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Analysing Its Mechanics and a proposed Remedy in a Simple Macroeconomic Model

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Author: Axel Lindner

Department of Macroeconomics

Email: Axel.Lindner@iwh-halle.de

Tel.: (0345) 77 53-703

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Hausanschrift: Kleine Märkerstraße 8, 06108 Halle (Saale)
Postanschrift: Postfach 11 03 61, 06017 Halle (Saale)
Telefon: (0345) 77 53-60
Telefax: (0345) 77 53-8 20
Internetadresse: http://www.iwh-halle.de

Original Sin: Analysing Its Mechanics and a proposed Remedy in a Simple Macroeconomic Model[1]

Abstract

This paper analyses the problem of "original sin" (the fact that the currency of an emerging market economy usually cannot be used to borrow abroad) in a simple third-generation model of currency crises. The approach differs from alternative frameworks by explicitly modeling the price setting behavior of firms if prices are sticky and the future exchange rate is uncertain. Monetary policy optimally trades off effects on price competitiveness and on debt burdens of firms. It is shown that the proposal by Eichengreen and Hausmann of creating an artificial basket currency as denominator of debt is attractive as a provision against contagion.

Keywords: original sin; currency crises

JEL classifications: F34

1 I would like to thank Diemo Dietrich, Tobias Knedlik, and Johannes Stephan for helpful comments. Any errors are my own.

Zusammenfassung

Der Artikel analysiert das “Erbsünden-Problem” (die Tatsache, dass sich ein Schwellenland üblicherweise nicht in Einheiten der eigenen Währung verschulden kann) im Rahmen eines Währungskrisenmodells der dritten Generation. Der Ansatz unterscheidet sich von anderen Modellen dieses Typs dadurch, dass das Preissetzungsverhalten der Unternehmen explizit modelliert wird. Dabei haben die Unternehmen zu beachten, dass Preise kurzfristig fix sind und der zukünftige Wechselkurs unsicher ist. Geldpolitik ist optimal in dem Sinn, dass die Zentralbank die Folgen ihrer Politik für die Wettbewerbsfähigkeit der Unternehmen auf der einen Seite und für deren Auslandsschuldenlast auf der anderen Seite gegeneinander abwägt. Es wird gezeigt, dass der Vorschlag Eichengreens und Hausmanns, auf den internationalen Finanzmärkten einen Schwellenländer-Währungskorb als Basis von Schuldverschreibungen zu etablieren, als Vorsorgemaßnahme gegen Ansteckungseffekte von Währungskrisen taugen könnte.

Schlagworte: Erbsünde; Währungskrisen

Original Sin: Analysing Its Mechanics and a proposed Remedy in a Simple Macroeconomic Model

This paper analyses the macroeconomic consequences of currency mismatches in emerging market countries due to original sin. For this purpose, a simple third-generation model of currency crises is constructed. The model helps also clarifying under which conditions the denomination of debt in an emerging market (EM) index can mitigate the problem of original sin.

Section 1 explains briefly the problem of currency mismatch and the proposal to solve it via the EM index. Section 2 reviews alternative models suitable for analysing original sin and explains why this paper takes a somewhat different approach. Section 3 presents the model (in 3.1 and 3.2) and its policy implications (in 3.3). Section 4 concludes.

1. Currency mismatches, original sin, and a reform proposal

Financial crises in emerging market economies have frequently disturbed the world economy during the last decades. A major element in almost every major crisis was a currency mismatch (Goldstein (2004), page 1). This concept means that the net worth or net income of agents (whether firms, households, or the government) is sensitive to changes in the exchange rate. In particular, agents in emerging market countries frequently have incurred debt denominated in foreign currency, but rely on assets that yield income denominated in the home currency. If this currency, for whatever reason, depreciates, the balance sheet effect of an increase in the burden of debt relative to assets due to the currency mismatch might force agents into default and might thus cause or exacerbate a crisis.

Currency mismatches are very wide spread in emerging market economies: between 1999 and 2001, only 2.7% of international debt instruments issued by residents in developing countries were issued in the domestic currency[2] (for the euro area, by comparison, the share was 56.8%.; see Eichengreen et al (2005a)). Although some Latin American countries (Uruguay, Colombia, and Brazil) have recently managed to issue internationally bonds in local currency, the share of overall debt in these countries is still small (Tovar 2005). An obstacle for raising such loans can certainly be the lack of trust in the

2 Developing countries are defined here according to the Bank for International Settlements; it includes such fairly advanced countries like the Czech Republic, Israel or South Korea.

stability of the domestic currency. However, even countries with quite a good recent track record of stability oriented macroeconomic policy appear to have a hard job in overcoming the high barriers. Eichengreen and Hausmann have therefore named the inability to use the home currency to borrow abroad "original sin" (Eichengreen et al. (2005a); the first, somewhat broader definition of original sin is found in Eichengreen and Hausmann 1999).

