$$

Alternatively, it could lend e_0 in foreign currency to the domestic firm at $t=0$. If the central bank is able to defend its currency at $t=1$, the probability of which occurring is conjectured to be $1-\theta^*$, the domestic firm can repay its obligations to the foreign bank,

[12] Note that if $[e_0(1+r_f)]/e_1]\le R$, the foreign loan is riskless, and there is no default. Therefore, the condition $[e_0(1+r_f)]/e_1]>R$ captures one of the most prominent features observed in the Asian crisis of 1997–1998; currency depreciations caused a lot of domestic firms to default on their foreign loans.

[13] We can easily incorporate these costs of bankruptcy. The effect this would have in our model is to discourage foreign borrowing, but, because the borrowing tax t_B achieves just that, we do not gain more economic insights by adding this variable.

which equals $e_0(1+r_f)$ in units of foreign currency. If, on the other hand, the central bank is not able to defend its currency at $t=1$, the probability of which occurring is conjectured to be θ^*, the domestic firm defaults on its payments, and the foreign bank gets to keep whatever the domestic firm has, which is e_1R in units of foreign currency. Therefore, in units of foreign currency, its expected takings at $t=1$ are

$$e_0[1+r_f][1-\theta^*]+\bar{e}_1^*\ R\theta^* \qquad \text{where } \bar{e}_1^* = E(e_1 \mid 0\le\theta_1\le\theta^*)$$

$$= \frac{1}{\theta^*}\int_0^{\theta^*} g(\theta_1)\mathrm{d}\theta_1 = \frac{G(\theta^*)-G(0)}{\theta^*} \tag{6}$$

Competition among foreign banks ensures that the rate foreign banks charge domestic corporate firms are driven down till Eq. (5) equals Eq. (6). This gives us

$$(1+r^*) = (1+r_f)(1-\theta^*)+\frac{\bar{e}_1^* R\theta^*}{e_0} \tag{7}$$

As we had assumed that default occurs when there is devaluation, the lending rate the foreign bank obtains by lending to the domestic firm that can default, r_f, has to be greater than the riskless foreign lending rate r^*. If we substitute out r_f from Eqs. (4) and (7), we get:

$$\frac{R-(1+r)}{\frac{R}{e_0}\left[(1-\theta^*)e_0+\theta^*\left(\frac{G(\theta^*)-G(0)}{\theta^*}\right)\right]-(1+r^*)} = \frac{R-(1+r)}{\frac{R}{e_0}[E(e_1)]-(1+r^*)} = 1-t_B \tag{8}$$

The domestic risk-free interest rate, r, will be linked to r^*, the exogenous foreign risk-free interest rate through the uncovered interest rate parity relationship. However, conventional uncovered interest rate parity—$(1+r)=(1+r^*)e_0/E(e_1)$—as given in international finance textbooks, will not hold here. To see why, notice that, if we substitute the expression for conventional uncovered interest rate parity in the left-hand side (LHS) of Eq. (8), the left-hand side simplifies to $e_0/E(e_1)$. As $e_0>E(e_1)$, the left-hand side is greater than 1. The right-hand side (RHS) of Eq. (8) is less than 1. Therefore, Eq. (8) cannot be an equation if conventional uncovered interest rate parity held.

The intuition why conventional uncovered interest rate parity relationship cannot hold in our economy is as follows. Conventional uncovered interest rate parity assumes, among other things, frictionless borrowing and lending between countries. In our economy, if the domestic bank is not charged a tax on foreign borrowing, but the domestic firm is, the domestic firm will use the domestic bank as an intermediary to borrow from abroad and, consequently, will pay no tax. This violates an integral assumption in our model. To prevent this tax shelter, the government can either forbid domestic banks from borrowing abroad or it can levy a tax on the domestic bank if it borrows abroad, a tax that makes the domestic borrower indifferent to using a domestic bank as an intermediary and not using a domestic bank as an intermediary. In this case, some domestic banks will lend only locally at an interest rate r, whereas other banks will act as intermediaries with the same local lending rate r. This means that, although r may be assumed to be exogenous, it is linked to r^* through Eq. (8). Eq. (8), therefore, is the uncovered interest rate parity of our model economy.

Note two facts about Eq. (8). Firstly, as the RHS of Eq. (8) is less than 1, so should the LHS of Eq. (8). This means that the denominator of Eq. (8) should be larger than the numerator. It is easy to show that this can only happen if r is greater than r^*.

