Another Twin Crisis: Currency and Debt

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Abstract

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Empirically, currency crises are more frequently accompanied by sovereign debt crises than by banking crises. Nevertheless the phenomenon of twin currency and debt crises has so far been neglected in economic literature. We analyze the optimal policy of a government that may choose and combine two policy alternatives. She may choose at the same time whether to keep or alternatively exit an existing exchange rate peg and whether or not to default on her debt. Both a devaluation and a default can be used to "finance" public expenditure. In addition both parameters have a large impact on the public welfare. The resulting incentive system can generate situations with self-fulfilling expectations. In some situations an internal contagion effect arises. A crisis in the sovereign debt market spreads to the sector of exchange rate policy and causes a devaluation as well. Private investors’ default expectations thus can not only cause a sovereign debt crisis but may lead to a currency crisis as well.

JEL-Classification: F 34, F 41, E 61.

Keywords:
Currency crises, sovereign default, self-fulfilling expectations, internal contagion.
1 Introduction

In the 1990s and most notably during the Asian crisis in 1997-98 a number of countries experienced problems in the banking sector and simultaneously in the balance of payments. The literature soon created the term "twin crisis" to describe this phenomenon which induced extensive research on the possible causal links between these two types of crises.\(^1\) Far less attention has been turned to a second type of twin crisis, a simultaneous currency and sovereign debt crisis.\(^2\) So far the extensive literature on currency crises and sovereign defaults has treated these two types of crises as separated issues.

The basic question of the sovereign debt literature was why governments repay their debt at all. There are only few legal institutions to apply or sanctions to impose for creditors to enforce their claims. The common answer is that governments repay their debt because they want to avoid a loss of reputation that would make it impossible or at least very expensive to issue new debt in the future.\(^3\) Recent research has focused on the question whether sovereign debt crises are mainly driven by economic fundamentals or private creditors’ default expectations.\(^4\)

Cole and Kehoe (1998) identify the level and the maturity structure of the debt to be important factors that can cause self-fulfilling debt crises. They find that multiple equilibria become possible as soon as the debt exceeds a crucial level. Lengthening the maturity increases this crucial debt level, i.e. with a longer maturity structure a higher debt level can be maintained without risking a financial crisis.

The currency crisis literature evolved in several steps. In the so-called first generation models the breakdown of a fixed exchange rate is explained as an inevitable result of an inappropriately excessive fiscal or monetary policy which is fundamentally inconsistent with the exchange rate regime (e.g. Krugman (1979) and Flood and Garber (1984)). In the so-called second generation or escape clause models the abandonment of an ex-

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\(^1\)See Kaminsky and Reinhart (1999) for a comprehensive overview.

\(^2\)Important exceptions are Corsetti and Mackowiak (2001) and Chui, Gai, and Haldane (2000).

\(^3\)See for example Eaton and Gersovitz (1981), Grossman and Van Huyck (1988) and Cole, Dow, and English (1995). Other incentives for the repayment of sovereign debt have been stressed by various authors. In general, the common characteristic of all the mechanisms described is the fact that a default causes some kind of costs for the government.

\(^4\)See among others Calvo (1988), Alesina, Prati, and Tabellini (1990), and Detragiache (1996).
change rate peg is seen as a deliberate and strategic policy choice of a government, that aims to maximize public welfare by weighing the costs and benefits of the fixed exchange rate (e.g. Obstfeld (1986), Obstfeld (1994), Obstfeld (1996), and Ozkan and Sutherland (1998)). The government is prepared to sacrifice the peg if she expects to enhance public welfare by doing so. Sudden shifts in private expectations play a crucial role in these models since they enter the government’s welfare function in various ways, e.g. via an expectations augmented Phillips curve or via interest rate premiums. The government’s policy choice becomes endogenous in so far as it depends to a certain extend on the private expectations. This feature typically allows for multiple equilibria solutions in which devaluation expectations emerge to be self-fulfilling and speculative attacks turn out to be successful even though they may seem to be fundamentally not justified. Nevertheless, fundamentals still play a decisive role in these models, since multiple equilibria only exist for certain ranges of fundamentals. With regard to the state of the fundamental variables these models distinguish between three kinds of situations. There are situations in which the fundamentals are sufficiently good so that the government keeps the exchange rate peg irrespective of the privates’ expectations. There also exist situations with very bad fundamentals in which regardless of the private expectations the government in any event chooses to devalue. Only in between these two extreme cases there is a zone with multiple equilibria, a "grey area" in terms of Krugman (1996), in which changes in the private beliefs lead to self-fulfilling currency crises. Jeanne (2000) calls these three scenarios heaven, hell, and purgatory. As it is quite helpful in describing several characteristic situations in our analysis as well, we will refer to this metaphor below.

While currency and debt crises have been treated separately in the literature so far, it is important to investigate their interrelations. Empirically, these two types of crises occur contemporaneously quite often. Reinhart (2002) explores the connections between sovereign credit ratings, currency crashes and financial crises. She finds that 84 percent of the defaults in her emerging markets sample are linked with currency crises and almost half

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5 Other mechanisms that may generate multiple equilibria in currency crisis models have recently been discussed. An important aspect of these models is the question how private investors form their expectations, whether they jointly react to some kind of signal or to the realization of a sunspot variable. In these models multiple equilibria may arise from coordination problems or from the asymmetric distribution of information among private agents. See e.g. Banerjee (1992) and Caplin and Leahy (1994).
of the currency crises in the sample are associated with defaults. Herz and Tong (2003) find that 32 percent of all debt crises in their sample are related to currency crises, while 20 percent of the currency crises are linked to debt crises. Recent examples of simultaneous currency and debt crises include Russia (1998) and Argentina (2001). Reinhart (2002) conjectures that in addition to their exchange rate disturbances countries such as Mexico, South Korea, Thailand and Turkey would most likely have experienced a sovereign default as well if they had not obtained vast international rescue packages.

A common feature of both the currency and the debt crisis literature is the question how the government finances her budget. If the budgetary position is strained, the government first may either reduce her expenditures or increase the taxes. If these two options are not available or not desirable e.g. due to political pressure, a devaluation and / or a debt default are the only alternatives to balance the budget. Through a monetary expansion and a devaluation the government may impose an inflation tax and generate seigniorage. By defaulting she avoids the debt service.