Eichengreen, Hausmann and Panizza (2002) and Eichengreen and Hausmann (2005) argue that a road to redemption from original sin leads over an inflation-indexed basket of currencies of emerging and developing countries, a so-called EM index, defined by the World Bank. Together with other international financial institutions as the IMF, the World Bank should then issue bonds denominated in the EM index and invest the proceeds into emerging markets bonds that are denominated in the currencies of the countries. Eichengreen and Hausmann argue that such financial transactions need only be temporary and of limited size in order to help establishing liquid international markets for bonds denominated in home currencies.[3]

This paper does not discuss the potential chances of that happening. Instead, we set up a framework in which original sin can be analysed, and discuss under which circumstances taking debt denominated in the EM index instead of dollars may be a safeguard against currency crises. In doing so we use some tools provided by the modern theoretical literature about currency crises.

3 Their proposal seems to find a political echo in plans of the Asian Development Bank to create an "Asian Currency Index" in order to help develop regional bond markets (Financial Times, March 27th 2006: "Launch of Asian Currency unit held up by political bickering").

2. Original sin and the third generation of currency crisis-models

The role of currency mismatches is central for third-generation models of currency crises (Aghion, Bacchetta and Banerjee (2000, 2001) and Jeanne and Zettelmeyer (2002)). Those models were built as a reaction of economic theory to the Asian crisis 1997/98, when fiscal and monetary policy in the countries hit by the crisis mostly appeared to be sound, but balance sheet effects due to depreciations forced many private agents like banks into default. Therefore, it is the private sector that is affected by original sin in these models, whereas original sin in principle can be a problem for both private and public agents.

One shortcoming of the standard type of third-generation models is that they focus only on the negative effects of depreciation on output. As Goldstein (2004, page 1) remarks, however, a good measure of the extent of currency mismatch ought to take the potential response of noninterest flows (like exports) to an exchange rate change into account as well; after all, a depreciation always makes the home producers of tradable goods more competitive and tends to cushion the effects of a negative shock on output. Therefore, in the next section the negative and positive effects of an unexpected currency move will be modeled. Clearly, if prices were perfectly flexible, they would adapt to exchange rate changes in such a way that there would be no real effect. This paper, however, is based on the assumption of sticky prices. It differs from the papers mentioned above in explicitly modeling the price setting behaviour of firms. Prices have to be set in home currency in advance and are sticky in the short run. On the one hand, firms may become insolvent due to balance sheet effects if the home currency depreciates. On the other hand, if the currency appreciates, firms will become less competitive.[4]

Aghion, Bacchetta and Banerjee (2000, 2001) derive important insights about the right reaction of monetary policy to a currency crisis; indeed, in their framework, the optimal reaction could in general prevent crises in the first place, and thus, in their framework, currency crises do not occur if all agents behave rationally. This appears to be a somewhat optimistic implication. In the model presented in the next section, the effects of monetary policy do not come off fast enough to prevent a currency crisis after a negative external shock has hit. Ex ante, monetary policy is optimal. The focus is not on mone-

4 The reader may ask whether these are realistic assumptions. The model, however, should be interpreted as a simple representation of much more complicated economies. For those economies, it appears plausible that export prices are largely determined by prices set in home currency units and that these are sticky in the short run. For example, home subcontractors might have contracted fixed prices with exporting firms for the running year.

tary policy, but on the basic mechanisms of nominal shocks affecting real output in an original sin economy, and on the implications of the option to incur debt denominated in the EM index.

Our approach differs from the standard type of third-generation models of currency crises in two other respects: first, the standard type focuses on multiple equilibria: pessimistic (and optimistic) expectations about the currency are self-fulfilling. While this is an interesting and serious issue, it has the drawback that nobody can be sure whether it is a real world phenomenon because two potential equilibria are usually unobservable. In addition, currency mismatches are, as shown below, still a problem even if the equilibrium is unique. Thus, although multiple equilibria are a possible scenario in the model presented below, they are not the focus of the paper. Finally, in the standard type of third generation models it is assumed that from a certain future period onwards, the economy will be stable again. This assumption is, without effects on results, replaced by modeling an economy with a final period in which prices are flexible.

