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The Logic of Twin Debt and Currency Crises

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I. Introduction

The episodes of financial turmoil and distress in the 1990s led researchers to not only look at currency crises as isolated events but also to take into consideration problems in the banking sector. Many of the countries that have experienced currency crises also have undergone domestic banking crises around the same time. Following Kaminsky and Reinhart (1999) this twin crisis approach has induced an extensive theoretical and empirical research on the links between banking and currency crises. In contrast, the literature has so far neglected a second type of twin crisis, the simultaneous occurrence of currency and debt crises. Many countries which have faced balance of payments problems have also been confronted with severe debt problems at the same time, with recent examples including Argentina, Ecuador, and Russia.

What kind of interrelations could exist between defaults and devaluations? Fiscal and monetary policy, and therefore the decisions of a government to devalue and/or to default are closely interlinked through the government's intertemporal budget constraint and the market expectations. In principle, debt (currency) crises can increase or decrease the likelihood of currency (debt) crises, i.e., debt crises and currency crises can be complements or substitutes.

Evidently, there are many reasons for expecting debt and currency crises to be complements and therefore to occur contemporaneously. In analogy to Masson's (1998) categories of emerging markets currency crises we can distinguish three types of twin crises. First, a twin debt and currency crisis can be due to common macroeconomic causes. For example, a worldwide economic downturn could increase the likelihood of a currency crisis because of lower export revenues and exchange re-

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serves. At the same time it could also make a debt crisis more likely because of lower tax revenues and a subsequent deterioration of the public finances. Second, a crisis in one policy field could have substantial effects on the macroeconomic fundamentals in a country and could spill over in other policy fields. Third, a crisis in one policy field could conceivably trigger a crisis elsewhere for reasons unexplained by macroeconomic fundamentals, e.g. because it leads to a shift in market sentiments or because it changes the interpretation given to existing information (internal contagion). For instance, a currency crisis might lead investors to reassess the economic policies of a country, even if the fundamentals had not changed, or it might change the risk tolerance of investors.

However, debt and currency crisis can also be substitutes as they are both "instruments" of public finance which ease the public fiscal burden. If a government is constrained in its fiscal policy and cannot provide a large enough primary surplus to service its debt coming due, e.g. because of institutional problems or political pressure, it is left with the following alternatives to "finance" its expenditures (table 1):

- a (partial) default on its debt, i.e., an implicit tax on bond holders (debt crisis),
- an increase in the money stock, i.e., an inflation tax on money holdings implying a devaluation of the currency (currency crisis), or
- a combination of a devaluation and a default (twin crisis).

Table 1

Debt Crisis, Currency Crisis, and Twin Crisis

	no default	default
no devaluation	no crisis	debt crisis
devaluation	currency crisis	twin crisis

The literature has typically treated currency and debt crises as isolated events. With the exception of the policy literature (e.g. Chiodo and Owyang (2002), Mussa (2002)) defaults and devaluations have not been analyzed as part of a wider menu of policy choices. In the field of currency crises the first-generation models emphasize the role of (monetary)

fundamentals in a speculative attack (e.g. Krugman (1979), Flood and Garber (1984)). The second-generation models of currency crises, e.g. Obstfeld (1994) and (1996), analyze how market expectations and fundamentals interact to give rise to multiple equilibria. While currency crises have primarily been characterized as monetary phenomena, fiscal factors can play a major role in theses crises because of the many interconnections between monetary and fiscal policy (see e.g. Giavazzi and Pagano (1990), Obstfeld (1994), and Benigno and Missale (2001)).

Recent research in debt crises has focused on the role of economic fundamentals and private investors' default expectations. If the creditors do not roll over all of the maturing debt, a default is the optimal choice for the debtor. If creditors are small and cannot co-ordinate there may be an equilibrium in which creditors do not roll over and the debtor defaults (Sachs (1984), Detragiache and Spilimbergo (2002)). Calvo (1988) and Alesina et al. (1990) develop the idea that a government partly repudiates its domestic currency debt through a surprise inflation in which high expected inflation rates are self-fulfilling. More recently, Cole and Kehoe (1996, 2000) and Detragiache (1996) analyzed self-fulfilling creditor runs in models of sovereign debt. Chang and Velasco (1998, 2000) model foreign creditor runs when the borrowers are banks instead of the government. A common feature of these models of self-fulfilling creditor runs is that the bad equilibrium disappears if the amount of debt to be rolled over is small or the fundamentals are benign.

Recently, a few theoretical papers have explicitly integrated aspects of debt and currency crises in the framework of an intertemporal budget constraint. Aizenman et al. (2002) analyze the role of swaps and their effects on devaluation and debt repudiation in a public-finance optimizing framework. They show how fixing the exchange rate via dollarization can increase the risk of a debt write-down. Bauer et al. (2003) model a government that balances the costs and the benefits of debt and currency crises. In their framework a debt crisis can evolve into a twin crisis due to investors' expectations. Jahjah and Montiel (2003) examine how the exchange rate affects the supply of short-term debt facing the government and thus the likelihood of a debt crisis.

