What Really Caused the Large Output Loss After the East Asian Crisis: Sharp Nominal Depreciations or Interest Rate Increases?

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Abstract

The right response to a speculative attack on the domestic currency by the monetary authorities in a country with dollarized liabilities has been a matter of hot debate among academics and policy makers especially after the East-Asian Crisis. We show here in a modified version of the currency crisis model discussed in Proaño, Flaschel, and Semmler (2005) that an increase of the domestic interest rate by the central bank as a response to the speculative attack can have serious negative effects on the aggregate demand by depressing the investment of the fraction of domestic firms not indebted in foreign currency. We demonstrate that in determinate situations the standard and by the IMF proposed increase in the domestic interest rate might not be the best response to a speculative attack on the domestic currency from the medium term point of view.

Keywords: Mundell-Fleming-Tobin model, liability dollarization, debt-financed investment, financial crisis, currency crisis, deflation, stable depressions.
JEL classifications: E31, E32, E37, E52.

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1 Introduction

The right response to a speculative attack on the domestic currency by the monetary authorities in a country with a significant fraction of foreign currency liabilities has been a matter of hot debate among academics and policy-makers in the years after the East Asian Crisis. Indeed, because a devaluation of the domestic currency can deteriorate dramatically the balance sheets of the domestic financial and entrepreneurial sectors by means of a currency mismatch between the value of assets and liabilities,[1] the majority of policy makers possess a "fear of floating"[2] and see in the defense of the prevailing exchange rate level the best response to a speculative attack given the eventual fragility of the domestic financial systems. Now, since the central banks have only a limited amount of foreign reserves[3] (and the borrowing of foreign funds becomes more difficult during episodes of financial turmoil), an increase in the domestic interest rate (in order to make domestic bonds more attractive and so to reduce the pressure in the foreign exchange market) is considered by the majority of economists as the most appropriate, practicable and sustainable way to defend the prevailing exchange rate level. Nevertheless, researchers like Jeffrey Sachs and others have expressed serious concerns about the effectiveness and the adequacy of such a measure due to its eventual negative effects on the aggregate investment and demand of the economy.

During the past East Asian Crisis, the IMF officials chose the first point of view and advised the attacked economies to increase the domestic interest rates[4] in order to prevent the occurrence of currency mismatches and the activation of credit constraints by financial sector. Due to the fact that in the East Asian crisis all exchange rate regimes collapsed to the foreign exchange market pressures despite the domestic interest rate increases, the advice of the IMF was sharply criticized in the years after, enlightening even more the academic debate.[5]

The purpose of this paper is to explicitly model in a theoretic framework the

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[1] See e.g. Eichengreen and Hausmann (1999), Mishkin (1996), Krugman (2000), Kaminsky and Reinhart (2001). The theoretic models discussed in Aghion, Bacchetta, and Banerjee (2001) and Flaschel and Semmler (2003) show how a currency crisis can lead to a widespread financial crisis and therefore to a significant economic slowdown due to the activation of credit constraints and the subsequent decrease in the aggregate investment.

[2] See Calvo and Reinhart (2002).

[3] Recent research has focused on the role of the international reserves of the central bank in the design of optimal monetary policy rules for small open economies, see Kato and Semmler (2005).

[4] IMF Deputy Managing Director Shigemitsu Sigusaki stated: "We know that higher interest rate are likely to hurt the corporate sector, but an appreciation of the currency that follows a tightening of monetary conditions would greatly benefit those corporations indebted in foreign currency. There is no alternative in the short term. A relaxation of the monetary policy would only lead to further depreciations of the currencies", see Radelet and Sachs (1998, p.49).

[5] See Corsetti, Pesenti, and Roubini (1999) and Radelet and Sachs (1998).

exchange rate policy dilemma and to explore to what extent the orthodox monetary policy recommendation of an increase in the domestic interest rate is the right measure to follow during a speculative attack in an economy with a fraction of liabilities denominated in foreign currency. The same line of research has been recently pursued also by Braggion, Christiano, and Roldos (2005) within a general equilibrium framework. This work is nevertheless different from ours in a variety of points: while there a general equilibrium, new open economy macroeconomics type of model is discussed, our approach sticks to the more traditional stream of macro-founded third-generation currency crisis models as in Krugman (2000) and Flaschel and Semmler (2003).[6]

In our framework the optimal response by the monetary authorities to a speculative attack on the domestic currency depends on the degree of foreign currency indebtedness (and therefore on the potential impact of a currency mismatch) in the economy and on the elasticity of aggregate investment with respect to domestic interest rate changes. We attempt to highlight the pitfalls of *one-size-fits-all* receipts for the conduction of monetary policy in emerging market economies.

The remaining of the paper is structured as following: In section 2 the model developed in Proaño, Flaschel, and Semmler (2005) is modified to capture the negative influence of an increase in the domestic interest rate on the aggregate demand and so to explicitly model the dilemma of the exchange rate policy in emerging markets. The local stability properties of the modified model are also explored in section 2. Section 3 analyses different scenarios that are possible in the modified model when the exchange rate policy dilemma is taken into account. In section 4we we present some empirical evidence which backs up the results of the theoretic model developed in the previous section. Section 5 concludes.

2 The Model

We analyse a small open economy of Mundell-Fleming-Tobin type as discussed in Rødseth (2000). The analyzed time span is assumed to be short enough to allow

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[6]Furthermore, the authors do not explicitly focus on the currency mismatch problem and their model does not possess multiple equilibria as our theoretic framework does. The authors summarize the somewhat puzzling results of their model in the following way: "the optimal response to a financial crisis is an initial sharp rise in the interest rate, followed by a fall to below pre-crisis levels."Braggion, Christiano, and Roldos (2005, p.1). This conclusion, nevertheless, is erroneous because the initial rise in the interest rates is not a consequence of monetary policy actions but the outcome of the activation of the credit constraints and therefore the increase in the value (in units of the traded good) of the capital stock in the traded and non-traded sector, see also Braggion, Christiano, and Roldos (2005, p.16). Only the subsequent fall in the interest rates can be seen as the result of policy actions since it comes from the injection of liquidity by the monetary authorities.

for the assumption of a basically unchanging capital stock K as well as private financial wealth W_p, the firms' foreign currency and domestic currency debt F_f and B_f, respectively, despite the presence of positive or negative net investment and households' savings. Since foreign prices are assumed to be constant and are normalised to one $p^* = 1$, the real exchange rate can be defined as $\eta = e/p$. In contrast to Flaschel and Semmler (2003) and Proaño, Flaschel, and Semmler (2005), where the totality of the domestic firms financed its investment projects through foreign currency credit (what implied that the domestic interest rate did not affect the aggregate demand in a direct way), we assume there are two different groups of firms in the economy which desire to undertake investment projects. While a fraction of the domestic firms υ finances its investment projects through foreign currency denominated credits, the other fraction $(1 - \upsilon)$ does it by borrowing in domestic currency.[7] The balance sheet of the two fractions of domestic firms is represented in table 1 as following: The net worth of a firm is defined as the difference between

Table 1: Business Sector's Balance Sheets

	Business Sector's Balance Sheets	
Firms' Fraction	**Assets**	**Liabilities**
υ	$\upsilon p K$	$e F_f$
$1 - \upsilon$	$(1 - \upsilon) p K$	B_f

its assets and its liabilities (both expressed here in domestic currency). Note that while the exchange rate influences the net worth of the firms with foreign currency liabilities, the net worth of the other fraction of firms $(1 - \upsilon)$ remains unaffected by changes in the exchange rate.