3. A formal analysis

3.1 The simple macro model of an original sin-economy

Economies frequently get into trouble when the exchange rates of their currencies change abruptly. One important reason for this is that prices usually react with some lag if the exchange rate moves unexpectedly, although prices are flexible in the long run. This fact is captured by the time structure of the simple model presented in this section. In $t=0$, firms form expectations about exchange rate in $t=1$ and set their prices for this period. Between $t=0$ and $t=1$, the central bank injects money into the economy. In $t=1$ there might be a money demand shock (which will be discussed in section 3.2) and the short term equilibrium of the economy with an exchange rate, trade in goods and liquidation of insolvent firms is realized. If there is a money demand shock, the exchange rate and output are affected. As to output, this is so because prices in period 1 have already been fixed in $t=0$. Period $t=2$ is the long run period, because now prices are flexible. The "long run" realizations of prices and the exchange rate in this final period are important because expectations about these realizations are determinants of the exchange rate in $t=1$.

The economy is small relative to world markets. There is a sector for nontraded goods with output y, and a sector for tradable goods that are mostly exported with output x. The model explains how much output is sold in the short run-period 1. In the export-oriented sector, there is an infinity of identical, small firms each offering one unit of output on the competitive world market. If all firms sell their unit of output, the aggregate sale will be $x^{\max}$. Firms maximize expected profits by setting their prices. We assume that prices have to be denominated in terms of the home currency. Since the world market price (in dollar terms) is $p^*=1$, the highest price for which firms can sell their unit of output is $p_{x1}=e_1$ with e_1 as the exchange rate in period 1 in price notation. Prices, however, have to be set before, in period $t=0$. Firms will only be able to sell their unit of output if $e_1 \geq p_{x1}$. We assume that the equilibrium exchange rate in the absence of shocks, e_1^*, which will be derived in the following, is unique; this rate is calculated by each firm i in period 0; however, an error term enters the calculations: $E_0^i[e_1]=e_1^*+\varepsilon_i$ with ε_i as a random variable which, for all firms in the export sector, follows the lognormal distribution (log because there are no negative prices) with mean 0 and standard deviation σ. Thus, the mean of the exchange rates expected by firms $E_0[e_1]$ equals the equilibrium exchange rate: $E_0[e_1]=e_1^*$. Each firm i knows that it makes errors in forecasting, and it knows the distribution of the error term ε_i (this structure of knowledge is similar to that e. g. found in Morris and Shin (1998) or Lindner (2006)).

Clearly, the lower the price p_{x1}, the higher the probability that the output will be sold; firms, however, can fail for another reason: the currency can be too weak as well as too high for the price set in advance, because each firm has incurred the same amount of debt $D_i = 1/2$ denominated in dollar terms to finance production of $t=1$-output. If revenues are so low that the firm is not able to repay its debt in period 1, the foreign creditors will seize the unit of output. For simplicity, we assume that there are no costs other than debt repayment. Thus, a further condition for firm i to sell its unit of output is $p_{x1} \geq e_1 D_i = e_1/2$. All in all, firms maximize their profit function (in home currency) over their price p_{x1}, with the exchange rate as a random variable due to the errors firms make in forecasting it:

$$p_{x1}^* = \arg\max_{p_{x1}} \prod = \arg\max_{p_{x1}} \int_{p_{x1}}^{2p_{x1}} (p_{x1} - \frac{e_1}{2}) f(e_1, \mu = E_0^i[e_1], \sigma) de_1 \quad (3.1)$$

This leads to the following first order condition that determines the unique optimal price p_{x1}^* of firm i:

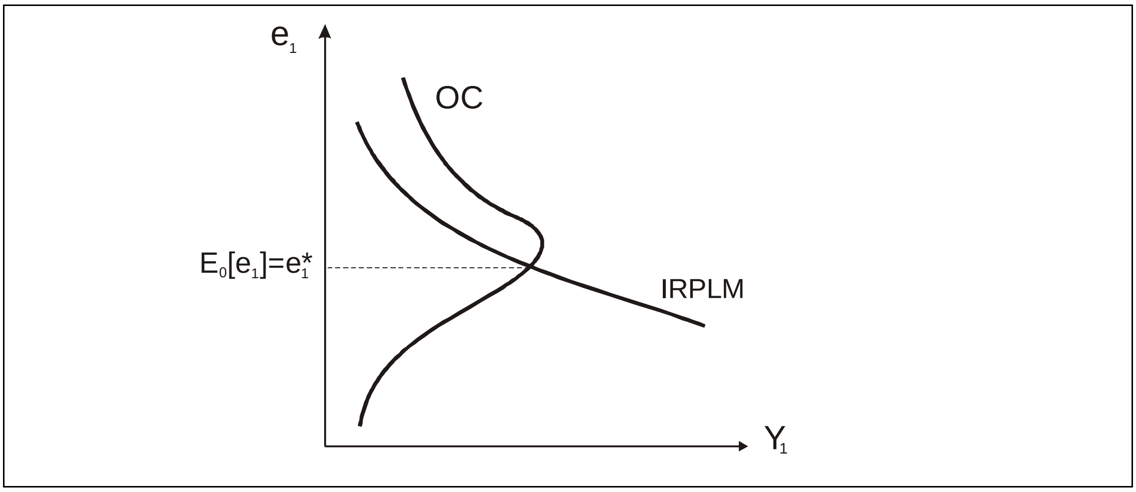
$$\int_{p_{x1}}^{2p_{x1}} f(e_1, \mu, \sigma) de_1 - \frac{p_{x1}}{2} f(e_1, \mu, \sigma) = 0 \quad (3.2)$$

As the integral in equation 3.2 shows, a marginal increase in the price increases revenues in case of a sale. On the other hand, it increases the probability that it will turn out to be too high to be competitive; this is the second term on the left. At p_{x1}^*, these two effects on expected profits cancel each other out. Note that this means that p_{x1}^* is higher than the prize that maximizes the probability that output will be sold.

The distribution of information about the exchange rate and the price setting strategy of individual firms imply that the aggregate of the output sold by the export sector is a function $x_1 = F(E_0[e_1], e_1)$ which, for given expectations $E_0[e_1]$, is quasiconcave in the exchange rate e_1 (see appendix). If the home currency turns out to be much stronger than expected by most firms, the prices of most firms are too high to attract demand; if the home currency is much weaker, most firms will not be able to repay their debt and their output will be seized by the foreign creditors. However, since firms do not maximize the probability of selling but maximize their profits, the exchange rate for which output is maximal, e_1^{max}, exceeds the mean expected exchange rate (which equals the equilibrium exchange rate in the absence of shocks): $e_1^{max} > E_0[e_1]$ (see figure 1).

The output of nontraded goods y is, for simplicity, assumed to be stable: $y = \bar{y}$. By definition, there is no world market price in dollars; moreover, producers do not need loans and real balance effects are negligible; therefore, the output for nontraded goods is not affected by the exchange rate nor by monetary policy. The price index of nontraded goods is the price level of the economy in period 1. Firms can decide in period 0 to produce either nontraded or export goods; therefore, in equilibrium, expected profits of firms producing either nontraded or export goods are equal and profits denominated in the home currency are a positive function of the expected exchange rate; thus, a higher expected exchange rate means that prices set for nontraded goods are also set to a higher level; the price level is a positive function of the expected exchange rate: $P_1 = g(E_0[e_1])$ with $g' > 0$ (see appendix).

Figure 1:
Output and exchange rate in the absense of shocks



We are now able to express the aggregate output of the economy Y_1 in prices of the nontraded good by an output curve function that is, like the output function for the sector producing tradables, quasiconcave in the exchange rate e_1. The output curve function defines the OC curve in figure 1:

$$Y_1 = \bar{y} + \frac{F(E_0[e_1], e_1)}{g(E_0[e_1])} \tag{3.3}$$

The exchange rate e_1 and expectations about its realization $E_0[e_1]$ depend on the money market. In period 1, this takes the standard LM form:

$$\frac{M}{P_1} = \frac{M}{g(E_0[e_1])} = L(Y_1, i) \tag{3.4}$$

with M as the quantity of money injected into the economy by the central bank in period 1, Y_1 as the output level of the economy in $t = 1$ and i as the interest rate for income invested at home in period 1 and withdrawn in period 2. According to interest rate parities, the interest rate is a function of the foreign interest rate and the expected depreciation (or appreciation) of the home currency between period 1 and period 2:

$$1+i=(1+i^{*})\frac{E_1[e_2]}{e_1} \tag{3.5}$$

Inserting equation 3.5 into 3.4 gives the interest rate parity-LM-function that defines the IRPLM curve in figure 1:

$$\frac{M}{g(E_0[e_1])}=L(Y_1,(1+i^{*})\frac{E_1[e_2]}{e_1}) \tag{3.6}$$

The curve has a negative slope because a weaker home currency (a higher exchange rate) in period 1 means that, for a given long-run exchange rate, the currency is expected to appreciate more (or depreciate less), which makes holding money more attractive; this is, for a constant money supply M, only compatible with equilibrium on the market for money if less output reduces money demand.