In the following we analyze the interrelations between debt and currency crises in an Obstfeld (1994) type framework. The welfare maximizing government decides on its monetary and fiscal policy by balancing the costs of alternative means to finance its expenditures, in particular the costs of an inflation/devaluation and the costs of a default. The gov-

ernment cannot commit itself to honor neither its debt nor its exchange rate peg. On the one side the government has an incentive to finance its expenditures by printing money implying subsequent inflation and devaluation in order to avoid the costs of a default. One the other hand it has an incentive to default on its debt in order to avoid the welfare costs of inflation and devaluation. As is typical for escape clause models, this can give rise to multiple equilibria with a self-fulfilling twin debt and currency crises. A special focus is on the possibility of internal contagion. Problems in the bond market (debt crisis) can affect the exchange market (currency crisis) within the same country. Finally, we investigate the transmission mechanisms that are responsible for a currency or debt crisis to evolve into a twin crisis.

The paper is organized as follows. In the next section we will describe a simple model which can be used to analyze how governments decide to honor their debt and their exchange rate peg or to renege on theses promises. Section III discusses the choice between a twin and a currency crisis and section IV analyzes the option of a twin vs. a debt crisis. Section V concludes.

II. A Simple Model of Debt cum Currency Crises

To analyze self-fulfilling debt and currency crises the following model builds on the well known contribution of Obstfeld (1994). In Obstfeld (1994) the alternative instruments of government finance are printing money and levying taxes. In the context of twin debt and currency crises we focus on the alternatives of printing money and (partial) default. A main factor in explaining why a government gives in to default and devaluation expectations is the increased costs of servicing the public debt. Currency and debt crises are symptoms of the underlying weakness of the fiscal position. If the fiscal position was robust a government could always prevent a debt crises by borrowing to service its existing debt and it could also defend its currency by borrowing sufficient international reserves.

The focus of our analysis is on the interaction between debt and currency crises. The government is not able or not willing to further increase its tax revenues or to reduce the expenditures, e.g. because of institutional problems or political pressure. In this situation the government can "finance" its debt coming due and the public expenditures through a default on its debt (debt crisis), through inflation and the sub-

sequent devaluation (currency crisis) or through a combination of default and devaluation (twin crisis).

The world lasts for two periods, labeled 1 and 2. The government issues the domestic currency M, called the peso, and the foreign debt f denominated in dollars. The foreign debt f is risky and can be subject to default. f_{mn} denotes foreign debt that is issued in period m and is coming due in period n. i is the nominal interest rates on the risky foreign currency debt, while i^* is the nominal interest rate on risk free dollar debt. Real government consumption in the two periods, g_1 and g_2, is given exogenously. P denotes the price level.

The government's period 1 budget constraint is

$$\frac{P_1 f_{12}}{1+i} = P_1 g_1. \tag{1}$$

Purchasing power parity is assumed to hold so that the exchange rate E is equal to the price level, i.e., $E = P$ with the foreign price level being unity. Equation (1) can then be rewritten as

$$\frac{E_1 f_{12}}{1+i} = E_1 g_1 \tag{1'}$$

In period 1 the peso-dollar-exchange rate is fixed at E_1, but it can be changed to E_2 in period 2.

For simplicity we assume that taxes are levied only in period 2. The government finances its period 1 expenditures by new issuing debt f_{12}. Following the original sin hypothesis the government is constrained to issue foreign currency debt only (Eichengreen and Hausman (2002)).

In period 2 the government's budget constraint is

$$(1-\eta)(E_2 f_{12} + E_2 f_{02}) + E_2 g_2 = M_2 - M_1 + E_2 \tau y \tag{2}$$

or

$$E_2 f_{12} + E_2 g_2 = M_2 - M_1 + \eta(E_2 f_{12} + E_2 f_{02}) + E_2 \tau y. \tag{2'}$$

The government has to meet its period 2 current expenditures as well as the debt service for old debt f_{02} and new debt f_{12}. These obligations may be financed alternatively by an increase of (high-powered) money held in period 2, $M_2 - M_1$, by an income tax τy, and by defaulting on the fraction η of the foreign debt f_{12}. As we are interested in the interaction

of debt and currency crises we take the real tax revenues with the tax rate τ and output y as exogenously given.

Under the assumption of capital mobility the perfect-foresight equilibrium implies that the returns on the risk free debt and the risky foreign debt are equal,

$$(1+i)(1-\eta) = (1+i^*). \tag{3}$$

Private money demand is given by the simple quantity equation

$$M_t = kE_t y(t = 1,\ 2). \tag{4}$$

The government aims at minimizing the distorting effects of a debt and currency crisis. A debt crisis with a subsequent (partial) default might be accompanied by a breakdown in international trade (e.g. Rose (2002), Rose and Spiegel (2002)) and by a loss of output (e.g. Dooley (2000)). Accordingly a currency crisis might cause a reputation loss as the government reneges on its exchange rate promise. The devaluation increases the uncertainty about the future policy and decreases the welfare as the private sector relocates resources from productive activities to the hedge against expected inflation.[1]

The domestic inflation rate ε which is also the peso depreciation rate against the dollar is defined as

$$\varepsilon = \frac{E_2 - E_1}{E_2}. \tag{5}$$

The inflation/devaluation rate and the default rate are assumed to be zero in period 1, so that the loss function of the government can be written as

$$L = \frac{1}{2}\eta^2 + \frac{\theta}{2}\varepsilon^2. \tag{6}$$

θ measures the relative weight of the exchange rate target vis-à-vis the debt service target in the government's loss function.

