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Abstract

Despite the success of third generation currency crisis models in describing the effects of currency shocks in countries with a large fraction of domestic liabilities denominated in foreign currency, these models lack some realism in the medium run. This is because they mostly disregard wage and price movements. Although these may not play an important role in the short-run, they become significant in the medium run and are therefore very relevant for the role of monetary policy during and after currency and financial crises. Based on previous work by Flaschel and Semmler (2003), we investigate empirically the effect of a sharp devaluation of the currency on aggregate investment and introduce a Phillips Curve in a basic financial crisis model to explore medium run scenarios that might occur when wage and price dynamics are taken into account.

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

Recent studies on the Asian 1997-98 financial crisis such as the work by Krugman (2000), Mishkin (1998), Miller and Stiglitz (1999) and Flaschel and Semmler (2003) have elaborated on the mechanisms of how a currency crisis can trigger a financial crisis that may lead to a severe economic slowdown. This previous research has focused on the credit market problems that arise for firms after a strong currency devaluation, in a country where credit market frictions exist and where a significant fraction of domestic banks' and firms' debt is denominated in foreign currency. Yet, in those models the wage and the price levels were usually fixed. The main contribution of this paper to the currency crises literature is to introduce a macroeconomic framework with flexible domestic wages and prices which models in a more realistic way how not only nominal, but also (through domestic wages and price level changes) real exchange rate fluctuations affect the dynamics of the macroeconomic activity in the medium run through possible deflationary situations after the occurrence of a currency crisis. In our view wage and price dynamics are the missing link to explain what happens in the medium run in a country that has experienced — through a currency and financial crisis — a severe slowdown in its economic activity.

Our study is organized as follows: In sections 2 and 3 the model developed by Flaschel and Semmler (2003) and its main implications for output and exchange rate dynamics, and thus for the real-financial interaction, will briefly be discussed. The empirical results of a VARX analysis are presented and discussed in section 4. In section 5 the extended currency crisis model which allows for wage and price changes — here in the context of a currency and financial crisis under an initially fixed exchange rate and a one-time devaluation — will be investigated and the dynamics of the currency and financial crises with a standard and a nonlinear Phillips-curve will be explored. In an outlook, in section 6, the potentials and limitations of this extended model will evaluated.

2 The Basic Model

The macroeconomic framework introduced by Flaschel and Semmler (2003) is based on the Mundell-Fleming-Tobin model as formulated and investigated in Rødseth (2000).[1] A small open economy is analysed where domestic and

[1] Note that this type of models does not explain the causes of currency and financial crises by a microfounded, utility maximizing representative agent approach, but investigates the dynamics of the economic consequences of such crises from a more traditional

foreign goods prices are fixed and set for simplicity to be equal to one, i.e. $p = 1$, $p^* = 1$. Nominal exchange rate variations are thus always equal to real ones. Furthermore, due to the absence of an inflationary environment, it is also presumed that the expected inflation π^e is zero. The analyzed time span is also assumed to be short enough to allow for the assumption of a basically unchanging capital stock K as well as private financial wealth W_p and firms' foreign currency debt F_f, despite the presence of positive or negative net investment and households' savings.

The aggregate consumption function is assumed to be dependent in a very standard way on national disposable income

$$C = C(Y^D) = C(Y - \delta\bar{K} - T), \qquad 0 < C_Y < 1. \tag{1}$$

The main feature of this currency crisis model is the investment function which is based, in a very simple way, on the financial accelerator concept first introduced by Bernanke, Gertler, and Gilchrist (1994). Focusing especially on the liability dollarization problem, we assume that domestic firms can only finance their investment projects through loans denominated in foreign currency.[2] Under this assumption an extremely simple balance sheet of the business sector can be obtained as follows:

Table 1: Business Sector's Balance Sheet

Business Sector's Balance Sheet	
Assets	**Liabilities**
pK	eF_f

The net worth of a firm is defined as the difference between its assets and its liabilities (both expressed here in domestic currency).[3] Due to our assumptions with respect to the capital stock and debt, the nominal exchange rate

macroeconomic perspective, where however all budget equations of the four sectors of the economy are carefully specified. This approach proves useful to investigate the dynamics of currency and financial crises since it can be extended more easily than the rigidly microfounded ones where macroeconomic results are to be derived from an intertemporally optimizing representative household, see also Rødseth (2000, p.5) in this regard.

[2]Hereby it is irrelevant if the creditors are foreign or domestic financial institutions. The main point here is the currency denomination of the loan, not its origin.

[3]See Mishkin (2001, p.192). Note that no intertemporal considerations are taken into account in this definition, as the firms' net worth is defined by means of actual stocks and prices solely.

is the sole variable which can influence the net worth of firms. We assume that banks (domestic and foreign) evaluate credit-worthiness based on the actual net worth of domestic firms, or on the dollarized debt-to-capital ratio $\tilde{q} = e\bar{F}_f/\bar{p}\bar{K} = \tilde{q}(e)$ (we assume here $F_f < 0$, indicating a negative foreign currency bond stock held by domestic firms, or in other words, that firms are indebted). The credit awarding, Cr^S, is equal to the change of foreign currency bonds by domestic firms accepted by the credit institutions, that is

$$Cr^S = e\dot{F}_f(\tilde{q}), \quad \frac{\partial Cr^S}{\partial \tilde{q}} < 0 \quad \text{if} \quad \frac{d\dot{F}_f}{\dot{F}_f}/\frac{de}{e} < -1 \tag{2}$$

since $\hat{q} = \hat{e}$. A glance at the firms' balance sheets can clarify why a depreciation of the domestic currency has a negative effect credit awarded by banks: a rise of the nominal exchange rate leads to an increase in the nominal (and here also real) value of the firms' liabilities and therefore to a decrease in its net worth.

Under the assumption that investment solely depends on the creditworthiness of the borrowing firms — which in turn depends on the firms' balance sheet — a sharp devaluation can lead to a radical investment contraction and thus to a severe economic slowdown (if investment goods are produced domestically as is assumed to be the case in this model).

The aggregate investment function is thus defined as

$$I = min(I^d, Cr^S) \tag{3}$$

which shows clearly that the credit constraint determines the actual investment level, under the assumption that $I^d > Cr^S$ normally holds.

The relationship between the nominal exchange rate and aggregate credit cannot be considered as a linear one from the global point of view. In Krugman (2000, p.84) it is referred in this regard as following:

"Loosely, the idea is that when the domestic currency is sufficiently strong, most firms are not wealth-constrained, and so the balance sheet effect is weak. When the domestic currency is very weak most of the domestic firms with foreign-currency debt are already bankrupt, so that things can't get any worse, and the pro-competitive effect of depreciation again dominates. So, the perverse region in which depreciation is contractionary is for the intermediate levels of the exchange rate".

The shape of the following aggregate investment function represents Krugman's ideas. The elasticity of the investment function now with respect to changes of $\tilde{q}$ is assumed to be state-dependent: for high values of $\tilde{q}$, where the nominal value of the dollarized liabilities of the business sector is significantly higher than the nominal replacement costs of capital, the investment reaction is assumed to be inelastic. In such a situation the firms' balance sheets are in such a bad state that the firms either cannot afford to invest in projects or cannot get any bank loans, so that a further deterioration of their financial situation only has a minimal effect on their investment projects. Therefore, for $e \rightarrow \infty$ ($\tilde{q} \rightarrow \infty$) the existence of a (still positive) minimal gross investment level or "investment floor" $\underline{I}$ is postulated. Some positive level of gross investment therefore remains even in the worst scenario that is considered in this paper, since not all investment projects will be canceled, because of replacement investment and high scrapping costs, see Flaschel and Semmler (2003, p.7).