Based on the financial accelerator concept introduced by Bernanke and Gertler (1989), we assume that banks (domestic and foreign) evaluate the creditworthiness of the domestic firms based on their actual net worth, or more precisely on their debt-to-capital ratio $\tilde{q}^\upsilon = e F_f / \upsilon p \bar{K} = \tilde{q}^\upsilon(\eta)$ and $\tilde{q}^{1-\upsilon} = B_f / (1 - \upsilon) p K$ (we assume here $F_f < 0$ and $B_f < 0$, indicating a negative foreign and domestic currency bond stock held by domestic firms, or in other words, that firms are indebted). Despite the fact that both groups might be subject to the eventual imposition of credit constraints by the financial sector, their net worth is composed in a different way.

A glance at the balance sheet of the fraction of domestic firms υ can clarify why a devaluation of the real exchange rate has a negative effect on credit awarded by banks to the group of firms with foreign currency liabilities υ: a rise of the nominal exchange rate (or an decrease of the domestic price level) leads to an increase in

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[7]For simplicity we assume that each firm possesses the same amount of capital so that the distribution of the aggregate capital stock between these two groups is represented also by υ.

the nominal (and here also real) value of the liabilities of this group and therefore to a decrease in its net worth. The other share of domestic firms $(1 - \upsilon)$, which is not indebted in foreign currency, is not affected by a devaluation of the domestic currency. The aggregate investment function, consistent of the aggregate investment by the two groups, can be expressed then as

$$I = \upsilon I \left(\bar{i}^*, \tilde{q}^\upsilon(\eta) \right) + (1 - \upsilon) I \left(r, \tilde{q}^{1-\upsilon} \right).$$

with $\bar{i}^* = r^* - \pi^* = r^*$ and $r = i - \pi$. Despite the fact that the share of domestic firms borrowing in υ is kept constant here, one could think of it as being a function of the risk premium ξ. For now we will just assume that due to financial technology differences or firm size factors not the totality but only a constant fraction of the domestic entrepreneurial sector can actually obtain credits denominated in foreign currency.

The elasticity of the investment function with respect to η is assumed to be state-dependent, so that while for high and low values of η (of $\tilde{q}^\upsilon$) the investment reaction is assumed to be inelastic, for intermediate values of η (of $\tilde{q}^\upsilon$), by contrast, the gross investment function results to be very elastic with respect to changes in the real exchange rate (in the debt-to-capital ratio), reflecting the activation of credit constraints. Such an aggregate investment function is shown in figure 1.
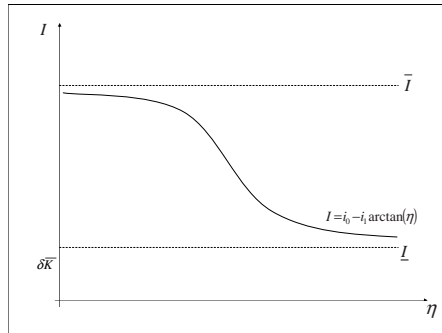

Figure 1: A Balance Sheet Dependent Investment Function

Even though the above gross investment function is of a very simple nature, it incorporates the financial accelerator concept and, more generally, the basic implications of the theory of imperfect capital markets, leading to the possibility of multiple equilibria and, therefore, to the existence of "normal" and "crisis" steady states respectively. Note nevertheless that the magnitude of the balance sheet effect depends in a great manner on υ, that is on the degree of liability dollarization of the economy. For $\upsilon = 1$, i.e. in the case of total liability dollarization (as in Flaschel and Semmler (2003)), the balance sheet effect alone (except foreign interest rate changes) determines the level of aggregate investment. For $\upsilon = 0$, on the contrary,

changes in the real exchange rate do not affect the financial state of the domestic firms.

The aggregate consumption and export functions remain as in Proaño, Flaschel, and Semmler (2005), with the only difference that the latter depends now on the real (and not nominal) exchange rate $\eta = e/p$ (the foreign goods price still set equal to one for simplicity).

The goods market equilibrium can again be expressed as

$$Y = C_1(Y^D) + I(\bar{i}^*, \tilde{q}^v(\eta), r, \tilde{q}^{1-v}) + \delta\bar{K} + \bar{G} + X(Y^{n*}, \eta). \tag{1}$$

Note that we have removed here from explicit consideration all imported consumption goods C_2 and thus have reduced the representation of aggregate demand to include only domestic consumption goods $C_1 = C - eC_2$. In view of this only exports X have therefore to be considered from now on.

The dynamic multiplier is now based on the law of motion

$$\dot{Y} = \beta_y \left[C_1(Y^D) + I(\bar{i}^*, \tilde{q}^v(\eta), r, \tilde{q}^{1-v}) + \delta\bar{K} + \bar{G} + X(Y^{n*}, \eta) - Y \right] \tag{2}$$

The slope of the $\dot{Y} = 0-$isocline is described in the extended phase space (Y, η) by:

$$\left. \frac{\partial Y}{\partial \eta} \right|_{\dot{Y}=0} = -\frac{v I_\eta + X_\eta}{C_Y - 1}$$

It can easily be seen that the slope of the $\dot{Y}=0-$isocline depends on which of the two opposite effects dominates: the balance-sheet-effect $v I_\eta < 0$ or the competitiveness effect $X_\eta > 0$:

$$|v I_\eta| > X_\eta \implies \left. \frac{\partial Y}{\partial \eta} \right|_{\dot{Y}=0} < 0$$

and

$$|v I_\eta| < X_\eta \implies \left. \frac{\partial Y}{\partial \eta} \right|_{\dot{Y}=0} > 0.$$

From the shape of the assumed investment function there results (if its interior part is sufficiently steeper than its counterpart in the export function) that for intermediate values of η ($\tilde{q}^v$) the creditworthiness (the balance-sheet) effect is stronger than the "normal" competitiveness effect, changing the slope of the $\dot{Y}=0-$isocline and therefore opening up the possibility of multiple equilibria now in the (Y, η) phase space. Note the strength of the balance-sheet effect on the aggregate demand depends on the degree of dollarization of liabilities in the economy v: For $v = 1$, the balance-sheet effect operates with full strength, while for $0 < v < 1$ this effect is dampened.