With the foreign price level and the exchange rate of period 1 set to unity equation (1) simplifies to

[1] As a devaluation is associated with inflation, the costs of a devaluation might also be interpreted as the costs of inflation. See *Fischer* (1981) and *Briault* (1995) for a comprehensive overview of these costs.

$$f_{12} = (1+i)g_1. \tag{7}$$

and equations (2), (4), and (5) can be combined to

$$\varepsilon ky + \eta(f_{12} + f_{02}) = f_{12} + f_{02} + g_2 - \tau y \tag{8}$$

In period 2 the government minimizes (6) subject to (8) if it cannot precommit to repay all the foreign debt. This leads to the necessary condition

$$\frac{\theta\varepsilon}{ky} = \frac{\eta}{f_{12} + f_{02}}. \tag{9}$$

In the optimum the marginal costs of inflation equal the marginal costs of default on the debt coming due in period 2. For a given default rate η the devaluation rate ε rises with an increase in money supply ky relative to debt f_{12},

$$\varepsilon = \frac{\eta\varkappa\psi}{\theta(\phi_{12} + \phi_{02})} \tag{9'}$$

i.e., a larger asset base implies a (relative) higher tax rate on this asset.

Using (9') to eliminate ε from (8) gives the preferred default rate as

$$\eta = \frac{\theta(f_{12} + f_{02})(f_{12} + f_{02} + g_2 - \tau y)}{(ky)^2 + \theta(f_{12} + f_{02})^2} \tag{10}$$

Combining equations (7) and (10) shows how the optimal default rate depends on the interest rate of the risky foreign debt i

$$\eta_{TW} = \frac{\theta\left[(1+i)g_1 + f_{02}\right]\left[(1+i)g_1 + f_{02} + g_2 - \tau y\right]}{(ky)^2 + \theta((1+i)g_1 + f_{02})^2}. \tag{11}$$

Equation (11) can be rewritten as

$$\eta_{TW} = \frac{(i+\alpha)(i+\alpha+\beta)}{\gamma + (i+\alpha)^2} = \frac{i+\alpha+\beta}{\frac{\gamma}{i+\alpha} + i + \alpha} \tag{11'}$$

with $\alpha = \frac{g_1 + f_{02}}{g_1} = 1 + \frac{f_{02}}{g_1}$ that depends on the ratio between long term debt and the real primary deficit in period 1, $\beta = \frac{g_2 - \tau y}{g_1}$, the ratio of the primary deficits in the two periods, and $\gamma = \frac{(ky)^2}{\theta g_1^2} > 0$, the ratio of money supply and the period 1 primary deficit.[2]

With an increase in the market interest rate the government faces higher financing requirements and chooses a higher default rate. A large money supply relative to the foreign debt, i.e., a high γ, lowers the default rate as the financing effect of a given inflation/devaluation rate is larger.

The arbitrage condition (3) also relates the default rate to the interest rate i

$$\eta_M = \frac{i - i^*}{1 + i} \tag{3'}$$

In a perfect-foresight equilibrium the default rate that the market expects, equation (3'), is equal to the default rate the government finds optimal for given market expectations, equation (11). Together these conditions can give rise to multiple equilibria (figure 1).[3]

Solving for the equilibrium $\eta_M = \eta_{TW}$ leads to the quadratic equation $(1 + i^* + \beta)x^2 + ((1 - \alpha)\beta - \gamma)x + \gamma(\alpha + i^*) = 0$ with $x = i + \alpha$. This equation has the unique solution $i = \gamma \frac{i^* + \alpha}{\gamma - \beta(1-\alpha)} - \alpha$ for $1 + i^* + \beta = 0$. In this case i is positive for $i^* > -\frac{\alpha\beta(1-\alpha)}{\gamma}$. With $1 + i^* + \beta \neq 0$ there are two real solutions for $((1 - \alpha)\beta - \gamma)^2 - 4\gamma(\alpha + i^*)(1 + i^* + \beta) > 0$, i.e., for sufficiently low foreign interest rates.

In figure 1 there are two equilibria if the government cannot precommit to honor neither its debt nor its exchange rate peg. The government's loss is smaller in the low default equilibrium ($I^1{}_{TW}$). However, there is no possibility to ensure that this better equilibrium is realized as the government cannot credibly commit to not validate expectations if the bond market settles on the interest rate of the high default equilibrium ($I^2{}_{TW}$). The high default equilibrium also implies a higher inflation and depreciation rate (see equation 9), as the increased interest rate causes higher interest expenditures for the government.

Figure 1 characterizes an intermediate situation. Improvements in the fundamentals, e.g. lower public expenditures g or debt f, shift the gov-