In the opposite case, where $\tilde{q}$ is low, the firms' dollarized liabilities are low relative to their assets and therefore firms do not face any constraints in the credit markets. In such a benign situation, the investment spending is at its maximum. Because of the existence of supply-side bottlenecks, the investment function is assumed to be again very inelastic in such a situation, i.e. for $e \rightarrow 0$ ($\tilde{q} \rightarrow 0$) aggregate investment is at its maximum level defined as the "investment ceiling" $\overline{I}$.

For intermediate values of $\tilde{q}$, by contrast, the gross investment function is very elastic with respect to changes in the debt to capital ratio, reflecting the activation of credit constraints.[4] Such an aggregate investment function is shown in figure 1.

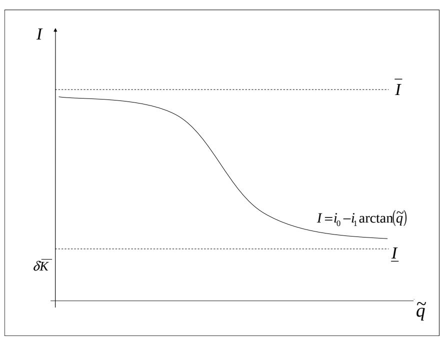

Figure 1: An arctan type of Investment Function

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.

[4]An nonlinear investment function with a similar shape, though there in the (Y,K) phase space, was utilized — applying some concepts from Catastrophe Theory — to construct a generalization of Kaldor's 1940 business cycle, see Varian (1979).

As for the investment function we also assume for the export function the existence of some kind of "export floor" and "export ceiling". The reason for this assumption may be that there are foreign demand saturation effects leading to an export maximum or ceiling. The assumption of a floor may be reasonable in cases where domestic products are unique or necessary and so foreigners will demand them even in the case of a very strong real appreciation and a subsequent loss of competitiveness.

In view of the above type of investment and export behavior, the goods market equilibrium in the analyzed small open economy can be written as

$$Y = C_1(Y - \delta\bar{K} - \bar{T}) + I(e) + \delta\bar{K} + \bar{G} + X(Y^{n*}, e) \qquad (4)$$

where $\bar{G}$ represents government expenditures (which for simplicity are also assumed to be composed of domestic goods solely). 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 export function $X(Y^{n*}, e)$ furthermore is supposed to depend in a standard way positively on foreign (normal) output Y^{n*} and the nominal exchange rate

$$X_{Y^{n*}} > 0, \qquad X_e > 0.$$

The following simple dynamic adjustment process in the goods markets, a traditional type of dynamic multiplier process, is now assumed:

$$\dot{Y} = \beta_y(Y^d - Y) = \beta_y\left[C_1(Y^D) + I(e) + \delta\bar{K} + \bar{G} + X(Y^{n*}, e) - Y\right]. \qquad (5)$$

Using the Implicit Function Theorem, it follows for the displacement of the IS-Curve with respect to currency shocks

$$\left.\frac{\partial Y}{\partial e}\right|_{\dot{Y}=0} = -\frac{I_e + X_e}{C_Y - 1} \gtrless 0.$$

Here, one of the essential points of this model as follows. The effect of a devaluation of the domestic currency on economic activity depends on the relative strength of the exports reaction as compared to the reaction of aggregate investment.[5] In the "normal case", where firms are not wealth constrained, the exchange rate effect on investment is supposed to be very weak and thus dominated by the exports effect. Then we have

$$X_e > |I_e| \Longrightarrow \left|\frac{\partial Y}{\partial e}\right| > 0.$$

[5]The denominator is assumed to be unambiguously negative, so that the sign of the numerator is decisive for the slope of the IS-Curve.

In the "fragile case", i.e. in a middle range for the exchange rate, the balance-sheet effect of a devaluation of the domestic currency is assumed to be large so that it overcomes the positive exports effect:

$$|I_e| > X_e \Longrightarrow \left|\frac{\partial Y}{\partial e}\right| < 0.$$

The financial sector is also an important feature of this basic currency crisis model. 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:

$$W_p = M_0 + B_{p0} + eF_{p0} \tag{6}$$

$$\xi = i - \bar{i}^* - \epsilon \tag{7}$$

$$eF_p = f(\xi, W_p, \alpha), \tag{8}$$

$$M = m(Y, i), \qquad m_Y > 0, \quad m_i < 0 \tag{9}$$

$$B_p = W_p - m(Y, i) - f(\xi, W_p) \tag{10}$$

$$F_p + F_c + \bar{F}^* = 0 \qquad \text{or} \qquad F_p + F_c = -\bar{F}^*. \tag{11}$$

Equation (6) describes the initial financial wealth of the private sector, expressed in domestic currency, consisting of domestic money M_o, bonds in domestic currency B_{po} and bonds in foreign currency F_{po}. Domestic and foreign-currency bonds are assumed to be imperfect substitutes, which means that the Uncovered Interest Rate Parity does not hold. The expected rate of return differential between the two interest bearing financial assets, with ϵ denoting the expected rate of currency depreciation, is referred to as *risk premium*, see equation (7).[6]

Equation (8) stands for the foreign currency bond market equilibrium. The demand for foreign currency denominated bonds is assumed to depend negatively on the risk premium, positively on private financial wealth and positively on the parameter α. This parameter is supposed to represent

[6]See Rødseth (2000, p.17). Even though financial capital markets throughout the world were liberalized during the last decades, it still seems to be a very unrealistic assumption to suppose that international capital mobility is perfect. Significantly high spreads (and thus risk premia) between domestic and international interest rates (for example the U.S. 3-month T-Bill) are observable, especially in emerging market economies.

other foreign exchange market pressures like the propensity for a speculative attack on the domestic currency, political instability, etc.

Equation (9) represents the domestic money market equilibrium with the usual reactions of the money demand to changes in interest rates and output. The domestic bond market (equation (10)) is then in equilibrium via Walras' Law of Stocks, if this holds for the bonds denominated in foreign currency.

The last equation describes the equilibrium condition for the foreign exchange market. It states that the aggregate demands of the three sectors — domestic private sector, the monetary authority and foreign sector — sum up to zero, see Rødseth (2000, p.18). On the assumption that the supply of foreign-currency bonds from the foreign sector is constant ($-\bar{F}^*$), the additional amount of foreign-currency bonds available to the private sector (besides his own stocks) is solely controlled by the monetary authorities (This assumption can be justified by assuming as in Rødseth (2000) that domestic bonds cannot be traded internationally). The prevailing exchange rate regime thus depends on the disposition of the central bank to supply the private sector with foreign-currency bonds.

The mechanism for expected exchange rate fluctuations is described by the following equation:

$$\varepsilon = \beta_\varepsilon \left(\frac{e_0}{e} - 1 \right), \qquad \varepsilon_e \leq 0. \tag{12}$$

For the steady state exchange rate e_o it is obvious that $\varepsilon(e_0) = 0$ holds. Note that the expectation of an exchange rate devaluation can be perceived as purely forward looking and in this respect asymptotically rational, by assuming that economic agents have perfect knowledge of the future steady state exchange rate level e_o with respect to which the actual exchange rate is expected to converge in a monotone fashion after each shock that hits the economy.