The quantity of money injected into the economy in period 1 raises the price level in the "long run" period 2.[5] In this final period, all prices are flexible and output is on its natural (or Walrasian) level. Given the quantity of money M and the natural output level Y_2, the price index P_2 clears the market for money:

$$\frac{M}{P_2}=L(Y_2) \tag{3.7}$$

As period 2 is the final period, no interest rate enters the money demand function. Furthermore, export prices in home currency units and the exchange rate are a function of the internal price level: $e_2 = p_{x2} = g^{-1}(P_2) = g^{-1}(M/L(Y_2))$. This is anticipated by agents on the market for money in period 1 ($E_1[e_2]=e_2$). Thus, the interest rate parity-LM-function can be rewritten as:

$$\frac{M}{g(E_0[e_1])}=L(Y_1,(1+i^{*})\frac{f^{-1}(M/L(Y_2))}{e_1}) \tag{3.8}$$

5 For simplicity, we assume that the central bank cannot alter the quantity of money in period 2.

Intuitively, for a higher quantity of money M, the home currency gets weaker (the exchange rate e_1 increases) in spite of a fixed price level in period 1, because the foreign exchange markets anticipate the fall of the home currency in period 2.

The two equations 3.3 and 3.8 determine output Y_1 and exchange rate e_1 for given expectations about the exchange rate in t = 1, $E_0[e_1]$, and for a given quantity of money M. The latter two variables are determined by monetary policy. In period 1, the central bank chooses the quantity of money which is optimal according to its objective function: monetary policy aims at a high output, and it wants to keep the difference between the internal return on holding the home currency between period 1 and 2 and the return of bonds low (see Friedman 1969). The return on holding money depends on the change in the price level. Assuming price stability abroad, the central bank minimizes the following loss function for period 1 over M:

$$L = -Y_1 + \frac{\beta}{2}((1+i^*) - \frac{P_1}{P_2})^2 = -(\bar{y} + \frac{F(E_0[e_1], e_1(M))}{g(E_0[e_1])}) + \frac{\beta}{2}((1+i^*) - \frac{g(E_0[e_1])}{M/L(Y_2)})^2 \tag{3.9}$$

with β as the factor weighing the target for the return on money relative to that for output. The first order-condition defines the Monetary Policy-function:

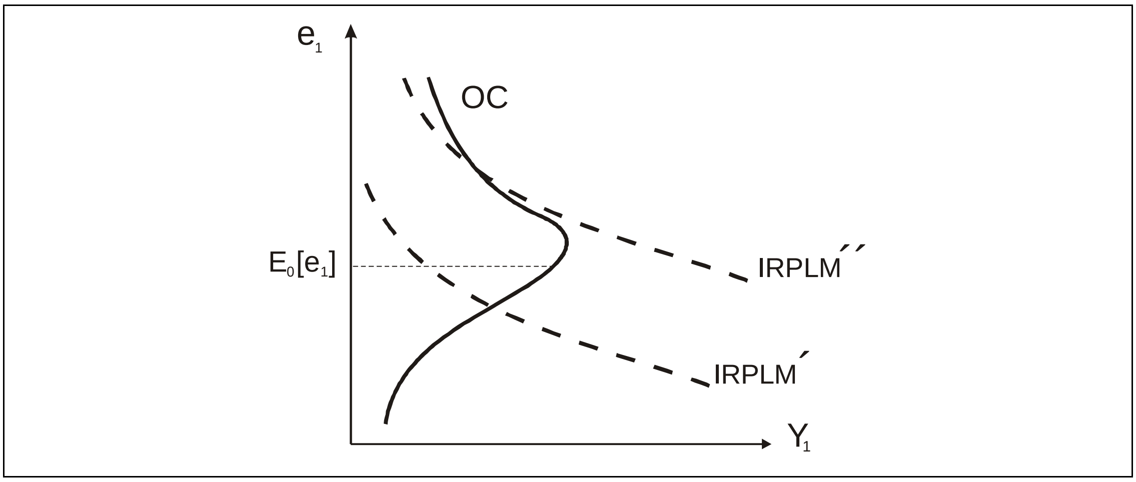
$$\beta\left\{\left((1+i^*) - \frac{g(E_0[e_1])}{M/L(Y_2)}\right)\left(\frac{g(E_0[e_1]L(Y_2)}{M^2}\right)\right\} = \frac{\partial F/\partial M}{g(E_0[e_1])} \tag{3.10}$$