The structure of the financial markets is assumed to be the same as in Flaschel and Semmler (2003) and Proaño, Flaschel, and Semmler (2005). Following Rødseth

(2000), a portfolio approach of Tobin type, which allows different rates of return on domestic and foreign bonds, is chosen for the modelling of the financial markets. The defining financial market equations are:

$$\text{Private Sector's Initial Private Wealth} \qquad W_p = \frac{M_0 + B_{p0} + eF_{p0}}{p} \qquad (3)$$

$$\text{Risk Premium} \qquad \xi = i - \bar{i}^* - \epsilon \qquad (4)$$

$$\text{Foreign Currency Bond Market Equilibrium} \qquad \frac{eF_p}{p} = f(\xi, W_p, \alpha), \qquad (5)$$

$$f_\xi < 0, f_{W_p} > 0, f_\alpha > 0$$

$$\text{Money Market Equilibrium} \qquad \frac{M}{p} = m(Y, i), m_Y > 0, m_i < 0 \qquad (6)$$

$$\text{Bond Market Equilibrium} \qquad \frac{B_p}{p} = W_p - m(Y, i) - f(\xi, W_p) \qquad (7)$$

$$\text{Equilibrium Condition} \qquad F_p + F_c + \bar{F}^* = 0 \qquad \text{or} \qquad F_p + F_c = -\bar{F}^*. \qquad (8)$$

Thereafter, the nominal exchange rate adjustment mechanism is determined by

$$\dot{e} = \beta_e \left[f \left(i \left(Y, \frac{M}{p} \right) - \bar{i}^* - \beta_\varepsilon \left(\frac{e_0}{e} - 1 \right), \frac{M + B_p + eF_p}{p}, \alpha \right) - \frac{eF_p}{p} \right]. \qquad (9)$$

with

$$\frac{\partial \dot{e}}{\partial Y} = \beta_e f_\xi i_Y < 0.$$

The main innovation in the extended currency crisis model discussed in Proaño, Flaschel, and Semmler (2005) is the modelling of domestic price fluctuations undertaken through a wage-price Phillips-curve. An expectations augmented, open-economy Phillips-curve (on the assumption of a constant productivity production function and mark-up pricing) can be written as

$$\hat{p} = \gamma(Y - Y^n) + \pi_c^e \text{ with } \pi_c^e = (\hat{p}_c)^e \text{ and } p_c = p^\theta(ep^*)^{1-\theta}, \ \theta \in (0,1). \qquad (10)$$

We now use p_c for the consumer price level, based on a geometric mean of the domestic and the foreign price level, both expressed in the domestic currency. Superscript e denotes expected variables, implying that marked up domestic wage inflation is explained in this Phillips Curve by the output gap and the expected consumer price inflation rate. In Proaño, Flaschel, and Semmler (2005) this open economy Phillips Curve was reduced to

$$\hat{p} = \frac{1}{1-\theta}\gamma(Y - Y^n) \quad \text{or}$$

$$\dot{p} = (\beta_p(Y - Y^n))p. \tag{11}$$

due to the assumption that the exchange rate as well as the foreign price level is kept fixed and that in addition that current domestic inflation is perfectly foreseen.

Now, if we drop the assumption of a constant nominal exchange rate and allow it to (eventually) fluctuate, the Phillips Curve turns to

$$\hat{p} = \frac{\gamma}{1-\theta}(Y - Y^n) + \beta_\epsilon(e_0/e - 1) \quad \text{or} \quad \dot{p} = \left(\beta_p(Y - Y^n) + \beta_\epsilon\left(\frac{e_0}{e} - 1\right)\right)p. \tag{12}$$

Let's turn now our attention to the real exchange rate $\eta = e/p$. The time derivative of the exchange rate $\dot{\eta}$ is given by

$$\dot{\eta} = \frac{\dot{e}p - e\dot{p}}{p^2} = \frac{1}{p}(\dot{e} - e\hat{p})$$

From this formulation follows that $\dot{\eta} = 0$ when $\hat{e} = \hat{p}$. This solution, nevertheless, is not a stable one since it would probably be fulfilled only in very short periods of time. The true solution for which the real exchange rate remains constant ($\dot{\eta} = 0$) is when simultaneously $\dot{e} = 0$ and $\dot{p} = 0$ hold. The first condition $\dot{e} = 0$, that is the equilibrium in the domestic financial (foreign, money and bond) markets is fulfilled almost immediately in the short run and is surely true in the medium run. In the medium run the nominal exchange rate is at its steady state value, i.e. $e = e_0$, so that $\dot{\epsilon} = 0$. In the absence of expected nominal exchange rate depreciations in the medium run, $\dot{p} = 0$ holds only if $Y = Y^n$. Since there is no restriction on the level of the domestic price level in the medium run, follows that the $\dot{\eta} = 0$ isocline in the (η, Y)−space is a vertical line which cuts the $Y-$ axis at $Y = Y^n$. Note that in contrast to the $\dot{p} = 0$ isocline described in Proaño, Flaschel, and Semmler (2005), the $\dot{\eta} = 0-$isocline here does not only represent the Phillips Curve and therefore the medium run equilibrium in the labor markets, but it also represents the medium run equilibrium in the financial markets. Here thus, we have a clear theory of real exchange rate determination which states that while the nominal exchange rate is determined in the financial markets, the domestic price level is set primarily in the goods and labor markets. Therefore we call the $\dot{\eta} = 0-$isocline the PF-curve.

2.1 Local Stability Analysis

The model consists thus of the following differential equations:

$$\dot{Y} = \beta_y\left[C_1(Y^D) + I(\bar{i}^*, \tilde{q}^\upsilon(\eta), r, \tilde{q}^{1-\upsilon}) + \delta\bar{K} + \bar{G} + X(Y^{n*}, \eta) - Y\right]$$

$$\dot{\eta} = \frac{\beta_e}{p}\left[f\left(i\left(Y, \frac{M_o}{p}\right) - \bar{i}^* - \beta_\varepsilon\left(\frac{e_0}{e} - 1\right), \frac{M_o + B_{po} + eF_{po}}{p}, \alpha\right) - \frac{eF_{po}}{p}\right]$$

$$- \left(\beta_p(Y - Y^n) + \beta_\epsilon\left(\frac{e_0}{e} - 1\right)\right)\eta$$

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The first differential equation is the standard goods markets adjustment mechanism. The second equation gathers eq.(9) and eq.(12) and represents the adjustment of the real exchange rate to changes in Y. As it can easily be seen, for $Y > Y^n$ the real exchange rate appreciates, i.e. $\dot{\eta} < 0$. This development results from two effects: on the one hand, a rise in Y leads to a nominal exchange rate appreciation (given a constant money stock supply by the domestic monetary authorities), i.e. $\dot{e} < 0$. On the other hand, for $Y > Y^n$ follows that $\dot{p} > 0$. The additional term of exchange rate expectations only strengthens this effect. For $Y < Y^n$, the opposite holds.