By inserting the money market equilibrium interest rate (the inverse function of equation (9)) in equation (8) the Financial Markets Equilibrium- or AA-Curve is derived

$$eF_p = f\left(i(Y, M_o) - \bar{i}^* - \beta_\varepsilon \left(\frac{e_0}{e} - 1 \right), M_o + B_{po} + eF_{po} \right). \tag{13}$$

This equilibrium equation can be interpreted as a representation of the $\dot{e}$=0−isocline. Under the assumption that the exchange rate does not adjust automatically to foreign exchange market disequilibria, one may postulate as exchange rate dynamics:

$$\dot{e} = \beta_e \left[f\left(i(Y, M) - \bar{i}^* - \beta_\varepsilon \left(\frac{e_0}{e} - 1 \right), M + B_p + eF_p, \alpha \right) - eF_p \right]. \tag{14}$$

The slope of the $\dot{e}$=0−isocline is determined by the Implicit Function Theorem in the following way:

$$\left.\frac{\partial e}{\partial Y}\right|_{\dot{e}=0} = -\frac{f_\xi i_Y}{f_\xi \epsilon_e + \left(f_{W_p} - 1\right) F_{p0}} < 0.$$

Figure 2 shows the phase diagram of the complete IS-AA system for an instantaneously adjusting foreign exchange market.

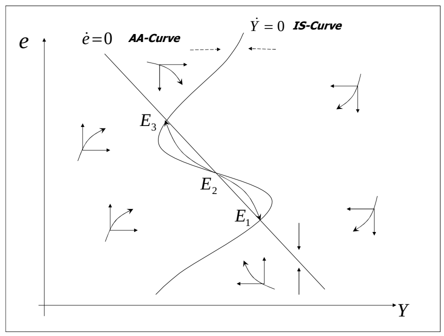

Figure 2: The IS-AA Model

Note that the AA-curve becomes only binding if the monetary authorities choose a flexible exchange rate regime. In a pegged exchange rate system the output level defined by the $\dot{Y}$=0−isocline at the given exchange rate level fully defines the unique equilibrium of the system. In such a currency system the $\dot{e}$=0−isocline can be interpreted as a “shadow curve” which represents the exchange rate level which would prevail if the currency were left to float freely. Because the monetary authorities are committed to remove any foreign exchange market disequilibria by buying or selling any amount of foreign currency bonds needed to defend the prevailing exchange rate level, the $\dot{e}$=0−isocline represents the over-demand or over-supply with which the central bank is confronted. Consequently, the larger the difference between the exchange rate level given by the “shadow curve” and the currency peg level, the higher is the demand for foreign currency bonds that the domestic central bank has to satisfy, and vice versa.

2.1 Local Stability Analysis

The Flaschel and Semmler (2003) currency crisis model discussed above consists of the following differential equations:

$$\begin{aligned}\dot{Y} &= \beta_y \left[C(Y - \delta\bar{K} - \bar{T}) + I(e) + \delta\bar{K} + \bar{G} + X(Y^{n*}, e) - Y\right] \\ \dot{e} &= \beta_e \left[f\left(i(Y, M_o) - \bar{i}^* - \beta_\varepsilon\left(\frac{e_0}{e} - 1\right), M_o + B_{po} + eF_{po}, \alpha\right) - eF_{po}\right].\end{aligned}$$

The Jacobian of this system is

$$J = \begin{bmatrix} \beta_y\left[C_Y - 1\right] & \beta_y\left[I_e + X_e\right] \\ \\ \beta_e(f_\xi i_Y) & \beta_e(-f_\xi \epsilon_e + (f_{W_p} - 1)F_{p0}) \end{bmatrix}.$$

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 dynamics of this currency crisis model are described by the 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 $|I_e| < X_e$ holds. Steady State $E2$ represents the fragile case with $|I_e| > X_e$: 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 $\dot{Y}$−isocline is again positive because of $|I_e| < X_e$ describing the dominance of exports over (the remaining) investment demand in the considered situation.

3 Currency Crises in a Pegged Exchange Rate System

In this section the dynamics of a currency and financial crisis under a fixed exchange rate regime will be discussed in order to show the effects of such crises on the economic activity of a small open economy with dollarized liabilities, credit constraints and a constant wage and price level. The results presented here will be useful to highlight the results of the extended 2D model to be discussed below.

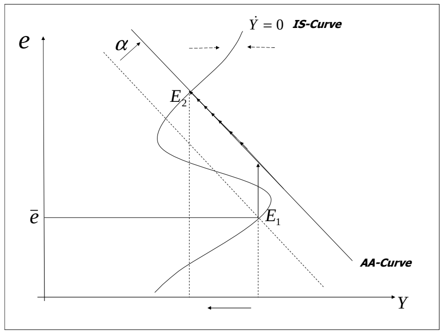

Figure 3: The Macroeconomic Effects of a Currency and Financial Crisis

Assume the economy is initially at steady state $E1$ in figure 3. The prevailing exchange rate system is a currency peg which is fully backed by the domestic central bank. Now suppose that the demand for foreign-currency bonds increases due to, say, a rise in the "capital flight" parameter α. As long as the central bank is disposed to defend the prevailing currency peg by selling foreign currency bonds or alternatively through interest rate increases, there are no real effects on the domestic economic activity.[7]

In the case that the domestic monetary authorities decide to give in to the speculative pressures and to let the exchange rate float, the AA-Curve becomes the binding curve in the model. The exchange rate then jumps from the initial equilibrium $E1$ to the corresponding point at the AA-Curve (with a still unchanged output level). The sharp devaluation of the domestic currency leads to a severe deterioration of the balance-sheet of the business sector and thus to an investment contraction. Because the economic agents consider the exchange rate level at the steady state $E2$ as the long-run level, the actual exchange rate depreciates further, reducing investment even further, and thereby aggregate demand and now also domestic output which follows the large decline in aggregate demand with some time delay until a new goods market equilibrium with a large output loss is reached.

The currency crisis ends when the economy arrives at its new equilibrium $E2$. Because of the assumption of fixed domestic prices and wages the economy exhibits no endogenously determined mechanism to return to the initial

[7]Note that this assertion follows the assumption that interest rates do not directly affect the real side of the economy.

high output level.[8]

4 Empirical Evidence

In the work of Krugman (2000), Mishkin (1996) and Flaschel and Semmler (2003) a negative relationship between the liabilities denominated in foreign currency and the actual investment undertaken by the domestic economy is a central issue. In this section we present some empirical evidence of this relationship for Mexico, South Korea and Thailand, three of the countries which suffered the most devastating real effects after their respective currency and financial crises in the 1990s.

Before proceeding with the description of the applied methodology, we would like to point out that the empirical analysis of the macroeconomic impact of currency and financial crises in developing countries is not an easy task, as the availability and reliability of the usable macroeconomic data, not to say anything about the nonlinearity of these episodes, often turns out to be a grave problem. Since our aim is to look for a *relationship* and not for an exact coefficient value, we employ here a *Vector Autoregressive Model with Exogenous Terms (VARX)* as discussed in Lütkepohl (1993, Ch.10) of the form:

$$D_t = A_{11}(L)\ D_{t-i} + A_{12}(L)\ Inv_{t-i} + b_1\ X_t + \epsilon_{1t} \tag{15}$$

$$Inv_t = A_{21}(L)\ D_{t-i} + A_{22}(L)\ Inv_{t-i} + b_2\ X_t + \epsilon_{2t} \tag{16}$$

where D_t represents the domestic currency value of the dollarized liabilities, Inv_t the aggregate domestic investment, X_t a vector of non-stochastic terms as seasonal, impulse and shift dummmies for the exchange rate regime change[9] and ϵ_{1t} and ϵ_{2t} *i.i.d.* white noise errors. $A_{ii}(L)$ represent scalar lag operators which length was determined by the multivariate versions of the Hannan-Quinn and Schwartz-Bayesian lag order selection criteria. The main reason why a VARX model was chosen as the estimation procedure for this particular empirical analysis is its capability to represent the effect (and duration) of an increase of the domestic value of dollarized liabilities on the aggregate investment through impulse response functions.