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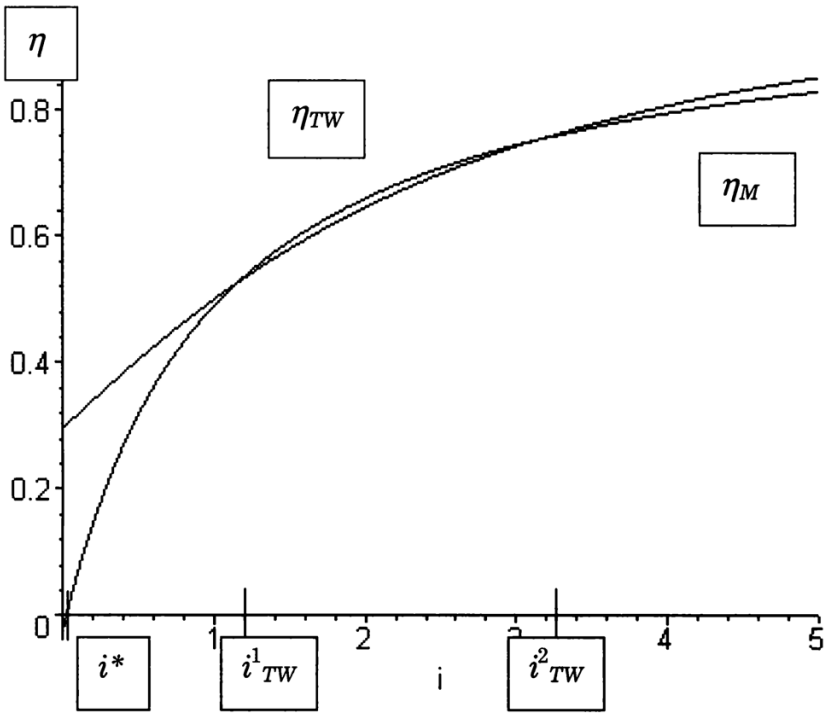
[2] In the following analysis we assume $g_1 + f_{01} + f_{02} + g_2 - \tau y > 0$ or equivalently $\alpha + \beta > 0$, i.e., the sum of public expenditures in both periods and period 1 long-term and short-term debt exceeds the tax revenues.

[3] For equation (11) to be increasing in the interest rate, a sufficient condition is $\beta + 2\alpha > 0$ in case of a primary surplus ($\beta < 0$) and $\gamma > \alpha\beta$ in case of a primary deficit ($\beta > 0$). Both conditions are very likely to be fulfilled for standard parameter values.



$f_{02} = 0.3$, $g_1 = 0.35$, $g_2 = 0.3$, $\theta = 1$, $\tau = 0.3$, $k = 1$, $y = 1$

Figure 1: Interest Rate and Default Rate Under a Twin Crisis: Government and Market Reaction Functions

ernment's η-i-curve to the southeast. As a consequence the default rate and the interest rate of the good (bad) equilibrium fall (rise). The bad equilibrium becomes less likely in the sense, that the investors have to coordinate their expectations on a higher default rate. A relatively large money supply, i.e., a high value of γ , has similar effects as the improvement of the fundamentals. It induces the government to shift from the tax on bonds, the partial default, to the inflation tax thereby reducing the default rate in the good equilibrium. In contrast, a deterioration of the fundamentals and a reduction in money supply shifts the η-i-curve to the northwest.

What does this analysis imply for the security of foreign debt and the viability of a fixed exchange rate regime? In principle, a sovereign government can always renege on its debt if the economic conditions war-

rant a default. Similarly, a sovereign government can always abandon a currency peg if the economic conditions make a realignment advantageous. Governments abstain from using these escape clauses if they face large enough fixed costs of a default C_η and a devaluation C_ε.

As discussed above, these costs could include the political embarrassment, the loss of credibility, and the output losses countries typically face in the aftermath of currency crashes and a default. It is likely that the costs of both crises entail a fixed as well as a variable component. In the case of the debt crisis the fixed costs are mainly due to fact that a default is typically initiated by suspending all payments. As a consequence e. g. trade and output decline. In the subsequent process of debt resolution the final default rate is determined. Obviously the ultimate costs of the default also depend on the extent of the default. In a similar way, the devaluation has fixed and a variable component. Reneging on its exchange rate promise leads to a loss of credibility for the government as investors review their decisions. Again these costs also depend on the extent of the devaluation.

Without fixed costs of a default and a devaluation governments would always choose the twin crisis instead of a currency or a debt crisis. As the variable costs are quadratic in the devaluation rate and the default rate it would be more favorable to opt for the twin crisis to balance these costs.

With the fixed default and devaluation costs the loss function under discretion is

$$L = \frac{1}{2}\eta^2 + \frac{\theta}{2}\varepsilon^2 + \lambda_\eta C_\eta + \lambda_\varepsilon C_\varepsilon \quad \text{with } \lambda_\eta = 1 \text{ if } \eta \neq 0, \lambda_\varepsilon = 1 \text{ if } \varepsilon \neq 0, \lambda_\eta, \lambda_\varepsilon = 0 \tag{12}$$

otherwiese instead of (6).

In the following we contrast the purely discretionary regime (twin crisis) analyzed so far with

(1) a no-default regime, in which the default rate η is constrained to be zero but devaluation is possible (currency crisis only), and

(2) a fixed exchange rate regime, in which the depreciation rate ε is restricted to zero but default is possible (debt crisis only).