If this condition is fulfilled, injecting marginally more money does not alter the overall loss, because, on the one hand, more money weakens the exchange rate and supports export firms in the short run, but, on the other hand, it increases inflation and widens the gap between the return on money and interest bearing assets. Firms, on average, anticipate this condition for optimal monetary policy correctly: in period 0, they expect such a weak exchange rate that it will not pay for the central bank to weaken it even more by a surprisingly expansionary policy. Thus, the equilibrium of the model consists of the equations 3.3 (output function), 3.8 (Interest Rate Parity-LM function), and 3.10 (monetary policy function), and of the conditions for (in the mean) rational expectations $E_0[e_1] = e_1^*$ and $E_1[e_2] = e_2 = g^{-1}(M/L(Y_2))$ (see figure 1).

3.2. Exchange rate shocks in the macro model

This section shows how unanticipated external shocks on the money demand function $L(Y_1, (1+i^*)\frac{g^{-1}(M/L(Y_2))}{e_1})$ can cause large output losses. These shocks occur after M is injected into the economy. This means that monetary policy is not able to react to the shocks, because its effects would not turn up in period 1. This is plausible if, for example, the quantity of money M is a broad monetary aggregate that reacts slowly to actions taken by the central bank. As shown in figure 2, positive shocks move the interest-rate-parity-LM curve downwards to IRPLM´: the exchange rate appreciates. This affects output adversely, because the goods of many firms become too expensive in dollar-terms. Negative shocks move the curve upwards to IRPLM´ ´: the exchange rate depreciates: these shocks may be interpreted as a sudden loss of confidence into the domestic currency. If they are small, output actually increases, because more firms are competitive than in the situation without shocks. This is so because, as explained in the section before, profit-maximizing firms take some risk of losing competitiveness in order to benefit from high profits as long as they remain competitive. A large negative shock, however, decreases output, because many firms become insolvent due to the balance sheet effect. Indeed, comparing the marginal effect of a surprisingly weak currency with the marginal effect for a surprisingly strong one, we find that the marginal effect is larger for the first case, if the slope of the output curve has the same absolute value. This is so because a contraction of output dampens the appreciation, while a depreciating exchange rate and output contraction reinforces each other. Such a situation is usually called a currency crisis. Indeed, the reinforcement mechanism can be so strong that the output curve and the interest-rate-parity-LM curve might cross more than once. In this case (which is not shown in figure 2, but which is the focus of Jeanne and Jerome (2002)), self-fulfilling pessimistic expectations mean that an inefficient equilibrium may be reached.

Figure 2:
Money demand shocks: foreign curreny denomination of debt



3.3. Original sin: Redemption through the EM index?

The framework presented above is helpful for analysing whether the proposal to set up a bond market denominated in the EM index is conducive to mitigating currency crises. Eichengreen and Hausmann (2005) argue that the EM index would ultimately enable emerging market countries to issue debt in their own currency. This paper does not discuss the chances of that happening. Even if it does not ultimately lead to home currency debt, the EM index might have some advantage over the dollar. In order to check this, it is helpful first to analyse the case that all debt is denominated in the home currency.

3.3.1. Home currency denomination of debt

Foreign investors still demand an expected return of 1/2 a dollar per firm. The expectations of international investors in $t=0$ about the exchange rate in $t=1$ are rational; they do not contain an error term. Thus, investors expect an exchange rate of $E_0[e_1]=e_1^*$ and all firms have to pay back $E_0[e_1]/2$ $E_0[e_1]/2$ in home currency. The profit function each firm i maximizes is now:

$$p_{x1}^* = \arg\max_{p_{x_1}} \prod = \arg\max_{p_{x_1}} \prod = \int_{p_{x1}}^{\infty} (p_{x1} - \frac{E_0[e_1]}{2}) f(e_1, \mu = E_0^i[e_1], \sigma) de_1 \quad (3.11)$$