[8] A fiscal expansion (a right-shift of the IS-Curve) could bring the economy to a higher output level. Nevertheless, fiscal policy management is much more complicated than monetary policy, and it takes more time to become effective. Furthermore, for many emerging market economies a significant fiscal expansion is not a feasible option due to the large fiscal deficits prevailing in those economies.

[9] Due to the fact that the breakdown of currency systems can be easily observed in the time series data for all analysed countries, the use of a shift and/or an impulse dummy for its representation seems adecuate.

We use quarterly data for the estimations, since time series of higher frequency are not available. The time series of aggregate investment, exchange rates and domestic price levels are taken from the International Financial Statistics 2003 of the IMF,[10] while the proxy for the dollarized liabilities of the private sector (domestic liabilities to BIS banks) stems from the Joint IMF-OECD-BIS-World Bank-External Debt Statistics,[11], as has been employed by Corsetti, Pesenti, and Roubini (1998) and Aghion, Bacchetta, and Banerjee (2000) since these transactions are basically in foreign currency.[12]

The question whether the analysed time series were integrated and eventually cointegrated was not pursued in the following econometric analysis because of two reasons: First, no economic interpretation or theory is available (as for as we know) about a "steady state" relationship between the *level* of dollarized debt of a country and its aggregate investment: A possible cointegrating relationship between these variables would face difficulties to be interpreted in form of economic theory. Second, because of the small size of the time series samples, the results of unit root and cointegration tests would not be reliable enough to make a definitive assertion about their order of integration and cointegration. We perform thus a VARX estimation of the influence of D_t (the log of U.S. dollar denominated debt in 1995 domestic prices) on I_t (aggregate investment in 1995 domestic prices) in levels, which results are shown in the next table.[13]

In the three analysed countries the VARX estimations show a significant and negative relationship between the dollarized debt and the domestic aggregate investment, described by the corresponding impulse response functions in the figure 4. Figure 4 shows the estimated reaction of the aggregate investment to a one percent increase in the domestic currency value of foreign currency denominated liabilities: In Mexico and South Korea such a shock produces a fall of around 0.2 percent after four quarters, the reaction in Thailand being somewhat weaker. This reaction might not seem to be particularly significant at first sight, but the fact that during the past currency crises in emerging market economies as Mexico, South Korea, Thailand or Indonesia experienced huge depreciations of their domestic currencies, as discussed for example in Corsetti, Pesenti, and Roubini (1998), puts these results into perspective. The tables in the appendix show the VARX model

[10]This database is available at the International Statistical Yearbook or at http://ifs.apdi.net/imf/logon.aspx.

[11]http://www1.oecd.org/scripts/cde/members/debtauthenticate.asp

[12]For details see Aghion, Bacchetta, and Banerjee (2000, p.2).

[13]All estimations were carried out with JMULTI, the econometric program developed by Helmut Lütkepohl and Markus Krätzig at the Humboldt University Berlin, downloadable at www.jmulti.de.

Table 2: VARX Estimation Results

Country	Endog. Variable	Variables	Coeff.	Std. Errors	T-Stat.
Mexico	$MX\text{-}Inv_t$	$MX\text{-}D_{t-1}$	-0.117	0.059	-1.977
1990Q2-2003Q1		$MX\text{-}Inv_{t-1}$	0.800	0.070	11.449
T=52		Impulse95Q1	-0.128	0.061	-2.088
		Constant	1.868	0.704	2.665
Thailand=39	$TH\text{-}Inv_t$	$TH\text{-}D_{t-1}$	-0.037	0.035	-1.056
1993Q2-2002Q4		$TH\text{-}Inv_{t-1}$	0.535	0.104	5.139
T=39		Shift97Q4	-0.293	0.060	-4.912
		Constant	3.066	0.575	5.331
South Korea	$SK\text{-}Inv_t$	$SK\text{-}D_{t-1}$	-0.107	0.024	-4.451
1993Q2-2004Q4		$TH\text{-}Inv_{t-1}$	0.863	0.065	13.374
T=39		Impulse97Q4	0.027	0.044	0.621
		Constant	2.538	0.680	3.731

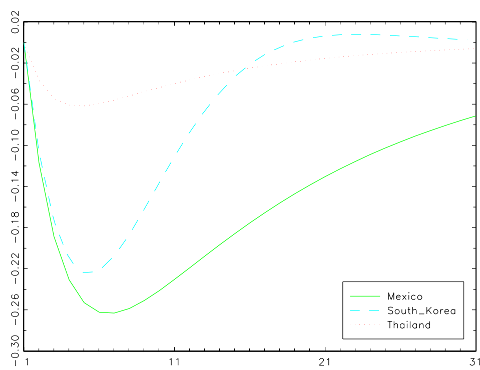

Figure 4: VARX Impulse Response Functions

adequacy statistics of the Hannan-Quinn and Schwarz-Bayesian lag length selection criteria, LM- and LMF-tests as well as the multivariate ARCH-LM test for serial autocorrelation. For the description of these statistics see Lütkepohl (1993). The results in these tables reject the hypotheses of serial autocorrelation and heteroskedasticity in the estimated residuals, supporting the adequacy of the model specification and lag length choice described in Table 1 for the three analysed countries. Additionally to the analysis of Mexico, Thailand and South Korea, a VARX estimation of Brazil was undertaken (which results are not reported here but are available upon request). In the Brazilian case, that economy did not experience a severe economic slowdown after its 1999 currency crisis as the East Asian countries in 1998, probably because, as stated in Gruben and Welch (2001, p.12), the "Brazilian private sector foreign liabilities were largely hedged in ways that shifted the impact of the devaluation from the private to the public sector." Supporting this view and also the relevance of our empirical findings for Mexico, Thailand and South Korea, we did not find any significant reaction of the Brazilian aggregate investment after the currency crisis and the resulting devaluation.

5 Wage-Price Movements in the Medium Run

Although the above presented model of sections 2-3 and the empirical tests of section 4 are capable of describing some empirically observed features of the last Mexican and East Asian currency and financial crises, it does not take into account another very important medium run dynamics,[14] namely the wage and price dynamics. Despite the fact that during a currency and financial crisis price fluctuations probably do not play an important role because of the short time span in which such a twin crisis takes place, they surely are of great importance for the economic recovery process of such an economy. Real as well as nominal exchange rate fluctuations determine the international competitiveness of the domestic goods and the volume of the exports of the economy.

The assumption of constant domestic commodity prices in the context of sharp exchange rate fluctuations is also problematic because the exchange rate can affect the domestic price level through the following channels:[15]

- The exchange rate level affects the domestic currency prices of imported goods, and therefore the CPI inflation rate.

[14] There are two other main points neglected in the above presented model: The first one is the assumption that the domestic interest rate does not influence domestic economic activity directly. Due to this assumption the domestic monetary authorities are not confronted with an exchange-rate policy dilemma during a currency crisis. Theoretically, they are capable to increase the domestic interest rates indefinitely in order to defend the currency peg without producing any negative effects on the domestic economy. The decision to give in to a speculative attack on the domestic currency here relies more on the level of the foreign exchange reserves that the country has at the time of the currency run which may of course, dissipate during the currency run. The second one is the modelling of exchange rate devaluation expectations and the actual exchange rate fluctuations. Even if the adoption of the "asymptotically rational" devaluation expectations is not unrealistic, it implies a very smooth convergence to the long-run steady state. In the real world there are many more forces at work, in the determination of the long-run exchange rate level as well as in the adjustment process to this level. The fact that the actual exchange rate level is solely determined by disequilibrium situations in the foreign-currency bonds market also seems to leave out important aspects of the real world. These two issues will not be dealt with here, but will be left for further research.