The Jacobian of this system is

$$
J \;\; = \;\; \begin{bmatrix} \beta_y\left[C_Y - 1\right] & \beta_y\left[\upsilon I_\eta + X_\eta\right] \\[2mm] \frac{\beta_e}{p}(f_\xi i_Y) - \beta_p\eta & \frac{\beta_e}{p}(f_{W_p}F_{po} - F_{po}) \end{bmatrix}.
$$

Because of the nonlinearity of the $\dot{Y}{=}0-$isocline there exist in the considered situation three economically meaningful steady states, whose local stability properties can easily be calculated:

$$
J_{E1} \;\; = \;\; \begin{bmatrix} - & + \\ - & - \end{bmatrix} \Longrightarrow tr(J_{E1}) < 0, \quad det(J_{E1}) > 0 \Longrightarrow \text{stable steady state}
$$

$$
J_{E2} \;\; = \;\; \begin{bmatrix} - & - \\ - & - \end{bmatrix} \Longrightarrow tr(J_{E2}) < 0, \quad det(J_{E2}) < 0 \Longrightarrow \text{saddle point}
$$

$$
J_{E3} \;\; = \;\; \begin{bmatrix} - & + \\ - & - \end{bmatrix} \Longrightarrow tr(J_{E3}) < 0, \quad det(J_{E3}) > 0 \Longrightarrow \text{stable steady state}.
$$

The resulting phase diagram of this currency crisis model is sketched in figure 2.

Steady state $E1$ represents the "normal" steady state, where the economy's output is high as well as the domestic investment activity. In this steady state, the standard case $|I_\eta| < X_\eta$ holds. Steady State $E2$ represents the fragile case with $|I_\eta| > X_\eta$: Because a slight deviation of the output level from this steady state level can lead the economy to a short-run investment boom or to a decline in the economic activity, this equilibrium point is unstable. Steady State $E3$ constitutes the "crisis equilibrium". At this equilibrium point the investment activity is highly depressed due to the high value of e. Nevertheless, the slope of the $\dot{Y} = 0-$isocline is again positive because of $|I_\eta| < X_\eta$ describing the dominance of exports over (the remaining) investment demand in the considered situation.
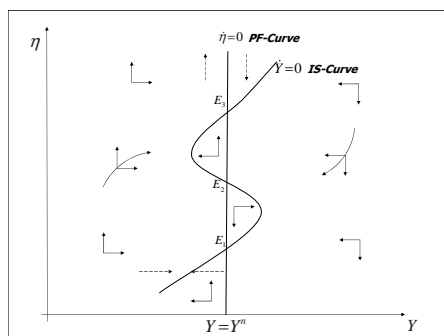
Figure 2: The IS-PF Model

3 Short Run Twin Crises and Medium Run Real Exchange Rate Adjustments

3.1 The Case of Total Liability Dollarization $v = 1$

In order to highlight the implications of the incorporation of the domestic interest rate in the aggregate investment function of our model, we discuss first the dynamics for the complete liability dollarization case ($v = 1$), as it was the case in Flaschel and Semmler (2003) and Proaño, Flaschel, and Semmler (2005). Assume the economy is initially situated at its NAIRU employment level in steady state $E1$. A significant flight into foreign currency can represented in the model through an increase of the α parameter in the foreign currency bond demand. As long as the monetary authorities can defend the old currency peg, the flight into foreign currency does not have any effects besides the reduction of the foreign exchange reserves of the central bank (because a constant money supply is assumed, a full sterilization of money base changes by the central bank is also implicitly assumed). Now suppose that the central bank gives in to the foreign market pressure because of the dangerous lowering of the foreign reserves. As a result of a speculative attack on the domestic currency, the nominal exchange rate sharply devaluates and the domestic economy experiences a financial crisis which depresses the domestic investment activity. In the model discussed in Proaño, Flaschel, and Semmler (2005), the new exchange rate level after the one-time devaluation was assumed for simplicity to be considered by the economic agents as "sustainable". Here, on the contrary, this must not be the case, as we will discuss below.

In the (η, Y)- space, the short run sharp nominal exchange rate devaluation is represented by a "jump" of the value of η along the $\dot{\eta} = 0-$ isocline up to point B.[8]

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[8]We assume that the nominal depreciation is of such magnitude that B lies above the unstable steady state $E2$. We will discuss the case where B lies below $E2$ below.
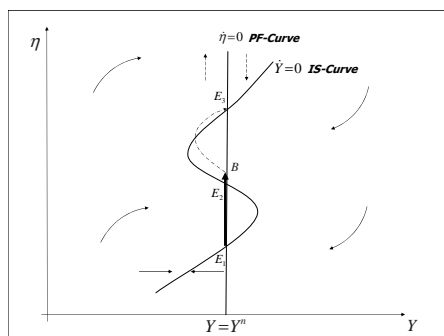
Figure 3: The Consequences of a Breakdown of the Currency Peg in the Case of Total Liability Dollarization

Now, due to the dynamic adjustment mechanism in the goods markets, Y sinks so that $Y < Y^n$. This development has two effects, as already discussed in the previous section. On the one hand (assuming now a post-crisis flexible exchange rate regime), a decrease in Y leads to a fall in the domestic interest rates and to a higher demand for foreign bonds and, in a flexible exchange rate regime, to a rise in e. On the other hand, the underemployment situation leads to a fall in the domestic price level, i.e. $\dot{p} < 0$. Both effects lead to a strong depreciation of real exchange rate, helping so the economy to return to its NAIRU employment level through the expansion of the domestic exports. Obviously, in a post-crisis fixed exchange rate regime, a much more severe deflationary process than in a flexible exchange rate regime is required for the domestic economy to return to its pre-crisis NAIRU level of employment, as discussed in Proaño, Flaschel, and Semmler (2005). These dynamics are sketched in figure 3.

The nominal exchange rate and domestic price level dynamics corresponding to the dynamic adjustment described in figure 3 are sketched in figure 4. Since now the nominal exchange rate is allowed to float after the occurrence of the currency crisis, there is no necessity for a severe deflationary process in order to reach the NAIRU consistent output again. Further nominal exchange rate adjustments (in this case depreciations) can also contribute for the real exchange rate to devaluate.