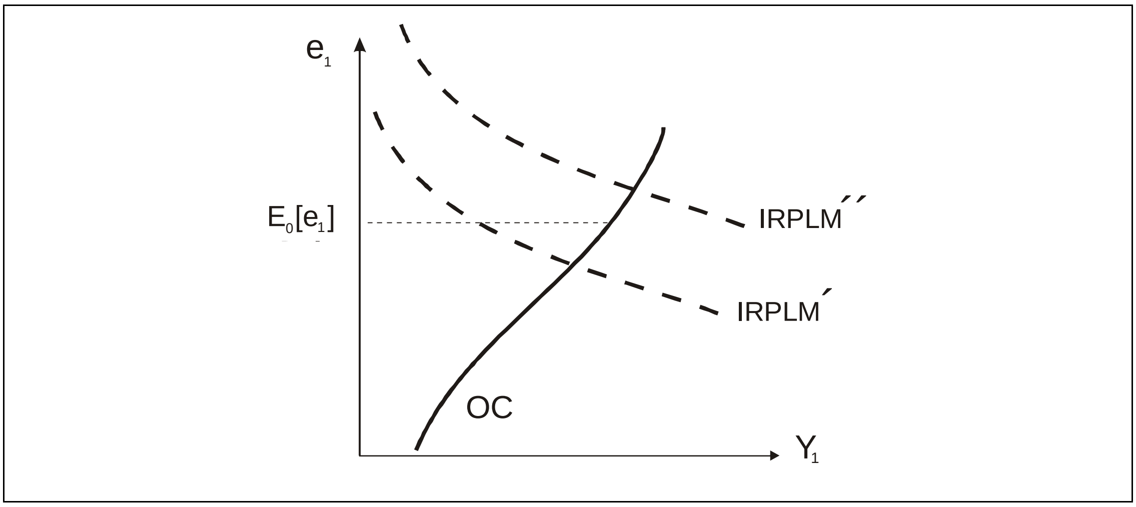
with $p_{x1} \geq E_0[e_1]$. This function differs from equation 3.1 in that a weak home currency does not force the firm into default, because the dollar value of debt as well as of revenues declines. The costs of repaying the debt are now fixed in home currency units. As in the original sin case, the optimal price p_{x1}^{**} is higher than that which maximizes the probability that output will be sold (here, the price that maximizes the probability of a sale would be $p_{x1}=E_0[e_1]/2$. It is the lowest price for which the investors are willing to give loans to firms).

The aggregate of the output sold by the export sector is, as in the original sin case, a function of the expected and the realized exchange rate $F(E_0[e_1],e_1)$. This function is, however, now increasing in the exchange rate e_1 for given expectations $E_0[e_1]$ (see figure 3 and appendix), because a home currency that turns out to be much weaker than expected by most firms does not trigger defaults. Therefore, negative money demand shocks do not depress output: on the contrary, output is close to its maximum level if the shock is large, because almost all firms are competitive.[6] Thus, in the framework pre-

6 There is still an expectational equilibrium for monetary policy, because, as in the case of original sin, the bank faces the trade off between high output and high inflation.

sented here, debt denominated in the domestic currency would protect the economy from currency crises.

Figure 3:
Money demand shocks: home currency denomination of debt



3.3.2. Debt denomination in an Emerging Market index

Now it is assumed that the debts of firms are denominated in the EM index, which is a basket of currencies of emerging markets countries.[7] Let the share of the home currency in the basket be α. The exchange rate of the EM index in price notation relative to the dollar is $e_b = \alpha E_0[e_{k,1}] + (1-\alpha)e_{b,i\neq k}$ with k indexing the home currency and $e_{b,i\neq k}$ as the notional exchange rate of the index if the home currency were no part of the index. Again, investors demand an expected return of 1/2 dollar. This equals $E_0[e_b]/2$ in EM index denomination. For now we assume that investors correctly expect other currencies to be stable relative to the dollar $(e_{i\neq k,t} = e_{i\neq k} = E_0[e_{i\neq k}])$. Clearly, if the home currency weakens, the index becomes a bit weaker too; the more so the larger the share of the home currency in the index. Thus, debt increases by less than in the case of denomination in dollar. In units of the home currency, the debt firms have to repay equals:

$$D_i = \frac{E_0[e_b]}{2}\frac{e_{k,1}}{e_b} = \frac{(\alpha E_0[e_{k,1}] + (1-\alpha)e_{b,i\neq k})}{(\alpha e_{k,1} + (1-\alpha)e_{b,i\neq k})} * \frac{e_{k1}}{2} \tag{3.12}$$

7 Eichengreen and Hausmann propose to index the basket according to the inflation rates of the currencies. This aspect is not important in our framework, because the price level is fixed in period 1.

EM index-debt is an intermediate case between original sin and home currency debt: for $\alpha \to 0$ the burden approaches its level in the original sin case and the index stays practically constant relative to the dollar; for $\alpha \to 1$, the burden approaches its level in the case of home currency debt. The output curve and the effects of a money demand shock are, accordingly, also intermediate cases which come close to that shown in figure 2 for $\alpha \to 0$ and close to that shown in figure 3 for $\alpha \to 1$.