[15] See Svensson (1998).

- The exchange rate affects domestic currency prices of intermediate inputs.
- The exchange rate can also influence the nominal wage determination through CPI inflation and thus again the domestic inflation.

Because the exchange rate can influence the domestic inflation through so many mechanisms, the assumption of constant domestic prices ignores a variety of effects which can influence the economic development of the small open economy in significant ways.

Given the above shortcomings of the basic model, we next will present an extended version of a currency crisis model. The purpose of this extended model is to show how besides the exchange rate- also domestic price level fluctuations can influence the macroeconomic performance of a small open economy with dollarized liabilities and credit market constraints.

The core of this extended model still is the balance-sheet state-dependent investment function. Because domestic price fluctuations are now included, besides the role of the exchange rate, changes in the domestic price level p now also influence the aggregate investment level of the small open economy (while K, F_f are still kept constant). The inclusion of price fluctuations into the considered dynamics through a standard Phillips-Curve, coupled with the price level dependent investment function indeed brings considerable complexity into the system.

As in the previous model of this paper, and also as in Krugman (2000), the elasticity of the investment function now with respect to changes of $\tilde{q}$ is assumed to be state-dependent: For high values of $\tilde{q}$ (p low), where the nominal value of the dollarized liabilities of the business sector is significantly higher than the nominal replacement costs of capital, the investment reaction is assumed to be inelastic.

In the opposite case, where $\tilde{q}$ is low (p high), the firms' dollarized liabilities are low relative to their assets and therefore firms do not face any constraints in the credit markets and therefore the investment function is assumed to be again very inelastic.

The aggregate consumption and export functions remain unchanged, 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

$$Y = C_1(Y^D) + I(\tilde{q}) + \delta\bar{K} + \bar{G} + X(Y^{n*}, \eta). \tag{17}$$

and the dynamic multiplier is now based on the law of motion

$$\dot{Y} = \beta_y \left[C_1(Y^D) + I(\tilde{q}) + \delta\bar{K} + \bar{G} + X(Y^{n*}, \eta) - Y \right] \tag{18}$$

On the assumption that a fixed exchange rate system prevails ($\bar{e} = e_0$), the slope of the $\dot{Y}= 0-$isocline is described by in the extended phase space (Y, p) (for output and the domestic price level now):

$$\left.\frac{\partial Y}{\partial p}\right|_{\dot{Y}=0} = -\frac{I_p + X_p}{C_Y - 1}$$

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 $I_p > 0$ or the competitiveness effect $X_p < 0$:

$$I_p > |X_p| \Longrightarrow \left.\frac{\partial Y}{\partial p}\right|_{\dot{Y}=0} > 0$$

and

$$I_p < |X_p| \Longrightarrow \left.\frac{\partial Y}{\partial p}\right|_{\dot{Y}=0} < 0.$$

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 $\tilde{q}$ 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, p) phase space. The structure of the financial markets is as in the original approach.

The innovation in this extended currency crisis model is the modelling of domestic price fluctuations 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) could be written as

$$\hat{p} = \gamma(Y - Y^n) + \pi_c^e \text{ with } \pi_c^e = (\hat{p}_c)^e \text{ and } p_c = p^\theta (ep^*)^{1-\theta},\ \theta \in (0, 1). \tag{19}$$

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 PC by the output gap and the expected consumer price inflation rate. This PC can be reduced to

$$\hat{p} = \frac{1}{1-\theta}\gamma(Y - Y^n) \quad \text{or} \quad \dot{p} = (\beta_p(Y - Y^n))p. \tag{20}$$

as long as the exchange rate as well as the foreign price level is kept fixed and if it is assumed in addition that current domestic inflation is perfectly foreseen. More generally, one may simply assume that inflationary expectations are still ignored by this model type in order to save one law of motion and to leave the discussion of destabilizing Mundell type effects for later extensions of the model, see our discussion of kinked Phillips curves below.

The implied $\dot{p}$=0−isocline turns out to consist of two parts: for $p > 0$ the $\dot{p}$=0−isocline is the straight vertical line $Y = Y^n$. Along the horizontal axis ($p = 0$), additionally, $\dot{p}$=0 also holds: As discussed in the next section, a further — though economically not meaningful — steady state exists at the intersection of the $\dot{Y}$=0−isocline and the horizontal axis.

5.1 Local Stability Analysis

The extended currency crisis model (under a fixed exchange rate regime) is fully described by the following differential equations:

$$\begin{aligned}\dot{Y} &= \beta_y \left[C_1(Y - \delta\bar{K} - \bar{T}) + I(\tilde{q}) + \delta\bar{K} + \bar{G} + X(Y^{n*}, \eta) - Y\right] \\ \dot{p} &= \left[\gamma(Y - Y^n)\right] p.\end{aligned}$$

where inflationary expectations are now fully ignored.

The Jacobian of this system at the steady state is given by:

$$J = \begin{bmatrix} \beta_y\,(C_Y - 1) & \beta_y\left(I'\frac{\partial\tilde{q}}{\partial p} + X_\eta\frac{\partial\eta}{\partial p}\right) \\ \gamma p_0 & 0 \end{bmatrix}.$$

Because of the nonlinear shape of the $\dot{Y}$=0−isocline there exist three possible economically meaningful steady states,[16] whose local stability properties can easily be calculated:

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

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

[16]Due to the nonlinearity of the second law of motion there exists a fourth steady state at the point where the $\dot{Y}$=0−isocline cuts the horizontal axis. This fourth steady state is not relevant however, since it cannot be approached by the trajectories in the presently considered dynamics.

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

The resulting dynamics of our extended currency crisis model (still a fixed exchange rate) are described in the figure 5.

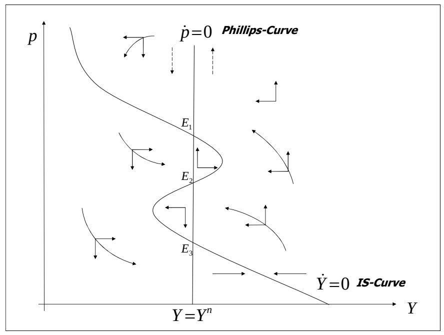

Figure 5: Phase Space Representation of the IS-PC Dynamics with a Normal and a Bad Equilibrium, E_1 and E_3, respectively.

Steady state $E1$ represents the "normal" situation, where the domestic price level is high and therefore (under the assumption of a fixed exchange rate) $\tilde{q}$ is low. In this steady state the economy's output is at its full employment level, the investment activity is high (due to the low $\tilde{q}$) and the exports are low due to a strong currency — relative to the high domestic price level — and thus low competitiveness.[17] In this steady state the standard situation $I_p < |X_p|$ holds.

Steady State $E2$ represents the fragile case where $I_p > |X_p|$ holds: A slight deviation of the output level from this steady state level can lead the economy to a short-run investment boom (and to an over-employment situation) or to an economic slowdown or a recession, since this equilibrium point is unstable up to the two stable arms that are shown as dotted lines.

Steady State $E3$ constitutes the "crisis equilibrium". At this equilibrium point the investment activity is severely depressed due to the high value of $\tilde{q}$. The economy, though it is situated at its full-employment level because of the strong export of goods production, induced by the very low level of domestic prices, and thus by the implied competitiveness of the economy.[18]

[17]Such a situation could be observed in the years preceding the East Asian Crisis, see Corsetti, Pesenti, and Roubini (1998).

[18]After the East Asian Crisis many of the countries that came under attack experienced a reversal in their current account because of the exporting boom that was caused by the sharp devaluation of their currencies, see Corsetti, Pesenti, and Roubini (1998).