As stated before, in the case of total liability dollarization, a defense of the prevailing exchange rate level by the domestic monetary authorities does not have a direct effect on the aggregate demand because the domestic firms finance their investment projects completely through foreign currency credit. Theoretically, the monetary authorities can thus indefinitely increase the domestic interest rates in order to reduce the pressure on the exchange rate without directly affecting the real sector of the economy. Such a measure can reduce the magnitude of an eventual nominal depreciation and might even generate a short run expansion due to the
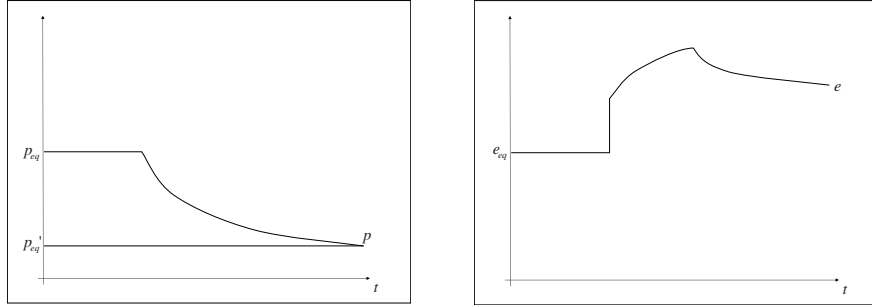
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Figure 4: Price Level and Exchange Rate Adjustments after a Breakdown of the Currency Peg in the IS-PF Model

expansion of the net exports, if the real exchange rate jumps in the short run to a point B' below the steady state $E2$.

3.1.1 Dynamics with a "Kinked" Phillips Curve

As already Keynes (1936) noticed, an economy-wide wage and price deflation of great magnitudes is unlikely to happen in modern economies. Indeed, numerous studies have shown that wages are downwardly rigid in the majority of countries. Taking this empirical fact into consideration the Phillips Curve can be modified in the following way:

$$\hat{p} = \max \left\{ \gamma(Y - Y^n) + \beta_\epsilon \left(\frac{e_0}{e} - 1 \right), 0 \right\}. \tag{13}$$

This modified Phillips-Curve implies that in under-employment situations prices do not fall but instead remain constant. Price changes can only take place in over-employment situations, where the price level is assumed to rise as before.

The empirical observation of downwardly rigid wages had important consequences for the dynamics of the model described in Proaño, Flaschel, and Semmler (2005). Because there a post-crisis fixed exchange rate level was assumed, the price deflation was the only process which enable the economy to return to the NAIRU-employment level. If prices are downwardly rigid, the economy lost that recovery mechanism and was "condemned" to remain at the "crisis equilibrium" as in Flaschel and Semmler (2003).

Here, in contrast, downward wage rigidity does not "condemn" the economy to remain in such under-employment equilibria due to the absence of a way to re-gain competitiveness and therefore to increase the level of exports again. In presence of downward rigidity the nominal exchange rate assumes the whole weight of the recovery process so that further nominal (and also real) exchange rate depreciations are

needed to enhance the competitiveness of the domestic products in the international goods markets and so to return to the NAIRU-production level.

3.2 The Case of Partial Liability Dollarization 0< v <1: Modelling the Exchange Rate Policy Dilemma

We now analyse the dynamics of the model for the case where a fraction of the domestic firms does not issue foreign-currency debt but finances its investment projects by domestic currency denominated credit. Despite the fact that the $\dot{Y} = 0-$isocline has basically the same shape as in the previous section, as stated before, the magnitude of the balance-sheet effect on the aggregate investment and therefore on the aggregate demand depends on the degree of dollarization of liabilities in the economy.

As it has been discussed in many articles, in an economy with liabilities denominated only partially in foreign currency, the monetary authorities are confronted during a speculative attack on the domestic currency with a lose-lose situation. Exactly this situation is represented when $0 < v < 1$. In this case an increase of the domestic interest rate (through a reduction of the money supply) has a direct effect on the aggregate investment due to a subsequent decrease of the investments undertaken by the fraction $(1 - v)$ of domestic firms. In our model, such a response to a speculative attack on the domestic currency does not only influence the dynamics of $\dot{\eta}$, but it also shifts the $\dot{Y} = 0-$isocline to the left reducing the aggregate investment and demand, as sketched in figures 5 and 6. In the next sections we show that this potential counterproductiveness of an increase in the domestic interest rate by the monetary authorities depends on the elasticity of the aggregate demand with respect to interest rate changes.

3.2.1 Dynamics after a Successful Defense of the Currency Peg

Under the assumption that the increase in the domestic interest rate by monetary authorities succeeds in lowering the pressure in the foreign exchange market so that prevailing exchange rate level (or currency peg in case of a fixed exchange rate regime) remains at its former level (or just slightly deviates from it), two possible scenarios are possible. If the elasticity of the aggregate investment with respect to domestic interest rate changes is low, the $\dot{Y} = 0-$isocline will not significantly shift to the left and the economy will return to an equilibrium point very similar to the pre-crisis equilibrium point after a short term period of slight over production and employment and a moderate domestic inflation, as sketched in figure 5a. If, on the contrary, the elasticity of the aggregate demand to interest rate changes is high, the IS-Curve will significantly shift to the left and the $E1$ equilibrium point might get lost, as sketched in figure 5b.

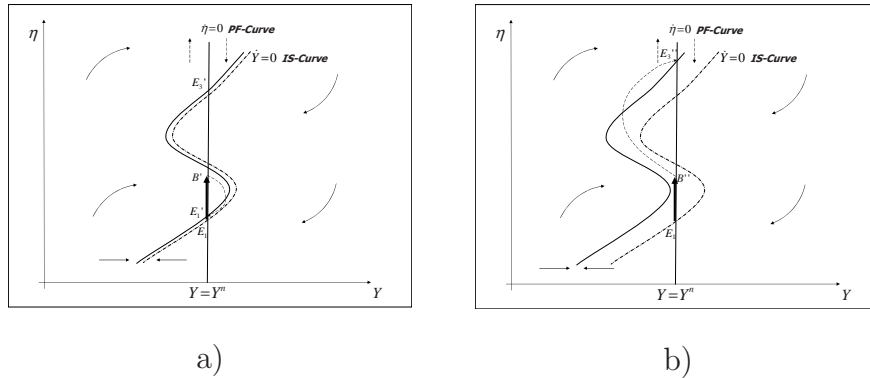$$\text{a)} \qquad\qquad\qquad\qquad\qquad \text{b)}$$

Figure 5: Real Exchange Rate and Output Dynamics resulting from a Successful Defense of the Exchange Rate Level under a) Low and b) High Interest Rate Elasticity of the Aggregate Investment

In this second case an increase in the domestic interest rate will thus lead to a severe economic slowdown in the short run due to the fall in the aggregate demand despite of the successful defense of the nominal exchange rate. In the medium run, the equilibrium point $E3$ is the only steady state to which the economy can converge to. Since $Y < Y^n$, the domestic price level will fall and $\dot{\eta} > 0$, even though the nominal exchange rate might be fixed. This decrease in the domestic price level enhances the competitiveness of the domestic products in the international markets, expanding so the next exports volume and leading the economy in the medium run to its pre-crisis full-employment level $E3$, nevertheless with a different composition, namely high exports and depressed investments. Note nevertheless that this recovery process might only take place if the domestic wages and prices fall sufficiently to enhance in a significant way the competitiveness of the domestic goods. If the domestic nominal wages and prices are downwardly rigid as empirically is the case in the majority of modern economies, then the economy might stay for a longer period in an unemployment situation where the nominal exchange rate is constantly under pressure. The government and the monetary authorities have in that case two alternatives: either the government expands its expenditures (shifting the IS-Curve back to the right) or the monetary authorities give in to the foreign exchange market pressure and devaluate the domestic currency, accelerating so the recovery process to $E3$.