Below we follow the escape clause approach on currency crises, which basically applies the time inconsistency problem of optimal monetary policy to an open economy. In a simple model we analyze the policy of a welfare optimizing government that strategically weighs the costs and benefits of her policy options. But in contrast to the previous models we do not confine the government’s options to either sticking to or alternatively exiting a fixed exchange rate peg. Instead, we combine several elements of the currency and the debt crisis literature and consider the government’s option of either paying back or alternatively defaulting on her debt as well. In effect, the government has to choose the best of four options: She can either choose neither to devalue nor to default, or she can choose to devalue but not to default, or to default but not to devalue, or both to devalue and to default. Table 1 illustrates the four policy options.

To find the optimal policy decision, the government has to consider and outweigh the costs and benefits of her decisions both on the private sector of the economy and her budget. Considering these effects, the government faces a complex incentive system. Our main focus is to analyze the interactions between the two policy fields based on this incentive system. The most important question is whether currency and debt crises are mainly caused by (common) economic fundamentals or by sudden shifts in private expectations.
Another important question is whether there exists something like an internal or inter-sectoral contagion between the two considered policy dimensions. Can the government’s decision to default make the exit from the fixed exchange rate more advantageous? And is it possible that a devaluation triggers a sovereign default?

In section 2 we describe the basic framework of our model. By simply comparing the resulting net welfare position we determine which of the four policy options is preferable for various levels of debt and interest rates. In section 3 we introduce private investors’ default expectations into our model. These expectations play an important role since they determine the interest rate level which is in fact realized. While in section 3 we assume the devaluation rate to be fixed, in section 4 we generalize our results to the case in which the devaluation rate is set in a way that suits the fundamental state of the economy.

2 The Model

At the beginning of period $t$ the government chooses whether or not to exit from a fixed exchange rate regime and whether or not to default on the debt coming due. $\lambda$ is a dummy variable which is one if the government chooses to devalue and zero if she keeps the peg. $\eta$ is a dummy variable that is zero if the government pays back the maturing debt and one if she chooses to default.

To keep our analysis simple we assume that the government only issues debt with a maturity of one period and that the sovereign debt is entirely denominated in foreign currency. The term $B_t$ denotes the amount of foreign currency debt which the government
incurred at the beginning of the preceding period $t - 1$ and which is now coming due at the beginning of period $t$. If the government pays back all of this maturing debt at the beginning of period $t$ ($\eta = 0$), she is able to issue new debt $B_{t+1}$ at a price of $q_t = \frac{1}{1+R_t}$, with $R_t$ the effective interest rate on the one period bonds. If she decides to default, international investors do not buy any new bonds.

Following Jeanne (2000) we assume that in case the government chooses to not devalue ($\lambda = 0$) she sets the (high-powered) money growth rate for period $t$ to $\widehat{M}_t = 0$, implying an inflation rate of $\widehat{P}_t = 0$ as well. If the government instead chooses to devalue ($\lambda = 1$) she sets the money growth rate equal to $d > 0$, which induces an inflation rate of $\widehat{P}_t = d$ as well.

In addition we assume that purchasing power parity holds, so that in the latter case the rate of devaluation in period $t$ is $\widehat{S}_t = d$. In summary, the level and the growth rate of the money supply $M$, the prices $P$, and the nominal exchange rate $S$ in period $t$ may be written as

\begin{align*}
M_t &= (1 + \lambda \cdot d) \cdot M_{t-1} \\
P_t &= (1 + \lambda \cdot d) \cdot P_{t-1} \\
S_t &= (1 + \lambda \cdot d) \cdot S_{t-1} \\
\widehat{M}_t &= \widehat{P}_t = \widehat{S}_t = \lambda \cdot d
\end{align*}

The government maximizes the welfare function

$$W_t = Y_t - \lambda \cdot E_t - \eta \cdot F_t - c \cdot T_t.$$  \hspace{1cm} (5)

$Y_t$ is the real GDP of period $t$. $E_t$ are the real costs the government faces if she chooses to devalue and $F_t$ are the real costs she faces if she chooses to default. The term $-c \cdot T_t$ captures the costs of taxation, i.e. the deadweight losses (excess burden) and the costs of tax administration and enforcement, which we assume to be a linear function of the government’s real tax revenue in period $t$, $T_t$.\footnote{For a similar approach see e.g. Barro (1979) and Calvo (1988).}

The real GDP is determined by an expectations-augmented Phillips curve,

$$Y_t = Y_t^N + \alpha (\widehat{P}_t - \widehat{P}_t^e).$$
\( Y^N \) is the natural level of output. \( \hat{P}_t \) is the actual and \( \hat{P}^e_t \) the expected inflation rate for period \( t \). Together with equation (4) we can rewrite the Phillips curve as

\[
Y_t = Y^N + \alpha (\lambda \cdot d - \hat{P}^e_t). \tag{6}
\]

The government can increase the real output level if she devalues unexpectedly. The inflation expectations \( \hat{P}^e_t \) are determined at the end of period \( t - 1 \) already, e.g. via long term wage contracts, so that they are exogenous for the government’s considerations for period \( t \).

The costs of a devaluation \( E_t \) consist of a fixed and a variable part.

\[
E_t = A_t + b \cdot (1 - \eta) \cdot d \cdot B_t \tag{7}
\]

The fixed costs \( A_t \) may be interpreted as the reputation loss that the government suffers if she breaks her exchange rate promise. A sudden devaluation damages the privates’ confidence into the government’s stabilization efforts and causes uncertainty about future policy measures. The welfare decreases as the private sector relocates resources from productive activities to the hedging against presumed inflation fluctuations.\(^7\)

Following Calvo and Reinhart (2000) we assume that after a devaluation it is difficult for the country to keep access to credits from the international capital market. This assumption is captured by the variable devaluation costs \( (1 - \eta) \cdot d \cdot B_t \). In fact, Reinhart (2002) presents evidence that especially in emerging market economies currency crises are often followed by credit rating downgrades. Such downgrades cause long-lasting rises in the interest rate risk premium and make future borrowing expensive. We assume that the higher the devaluation rate \( d \) the higher is that kind of costs. Furthermore, the negative effects of such downgrades are higher the more the country is dependent on the international capital market. The government’s current debt level \( B_t \) is a measure for the dependence on the international capital market.