The reason why this equilibrium might not be preferable one to be in will be discussed below.

Before discussing the reasons and the effects of an enforced one-time devaluation of the domestic currency on investment and output, we will first consider the global stability of the system.

5.2 Global Stability Analysis

Global stability analysis of a dynamic model is important because we are considering systems that can be subject to large shocks so that an analysis that is concentrated on the neighborhoods of the two stable steady states is too limited in such an environment. Furthermore – as our subsequent analysis will show – we will always have upper and lower turning points for output as well as the price level if the system is started in a certain bounded domain. There are thus global forces at work that prevent the collapse of economic activity as well as unbounded growth of output partly due to the floors and ceilings we have built into the investment and export function and that also – perhaps more surprisingly – prevent the occurrence of an endless hyperinflation or of a deflationary spiral.

We note first of all that the extended currency crisis model allows for nonnegative price levels only (and for zero price levels at best when time goes to infinity). This is due to the fact that the horizontal line is an invariant subset of the dynamics, i.e., trajectories which start in this set must stay in it.

In order to see how the $\dot{Y}$=0−isocline behaves in the proximity of the horizontal, i.e. for $p \to 0$, $\dot{Y}$ is set equal to zero in equation (18) and then solved for Y (we here assume a linear consumption function for simplicity):

$$Y = \frac{1}{1-c_1}[c_0 + c_1(\delta \bar{K} + \bar{T}) + I(\tilde{q}) + \delta \bar{K} + \bar{G} + X(Y^{n*}, \eta)]. \qquad (21)$$

As was assumed in the preceding sections, for $p \to 0$, investment goes to $\underline{I}$ and exports to $\overline{X}$, such that

$$Y^n < \bar{Y} = Y\big|_{p=0} = \frac{1}{1-c_1}\left[c_0 + c_1(\delta \bar{K} + \bar{T}) + \underline{I} + \bar{G} + \overline{X}\right] > 0.$$

comes about.

Because $\underline{I}$ and $\overline{X}$ are finite, it follows that the $\dot{Y}$=0−isocline must cut the horizontal axis when p=0 is reached. It is obvious that the corresponding output level must lie above the NAIRU level Y^n, i.e., on the right hand side of the vertical labor market equilibrium curve.

In the same way the value of Y can be calculated for $p \to \infty$ and it is assumed that:

$$Y^n > \underline{Y} = Y|_{p=\infty} = \frac{1}{1-c_1}\left[c_0 + c_1(\delta\bar{K} + \bar{T}) + \bar{I} + \bar{G} + \underline{X}\right] > 0.$$

holds true.

The fact that the $\dot{Y}$=0−isocline converges to a strictly positive Y value for $p \to \infty$ – as already shown in figure 5 – implies that the vertical axis cannot be reached by the dynamics when started in the positive orthant of the phase space. There are thus always lower turning points for output as well as the price level due to the shape of the $\dot{Y}$=0−isocline and the underlying assumptions on floors and ceilings in the investment and the export function. The upper turning point of the output dynamics also follows from the same assumptions since the vertical line that starts in the intersection of this isocline with the horizontal axis limits all possible output dynamics. Our choice of investment and export functions thus constrain the dynamics in a vertical strip in the positive orthant, but does not yet exclude the occurrence of hyperinflation as the only possibility for an unlimited explosive spiral.

A further simple assumption here however suffices to also exclude the occurrence of hyperinflation from the model. This assumption again concerns the floors and ceilings in the investment and export functions and reads

$$Y^n > C_1(Y^n) + \bar{I} + \bar{G} + \underline{X}$$

This assumption states that aggregate demand falls below the NAIRU level at least when the price level approaches infinity, i.e., the ceiling in investment is not so large as to overcome the floor in exports if the real exchange rate approaches zero. Any trajectory to the right of the NAIRU level must therefore experience an upper turning point in the evolution of its price level.

In sum we therefore obtain the situation shown in figure 10 where we have drawn an invariant domain (that cannot be left by the dynamics) that basically contains the two basins of attractions of the two stable steady states, besides the stable separatrices of the unstable steady state. We thus conjecture, but cannot prove this here, that there are no closed orbits in the considered part of the phase space, i.e., in particular there are no stable persistent oscillations possible. This then justifies the consideration of the normal as well as the crisis equilibrium point as the relevant attractors also from the global point of view.

Figure 6 conjectures — based on what is stated in Hirsch and Smale (1994, p.249) — how the two stable arms of the saddle point E_2 will look like. It suggests very straightforward domains of the two basins of attractions

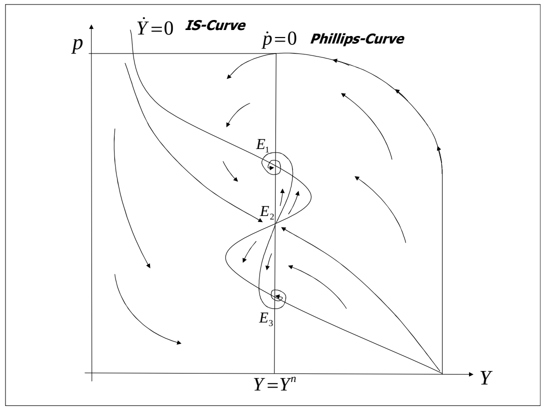

Figure 6: The Global Dynamics with their Two Basins of Attraction

of the two stable steady states E_1, E_3. We thus have multiple equilibria in a 2D phase space with a very clear-cut structure of the dynamics in the economically meaningful part of the phase space.

In contrast to our basic model, discussed in section 2-3, where we could have large output loss in the crisis equilibrium, this extended model however may raise the question to what extent the lower equilibrium represents a bad equilibrium. We have full employment in the sense of the NAIRU theory, coupled with high exports, but very low investment activity. The growth rate of the capital stock is thus very depressed or even negative. This, of course, is bad for the future evolution of the economy with respect to income growth and employment growth. Furthermore if economic activity is moving towards the lower equilibrium, the evolution may be subject to long periods of deflation, in particular if there are downward rigidities in money wage adjustments (a nonlinear PC) as we will consider them briefly below. In the present model, the dangers of deflation are not fully included in the model, and thus do not call for particular attention by the monetary authority – with the exception that monetary policy may be used to speed up the process of convergence to the good equilibrium and to avoid the bad equilibrium. This will be discussed in the next section.

5.3 Dynamics with a Standard Phillips-Curve

Next, by employing a standard Phillips-Curve we discuss a situation where, after a one-time devaluation of the domestic currency as a result of a speculative attack, the economy experiences a financial crisis and can, eventually, shift from a "normal" equilibrium with high investment and low exports to a "crisis" equilibrium with depressed investment activity and high exports due to the included domestic price level adjustments. Assuming again a constant exchange rate after the devaluation, the model dynamics will be sketched in the $p-Y-$space instead of the $e-Y-$space as in the Flaschel and Semmler (2003) model.

Assume the economy is initially situated at its upper full employment level. A significant flight into foreign currency can take place 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 after a while, because of the dangerous lowering of foreign reserves. It lowers the exchange rate in order to release the pressure from the foreign exchange market, see eq.(7) in this regard. It carries out a one-time devaluation (for simplicity we assume that the new exchange rate is then considered by the economic agents as "sustainable"). The effect of the currency devaluation on the $\dot{Y}$=0−isocline, i.e. the direction of the shift of the $\dot{Y}$=0−isocline depends on the strength of the balance-sheet and the competitiveness effects. To understand this point, consider the original model of section 2-3 where prices were held constant: There too the output reaction to the exchange rate change depended on the strength of the exchange rate effect on investment and exports.