3.2.2 Dynamics after a Failed Defense of the Currency Peg

The two possible scenarios discussed in the previous section were based on the assumption that the interest rate increase by the domestic monetary authorities was successful in the defense of the prevailing exchange rate (or currency peg in case of

a fixed exchange rate regime). Nevertheless, as the majority of currency crises in the last decades have demonstrated, the foreign exchange market pressure can be of such a magnitude that the monetary authorities might be forced to devaluate or let the nominal exchange rate float. In such a case the currency mismatch between the assets and liabilities of the fraction of domestic firms which finance their investment projects through foreign currency credit takes place all in all, leading to the activation of credit constraints by the financial sector and to a fall of the investment of the group of domestic firms indebted in foreign currency. The investment of the remaining firms, which actually does not depend on the level of the nominal exchange rate, is also affected due to the domestic interest rate increases undertaken by the monetary authorities in their effort to defend the currency peg. The aggregate consequences for the economy are then catastrophic, since not a fraction, but the complete investment by entrepreneurial sector is depressed. The extent of the investment decrease depends, of course, on the interest rate elasticity of the aggregate demand, as shown in figure 6.

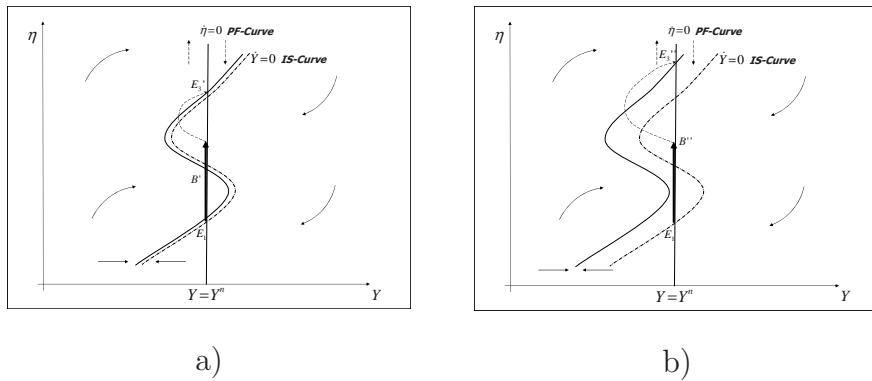a)   b)

Figure 6: Real Exchange Rate and Output Dynamics resulting from a Failed Defense of the Exchange Rate Level under a) Low and b) High Interest Rate Elasticity of the Aggregate Investment

Figures 6a and 6b show an important insight: the higher the interest rate elasticity of the aggregate demand, the longer is the recession period the economy experiences after the currency breakdown and the higher is equilibrium real exchange rate to which the economy converges in the medium run as shown in figure 6b. These results are intuitive: the higher the interest rate elasticity of the aggregate demand, the greater is the investment decrease and therefore the real exchange rate increase which is needed for the economy to return to its NAIRU level of employment and production. We see thus that a failed defense of the prevailing exchange rate by the monetary authorities can have disastrous implications for the short- and medium run performance of the economy.

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3.2.3 An Unorthodox Measure in the Face of a Speculative Attack

Due to the potential occurrence of the scenarios discussed above some researchers like Jeffrey Sachs have pledged that not an *increase*, but a *decrease* in the domestic interest rate is the right measure during a speculative attack on the domestic currency. Indeed, since the exchange rate level *per se* does not have a real meaning for the economic development, the monetary authorities might decide to bring the currency crisis behind them once and for all and stabilize or even enhance the economic activity by lowering the interest rates, not concerning about the exchange rate level. Such a measure will induce an even greater nominal exchange rate depreciation, i.e. a jump from $E1$ to B' as sketched in figure 7. As shown there, the resulting dynamics depend on whether the new nominal (and real in the short run) exchange rate lies beneath or above the unstable new steady state $E2''$.
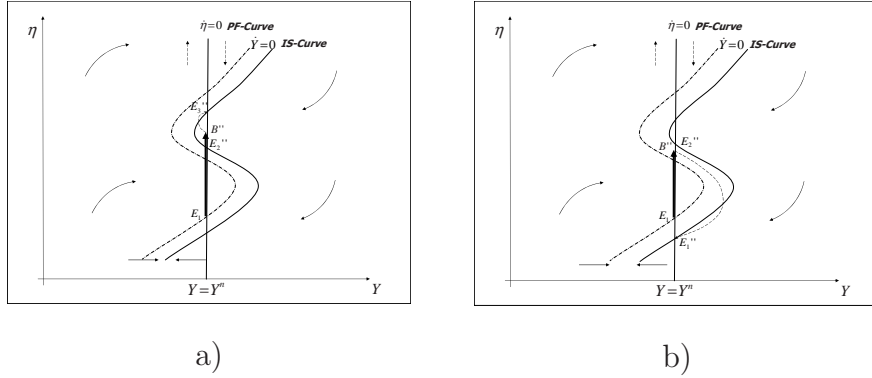

a)   b)

Figure 7: Two Possible Consequences of an Interest Rate Decrease as a Response to a Speculative Attack a in Economy with Dollarized Liabilities

    In figure 7a, where the interest rate elasticity of the aggregate demand is low and the aggregate investment rises due to the decrease of the domestic interest rate, the $IS-$Curve significantly shifts to the right so that B' lies above $E2''$ in the short run. The economy will experiment in this case a period of underemployment, depressed investment of the fraction of domestic firms indebted in foreign currency (due to the increase of the domestic currency value of the foreign currency liabilities of that group) and falling prices (since $Y < Y^n$) until $E3'$ is reached. Again, the enhancement of the net exports via real depreciation is the channel which enables the economy to return to its NAIRU level of employment. Nevertheless, the output loss in this case will probably be lower and the duration of the economic slowdown shorter than in the previous cases where the exchange rate was successfully defended but the aggregate investment was severely damaged, as sketched in figure 6.

    In figure 7b, where the interest rate elasticity of the aggregate demand is low, the $IS-$Curve does not significantly shift to the right and B' lies below $E2''$ in the short

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run, the domestic interest rate decrease overcomes the negative balance sheet effect resulting form the nominal depreciation of the domestic currency. In this scenario this nominal devaluation leads at the end only to an increase in the net exports and therefore, together with the higher aggregate investment, to a period of over-production and -employment in the economy. Nevertheless, Due to the resulting increase in the domestic price level (since $Y > Y^n$), the domestic products will loose competitiveness and the net exports will decrease over time, leading the economy to its NAIRU production level at $E1'$.