The term \( (1 - \eta) \) indicates that the variable costs of a devaluation in terms of higher future interest rates are only relevant if the government repays and rolls over her debt. If

\(^7\)As a devaluation is associated by inflation, the costs of a devaluation may as well be interpreted as the costs of inflation. See Fischer and Modigliani (1978), Fischer (1981), and Briault (1995) for a comprehensive overview on the costs of inflation.
the government instead chooses to default, the costs of a devaluation recede to the fixed costs of a reputation loss. As soon as the government defaults, she is no longer able to issue any new bonds no matter what interest rate she offers. Therefore, the rising future interest rates due to the devaluation do not matter for the government anymore. The term $b$ indicates the relative weight of the variable costs of a devaluation compared to the fixed costs.

The costs of a default $F_t$ consist of a fixed and a variable part as well.

$$F_t = D_t + (1 - h) \cdot B_t \cdot \rho(h), \quad (8)$$

$$p(0) = 0,$$

$$p'(h) > 0.$$

A default causes fixed costs $D_t$ as it is usually followed by a breakdown in international trade (see e.g. Rose (2002) and Rose and Spiegel (2002)) and by output losses (see e.g. Dooley (2000)). Another rationale is a deterioration of the performance within the civil services as a default on maturing debt causes fears that the wages of the government employees might be cut as well.

The variable costs are only relevant if the government chooses to default partially ($h$ is the repudiated part of the debt). If the government defaults partially, the investors may still be willing to roll over the remaining part of the debt, $(1 - h) \cdot B_t$, in the future. In this case they would, however, demand a risk premium $\rho$ henceforth, so that the debt roll-over would become more costly for the government. The higher the rate of default, the higher are the risk premium and thus the costs of bond financing. In the following we restrict our analysis to the case in which the government either defaults on the total debt ($\eta = 1, h = 1$) or not at all ($\eta = 0, h = 0$).

The real tax revenue $T_t$, which the government needs to balance her budget, can be derived from her nominal budget. As long as the government chooses not to default, the amount spent on government consumption and on the repayment of debt has to be equal to the tax revenue, the issue of new debt, and the seigniorage.

$$G_t \cdot P_t + (1 - \eta) \cdot S_t \cdot B_t = T_t \cdot P_t + (1 - \eta) \cdot S_t \cdot \frac{1}{1 + R_t} \cdot B_{t+1} + (M_t - M_{t-1}) \quad (9)$$

$G_t$ is the real level of government consumption which we assume to be fixed as the gov-
ernment is not able or not willing to reduce her spending e.g. due to political pressure. $S_t \cdot B_t$ is the domestic currency value of the debt due at the beginning of period $t$. The government collects $\frac{1}{1+R_t} \cdot B_{t+1}$ from selling new debt at the price $\frac{1}{1+R_t}$. This expression is denoted in domestic currency as well. $M_t - M_{t-1}$ is the seigniorage. In the event of a default ($\eta = 1$) the government is no longer able to issue any new bonds. In this case the government consumption has to be financed completely by tax revenue and seigniorage.

In the following we assume that the government can borrow from the international capital markets up to a level $B$. Corsetti and Mackowiak (2001) argue that solvency aspects determine such an upper bound of government borrowing. We furthermore assume that the government has already reached this maximum level, so that $B_t = B_{t+1} = B$. Combining the equations (9), (2) and (3) yields

$$T_t = G_t \cdot (1 + \lambda d) P_{t-1} + (1 - \eta) \cdot (1 + \lambda d) S_{t-1} \cdot \frac{1}{1 + R_t} \cdot B + \lambda \cdot d \cdot M_{t-1}. \quad (10)$$

Solving equation (10) for $T_t$ and setting $\frac{S_t}{P_t} = \frac{S_{t-1}}{P_{t-1}} = 1$ due to purchasing power parity leads to

$$T_t = G_t + (1 - \eta) \cdot \frac{R_t}{1 + R_t} \cdot B - \frac{\lambda d}{1 + \lambda d} \cdot \frac{M_{t-1}}{P_{t-1}}. \quad (11)$$

By inserting equations (6), (7), (8), and (11) into the welfare function (5) we obtain

$$W_t = \lambda \cdot \alpha \cdot d + c \cdot \frac{\lambda d}{1 + \lambda d} \cdot \frac{M_{t-1}}{P_{t-1}} - \lambda \cdot (A_t + (1 - \eta) \cdot b \cdot d \cdot B) - c \cdot (1 - \eta) \cdot \frac{R_t}{1 + R_t} \cdot B - \eta \cdot D_t + Y^N - \alpha \cdot \hat{P}_t^e - c \cdot \hat{G}_t \quad (12)$$

Equation (12) shows how the devaluation and default decisions, $\lambda$ and $\eta$ respectively, affect the welfare $W_t$ in various ways. The first two terms summarize the two benefits of

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8 Eaton and Gersovitz (1981) give another explanation for the existence of such an upper bound. Depending on the level of debt, they endogenously determine a "credit ceiling" that is equal to the debt level at which the benefits of a default start exceeding its costs.

9 The foreign price level is set equal to 1.
an unexpected devaluation and inflation, namely the increase in output via the Phillips curve \( \lambda \cdot \alpha \cdot d \) and the gain in seigniorage \( c \cdot \frac{\lambda d}{1+\lambda d} \cdot \frac{M_{t-1}}{P_{t-1}} \). The term \( \frac{\lambda d}{1+\lambda d} \cdot \frac{M_{t-1}}{P_{t-1}} \) reflects the real amount of seigniorage, which depends on both the real money supply in the preceding period \( \frac{M_{t-1}}{P_{t-1}} \) and the rate of devaluation \( \hat{S}_t = d \). The third term \( \lambda \cdot (A + (1 - \eta) \cdot b \cdot d \cdot B) \) describes the costs of a devaluation as defined in equation (7). \( (1 - \eta) \cdot \frac{R_t}{1+R_t} \cdot B \) denotes the amount of interest payments which the government has to pay if she chooses to roll over the debt. If the government chooses to default \( (\eta = 1) \) she can avoid these interest payments and reduce the taxes. Lowering the taxes in turn increases the welfare as the costs of taxation fall proportionally. Thus, the fourth term \( -c \cdot (1 - \eta) \cdot \frac{R_t}{1+R_t} \cdot B \) can be interpreted as the benefits of a default. The fifth term \( \eta_t \cdot D_t \) reflects the fixed costs of a default as defined in equation (8). The sixth term \( Y^N - \alpha \cdot \hat{P}_t^c - c \cdot \overline{G}_t \) collects the variables that are exogenous from the government’s point of view.