III. Currency vs. Twin Crisis

In a first step, we compare the purely discretionary policy (twin crisis) with the regime, in which the government can credibly commit to honor its debt and instead finances its deficit by inflation and the subsequent devaluation (currency crisis only). Combining equations (9) and (12) yields the loss functions under the twin crisis L_{TW}

$$L_{TW} = \frac{1}{2}\eta^2 + \frac{\theta}{2}\left(\frac{\eta k y}{\theta(f_{12} + f_{02})}\right)^2 + C_\eta + C_\varepsilon \tag{13}$$

which together with (11) is

$$L_{TW} = \frac{1}{2}\frac{\theta^2(f_{12} + f_{02})^2(f_{12} + f_{02} + g_2 - \tau y)^2}{((ky)^2 + \theta(f_{12} + f_{02})^2)^2}\frac{\theta(f_{12} + f_{02})^2 + (ky)^2}{\theta(f_{12} + f_{02})^2} + C_\eta + C_\varepsilon, \tag{14}$$

and can be simplified to

$$L_{TW} = \frac{1}{2}\frac{(i + \alpha + \beta)^2}{\gamma + (i + \alpha)^2} + C_\eta + C_\varepsilon. \tag{15}$$

Accordingly, we obtain the loss function of the currency crisis L_{CU} by combining equations (7), (8), and (12) and setting $\eta = 0$ as the government honors all its debt

$$L_{CU} = \frac{\theta}{2}\left(\frac{(1 + i)g_1 + f_{02} + g_2 - \tau y}{ky}\right)^2 + C_\varepsilon \tag{16}$$

which can be rewritten as

$$L_{CU} = \frac{1}{2}\frac{(i + \alpha + \beta)^2}{\gamma} + C_\varepsilon. \tag{17}$$

Figure 2 displays the two loss functions. For interest rates higher than i_0^A the loss under the twin crisis L_{TW}^A is smaller than the loss under the currency crisis L_{CU}. The twin crisis has the advantage that the government can balance the variable costs of a devaluation and a default by using two policy instruments instead of only one as in the case of the currency crisis. As a result the devaluation rate is lower in the twin crisis than in the currency crisis. However, the twin crisis has the disadvantage that the fixed costs of the default C_η accrue. With high interest rates the twin crisis is relatively more attractive as these fixed costs

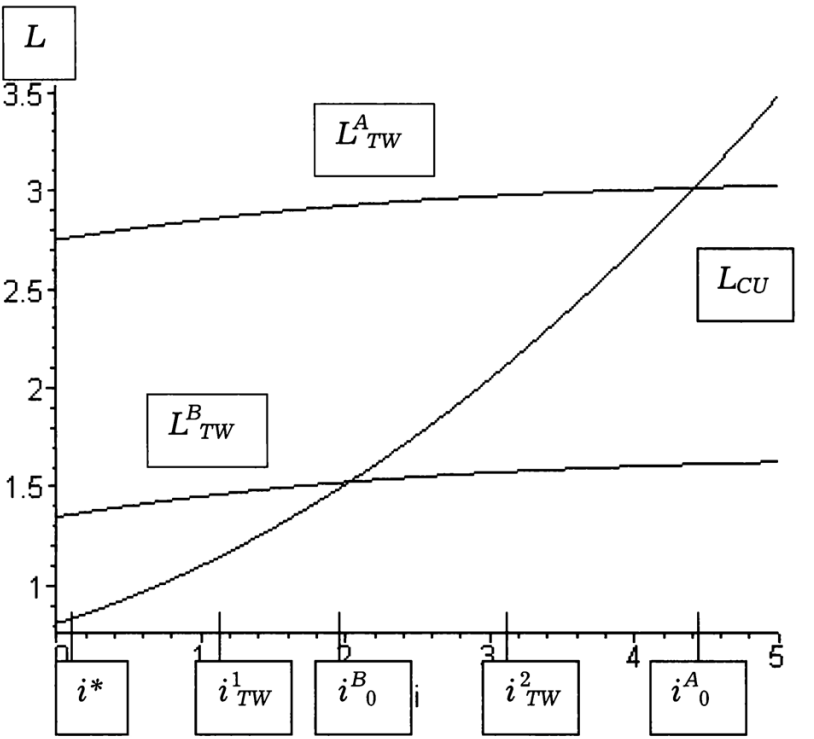
become quantitatively less important. Therefore, with higher interest rates it is more likely that the government does not only devalue but also defaults.

As $L_{CU} > L_{TW}$ for $i = \infty$ and $L'_{CU} > L'_{TW}$ for $i > 0$, there exists one and only one point of intersection between the two loss functions if $L_{CU} < L_{TW}$ for $i = 0$. This is the case if the fixed costs of a default are sufficiently large, i.e., if $C_\eta > \frac{\alpha^2(\alpha+\beta)^2}{2\gamma(\gamma+\alpha^2)}$. If instead the fixed costs of the default are relatively small, then the government only devalues and puts up with the higher devaluation rate in order to avoid the fixed costs of the default.

Figure 2 also depicts the two market interest rates i^1_{TW} and i^2_{TW} from the dual equilibrium case of figure 1. These interest rates as well as the risk free world interest rate i^* are all to the left of i^A_0. In this case the investors anticipate that it is beneficial for the government to only devalue and to not default on its foreign currency debt so that the risk free interest rate i^* is realized.