Original sin, by its definition, prevents agents to take foreign debt in their domestic currency. It is plausible that it will also prevent them taking debt in EM index units if the share of the home currency is large. If it is small, the index appears to have little protective power against currency crises. However, if we lift the assumption that the other currencies of the index are stable, the instrument looks more attractive: a plausible reason for the existence of original sin is that investors might not be sure about the soundness of the macroeconomic policy of the emerging market country. In our framework, that means that they might not be sure about the objective function of the central bank. If the central bank puts less emphasis on inflation than expected by firms and investors, the bank might have an incentive to devalue, diminishing the dollar value of the loans. A safeguard against such a policy may be a very small weight of the currency in the EM index basket, because this makes the trade off between inflation and output becomes very unfavourable. Hence, under this condition, investors might accept debt denominated in the EM index. Now consider for this case a situation that the shock hits a significant share of the emerging markets countries, for example via contagion. For simplicity, let's assume that all economies of the index are identical and that the same shock hits all economies. Then, clearly, the single economy behaves almost as if firms were indebted in the home currency: the depreciations will not reduce the output (or, indeed, will cause output gains, see figure 3). This is good for the country, but it might also be good for investors, because many defaults of debtors are avoided. If this point is more important for investors than the loss of return in dollars per loan, a denomination of debt in the EM index is Pareto superior to that in dollars.

4. Conclusions

This paper has analysed the mechanics of original sin in a simple third-generation model of currency crises. The approach differed from alternative contributions mainly by explicitly modeling the price setting behavior of firms if prices are sticky and the future exchange rate is uncertain, by taking into account the positive effects of a devaluation on export performance, and by deriving an optimal monetary policy in the pre-crisis time. It was argued that the proposal of creating an EM index as denominator of debt is attractive because the index might be a useful provision against contagion. While in normal times there would be little incentive for monetary policy to devalue its own currency because devaluation affects the value of index-denominated foreign claims only slightly, in times of contagion, when many currencies of emerging market economies come under pressure, the devaluation of the index would mitigate negative balance sheet effects. The distribution of crisis-related costs, however, would shift in favor of firms and to the disadvantage of foreign investors. Investors might accept this in normal times if the overall costs decrease sufficiently.

What is not done in this paper, and what may appear as a promising further step, is an explicit analysis of the incentives of investors to lend and to stop lending on the basis of our framework. This may also lead to an explanation of why original sin exists in the first place. From the perspective of Eichengreen and Hausmann, it is a failure of the international financial markets that has to be addressed by international policy intervention. For Goldstein (2004, page 2), foreign investors have good reasons not to accept loans denominated in domestic currency: "We see the origins of currency mismatch primarily in past and present weaknesses of economic policies and institutions in emerging markets themselves rather than in imperfections in international capital markets." Theoretical as well as empirical work will have to address the question which of the two points of view is more accurate.

Appendix

Deriving the aggregate output function for the original sin case

Application of the implicit function rule on equation 3.2 shows that p_{x1}^{*} is a strictly increasing function of $\mu = E_0^i\left[e_1\right]$. Because $E_0^i\left[e_1\right]$ is quasiconcave (it is lognormally distributed), the frequency distribution $h(p_{x1}^{*})$ of prices set by firms is quasiconcave as well. The aggregate sales of the export sector for a given exchange rate e_1 are given by:

$$x_1 = \int_{e_1/2}^{e_1} h(e_1, \mu(E_0\left[e_1\right]), \sigma) dp_{x1}^{*}$$

This function is, again, quaisconcave in e_1. It enters into equation 3.3.

Deriving the aggregate output function for the case of redemption

If firms have to repay credit amounting to $E_0(e_1)$ in

home currency, the following first order condition determines the unique optimal price p_{x1}^{**} of firm i:

$$\int_{p_{x1}}^{\infty} f(e_1, \mu, \sigma) de_1 - (p_{x1} - E_0(e_1)) f(e_1, \mu, \sigma) = 0$$

Again, application of the implicit function rule shows that p_{x1}^{**} is a strictly increasing function of $\mu = E_0^i\left[e_1\right]$. Because $E_0^i\left[e_1\right]$ is lognormally distributed, the frequency distribution $h(p_{x1}^{*})$ of prices set by firms is quasiconcave as well. The aggregate sales of the export sector for a given exchange rate e_1 are given by:

$$x_1 = \int_{-\infty}^{e_1} h(e_1, \mu(E_0\left[e_1\right]), \sigma) dp_{x1}^{**}$$

with $\partial x_1 / \partial e_1 > 0$ and $x_1 \to x^{\max}$ for $e_1 \to \infty$ (see figure 3).

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