In her effort to maximize the welfare function the government has to decide simultaneously whether or not to devalue and whether or not to default. Thus she has to choose among four options. Table 2 summarizes the net welfare positions that arise from the costs and benefits of each of these four options according to equation (12).

<table>
<thead>
<tr>
<th></th>
<th>No default ( (\eta = 0) )</th>
<th>Default ( (\eta = 1) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>No devaluation ( (\lambda = 0) )</td>
<td>No crisis (-c \cdot \frac{R_t}{1+R_t} \cdot B )</td>
<td>Debt crisis (-D_t )</td>
</tr>
<tr>
<td>Devaluation ( (\lambda = 1) )</td>
<td>Currency crisis ( \alpha \cdot d + c \cdot \frac{d}{1+d} \cdot \frac{M_{t-1}}{P_{t-1}} - A_t ), ( -b \cdot d \cdot B - c \cdot \frac{R_t}{1+R_t} \cdot B )</td>
<td>Twin crisis ( \alpha \cdot d + c \cdot \frac{d}{1+d} \cdot \frac{M_{t-1}}{P_{t-1}} - A_t - D_t )</td>
</tr>
</tbody>
</table>

Table 2: Net welfare position of the devaluation and default decisions.

Subsequently, we denote the four options as vectors \((\lambda/\eta)\). To find out which option is optimal, the government has to compare the net welfare positions of each of them. In a
first step we take the rate of devaluation \( d \) as exogenous and analyze which policy option is optimal for alternative given combinations of interest rates \( R_t \) and debt levels \( \overline{B} \). In doing so we need to differentiate between the case in which the fixed costs of a devaluation exceed the benefits of a devaluation \( (A > \alpha \cdot d + c \cdot \frac{d}{1+d} \cdot \frac{M_{t-1}}{P_{t-1}}) \) and the opposite case.\(^{10}\)

In the first case \( (A > \alpha \cdot d + c \cdot \frac{d}{1+d} \cdot \frac{M_{t-1}}{P_{t-1}}) \), already the fixed devaluation costs exceed the benefits of a devaluation. In this case it is obvious that the government keeps the peg no matter what debt level and what interest rate is realized. Thus, neither "currency crisis" (1/0) nor "twin currency and debt crisis" (1/1) is the optimal choice in this case and we concentrate on the question which of the two remaining options is optimal, "no crisis" (0/0) or "debt crisis" (0/1). Put another way, the government only has to decide whether or not to default. She compares the fixed default costs and the interest payments she saves by a default. If the interest savings are high either due to a high level of debt or due to a high interest rate, a default is beneficial and the government chooses the debt crisis (0/1). If instead the prospective interest savings are small compared to the fixed default costs, no crisis (0/0) is the optimal policy choice. Figure 1 illustrates the combinations of interest rates \( R_t \) and debt levels \( \overline{B} \) for which the respective options are optimal.\(^{11}\)

In the second case the benefits of a devaluation exceed the fixed costs of a devaluation \( (\alpha \cdot d + c \cdot \frac{d}{1+d} \cdot \frac{M_{t-1}}{P_{t-1}} > A) \). From equation (7) we know that the variable costs of a devaluation, that is the reputation loss on the international capital markets which leads to rising interest rate premiums in the future, is only relevant if the government pays back and wishes to roll over her debt \( B_t \). As soon as the government defaults, the variable devaluation costs are zero so that the devaluation benefits exceed not only the fixed but

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\(^{10}\)The calculations for the case differentiation and for the figures 1 and 2 are presented in the appendix. The fixed costs of a default are set to \( D_t = 0.1 \), i.e. we assume the output loss following a default to be ten percent of the GDP. The real money supply is set to \( \frac{M_{t-1}}{P_{t-1}} = 1 \), the constant describing the costs of taxation to \( c = 0.4 \), the relative weight of the variable devaluation costs to \( b = 1 \), and the parameter of the Phillips curve to \( \alpha = 0.5 \). In the event of a devaluation, we assume the rate of devaluation and the inflation rate to be equal to \( \tilde{S}_t = \tilde{P}_t = d = 0.1 \). The fixed costs of a devaluation are set to \( A = 0.1 \) for the first case in which the fixed devaluation costs exceed the benefits of a devaluation, and to \( A = 0.01 \) for the opposite case.

\(^{11}\)In figure 1 as well as in figure 2 the x-axis is labeled \( R_t/(1+R_t) \) instead of \( R_t \). This scale allows to illustrate the whole range of positive values for the interest rate. For small interest rates the term \( R_t/(1+R_t) \) is close to \( R_t \). If \( R_t \) is infinitely high, the term \( R_t/(1+R_t) \) approaches 1. The labeling of the curves as curve I, II etc. in the figures 1 and 2 corresponds to the denomination in the appendix where the curves are derived from table 2.
Figure 1: Optimal policies if the fixed costs of a devaluation exceed the benefits of a devaluation.

also the total devaluation costs. Thus, as soon as the government defaults ($\eta = 1$), she chooses to devalue as well, the twin crisis (1/1) is preferable to debt crisis (0/1) for any combinations of interest rates $R_t$ and debt levels $\overline{B}$ in this second case. We can be sure that a debt crisis (0/1) will under no circumstances be the best option. Therefore we can concentrate on the remaining three options, no crisis (0/0), currency crisis (1/0), and twin crisis (1/1). Figure 2 illustrates the appropriate considerations. Curve II separates the combinations of interest rates $R_t$ and debt levels $\overline{B}$ in which (0/0) is preferable to (1/0) and vice versa. Curves III and IV are relevant for the comparison of (0/0) and (1/1) and of (1/0) and (1/1) respectively. The policy relevant parts of these curves divide the figure into three sectors labeled sectors A, B, and C. In each sector a different policy is optimal.\footnote{Those parts of the curves which are not relevant for the government’s policy choice are plotted dashed in figure 2.}

For all combinations of $R_t$ and $\overline{B}$ in sector A a twin crisis (1/1) is the welfare maximizing option. Due to the high debt level and/or the high interest rate the government faces a large debt service. The payments that can be saved by a default outweigh the fixed default costs and the government chooses to default. This default decision implies that the variable devaluation costs are no longer relevant for the government’s devaluation con-
Figure 2: Optimal policies if the benefits of a devaluation exceed the fixed costs of a devaluation.