What are the consequences of a reduction in the fixed costs of a default, e.g. because a new government reaches a different assessment. If the fixed costs of a default fall, then the loss function of the twin crisis shifts downwards (L^B_{TW}) and the point of intersection i^B_0 moves to the left. Obviously, such a reduction in the fixed costs of a default, i.e., $i^1_{TW} < i^B_0 < i^2_{TW}$, can cause a twin crisis to arise where none existed before, i.e., $i^1_{TW} < i^2_{TW} < i^A_0$. In this case the risk free interest rate i^* and the interest rate i^1_{TW} are to the left of i^B_0 while i^2_{TW} is to the right (see figure 2). Two very different outcomes are possible. In the good state the market participants do not expect a default, and the market interest rate is set equal to i^* and the government does not default as $L_{CU} < L^B_{TW}$ at $i = i^*$. In the bad state the market expects the default rate η_2 and the nominal interest rate is set equal to i^2_{TW}. For this interest rate the loss under the twin crisis is smaller than the loss under the currency crisis so that the government reneges on its foreign debt in a self-fulfilling debt and currency crisis. There exists an equilibrium in which there is only a currency crisis if the market expects the government to honor its debt, and an equilibrium under the same fundamentals in which there is a self-fulfilling twin debt and currency crisis if the market expects the government to renege on its debt.[4]

[4] Whether the devaluation rate in the currency crisis is lower or higher than in the twin crisis depends on the specific parameter values.



$f_{02} = 0.3$, $g_1 = 0.35$, $g_2 = 0.3$, $\theta = 1$, $\tau = 0.3$, $k = 1$, $y = 1$, $C^A{}_\eta = 2.0$, $C^B\eta = 0.6$, $C_\varepsilon = 0.6$

Figure 2: Loss Functions for Currency Crisis and Twin Crisis

A further reduction of the fixed costs of a default could lead to a situation in which the two market interest rates i^1_{TW} and i^2_{TW} are above the interest rate i^B_0. Then the government is going to default and to devalue in any case with the private default expectations only determining whether the (relatively) good or the (relatively) bad equilibrium is realized.

A deterioration of the fundamentals, e.g. an increase in public expenditures or debt, has two effects. It shifts the government's $\eta - i$-curve to the northwest, so that the interest rate of the good equilibrium i^1_{TW} rises whereas the interest rate (and the corresponding default rate) of the bad equilibrium i^2_{TW} decreases. A lower expected default rate is necessary for the market to realize the bad equilibrium. A deterioration of the fundamentals also moves the crucial interest rate i^B_0 to the left.[5] Both changes make it more likely that a twin crisis occurs instead of a currency crisis.

Taken together, defaults and devaluations can be considered as alternative means of public finance that are interlinked through the government's intertemporal budget constraint. Both crisis can be triggered by common fundamental factors as well as market expectations. A deterioration of the economic fundamentals raises the public financing requirements which the welfare maximizing government can compensate with the inflation tax and/or the bond tax. Without any fixed costs of a debt or a currency crisis the government would always choose a twin crisis to balance the marginal costs of the two crises. It is the fixed costs of a default that can induce the government to opt for the currency crisis only.

Twin crises can also be triggered and aggravated by changing market expectations in situations of multiple equilibria. As the market participants expect a higher default rate they demand a higher interest rate which further increases the public financing requirements. Not only can this intensify the currency crisis but it can additionally induce a debt crisis. If there is already a twin crisis a deterioration in the private default expectations can cause the economy to move from the (relatively) good or the (relatively) bad state, implying higher default and interest rates. The larger financing requirements do not only intensify the debt crisis but also aggravate the accompanying currency crisis.

IV. Debt vs. Twin Crisis

In the next step we compare a twin crisis with a debt crisis, i.e., the government pegs its exchange rate and instead finances its expenditures by defaulting on its debt. The necessary default rate in the case of a debt crisis is given by combining (7) and (8) and setting $\varepsilon = 0$

$$\eta_{DE} = \frac{f_{12} + f_{02} + g_2 - \tau y}{f_{12} + f_{02}} = 1 + \frac{g_2 - \tau y}{(1+i)g_1 + f_{02}} \tag{18}$$

which can be simplified to

$$\eta_{DE} = \frac{i + \alpha + \beta}{i + \alpha}. \tag{19}$$

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[5] Technically, deteriorating fundamentals shift the loss of the currency crisis to a larger degree upwards than the loss curve of the twin crisis, i.e., $\partial(L_{CU} - L_{TW}/\partial x > 0$ with $x = f_{01}, f_{02}, g_1, g_2$. Correspondingly, a smaller money supply narrows the base of the inflation tax, thereby also shifting i_0 to the left and making the currency crisis relatively less beneficial.

Obviously, the default rate under the debt crisis is always higher than the default rate under the twin crisis as the government cannot additionally reduce its real fiscal burden via inflation.

It is evident from equation (19) that a debt crisis is not a viable choice if the government generates a primary deficit in period 2. For $g_2 - \tau y > 0$ the necessary default rate would have to be above 100 %, i. e., $\eta_{DE} > 1$. Even if the government defaulted on all the debt coming due in the second period $f_{12} + f_{02}$ it would still have to finance the primary deficit $g2 - \tau y$. Clearly, in such a situation the government is going to choose the twin crisis.

In contrast, a debt crisis is a viable option if the government generates a primary surplus in period two, $g_2 - \tau y < 0$. In the perfect-foresight equilibrium the default rate that the market expects η_M is equal to the default rate the government sets for given market expectations η_{DE}. Combining equations (3') and (19) yields the equilibrium interest rate under a debt crisis

$$i_{DE} = -\frac{\alpha(1+i^*)+\beta}{1+i^*+\beta} \tag{20}$$

As the default rate is higher under the debt crisis, the corresponding interest rate i_{DE} is also higher than interest rate under the twin crisis.