Secondly, note that the first derivative of $(-e_0\theta^* + G(\theta^*))$ with respect to θ^* is $(-e_0 + g(\theta^*))$. As $e_0 > g(\theta^*)$ by assumption, this derivative is negative. This implies that $(-e_0\theta^* + G(\theta^*))$ is decreasing in θ^*, which implies that the LHS of Eq. (8) is increasing in θ^*. Thererfore, t_B in the RHS of Eq. (8) must be decreasing in θ. We obtain our first lemma.

Lemma 1. *θ^* and t_B are inversely correlated.*

This lemma is important because it tells us that the central bank may, under circumstances we shall determine later, increase the stability of the currency peg (the lower the θ^*, the higher the stability of the currency peg) by raising foreign borrowing taxes (increasing t_b).

We are now in a position to analyze the interactions between the various agents.

4. The interactions between the various agents

4.1. Interaction between the foreign exchange short seller and the central bank when there are no domestic firms borrowing abroad

It is clear from our previous discussion that the foreign exchange short seller, after observing the fundamental θ_1 at time $t = 0$, will not short sell at $t = 0$ if he observes that $\theta_1 > \theta^*$ because it is his conjecture that the government can successfully defend its currency at $t = 1$ if $\theta_1 > \theta^*$, and he will lose if he short sells. On the other hand, the short seller will short sell at $t = 0$ if he observes at $t = 0$ that $\theta_1 \leq \theta^*$ because it is his conjecture that the government will surrender at $t = 1$ if $\theta_1 \leq \theta^*$, and he will gain if he short sells.

How do we obtain a θ^* in a Nash equilibrium? The answer to this question is given in our next proposition.

Proposition 1. *The point at which the central bank surrenders is θ^*. It is the point of intersection of horizontal line S and $m(\theta_1)$ in Fig. 2.*

As this result is so intuitive, we prefer to give a graphical proof using Fig. 2. If the short seller conjectures that the defense of the currency will be successful at $t = 1$ if $\theta_1 > \theta^*$, and will not be successful at $t = 1$ if $\theta_1 \leq \theta^*$, his optimal strategy is to short sell at $t = 0$ a quantity $S(\theta_1)$. $S(\theta_1)$ will equal S if $\theta_1 \leq \theta^*$, and will be zero if $\theta_1 > \theta^*$. $S(\theta_1)$ is given by the solid line with arrows in Fig. 2. This line tells us that there will be no short selling to the right of θ^*. Why short sell when you will lose for sure? This line also tells us that a quantity S of the local currency will be short sold to the left of θ^*. This happens because, in this region, the foreign exchange short seller will win and make a profit for sure. If the central bank conjectures that the above is the strategy of the short seller, the central bank's optimal strategy is to not fight (fight and win) to the left (right) of θ^*. This is because $m(\theta_1)$, the maximum currency sales that the central bank can purchase to defend the local

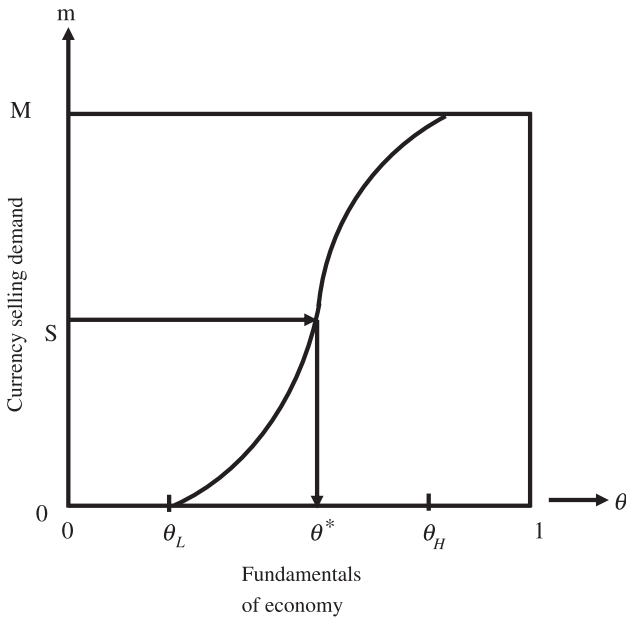

Fig. 2. Equilibrium when there is no domestic firm borrowing abroad.

currency, is below (above) S to the left (right) of θ^* in Fig. 2. Conjectures on the other's strategies are upheld, and we have a Nash equilibrium.