Considerations as after a default the government is no longer able to issue new debt, anyway. Since the benefits of a devaluation exceed the fixed devaluation costs, the government chooses to devalue as well.

With respect to the default decision the sectors $B$ and $C$ show the same features. For all combinations of $R_t$ and $\overline{B}$ within these two sectors either the debt level or the interest rate is sufficiently low, so that the interest payments, that can be saved by a default, are not high enough to outweigh the costs of a default. The government chooses to pay back the maturing debt $B_t$.

However, the sectors $B$ and $C$ do differ with respect to the government’s devaluation decision. The crucial factor for this decision are the variable devaluation costs. In sector $B$ the debt level is relatively low, implying that the country’s dependence on the international capital market is small. The reputational loss on the international capital markets, which follows a devaluation, does not carry much weight in the government’s decision whether or not to devalue. Not even the combined fixed and variable costs of a devaluation outweigh the benefits of a devaluation and the government chooses to devalue. Thus, sector $B$ contains all combinations of $R_t$ and $\overline{B}$ which lead to a currency crisis (1/0). In contrast, in sector $C$ the debt level is relatively high, which indicates
that the country’s dependence on the international capital markets is high. Therefore the reputation loss on the international capital markets, which would follow a devaluation, becomes an important factor in the government’s devaluation considerations. Although the benefits of a devaluation exceed the fixed devaluation costs, they do not offset the total costs of a devaluation including the variable part. The government keeps the peg and no crisis (0/0) occurs.

3 The Role of Expectations

The investors’ default expectations play a crucial role in our analysis since they determine which interest rate $R_t$ is in fact realized. $R_t$ is the interest rate which the investors demand on the debt the government issues at the beginning of period $t$, $B_{t+1}$. The investors buy the new debt only if two conditions are met. The first condition is that the government pays back the old debt $B_t$ ($\eta = 0$) at the beginning of period $t$. The second condition is that the investors expect the government to pay back the new debt $B_{t+1}$ at the beginning of the next period as well. If both conditions are met, the investors allow the government to roll over her debt and do not demand any default risk premium. In this case the interest rate $R_t$ is equal to the risk free interest rate on the international capital markets $r_t$. If instead either the government defaults on the old debt ($\eta = 1$) or the investors expect the government to default on the new debt, they don’t buy any new debt $B_{t+1}$. In this case the default risk premium and thus the interest rate $R_t$ is infinitely high and the term $R/(1 + R)$ approaches 1. For simplicity we confine our analysis to these two extreme situations and disregard all the cases in which the investors set the default risk premium $\rho$ to an intermediate value of $0 < \rho < \infty$.

In the following we impose the two possible realizations for the interest rate, $R_t = r_t$ and $R_t = \infty$, in the figures 1 and 2 and in doing so derive the figures 3 and 4. Figure 3 is the extended version of figure 1 which displays the case in which the fixed costs of a devaluation exceed the devaluation benefits ($A > \alpha \cdot d + c \cdot \frac{d}{1+d} \cdot \frac{M_{t+1}}{M_t}$), so that the government under no circumstances chooses to devalue. The two vertical dashed lines illustrate the possible realizations for the interest rate, $R_t = r_t$ and $R_t = \infty$.\footnote{In figure 3 as well as in all figures below the real interest rate is set to $r = 0.05$, which implies that if the default risk premium is $\rho = 0$ the term $R_t/(1 + R_t)$ is close to 0.05 as well.}
Figure 3: Optimal policies if the fixed costs of a devaluation exceed the benefits of a devaluation.

If we take the level of sovereign debt $B$ as the crucial fundamental variable, figure 3 yields the same structure of heaven, hell and purgatory as the second generation escape clause literature (Jeanne (2000)). For sufficiently low and high debt levels there exist unique equilibria in which the government’s devaluation and default decisions are independent of the investors’ default expectations and the interest risk premium they demand. If the debt level is below $B_1$, it is optimal to neither devalue nor default ($0/0$). Even if the investors expect a default and thus do not allow the government to roll over her debt ($R_t = \infty$), the benefits of a default, namely the interest payments that can be saved by a default, do not outweigh the costs of a default. Likewise, if the debt level exceeds $B_2$, it is optimal to default but to keep the exchange rate peg ($0/1$) no matter whether or not the investors expect a default. The debt is so high, that the interest rate payments which can be saved by a default outweigh the default costs even if the interest rate is at its lowest level of $R_t = r_t$.

In between these two extremes there exists a grey area of multiple equilibria, in which the risk premium plays a crucial role and default expectations emerge to be self-fulfilling. With a debt level in the range between $B_1$ and $B_2$, the government chooses ($0/1$) if the investors expect a default ($R_t = \infty$) and ($0/0$) if they don’t ($R_t = r$). As long as the interest rate is equal to $R_t = r_t$, the default costs exceed the benefits of a default. Only if
the risk premium rises due to investors’ default expectations the interest payments that can be saved by a default outweigh the costs of a default.

Figure 4 is an extended version of figure 2, which displays the case in which the devaluation benefits exceed the fixed costs of a devaluation \( (\alpha \cdot d + c \cdot \frac{d}{1+r} \cdot \frac{M_{t-1}}{R_{t-1}} > A) \). Similar to figure 3 sufficiently low and high debt levels imply unique equilibria. If the debt level is below \( B_3 \), devaluing the currency while honoring the debt \((1/0)\) is the best option independent of the investors’ default expectations. Due to the low debt level the variable costs of a devaluation, i.e. the bad credit ratings and the rising interest rates following a devaluation, do not carry much weight, so that not even the combined fixed and variable devaluation costs exceed the benefits of a devaluation. The government chooses to devalue. Furthermore, the debt level is sufficiently low so that the benefits of a default are smaller than the costs of a default, even if the interest rate is infinitely high. The government chooses not to default.