It is evident from equation (20) that a default equilibrium is only viable for

$$1 + i^* + \beta = 1 + i^* + \frac{g_2 - \tau y}{g_1} < 0, \tag{21}$$

i. e., in addition to generating a budget surplus the government has to ensure a low level of public expenditures g_1.[6]

The government is going to decide on the basis of the corresponding losses whether to default only or to default and to devalue. In the case of the twin crisis the loss function is again

$$L_{TW} = \frac{1}{2}\frac{(i+\alpha+\beta)^2}{\gamma+(i+\alpha)^2} + C_\eta + C_\varepsilon. \tag{15}$$

[6] Given $\alpha + \beta > 0$ (see footnote 2) $1 + i^* + \beta < 0$ holds for $-\alpha < \beta < -(1 + i^*)$.

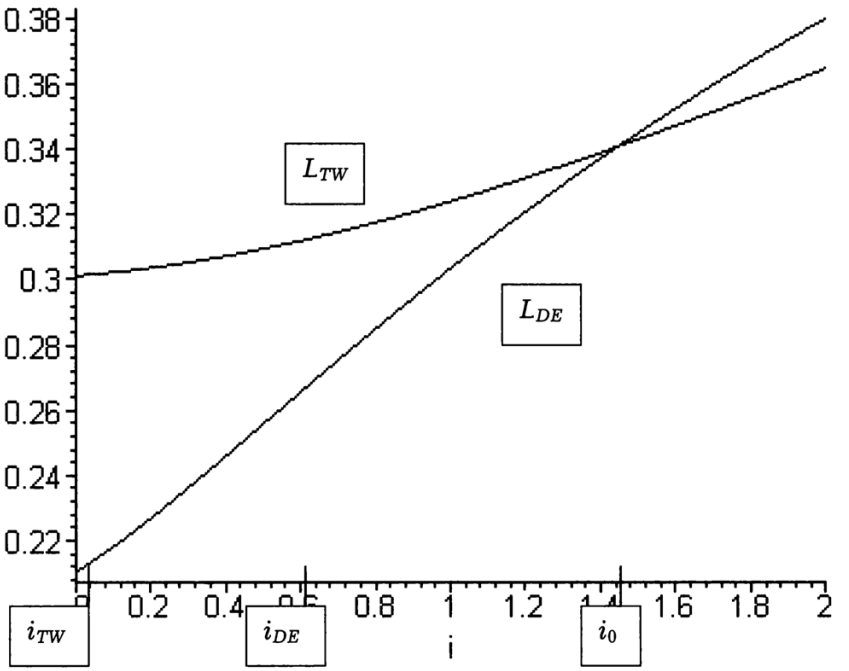

Figure 3: Loss Function for Debt and Twin Crisis

The loss function of a debt crisis L_{DE} is given by combining equations (7), (8) and (12) as well as setting $\varepsilon = 0$ as the government honors the exchange rate peg

$$L_{DE} = \frac{1}{2}\left(\frac{(1+i)g_1 + f_{02} + g_2 - \tau y}{(1+i)g_1 + f_{02}}\right)^2 + C_\eta \tag{22}$$

which can be rewritten as

$$L_{DE} = \frac{1}{2}\frac{(i+\alpha+\beta)^2}{(i+\alpha)^2} + C_\eta. \tag{23}$$

For high expected default rates and subsequent high interest rates the government is likely to choose the debt crisis. The default rates in the case of the twin crisis and the debt crisis and therefore the variable costs of the two types of crises are then very similar. By only defaulting the

government can avoid the fixed costs of a devaluation that arise in the twin crisis. For low interest rates the loss under the twin crisis can be below or above the loss under the debt crisis, depending on the relative size of the variable and fixed costs of a default and a devaluation. This can give rise to situations with no or at least one point of intersection between the loss functions of the twin and debt crisis.

As $L_{DE} < L_{TW}$ for $i = \infty$, there exists at least one point of intersection between the two loss functions if $L_{DE} > L_{TW}$ at $i = 0$. This is the case if the fixed costs of the devaluation are sufficiently small, i.e., if $C_\varepsilon < \frac{\gamma(\alpha+\beta)^2}{2\alpha^2(\gamma+\alpha^2)}$. If instead the fixed costs of a devaluation are relatively large, there is no intersection between the two loss functions and the government will only default on its debt. If there is exactly one intersection between the two loss functions than a situation of multiple equilibria can exist similar to the situation discussed in section 3. Such a situation is likely if the fixed and variable costs of a devaluation are relatively low so that i_{TW} is below i_0 while i_{DE} is above (see figure 3). A twin crisis with interest rate i_{TW} will occur if the market participants expect the government to both default and devalue whereas a debt crisis with interest rate i_{DE} will be realized if the market participants expect the government to default only.[7] The government cannot make sure that the better equilibrium, i.e., the twin crisis with the lower default rate is realized as it cannot bind itself to not renege on its exchange rate peg.

How does an improved credibility of the exchange rate peg affect the government's decision? Let us assume that the costs of a devaluation are increased by making it more difficult and costly for the government to give up the exchange rate peg for example via a currency board, so that $i_{TW} < i_{DE} < i_0$ holds instead of $i_{TW} < i_0 < i_{DE}$. In this case the government is always going to choose the debt crisis and the equilibrium with the higher default rate and the higher interest rate i_{DE} is realized. Strengthening the fixed exchange rate regime can therefore increase the likelihood and the severity of a debt crisis as the government is left with only one instrument to finance its expenditures. Thus, sound fiscal policies are especially important if governments want to credibly fix their exchange rate.