Define the stability of a currency peg as the probability that the peg will be defended. In our model, this is just $1-\theta^*$. Therefore, if θ^* increases, we conclude that the currency peg has become more unstable. Fig. 2 substantiates some of our intuitive hunches on the stability of currency pegs. Firstly, a curb on foreign exchange short sellers lowers S, which from Fig. 2 is seen to lead to a decrease in θ^*. Therefore, the currency peg becomes more stable if foreign exchange short sellers are curbed. Secondly, recall that we defined $m(\theta_1)$ as the value of m which solved $c(m,\theta_1)=v\ \forall\ \theta_1\in(\theta_L,\theta_H]$. This was interpreted in Fig. 1 as the minimum currency sales that is needed by others to force the central bank to surrender the defense of its currency. Therefore, for a given θ_1, if c increases, $m(\theta_1)$ will decrease. As weaker central banks have a higher cost of defense, the curve $m(\theta_1)$ is lower in Fig. 2 which is seen to lead to an increase in θ^*. Therefore, the currency peg is more unstable for weaker central banks.

It should be noted here that these results may not hold when domestic corporate borrowers are present.

4.2. Interaction between the domestic firm and the central bank when foreign exchange short sellers do not exist

It is clear that, unlike the short seller and the central bank, the domestic corporate borrower signs its loan contract at $t=0$ before the realization of θ_1. Recall that we argued that, if domestic and foreign loan markets have to coexist, there cannot be any arbitrage

between these two markets. This implies that the domestic firm has to be indifferent between borrowing abroad and borrowing locally. Therefore, the domestic firm will mix its strategy. It will borrow some money abroad and it will borrow some money locally. How do we pin down how much of the foreign currency the domestic firm wants to sell at $t=1$ to repay the foreign loan it acquired at $t=0$ in a Nash equilibrium? The answer to this question is given in our next proposition.

Proposition 2. *Solve for θ^* from Eq. (8). To repay its foreign loan, the domestic firm wants to sell an amount b^* of the local currency at $t=1$, where b^* is the point of intersection of vertical line θ^* and $m(\theta_1)$ in Fig. 3.*

As this result is also intuitive, we prefer to give a graphical proof using Fig. 3. If the corporate borrower conjectures that the defense of the currency will be successful at $t=1$ if $\theta_1>\theta^*$, but the central bank will surrender at $t=1$ if $\theta_1 \le \theta^*$, its optimal strategy at $t=0$ is to borrow foreign currency, such that at $t=1$ it would have to repay a foreign currency amount b^*. Why is this? Because if repayment is higher than b^* at $t=1$, notice from Fig. 3 that the successful defense region of the central bank will shrink, and the surrender region will expand, which implies that the belief of the corporate borrower will not be upheld. If repayment is lower than b^* at $t=1$, notice from Fig. 3 that the successful defense region of the central bank will expand and the surrender region will shrink, which implies that the belief of the corporate borrower will not be upheld. If the central bank conjectures that the above is the strategy of the corporate borrower, the central bank's optimal strategy is to not fight (fight and win) to the left (right) of θ^*. This is because $m(\theta_1)$, the maximum currency sales that the central bank can purchase to defend the local currency, is below (above) b^* to

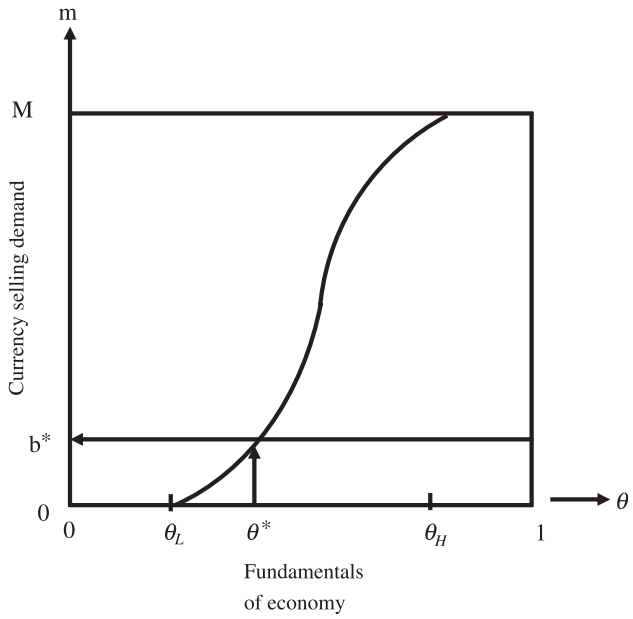

Fig. 3. Equilibrium when there is no foreign exchange short seller.

the left (right) of θ^* in Fig. 3. Conjectures on the other's strategies are upheld, and we have a Nash equilibrium.