The direction of the shift of the $\dot{Y}$=0−isocline in the extended 2D model (in the $p-Y-$space) is analogous to the exchange rate effect on output in the original model (in the $e-Y-$space): If $I_e > |X_e|$ holds, the nominal devaluation of the domestic currency will shift the $\dot{Y}$=0−isocline to the left and vice-versa.

The resulting system dynamics after a severe nominal devaluation of the currency under the first situation are sketched in the figure 7.

Directly after the currency crash, the banks take into account the sharp deterioration of the balance sheets of the business sector due to the strong devaluation of the domestic currency. As a means of hedging themselves against "bad creditors", they implement credit constraints and cut the volume of the granted loans. The industrial sector, put now in a dramatic financial situation, must cancel the majority of the investment projects either voluntarily or due to the credit constraints, reducing aggregate demand and therefore inducing unemployment. Because of this the prices begin to react and start to fall, due to the Phillips-curve together with economic activity.

We consider now as an example the case where the IS-curve – with the exception of the zero price level situation – unambiguously shifts to the left

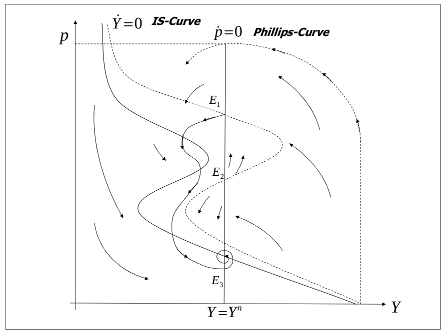

Figure 7: The Consequences of a Breakdown of the Currency Peg

as a result of the currency devaluation. The steady state $E3$ is assumed, due the size of the shift of the IS-curve, to be the only economically meaningful steady state. Falling prices are then at first accompanied by falling output levels. They lead to a further real depreciation, in addition to the initially caused nominal exchange rate shock. Thus in turn leads to further gains in competitiveness on the international goods market. Sooner or later, the increased foreign demand for domestic goods leads to such an increase in exports and that aggregate demand starts rising again, when the IS-curve is crossed from above by the initiated temporary deflationary process. The deflationary spiral, since output cannot rise by so much that the NAIRU level is reached again. Instead output will start falling once again – when the IS-curve is crossed again on the way down to the bad equilibrium – which still further down leads again to increasing output and then either to monotonic adjustment to the steady state E_3 or to damped cycles around it (shown in figure 7). We thus in sum observe a deflationary process with fluctuating economic activity below the NAIRU output level until the economy is back to normal output levels and smaller cycles around them.

Falling prices have negative effects as well as positive effects on aggregate demand. The latter because of an export increase and the former because they reduce the nominal value of the firms' capital, deteriorating even more their financial situation. We thus have therefore counteracting forces operating simultaneously with a stronger investment effect initially, and after a while again (implying decreasing output levels), while in between improvements in the trade balance can be so strong that economic activity is rising then, though still always less than normal and thus still accompanied by further deflationary pressure. The graphical analysis here shows that the economy will fluctuate around a somewhat persistent underemployment situation (with still falling prices) until the competitiveness effect finally dominates (maybe because the investment level has come close to its "floor" level) and the economy returns to the its 'full'-employment level. This must happen by assumption since it was assumed that the intersection of the IS-curve with the horizontal axis lies to the left of the NAIRU output level. Deflation therefore must come to an end and – maybe also with temporarily increasing price levels – approach the steady state price level at E_3 finally.

Note that the crucial mechanism in this dynamics that allows the economy to return to the full-employment situation is the variation of the domestic price level. Because in basic model sketched in section 2-3 there are assumed prices to be constant, one cannot consider the (medium-run) possibility for the economy to return to a 'full'-employment situation. In the basic model the country which suffered from a currency and financial crisis is “thrown back” to a lower steady state output level where it remained because the model did not produce any endogenous mechanism that would allow the economy to recover from the twin crisis. In this extended version where we allow prices to be sufficiently flexible the economic performance of the economy can sufficiently improve through a real depreciation of the domestic goods, leading it back to the full-employment level if the ceilings and floors in the investment and the export function are chosen appropriately.

5.4 Dynamics with a “Kinked” Phillips Curve

Yet, already Keynes (1936, ch.2) had recognized that an economy-wide wage deflation with a simultaneous deflation in money wages is rare to be observed. Taking downward money wage rigidity into account the wage-price Phillips-Curve can be modified as follows:

$$\hat{p} = \max\left\{\gamma(Y - Y^n), 0\right\}. \tag{22}$$

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. Adding such a kink in money wage behavior modifies the considered dynamics as follows:

The empirical observation of downwardly rigid wages has important consequences for the dynamics of the extended model. Assume the country finds itself in the same situation as discussed above: After a run on the foreign currency the monetary authorities are forced to devaluate, so that – under the assumption that $I_e > |X_e|$ holds – aggregate demand declines and the $\dot{Y}$=0−isocline shifts again to the left. Because in the entire economic domain to the left of the $\dot{p}$=0−isocline we have that $\hat{p}$=0 holds true, the $\dot{Y}$=0−isocline is in this domain an attracting curve representing stable depressions. All

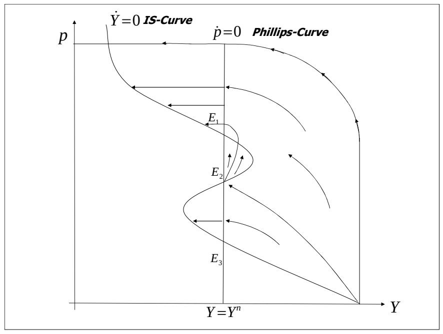

Figure 8: The Consequences of Downward Money Wage Rigidity

points on the $\dot{Y}=0-$isocline to the left of the $\dot{p}=0-$isocline are thus now equilibrium points. For each of these steady states, there is no longer a mechanism that allows the economy to return to its "full"-employment level. The "crisis" equilibrium in the basic model of sections 2-3, derived from Flaschel and Semmler (2003), is now just one of these under-employment equilibria.

One may argue therefore that the assumed wage rigidity is bad for the working of the economy. However, at present deflation is still too tranquil a process in order to allow for any other conclusion. Advocates of downward wage flexibility should therefore not yet interpret the present framework as an developed argument that supports their view. Adding real rate of interest effects (Mundell-effects) to the formulation of aggregate demand, or adding a Fisher debt effect to investment behavior, can easily remove the lower turning point in deflation dynamics from the model. This would therefore imply an economic breakdown, in case the kink in the money wage PC was not there. The kinked wage PC prevents or at least delays deflationary processes from working their way. Though stable depressions may be considered a big problem, the remedy to allow for a significant degree of wage flexibility would in such situations not revive the economy, but make things only worse, in particular in situations where a liquidity trap has become established.

In the present form of the model the kink in wage behavior however implies that a stable depression becomes established to the left of the good equilibrium E_1 with no effect on the price level, as it was already considered in Flaschel and Semmler (2003).