4   Empirical Evidence

The Mexican and East Asian crises are quite particular episodes in recent history due to the abruptness and extent up to which the real side of the economy reacted to the sharp devaluations of the domestic currency. Nevertheless, the fact that in the majority of cases the domestic monetary authorities tried, unsuccessfully, to defend the prevailing nominal exchange rate level by raising the domestic short term interest rates opens up the question whether that strategy was not in part responsible for the subsequent sharp decay in the aggregate demand, and especially in the aggregate investment, as discussed for example in the model scenario represented in figure 6. In this section we attempt to bring some light to this question by trying to identify the main cause of the sharp decline of aggregate investment in the attacked economies.
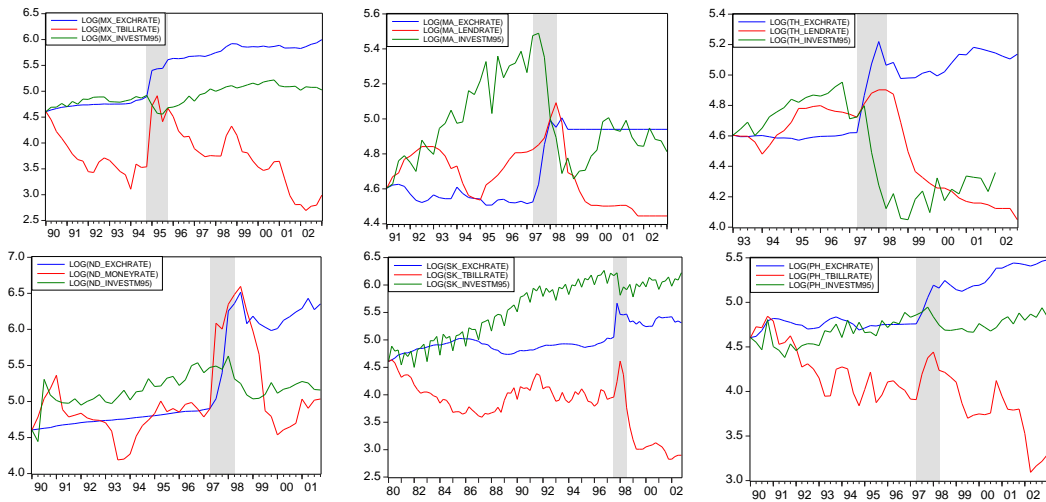

Figure 8: Real Aggregate Investment, Exchange and Interest Rates
(First Quarter = 100, in logs)

In figure 8 we show time series data of Mexico and selected East Asian countries for the 1990s, the decade where currency and financial crises took place in those

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countries. In all cases a sharp nominal exchange rate depreciation, caused by a successful speculative attack, as well as a rise in the domestic interest rates (due to the intervention of the domestic monetary authorities) preceded an abrupt and severe decline in the aggregate investment activity in the following quarters.

Figure 9 shows the currency crisis-resulting interest rate increase and nominal depreciation rates against the subsequent output loss (the negative of the post-crisis annual investment growth rates). No direct relationship can be observed. Indeed, due to the uniqueness and high non-linearity of these financial episodes and to the fact that both variables, nominal exchange rates *as well as* domestic interest rates experienced the same "jumps" in the same time intervals, as well as to the small number of available time series data, a direct econometric identification of the main determinants (the nominal exchange rate depreciations or the sharp interest rate increases) for these sharp investment declines is extremely difficult to perform. Indeed, there is no significant cross-country correlation between the nominal exchange- and interest rate increases and the largest output loss observed in the respective economies.
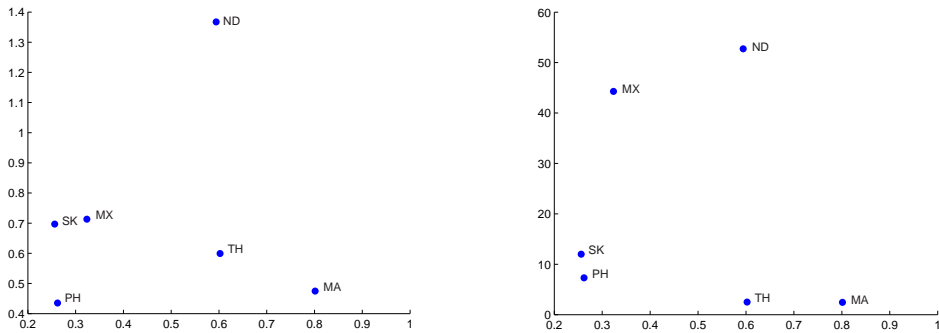

Figure 9: Nominal Exchange and Interest Rate Increase (Y-Axis) and Largest Output Loss (X-Axis)

We pursue here an alternative, indirect strategy which can be summarized in the following way: We first estimate the elasticity of aggregate investment with respect to the domestic interest rate in the pre-crisis sub-samples of selected emerging market countries. We so estimate the intrinsic reaction of the economies with respect to domestic interest rate increases (no matter their cause) before the respective currency and financial crises.[9] We use for our analysis time series data of aggregate investment (in constant 1995 prices), the respective nominal bilateral US-Dollar

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[9]We do not do the same for the exchange rate elasticity of the aggregate investment since, from the theoretical point of view, in tranquil periods no direct relationship between these two variables can be expected. The effect of a nominal depreciation on investment is theoretically defined as highly nonlinear, see Krugman (2000).

exchange and domestic interest rates of Mexico (MX), Malaysia (MA), Thailand (TH), Indonesia (ND), South Korea (SK) and the Philippines (PH) stemming from the International Statistical Yearbook 2003. The OLS estimation results concerning the pre-crisis interest rate semi-elasticities (autoregressive terms as well as seasonal dummies and trends are omitted) in the pre-crisis sub-sample are reported in table 2.

Table 2: Domestic Interest Rate Semi-Elasticity of Aggregate Investment: OLS Estimations Results

Sample Period	Expl. Variable	Coeff.	Std. Errors	t-Stat.	$\bar{R}^2$
1991Q4-1994Q4	MX_tbillrate(t-2)	-0.012	0.001	-6.226	0.771
1991Q3-1997Q4	MA_lendrate(t-1)	-0.062	0.016	-3.882	0.938
1993Q4-1996Q4	TH_lendrate(t-3)	-0.042	0.003	-11.258	0.992
1990Q4-1997Q2	ND_moneyrate(t-3)	-0.008	0.002	-3.674	0.959
1981Q1-1997Q2	SK_tbillrate(t-3)	-0.006	0.002	-2.996	0.990
1990Q4-1997Q2	PH_tbillrate(t-3)	-0.011	0.004	-2.842	0.767

Figure 2 shows the estimated pre-crisis semi-elasticities of the selected countries plotted against the largest post-crisis output loss. Apparently the countries with the higher interest rate semi-elasticities were the ones with the higher output loss after the respective currency and financial crises.