Proposition 2 leads to the following corollary.

Corollary 1. *The higher the stage of financial liberalization (lower t_B), the more unstable the currency peg (higher θ^*) is.*

The proof follows directly from Lemma 1. It should be noted here that these results may not hold when short sellers are present.

We are now in a position to bring all agents together, solve for the Nash equilibrium and analyze the properties of the equilibrium.

5. The effect of financial liberalization on the stability of currency pegs

We will analyze two regimes: a regime in the early stages of financial liberalization and a regime in the advanced stages of financial liberalization. In the first regime, domestic firms are discouraged from borrowing abroad by the imposition of high tax rates on profits earned by borrowing abroad; in the second regime, domestic corporate borrowers are encouraged to borrow abroad by the lowering of these tax rates. For us to be able to make a precise distinction between these two regimes, we have to define a variable t^*.

Solve for θ^* in Fig. 2. It is the point of intersection of the horizontal line S with the curve $m(\theta_1)$ in Fig. 2. Define $\theta^s \equiv \theta^*$. Now solve for $\theta^*(t_B)$ from Eq. (8). Define $\theta^b \equiv \theta^*(t_B)$. The t_B that equates θ^s to $\theta^b(t^B)$ is t^*.

Given the above definition of t^*, it follows from Lemma 1 that, when $t_B > t^*$, $\theta^s > \theta^b(t^B)$, and, when $t_B < t^*$, $\theta^s < \theta^b(t_B)$. We are now in a position to define the two regimes. If $t_B > t^*$, we will interpret this to mean that domestic firms are discouraged from borrowing abroad by the imposition of high tax rates on profits earned by borrowing abroad. This is a regime which is in the early stages of financial liberalization. If $t_B < t^*$, we will interpret this to mean that domestic firms are encouraged to borrow abroad by the lowering of the tax rates on profits earned by borrowing abroad. This is a regime which is in the advanced stages of financial liberalization.

Let us now try to solve for the Nash equilibrium of a regime that is in the early stages of financial liberalization. Once we solve for this equilibrium, we will analyze how the various deep parameters of the economy, especially policy variables, can affect the stability of the currency peg.

5.1. The early stages of financial liberalization

Domestic corporate borrowers are discouraged from borrowing abroad by the imposition of high tax rates on profits earned by borrowing abroad. Here, $t_B > t^*$. This is a regime which is in the early stages of financial liberalization.

Theorem 1. *The point at which the central bank surrenders is θ^*. It is the point of intersection of horizontal line S and $m(\theta_1)$ in Fig. 4. The only currency seller is the foreign*

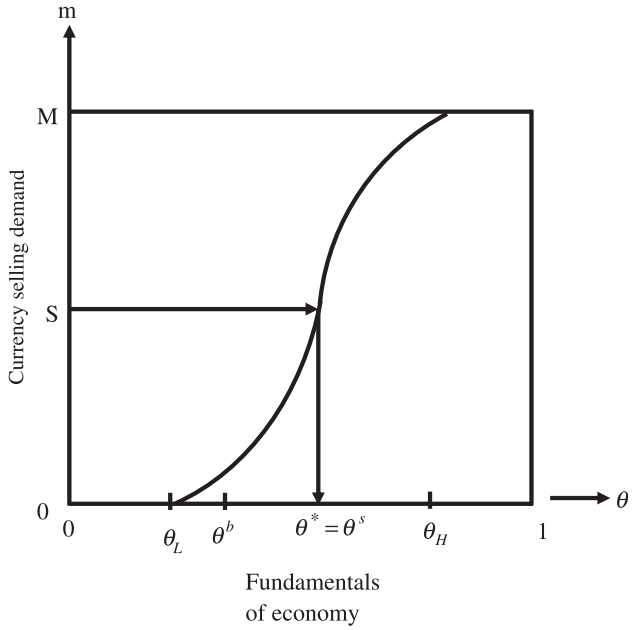

Fig. 4. Equilibrium in the early stages of financial liberalization.

exchange short seller. He will short sell an amount S of local currency at $t = 0$ if he observes that $\theta_1 > \theta^*$; he does not short sell at $t = 0$ of he observes that $\theta_1 > \theta^*$.