In contrast, if the debt level exceeds \( B_5 \), a combined default and devaluation \((1/1)\) is welfare maximizing regardless of the investors’ expectations. The debt is high enough to make a default profitable. Thus the variable devaluation costs are no longer relevant and as the benefits of a devaluation exceed the fixed devaluation costs, the government abandons the exchange rate peg also. A twin currency and debt crisis occurs.
In between these extremes there again exists a grey area of multiple equilibria, in which the investors’ default expectations are relevant. A debt level in the range between B 3 and B 4 implies that the country’s dependence on the international capital market is small so that the combined fixed and variable reputation costs of a devaluation do not outweigh the benefits of a devaluation. The government chooses to devalue. At the same time the investors’ expectations determine the interest payments, which the government would have to pay for a debt roll over, and thus whether or not a default is beneficial. The government chooses not to default (1/0) if the investors expect her not to default and therefore demand an interest rate of $R_t = r_t$. The government chooses to default (1/1) if the investors expect her to default and therefore demand an infinitely high risk premium. Put another way, the investors’ default expectations are self-fulfilling.

For debt levels in between B 4 and B 5 a phenomenon occurs that may be best characterized as internal contagion. In the recent literature the term contagion usually refers to a spread of a currency or financial crisis from one country or region to another. In our model contagion refers to a structural dimension. A crisis spreads from one field of economic policy to another, i.e. the debt crisis spreads to the monetary and the exchange rate regime and causes a currency crisis, too. In the range between B 4 and B 5 (0/0) is the best policy if the investors do not expect a default, but (1/1) is the best policy if they do expect a default. Thus, self-fulfilling default expectations do not only trigger a debt crisis but make a devaluation optimal as well. The reason for the self-fulfilling debt crisis is the same as was derived for the debt levels B 3 to B 4. With regard to the devaluation considerations, the variable devaluation costs are crucial. If the investors do not expect a default and consequently there is no default, the variable devaluation costs are high enough so that the combined fixed and variable devaluation costs outweigh the benefits of a devaluation. The government keeps the peg. If, however, the investors do expect a default and the default occurs, the variable costs of a devaluation are not relevant for the devaluation decision anymore. Since the fixed devaluation costs are not high enough to outweigh the benefits of a devaluation, the government chooses to devalue.
4 The Case of Variable Devaluation Rates

In the preceding section we have focused on the very special case in which the government chooses a specific devaluation rate of $\hat{S}_t = d$. This given value $d$ allows to exactly distinguish between debt levels which are sufficiently low or high to generate unique equilibria and intermediate debt levels which result in multiple equilibria. Subsequently, we turn to a more general case. In case the government chooses to devalue at all ($\lambda = 1$), the rate of inflation and devaluation $d$ is set in a way that suits to the fundamental state of the economy. The worse the economic fundamentals, the higher is the government’s incentive to push the economy by choosing a high rate of unexpected inflation and devaluation. If the fundamentals are in a good condition, the appropriate devaluation rate is low. If the fundamentals are in a bad condition, the appropriate devaluation rate is high. Due to this property we will treat the rate of inflation and devaluation $d$ not as a further policy parameter (in addition to $\lambda$ and $\eta$) but as a proxy variable for the fundamental state of the economy in the following.\[14\]

To explore the consequences of this more general case we impose the possible realizations for the interest rate, $R_t = r_t$ and $R_t = \infty$, into table 2 and explicitly differentiate between the two cases:

a. "No default expected" - The investors do not expect a default on the new debt $B_{t+1}$ and demand an interest rate of $R_t = r_t$ for the debt roll over unless the government defaults on the old debt at the beginning of period $t$ ($\eta = 1$, $R_t = \infty$).

b. "Default expected" - The investors expect a default on the new debt $B_{t+1}$ and do not roll over the debt ($R_t = \infty$).

Tables 3 and 4 show the net welfare positions of the four policy options ($\lambda/\eta$) for these two cases.

\[14\] In the context of the determination of $d$ the term economic fundamentals refers to a broader range of variables and may include parameters that we do not explicitly model below, e.g. the unemployment rate.
<table>
<thead>
<tr>
<th>Case a</th>
<th>No default</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>(η = 0)</td>
<td></td>
<td>(η = 1)</td>
</tr>
<tr>
<td>No devaluation (λ = 0)</td>
<td>( R_t = r_t )</td>
<td>( R_t = \infty )</td>
</tr>
<tr>
<td></td>
<td>( W_t = -c \cdot \frac{r_t}{1+r_t} \cdot \frac{M_t}{P_t-1} )</td>
<td>( W_t = -D_t )</td>
</tr>
<tr>
<td>Devaluation (λ = 1)</td>
<td>( R_t = r_t )</td>
<td>( R_t = \infty )</td>
</tr>
<tr>
<td></td>
<td>( W_t = \alpha \cdot d + c \cdot \frac{d}{1+d} \cdot \frac{M_t}{P_t-1} ) - ( A_t - b \cdot d \cdot \frac{M_t}{P_t-1} )</td>
<td>( W_t = \alpha \cdot d + c \cdot \frac{d}{1+d} \cdot \frac{M_t}{P_t-1} ) - ( A_t - D_t )</td>
</tr>
</tbody>
</table>

Table 3: Interest rates and net welfare positions for case a: "No default expected".

<table>
<thead>
<tr>
<th>Case b</th>
<th>No Default</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>(η = 0)</td>
<td></td>
<td>(η = 1)</td>
</tr>
<tr>
<td>No devaluation (λ = 0)</td>
<td>( R_t = \infty )</td>
<td>( R_t = \infty )</td>
</tr>
<tr>
<td></td>
<td>( W_t = -c \cdot \frac{M_t}{P_t-1} )</td>
<td>( W_t = -D_t )</td>
</tr>
<tr>
<td>Devaluation (λ = 1)</td>
<td>( R_t = \infty )</td>
<td>( R_t = \infty )</td>
</tr>
<tr>
<td></td>
<td>( W_t = \alpha \cdot d + c \cdot \frac{d}{1+d} \cdot \frac{M_t}{P_t-1} ) - ( A_t - b \cdot d \cdot \frac{M_t}{P_t-1} )</td>
<td>( W_t = \alpha \cdot d + c \cdot \frac{d}{1+d} \cdot \frac{M_t}{P_t-1} ) - ( A_t - D_t )</td>
</tr>
</tbody>
</table>

Table 4: Interest Rates and net welfare positions for case b: "Default expected".
As we use the devaluation rate \( d \) as a proxy for the fundamental situation we can analyze which policy is optimal for various combinations of debt levels \( B \) and fundamentals. This is done graphically in figures 5 and 6.\(^{15}\)

Figure 5: Optimal policies if private investors don’t expect a default (case a).