[7] For $i_0 < i_{TW} < i_{DE}$ only the debt crisis with the interest rate i_{DE} is realized and for $i_{TW} < i_{DE} < i_0$ the twin crisis with the interest rate i_{TW} is the only outcome.

V. Conclusion

In this paper, we have systematically investigated the potential linkages between debt and currency crises. Our starting point was the question whether a currency (debt) crisis makes a debt (currency) crisis more likely or not. Or put differently: are currency and debt crisis complements or substitutes?

Debt and currency crisis can be considered as alternative instruments of public finance which are closely interlinked through the government's intertemporal budget constraint. Debt and currency crises are driven by the same macroeconomic fundamentals that weaken the public fiscal position. Without the fixed costs of a debt or a currency crisis the government is likely to use both default and inflation/devaluation in a complementary way to balance the budget, thus giving rise to a twin crisis. From this perspective twin crises occur because debt and currency crises have the same (fundamental) causes. Improving the macroeconomic fundamentals should then yield a double dividend of reducing the risk of a twin debt and currency crisis.

Fixed costs of a currency or a debt crisis can make governments to default or to devalue only, so that debt and currency crisis can be considered as substitutes in the financing of public expenditures. The higher these fixed costs the more likely is the government to opt for a single crisis instead of a twin crisis. Measures that improve the credibility of an exchange rate peg through increasing the fixed costs of a currency crisis reduce the likelihood of a currency crisis but at the same time can make a debt crisis more likely and more severe. Accordingly, measures that increase the security of the public debt reduce the risk of a debt crisis and a twin crisis while possibly increasing the likelihood and severity of a currency crisis.

The analysis has also shown the possibility of self-fulfilling twin debt and currency crisis and the effects of internal contagion in situations of multiple equilibria. If private investors expect an imminent default they demand higher interest rates that increase the debt service. The subsequent deterioration of the fiscal position can induce the government to default as well as to inflate and devalue. Then two currency and debt crises can be considered to be complements.

For the design of stabilization programs this implies that the International Monetary Fund's focus on the improvement in the macroeconomic fundamentals is well taken as it yields a double dividend of reducing the

risk of a debt as well as a currency crisis. However, the IMF's emphasis on exchange rate stabilization can be counterproductive. Measures that increase the costs of a currency crisis relative to a debt crisis might increase the likelihood and the severity of a debt crisis.

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Summary

The Logic of Twin Debt and Currency Crises

While the well-known twin currency and banking crises has drawn a lot of interest a second type of twin crises, the simultaneous occurrence of currency and debt crises, has so far been neglected in the literature. The decision of a government to devalue and/or to default is closely interlinked through the government's intertemporal budget constraint and the market expectations. On the one hand, debt and currency crisis are negatively interlinked as a debt crisis eases the fiscal burden of the government thereby making a currency crisis less likely and vice versa. On the other hand, debt and currency crises are positively interlinked, as the expectation of a debt crisis can increase the fiscal burden by rising interest rates so that an additional currency crisis becomes more likely. (JEL F31, F33, F34, F41)

Zusammenfassung

Die Logik von Zwillings-Währungs- und Schuldenkrisen

Während es zu den bekannten Zwillings-Währungs- und Bankenkrisen zahlreiche Studien gibt, wurde eine andere Form der Zwillingskrise, das gleichzeitige Auftreten von Währungs- und Schuldenkrisen, in der Literatur bisher vernachlässigt. Die Entscheidungen einer Regierung, die Währung abzuwerten und die Schulden nicht zurückzuzahlen, sind über die intertemporale Budgetrestriktion der Regierung und die Erwartungen der Marktakteure eng miteinander verbunden. Auf der einen Seite besteht zwischen Schulden- und Währungskrisen eine negative Beziehung, da ein Zahlungsausfall die fiskalische Belastung des Staates verringert und damit auch eine Währungskrise weniger wahrscheinlich macht. Dies gilt entsprechend für die Entlastungswirkung einer Währungskrise. Auf der anderen Seite sind Schulden- und Währungskrisen auch positiv miteinander verbunden, da ein erwarteter Zahlungsausfall des Staates die fiskalische Belastung über steigende Zinsen erhöht und damit auch das Risiko einer Währungskrise vergrößert.

Résumé

La logique des crises jumelles de la dette et de change

Alors qu'il existe de nombreuses études sur les crises jumelles monétaires et bancaires, une autre forme de la crise jumelle, à savoir l'apparition simultanée de crises de change et de la dette, a été négligée jusqu'ici dans la littérature. Les décisions d'un gouvernement de dévaluer sa monnaie et de ne pas rembourser les dettes sont fortement liées par la restriction budgétaire intertemporelle et par les attentes des acteurs du marché. Il existe d'une part une relation négative entre les crises de la dette et les crises de change, car un défaut de paiement réduit la charge fiscale de l'Etat et rend par là aussi une crise monétaire moins probable. D'autre part, les crises de la dette et de change sont liées positivement, car un défaut de paiement attendu de l'Etat augmente la charge fiscale par des intérêts croissants et augmente, en conséquence, le risque d'une crise monétaire.