We give a graphical proof by using Fig. 4. If the corporate borrower conjectures that the defense of the currency will be successful at $t = 1$ if $\theta_1 > \theta^*$, but the central bank will surrender at $t = 1$ if $\theta_1 \leq \theta^*$, its optimal strategy is to not borrow foreign currency at $t = 0$. Why? As $\theta^* = \theta^s > \theta^b(t_B)$, and as $\theta^b(t_B)$ is the conjecture which makes the domestic firm indifferent between borrowing abroad and borrowing locally, if $\theta^* = \theta^s$ is its conjecture, it will not borrow abroad. This is because the region in which the currency is defended has shrunk, and so, borrowing abroad is dominated by borrowing locally [see Eq. (8)]. Therefore, the only currency seller will be the foreign exchange short seller. The analysis of this situation is tantamount to studying the interaction between the foreign exchange short seller and the central bank when there are no domestic firms borrowing abroad. We have done this in Section 4.1. The rest of the proof is identical to the proof of Proposition 1.

Theorem 1 leads to the following corollaries.

Corollary 2. *In the early stages of financial liberalization, the domestic firm will choose not to borrow abroad.*

Corollary 3. *In the early stages of financial liberalization, the central bank can improve the stability of the currency peg by curbing the foreign exchange short seller.*

Theorem 1 and its corollaries present an interesting set of conclusions. They tell us that, in the early stages of financial liberalization, it is the foreign exchange short seller that is the marginal player. If the objective of the central bank is to peg its currency, which means that the central bank has committed to "defend" its currency in times of currency weakness, it is the foreign exchange short seller that is the "enemy". Therefore, if the central bank wants to strengthen its hand in its defense of the currency, the only agent it needs to curb is the foreign exchange short seller. This could be achieved by any regulatory means that makes short selling of the local currency more difficult.

We now try to solve for the Nash equilibrium of a regime that is in the advanced stages of financial liberalization. Once we solve for this equilibrium, we will analyze how the various deep parameters of the economy, especially policy variables, can affect the stability of the currency peg.

5.2. The advanced stages of financial liberalization

The domestic firm is encouraged to borrow abroad by the imposition of low or zero tax rates on profits earned by borrowing abroad. Here, $t_B < t^*$. This is a regime which is in the advanced stages of financial liberalization.

Theorem 2. *The point at which the central bank surrenders is θ^*. It is obtained by solving for θ^* in Eq. (8). The foreign exchange short seller short sells an amount S of local currency at $t = 0$ if he observes that $\theta_1 > \theta^*$; he does not short sell at $t = 0$ of he observes $\theta_1 > \theta^*$. The domestic firm borrows from a foreign bank at $t = 0$. To repay its foreign loan at $t = 1$, the domestic firm wants to sell an amount b^* of the local currency, where b^* is obtained by subtracting S from $S + b^*$, where $S + b^*$ is the point of intersection of vertical line θ^* and $m(\theta_1)$ in Fig. 5.*

We give a graphical proof by using Fig. 5. If the short seller conjectures that the defense of the currency will be successful at $t = 1$ if $\theta_1 > \theta^*$, and will not be successful at $t = 1$ if $\theta_1 \leq \theta^*$, his optimal strategy is to short sell at $t = 0$ a quantity $S(\theta_1)$. $S(\theta_1)$ will equal equal S if $\theta_1 \leq \theta^*$ and will be zero if $\theta_1 > \theta^*$. What about the domestic firm? If the corporate borrower conjectures that the defense of the currency will be successful at $t = 1$ if $\theta_1 > \theta^*$, but the central bank will surrender at $t = 1$ if $\theta_1 \leq \theta^*$, its optimal strategy at $t = 0$ is to borrow foreign currency such that at $t = 1$ it would have to repay a foreign currency amount b^*. Why is this so? Because if repayment is higher than b^* at $t = 1$, notice from Fig. 5 that the successful defense region of the central bank will shrink and the surrender region will expand, which implies that the belief of the corporate borrower will not be upheld. If repayment is lower than b^* at $t = 1$, notice from Fig. 5 that the successful defense region of the central bank will expand and the surrender region will shrink, which implies that the belief of the corporate borrower will not be upheld. If the central bank conjectures that the above are the strategies of the corporate borrower and the foreign exchange short seller, the central bank's optimal strategy is to not fight (fight and win) to the left (right) of θ^*. This is because $m(\theta_1)$, the maximum currency sales that the central bank can purchase to defend the local currency, is below (above) $S + b^*$