Figure 6: Optimal policies if private investors expect a default (case b).

\(^{15}\)The calculations for the figures 5 and 6 are presented in the appendix. Notice the different scales in figure 5 and figure 6. Just as for figure 2 the parameters are set to \( D_t = 0.1, \frac{M_{t-1}}{P_{t-1}} = 1, c = 0.4, b = 1, \alpha = 0.5, \) and \( A = 0.01. \) The structural results of our analysis remain valid, however, if we change the parameter settings.
The figures 5 and 6 have a very similar structure. The fundamental situation, which is reflected in the appropriate rate of devaluation \( d \), is the crucial factor for the devaluation decision and the level of debt \( B \) is the crucial factor for the default decision. If the fundamental situation is good, i.e. if the appropriate devaluation rate is small, and the debt level is low, it is optimal to neither devalue nor default (0/0). If the fundamental situation is good but the debt level is high, it is optimal to keep the peg but to default (0/1). If the fundamental situation is bad, i.e. the appropriate devaluation rate is high, and the debt level is low, it is optimal to exit the exchange rate peg but to honor the debt (1/0). Finally, if the fundamental situation is bad and the debt level is high, it is optimal to both devalue and default (1/1).

There is, however, a kind of substitution effect between the debt level and the fundamentals with respect to the borderline that separates the "no crisis"-combinations of \( B \) and \( d \) from the "twin crisis"-combinations. Even if the fundamentals are bad, i.e. if \( d \) is high, (0/0) can be the optimal policy as long as the debt level is sufficiently low. On the other hand, even if the debt level is rather high, (0/0) can still be the optimal policy as long as the fundamentals are sufficiently good, i.e. as long as \( d \) is sufficiently small.

Although the figures 5 and 6 have a very similar structure in a qualitative respect, the sectors of the same optimal policy choice do not match exactly from one case to the other. Taking into account the different scales used in the two figures on both the \( d \)- and the \( B \)-axis it is obvious that the "no crisis" sector is much smaller if the investors expect a default than in case they do not expect a default. In contrast, the "twin crisis" sector is much larger if the investors expect a default than in case they don't. Thus there is a certain range of fundamentals and debt levels, which lead to a currency and / or a debt crisis only if the investors expect a default. Put another way, for certain combinations of fundamentals and debt levels the investors' expectations play a crucial role for the government's policy decisions. Figure 7 combines the figures 5 and 6 and thereby highlights this important feature of our analysis.
Figure 7 again shows the well known characteristic trichotomy of heaven, hell, and purgatory. Our results, however, show a more complex structure than the former escape clause models on currency crises as we need to differentiate between heaven, hell, and purgatory not only with respect to the monetary and exchange rate policy but with respect to the debt policy as well.

There are certain combinations of $B$ and $d$, the sectors labeled 1, 2, 3, and 4, which lead to unique equilibria, i.e. the optimal policy is independent of the investors’ expectations. Put another way, in these situations the debt and exchange rate policy is only driven by the economic fundamentals, indicated by the devaluation rate $d$ and the debt level $B$. In particular, the optimal policy choice is "no crisis" (0/0) in sector 1, "currency crisis" (1/0) in sector 2, "debt crisis" (0/1) in sector 3, and "twin currency and debt crisis" (1/1) in sector 4.

With respect to the default decision, the sectors 1 and 2 may be characterized as heaven. In these two sectors the debt level is so low that the debt service payments on the old debt, which could be saved by a default, do not outweigh the fixed costs of a default. The government pays back her debt $B_i$ even if the investors expect her to default and therefore refuse to roll over the maturing debt. If at the same time the fundamental economic condition is good, which is indicated by a low potential rate of devaluation $d$
(sector 1), the government keeps the peg and there is no crisis (0/0). If in contrast the fundamental state of the economy is not so good, which is indicated by a higher value of \(d\) (sector 2), the government chooses to devalue regardless of the investors’ expectations. A currency crisis but no debt crisis occurs (1/0).

The sectors 3 and 4 can be described as a situation of hell with respect to the government’s default decision. In both sectors the debt level is so high that the benefits of a default exceed the fixed default costs so that the government chooses to default. At the same time, analogously to the sectors 1 and 2, the fundamental condition of the country is good in sector 3 and bad in sector 4. So the government chooses to honor the peg in sector 3 and to devalue in sector 4. Comprisingly, regardless of the investors’ expectations a debt crisis (0/1) is the only possible result if the country is placed in sector 3 and a twin currency and debt crisis (1/1) is the inevitable consequence if the country is placed in sector 4.

The sectors 1, 2, 3, and 4 form an upper and a lower band around the remaining sectors 5, 6, and 7. The sectors 5, 6, and 7 are a grey area, in which it is not the fundamental state of the economy alone that drives the government’s decisions. In these sectors there exist multiple equilibria in which the optimal policy crucially depends on the investors’ default expectations.

With respect to the default decision these sectors can be characterized as purgatory as in either of these sectors the investors’ default expectations are self-fulfilling. If the investors do not expect a default and thus do not demand a risk premium \((R_t = r_t)\), the default costs exceed the benefits of a default and the government chooses to pay back the debt coming due. If, however, the investors do expect a default and therefore do not buy any new debt \((R_t = \infty)\), the interest payments on the old debt that can be saved by a default outweigh the costs of a default and the government chooses to default.

Although the sectors 5, 6, and 7 show the same features with respect to the debt policy, they differ drastically with respect to the optimal exchange rate policy. In sector 5 the fundamental state of the economy is in such a good condition \((d\) is low), that the benefits of a devaluation do not even outweigh the fixed costs of a devaluation. The government keeps the peg regardless of the investors’ expectations. Thus, though we have described sector 5 as a purgatory with respect to the default decision, it can be characterized as a
situation of heaven with respect to the devaluation decision. There is no crisis (0/0), if the investors do not expect a default, and a mere debt crisis (0/1) occurs, if the investors expect a default.