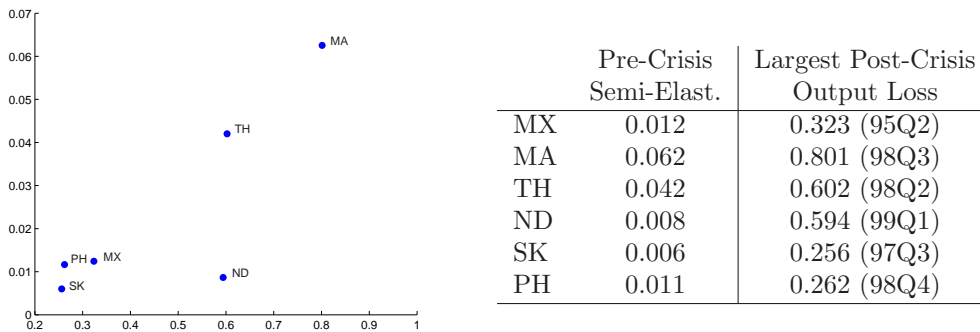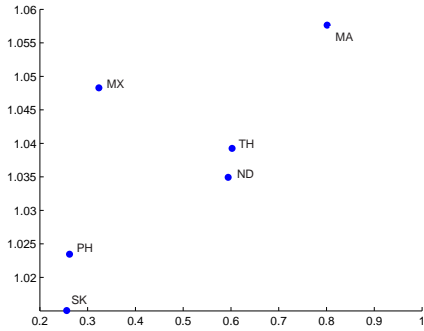|	Pre-Crisis Semi-Elast.	Largest Post-Crisis Output Loss
MX	0.012	0.323 (95Q2)
MA	0.062	0.801 (98Q3)
TH	0.042	0.602 (98Q2)
ND	0.008	0.594 (99Q1)
SK	0.006	0.256 (97Q3)
PH	0.011	0.262 (98Q4)

Figure 10: Interest Rate Semi-Elasticity (Y-Axis) and Largest Output Loss (X-Axis)

Nevertheless, the domestic interest rate increases resulting in part from the defense of the currency peg by the respective monetary authorities were not of the same magnitude across the attacked countries. We try to approximate the direct impact on investment of the interest rate increase during the speculative attack by taking into account the respective country-specific semi-elasticities of the aggregate investment (we assume here that the interest rate elasticity of aggregate investment remained unchanged by the respective crises). We plot then in figure 11 the resulting series against the largest output loss (the negative of the observed growth rates

of aggregate investment after the respective crises marked by the shaded areas in figure 8).

	Interest Rate Impact	Largest Post-Crisis Output Loss
MX	1.048	0.323 (95Q2)
MA	1.057	0.801 (98Q3)
TH	1.039	0.602 (98Q2)
ND	1.034	0.594 (99Q1)
SK	1.009	0.256 (97Q3)
PH	1.023	0.262 (98Q4)

Figure 11: Interest Rate Impact (Y-Axis) and Largest Output Loss (X-Axis)

As expected, a positive correlation can be observed. This graphical result can be interpreted in the following way: a sharp increase in the domestic interest rates caused in countries with a high intrinsic interest rate elasticity a greater output loss than in countries where the elasticity was low. For comparison we show in figure 12 the largest exchange rate increase, geometrically weighted with the end of 1996 short term liabilities to BIS banks (as percentage of GDP).[10]
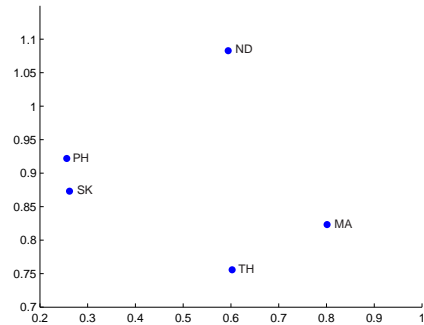
	Exchange Rate Impact	Largest Post-Crisis Output Loss
MA	0.823	0.801 (98Q3)
TH	0.755	0.602 (98Q2)
ND	1.082	0.594 (99Q1)
SK	0.092	0.256 (97Q3)
PH	0.873	0.262 (98Q4)

Figure 12: Exchange Rate Impact (Y-Axis) and Largest Output Loss (X-Axis)

Surprisingly, it seems as the great nominal exchange rate devaluation, weighted by the intrinsic degree of liability dollarization in the respective economies, is less

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[10]This measure is commonly used as a proxy for the degree of liability dollarization in an economy, see .... Other proxies for the degree of liability dollarization in the economy as the ratio of short term liabilities to foreign reserves or the ratio of liabilities to assets towards BIS banks delivered similar results.

correlated with the large output losses observed in the quarters following the currency and financial crises. This important result delivers a new insight on the real causes for the large output decrease in the attacked countries and relativizes the importance of the liability dollarization issue for the development of aggregate investment.

As stated before, the lack of adequate data represents a great problem for the empirical analysis of the Mexican and East Asian Crises since it difficults their econometric investigation in a great manner due to the small number of observations available. Nevertheless, the basic procedure discussed in this section delivers in our opinion some insights on the true determinants of the large output losses after these currency and financial crises.

5 Concluding Remarks

The right strategy to be followed by the domestic monetary authorities during a speculative attack is an issue which is far from being solved and which will keep researchers and policy makers busy in the next years. We contribute to this discussion by showing in a theoretic framework that both strategies (the increase or decrease the domestic interest rates) can turn out to be beneficial for the short and medium run performance of the economy. In our model the traditional strategy (backed by the IMF during the East Asian Crisis) of raising the interest rates results to be counterproductive if the aggregate demand reacts very elastically to domestic interest rate changes. This strategy can turn out to be the adequate one only if the interest rate changes do not affect in a great manner the aggregate investment and therefore the aggregate demand of the economy.

The most unorthodox alternative, namely a decrease in the interest rates, might be considered as more problematic from the short run point of view since it might provoke an even more sharper depreciation of the nominal exchange rate. Nevertheless, such a measure might be more beneficial in the medium run since a) it might lower the output loss and the duration of the economic recession or b) it might induce a short run over employment situation through a real exchange rate depreciation and a resulting expansion of the net exports volume as well as an inflationary process.

These results, together with the empirical findings of the last section, highlight the importance of the consideration of country-specific characteristics in the exchange rate policy making. Receipt solutions of the *one-size-fits-all* type can bring heterogeneous and, more important, adverse results in countries with different characteristics. If the fraction of the liabilities denominated in foreign currency is not significantly high and the aggregate demand of the remaining firms react elastically to interest rate changes, the unorthodox alternative of lowering the interest rate and

let the nominal exchange rate float might be a better medium run oriented strategy for the domestic monetary authorities to follow, even if its short run effects might seem radical and counterproductive.

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