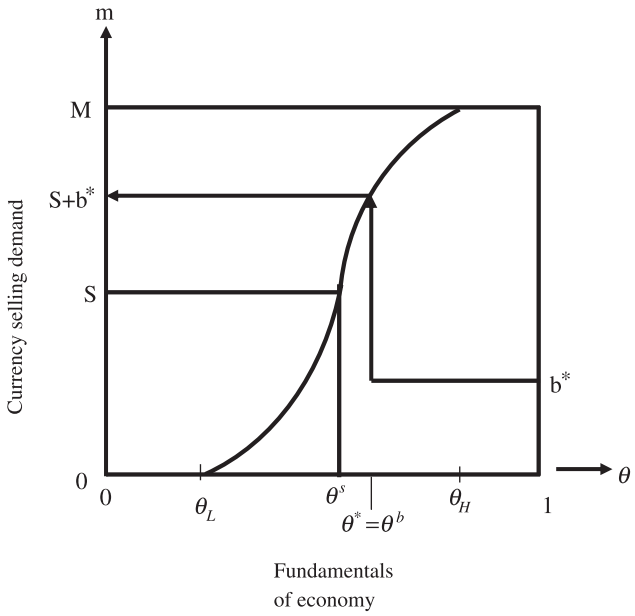

Fig. 5. Equilibrium in the advanced stages of financial liberalization.

to the left (right) of θ^* in Fig. 5. Conjectures on the other's strategies are upheld, and we have a Nash equilibrium.

Theorem 2 leads to the following corollaries.

Corollary 4. *In the advanced stages of financial liberalization, where the domestic firm is allowed to borrow abroad at low tax rates, it will borrow.*

Corollary 5. *In the advanced stages of financial liberalization, the central bank cannot improve the stability of the currency peg by curbing the foreign exchange short seller.*

Corollary 5 is the key result of our paper. The intuition for this result is as follows. In the later stages of financial liberalization, the tax on foreign borrowing is low. Therefore, the firm will not need as much compensation for borrowing abroad as before. This implies that it will borrow abroad even if it expects the central bank not to defend the local currency in all but the strongest states of the economy. The firm knows that the central bank can fulfil this expectation if the volume of currency sales by the other agents is below a high number. The firm also knows that the currency sales by the foreign exchange short seller is lower than this high number. Currency sales from the corporate borrower repaying his foreign loan, therefore, will make up the difference. Expectations of the firm will be fulfilled, and we will have a Nash equilibrium where the firm will borrow abroad. It is important to note here that if the currency sales of the foreign exchange short seller are decreased (increased) by regulatory action, the corporate borrower, knowing this, will borrow more (less) to

keep his expectation of the total currency sales unchanged. It is in this sense that the corporate borrower becomes the marginal agent.

Corollary 5 tells us that, if the objective of the central bank is to peg its currency, which means that the central bank has committed to "defend" its currency in times of currency weakness, it is the domestic firm borrowing abroad that is the "enemy". The foreign exchange short seller is not the "enemy". If the central bank wants to strengthen its hand in its defense of the currency, the agent it needs to curb is the domestic firm borrowing abroad and not the foreign exchange short seller. This could be achieved by raising the tax on domestic borrowing abroad, or by any other regulatory means that makes borrowing abroad more difficult. It cannot be achieved by "curbing" foreign exchange short sellers.[14]

5.3. Some data

Our model has an unambiguous prediction. It predicts that in the early stages of financial liberalization, firms do not borrow abroad and they do not affect the stability of an exchange rate peg in their country, but in the later stages of financial liberalization, they borrow from abroad and they destabilize exchange rate pegs in their country. Is this observed in the data?

We obtained official financial liberalization dates from Bekaert et al. (2003) for all the emerging markets in their sample. It is not clear whether these dates refer to an early stage of liberalization or an advanced stage of liberalization. We then obtained annual World Bank data on private borrowing from abroad by banks and nonbanks in these countries. Table 1 shows the average annual borrowing before and after the official liberalization, where the average is taken over 3 years. If the country had a foreign exchange crisis, Table 1 also shows the average annual borrowing before and after the foreign exchange crisis, where the average is taken over 3 years.