6 Concluding Remarks

This paper builds on some previous work of Flaschel and Semmler (2003) where a rather short run perspective, disregarding wage and price dynamics, was presumed. In the current paper we have provided some empirical evidence, obtained from a VARX model, that supports the short run dynamics described in that paper. Yet, going beyond the scope of that paper, this study has also focused on the medium run dynamics that are triggered by an exchange rate shock and a resulting financial crisis. Here we include a Phillips Curve which allows to study possible wage-price movements in the medium run. We would like to argue that models where currency shocks trigger a financial crisis and a severe economic slowdown need to take into account some specification of the Phillips Curve in order to also study medium run scenarios where inflation or deflationary pressures may arise and where the effects of monetary policy is to be considered. The wage and price dynamics have not been made an issue in the work of the third generation currency crisis models. The research there has mainly focused on the mechanisms that transmit large currency shocks to the financial sector and to real economic activity. The empirical literature on this issue has primarily focused on the preceding trends that foreshadow financial crisis episodes (such as deterioration of balance sheets, deterioration of current accounts, decreasing external debt to reserve ratio) and the mechanisms of the crisis scenario (such as sudden reversal of capital flows, unexpected exchange rate depreciation, domestic interest rate jumps, stock price fall, credit and banking crises and large scale bankruptcies of firms and financial institutions). Thus, our model variant presented here provides a useful perspective to trace out the possible medium run macrodynamics of a country which has suffered from a currency and a financial crisis. In order to evaluate what monetary policy effectively can achieve it is essential that the medium run mechanisms and scenarios are explored in models where exchange rates, Phillips-curve, and thus the wage price dynamics, are interacting as well. As we have shown in this paper, here too multiple equilibria models appear to be a useful device to study various scenarios of the medium-run after a financial crisis has been triggered by large exchange rate shocks. Such scenarios might bring with it, as we have demonstrated, depressed investment activities, liquidity trap and debt deflation, on the one hand, and periods with high inflationary pressure, on the other hand. Yet, we want to note here that a study of the effectiveness of monetary policy would have to be undertaken more thoroughly, for example if we assume that it follows a Taylor rule to control inflation and output. This is left for future research here.

7 Appendix: Statistics for Model Selection

The following tables represent the statistics which we have used to select our proper VARX model for the study of the impulse response functions in section 4. As we can see in table 4, the choice of only one lag for Mexico, Thailand and South Korea seems optimal. The statistics in table 5 reject for almost all lags the hypothesis of serial autocorrelation in the residuals. In the same way, in table 6 the hypothesis of heteroskedasticity in the residuals is rejected for all lags in the three countries.

Table 3: VARX Complete Estimation Results

Country	Endog. Variables	Variables	Coeff.	Std. Errors	T-Stat.
Mexico	$MX\text{-}D_t$	$MX\text{-}D_{t-1}$	0.816	0.049	16.656
		$MX\text{-}Inv_{t-1}$	-0.153	0.058	-2.636
Sample Period		Impulse95Q1	0.437	0.051	8.612
1990Q2-2003Q1		Constant	1.946	0.583	3.338
T=52	$MX\text{-}Inv_t$	$MX\text{-}D_{t-1}$	-0.117	0.059	-1.977
		$MX\text{-}Inv_{t-1}$	0.800	0.070	11.449
		Impulse95Q1	-0.128	0.061	-2.088
		Constant	1.868	0.704	2.665
Thailand	$TH\text{-}D_t$	$TH\text{-}D_{t-1}$	0.927	0.025	37.256
		$TH\text{-}Inv_{t-1}$	0.180	0.073	2.453
Sample Period		Shift97Q4	-0.048	0.042	-1.153
1993Q2-2002Q4		Constant	-0.476	0.405	-1.174
T=39	$TH\text{-}Inv_t$	$TH\text{-}D_{t-1}$	-0.037	0.035	-1.056
		$TH\text{-}Inv_{t-1}$	0.535	0.104	5.139
		Shift97Q4	-0.293	0.060	-4.912
		Constant	3.066	0.575	5.331
South Korea	$SK\text{-}D_t$	$SK\text{-}D_{t-1}$	0.769	0.062	12.445
		$SK\text{-}Inv_{t-1}$	0.218	0.166	1.311
Sample Period		Impulse97Q4	0.849	0.112	7.566
1993Q2-2004Q4		Constant	-0.074	1.754	-0.042
T=39		S1	0.136	0.052	2.647
		S2	0.068	0.052	1.310
		S3	0.020	0.048	0.424
		Trend	0.005	0.002	2.148
	$SK\text{-}Inv_t$	$SK\text{-}D_{t-1}$	-0.107	0.024	-4.451
		$TH\text{-}Inv_{t-1}$	0.863	0.065	13.374
		Impulse97Q4	0.027	0.044	0.621
		Constant	2.538	0.680	3.731
		S1	-0.270	0.020	-13.525
		S2	0.060	0.020	2.951
		S3	-0.103	0.019	-5.573
		Trend	0.002	0.001	2.374

Table 4: Lag Length Selection of VARX System with Information Criteria

	Mexico		Thailand		South Korea	
	MHQC	MSBC	MHQC	MSBC	MHQC	MSBC
VAR(0)	-7.885	-7.885	-6.587	-6.587	-8.761	-8.761
VAR(1)	-11.598	-11.494	-10.451	-10.324	-11.794	-11.667
VAR(2)	-11.576	-11.370	-10.202	-9.948	-11.579	-11.325
VAR(3)	-11.494	-11.184	-9.974	-9.593	-11.286	-10.905
VAR(4)	-11.603	-11.189	-9.905	-9.396	-11.031	-10.522
VAR(5)	-11.540	-11.023	-9.911	-9.275	-10.885	-10.250
VAR(6)	-11.446	-10.825	-10.065	-9.302	-11.140	-10.378
VAR(7)	-11.416	-10.692	-10.016	-9.127	-11.321	-10.431
VAR(8)	-11.222	-10.395	-10.029	-9.013	-11.381	-10.365
VAR(9)	-11.311	-10.381	-10.201	-9.058	-11.516	-10.373
VAR(10)	-11.195	-10.161	-10.141	-8.871	-12.031	-10.760

Table 5: LM- and LMF-tests for Residual Serial Autocorrelation

	Mexico		Thailand		South Korea	
Lag	$p\text{-}val_{LM}$	$p\text{-}val_{LMF}$	$p\text{-}val_{LM}$	$p\text{-}val_{LMF}$	$p\text{-}val_{LM}$	$p\text{-}val_{LMF}$
1	0.559	0.616	0.519	0.589	0.1260	0.2160
2	0.576	0.660	0.276	0.353	0.2893	0.4588
3	0.870	0.921	0.318	0.442	0.2297	0.3971
4	0.267	0.322	0.148	0.203	0.0950	0.1772
5	0.335	0.440	0.194	0.250	0.0760	0.1644
6	0.313	0.406	0.037	0.021	0.0956	0.2263
7	0.246	0.281	0.078	0.054	0.0937	0.2715
8	0.174	0.165	0.035	0.010	0.0545	0.2260
9	0.276	0.294	0.056	0.023	0.0656	0.2577
10	0.403	0.461	0.095	0.061	0.0497	0.2114

Table 6: Multivariate ARCH-LM Test ($VARCH_{LM}(q)$)

		Mexico		Thailand		South Korea	
Lag q	DF	$VARCH_{LM}(q)$	p-$val(\chi^2)$	$VARCH_{LM}(q)$	p-$val(\chi^2)$	$VARCH_{LM}(q)$	p-$val(\chi^2)$
1	9	5.8597	0.7539	7.5678	0.5782	9.1488	0.4237
2	18	14.6291	0.6873	19.3398	0.3712	18.1345	0.4468
3	27	21.1492	0.7793	27.4603	0.4392	25.2675	0.5595
4	36	33.8536	0.5711	30.9266	0.7085	32.7585	0.6236
5	45	38.7617	0.7322	40.8130	0.6499	44.0869	0.5105
6	54	54.5748	0.4525	58.6235	0.3098	56.0210	0.3989
7	63	65.4918	0.3904	67.9043	0.3138	59.7219	0.5939
8	72	71.7375	0.4866	71.6089	0.4908	75.2401	0.3739
9	81	84.2816	0.3796	79.6063	0.5230	86.0400	0.3299
10	90	98.7090	0.2487	-	-	-	-

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