The summary statistics of Table 1 are dramatic. Countries in which private foreign borrowing did not increase much after the official liberalization date, implying perhaps that liberalization was at an early stage, did not have a foreign exchange crisis. Nearly all

[14] In a previous version of the paper, we had explicitly formalized how the government "curbed" foreign exchange short sellers. It was in the same way the government had curbed foreign borrowing: tax. We had assumed that foreign exchange short sellers were heterogenous in their fixed cost of transaction. This implied that only a proportion of them, those whose revenues exceeded their fixed costs, would short sell when they detected central bank vulnerability. This meant that as the tax on profits made on foreign exchange short selling, t_s, increased, or as the fundamentals, θ_1, increased, the proportion of potential foreign exchange short sellers taking part would decrease. In other words, S was $S(\theta_1,t_s)$, and the first partial derivative of S with respect to both θ_1 and t_s were negative. Therefore, instead of a horizontal line S to the left of $m(\theta_1)$ in Figs. 2, 4 and 5, we had a downward sloping curve $S(\theta_1)$ to the left of $m(\theta_1)$ in Figs. 2, 4 and 5. An increase (decrease) in the short selling tax, t_s, would lower (raise) the curve $S(\theta_1)$ to the left of $m(\theta_1)$ in Figs. 2, 4 and 5. This would result in a decrease (increase) of θ^* in Figs. 2 and 4 but not in Fig. 5. This implied that the government could increase (decrease) the stability of the exchange rate peg by increasing (decreasing) the tax on foreign exchange short sellers in Figs. 2 and 4—when liberalization was at its early stage—but could not affect the stability of the exchange rate peg by increasing (decreasing) the tax on foreign exchange short sellers in Fig. 5—when liberalization was at an advanced stage. In this version of the paper, to keep the model simple, we dropped the explicit formalization on how the government "curbed" foreign exchange short sellers.

Table 1
Annual net short term foreign borrowing by private creditors plus annual net foreign borrowing by banks in emerging markets (millions USD)

Country (1)	Exchange rate regime (2)	Average annual borrowing (3 years before liberalization to liberalization) (3)	Capital liberalization year (4)	Average annual borrowing (liberalization to 3 years after liberalization) (5)	Average annual borrowing (3 years before currency crisis to currency crisis) (6)	Currency crisis year (7)	Average annual borrowing (currency crisis to 3 years after currency crisis) (8)
Argentina	Pegged (1998)	164	1989	858	4970	1999	− 6459
Brazil	Managed Floating (1997)	902	1991	8700	7475	1998	− 4828
Chile	Managed Floating (1992)	777	1992	1551			
Colombia	Managed Floating (1991)	− 145	1991	1745			
Egypt	Managed Floating (1992)	− 404	1992	− 221			
India	Managed Floating (1992)	1638	1992	− 8			
Indonesia	Managed Floating (1996)	932	1989	5717	5937	1997	− 6949
Jordan	Pegged (1995)	− 488	1995	− 159			
Malaysia	Managed Floating (1996)	− 1072	1988	89	3008	1997	− 2177
Mexico	Managed Floating (1993)	968	1989	7351	5441	1994	− 1526
Morocco	Managed Floating (1988)	− 20	1988	7			
Nigeria	Managed Floating (1995)	− 244	1995	− 58			
Pakistan	Managed Floating (1991)	557	1991	− 446			
Philippines	Floating (1996)	− 164	1991	− 224	911	1997	1997
South Korea	Managed Floating (1996)	−5	1992	12116	19,233	1997	− 4663
Thailand	Pegged (1996)	182	1987	2988	11,786	1997	− 10,789
Turkey	Floating (1989)	1170	1989	2507			
Venezuela	Floating (1990)	− 862	1990	687			
Zimbabwe	Pegged (1993)	177	1993	1993			
Total (crisis countries)		1907 (Bank, − 18%)		37,595 (Bank, 24%)	58,762 (Bank, 33%)		− 39,158 (Bank, 46%)
Total (noncrisis countries)		2157 (Bank, 61%)		5727 (Bank, 51%)			

The countries in column 1 and their official liberalization dates in column 4 come from Bekaert et al. (2003).

The classification of exchange rate regimes in column 2 are official classifications by the International Monetary Fund. For countries which experienced foreign exchange crisis, the exchange rate regime is for the year before the crisis. For the other countries, the exchange rate regime is for the year of liberalization. The data come from Eduardo and Sturzeneger (2002).

The currency crisis dates in column 7 come from various press reports.

The data in columns 3, 5, 6 and 8 come from World Development Indicators, 2003, World Bank, Washington, D.C. (http://www.worldbank.org/data/wdi2003/index.htm).

countries in which private foreign borrowing increased dramatically after the official liberalization date, implying perhaps that liberalization was at an advanced stage, suffered a foreign exchange crisis. As more formal tests on this data set are beyond the scope of this paper, we would not like to overemphasize the results in Table 1, but would only want the reader to note that the stylized facts of the model do not violate those of the real world.

6. Concluding remarks

As the arguments in favor of floating exchange rates are as convincing as the arguments in favor of fixed exchange rates, many governments of the world opt to have it both ways: they peg their currency to an anchor and defend their currency as long as it is feasible. Many of these governments choose to liberalize their economies as well which, among other things, allow domestic firms to borrow abroad.

If we define financial liberalization as the degree of freedom given to domestic firms to borrow abroad, this paper finds that in the early stages of financial liberalization, foreign borrowing does not affect the stability of the currency peg. This is because the foreign exchange short seller, and not the domestic corporate borrower, is the marginal seller of the local currency in the early stages of financial liberalization. Therefore, the central bank's "fight" is with the foreign exchange short seller. However, in the advanced stages of financial liberalization, foreign borrowing destabilizes currency pegs. When this happens, we show that policies to curb currency short sellers have no effect. This is because the domestic corporate borrower, and not the foreign exchange short seller, is the marginal seller of the local currency in the advanced stages of financial liberalization. Therefore, the central bank's "fight" is with the domestic corporate borrower. This implies that financial liberalization and currency pegs are incompatible policy goals.

The above result is not new. Following Robert Mundell's seminal contributions in the 1960s, there is a large international macroeconomics literature that explains why fixed exchange rates, independent monetary policy and international capital mobility cannot coexist. What differentiates our paper from the above international macroeconomics literature are two factors. Firstly, we arrive at this old result in a new way: from microfoundations in the international corporate finance literature. Secondly, we make precise the financial liberalization state before which financial liberalization and currency pegs are compatible policy goals, but after which financial liberalization and currency pegs become incompatible policy goals.

Our contribution to the international corporate finance literature is the following. To the models that have been developed in this literature to formalize problems that occur when investment is done with the money of foreigners—the risk sharing and moral hazard involved in domestic firms borrowing from foreign banks under a promise of pegged exchange rates, offshore short term borrowing to fund onshore long-term illiquid assets, inefficient monitoring systems, lack of transparency, weak corporate governance and crony capitalism—we add one more model—how domestic corporate borrowers complicate the interaction between central banks and foreign exchange short sellers.

We believe this is an important issue because, as a currency peg basically implies that a central bank has committed itself to "defend" the currency against foreign exchange short

sellers, it is important to understand precisely how, if at all, domestic corporate borrowers make this "defending" job more difficult. This, as far as we know, has not been formally explored before. Furthermore, as far we know, no one had formally showed that corporate borrowers, and not foreign exchange short sellers, were the defending central bank's "enemy" in the advanced stages of financial liberalization.

Our work suggests several avenues for future research. Firstly, we assumed that the payoff of the project undertaken by the domestic firm is deterministic. Although this dramatically simplified our analysis, it would be interesting to introduce uncertainty here. That would allow us to examine the effect of asymmetric information (domestic banks know more about domestic borrowers than foreign banks do) and/or moral hazard (foreign banks may be encouraged to lend to riskier projects than domestic banks if they believe that the central bank will successfully defend its currency), issues that other commentators have raised in past currency crises. Secondly, we assumed that the input and the output of the project were generated in local currency. It would be interesting to note how our results would change if the numeraire currency for the input/output changed. Considering that many of the countries that had to abandon their currency pegs in 1997 were export-oriented countries, this would mean that they probably had a significant proportion of their output in foreign currency. But perhaps the most important, and certainly the most challenging extension to our work, would be to give the central bank an option of currency regimes and ask which dimensions of financial liberalization are compatible with each type of currency regime.

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