In sector 6 the fundamental state of the economy is in such a bad condition, that an exit from the fixed exchange rate system is profitable regardless of the investors’ expectations. The benefits of a devaluation do in any event exceed the costs of a devaluation, so that the government definitely chooses to devalue. Thus, though sector 6 is a purgatory with respect to the default decision, it is a hell with respect to the devaluation decision. A twin currency and debt crisis (1/1) occurs, if the investors expect default, and a mere currency crisis (1/0) occurs if the investors don’t expect a default.

Sector 7 is a purgatory with respect to both the devaluation and the default decision. Here we find the phenomenon of internal contagion again: A crisis in the sovereign debt market spreads to the field of monetary and exchange rate policy. In sector 7 no crisis (0/0) is the best policy if the investors do not expect a default, but a twin crisis (1/1) is the best policy if they do expect a default. Thus, the investors’ default expectations are not only self-fulfilling. Additionally, a self-fulfilling default causes a devaluation as well.

The reason why the sovereign debt crisis spreads to the field of monetary and exchange rate policy can be found in the variable devaluation costs. A devaluation causes a reputation loss on the international capital markets and via higher interest rates makes future borrowing more expensive. Combinations of medium high debt levels and medium fundamentals such as those in sector 7 reflect situations in which the fixed devaluation costs alone do not outweigh the benefits of a devaluation. The combined fixed and variable devaluation costs together do, however, exceed the benefits of a devaluation. If the investors do expect a default and thus a default in fact occurs, the variable costs of a devaluation are not relevant for the devaluation decision, as due to the default the government completely loses access to the international capital markets, anyway. Since the fixed devaluation costs alone are not high enough to outweigh the benefits of a devaluation, in addition to the default the government chooses to devalue as well. If, however, the investors do not expect a default and consequently no default takes place, the variable devaluation costs do matter and are high enough so that the combined fixed and variable devaluation costs outweigh the benefits of a devaluation and the government keeps the peg.
5 Conclusion

It is a common feature of currency and debt crises that they may not only occur because of bad fundamentals. They may also be driven by a sudden shift in private expectations. Self-fulfilling crises are only possible, however, if the fundamentals place the country into a crises zone in which multiple equilibria arise.

While currency and debt crises have been treated as separate events so far, we combine these two types of crises by allowing the government to choose from and also to combine two alternative means of budget financing, a devaluation and debt repudiation. The main findings and the basic structure of the second generation currency crisis escape clause models remain valid when we extend the range of possible policy options in this manner. With regard to the country’s fundamental economic condition there are still three constellations to distinguish between. There are two bands of extremely low and high debt levels and of extremely good and extremely bad fundamentals respectively, which allow for unique equilibria only. The government’s policy choice is not at all affected by private expectations but results solely from the sovereign debt level and from the fundamental state of the economy. Here in general the debt level is relevant for the decision whether or not to default and the remaining economic fundamentals are relevant for the decision whether or not to devalue. In some cases, however, a low debt can substitute good fundamentals in preventing a crisis and vice versa. Even if the fundamentals are rather bad, a currency crisis can be avoided if the debt level is sufficiently low. On the other hand, even if the debt level is rather high, a debt crisis can be avoided if the fundamentals are sufficiently good.

For intermediate situations in between the extreme constellations of very high and low debt levels and of very good and very bad fundamentals respectively, there is a crisis zone, in which multiple equilibria arise. Here, the private investors’ default expectations are always self-fulfilling. For certain ranges of economic fundamentals and debt levels an internal contagion is possible, i.e. default expectations do not only trigger a self-fulfilling sovereign debt crisis but make a devaluation advantageous as well. Put another way, a crisis in the sovereign debt market may spread to the field of monetary and exchange rate policy and cause a currency crisis, too.
Some aspects that have recently been discussed in the literature on currency and sovereign debt crises have been excluded from our approach so far. Introducing several of these aspects into our model in order to generalize our results is subject to further research. So far we assume the sovereign debt to be entirely denominated in foreign currency. Allowing for domestic debt as well would generate a further incentive for the government to devalue since she might consider to inflate away the real value of the domestic debt by a monetary expansion. Furthermore the expected rate of inflation would become an important factor for the government’s debt roll over as the interest rate which the private investors demand on local currency debt bonds increases with rising inflation expectations. Another assumption of our model is that the sovereign debt entirely consists of one period bonds. We thus ignore the possible effects of differing maturity structures. Lengthening the maturity may reduce the crisis zone as in Cole and Kehoe (1998), since with a longer maturity the amount which the government needs to roll over every period falls. As well it might be worth considering to generalize the assumption that the rate of devaluation is equal to the money growth rate and the rate of inflation still after a devaluation. Based on the empirical observation that in many cases large devaluations are followed by rather moderate money growth and inflation rates, such an attempt to diverge from the purchasing power parity assumption was recently made by Burnside, Eichenbaumn, and Rebelo (2001). In our model these considerations would affect the government’s strategic policy choice in various ways. Most important is the fact that in such a theoretical framework a devaluation would generate further costs for the government as due to a real devaluation the real burden of her external debt would increase. Furthermore a real depreciation may remove an existing real exchange rate misalignment and thus have a positive effect on real output. Both effects are incorporated in a model most recently presented by Jahjah and Montiel (2003). Further empirical research on currency and debt twin crises is currently made by Herz and Tong (2003).
A Appendix

A.1 Derivation of the figures 1 and 2

Based on table 2

I. neither to devalue nor to default (0/0) is preferable to (0/1) as long as $-c \cdot \frac{R_t}{1+R_t} \cdot \overline{B} > -D_t$ or $\overline{B} > \frac{D_t}{c \cdot \frac{R_t}{1+R_t}}$.

II. neither to devalue nor to default (0/0) is preferable to to devalue but not to default (1/0) as long as $-c \cdot \frac{R_t}{1+R_t} \cdot \overline{B} > \alpha \cdot d + c \cdot \frac{d}{1+d} \cdot \frac{M_{t-1}}{P_{t-1}} - A_t - b \cdot d \cdot \overline{B} - c \cdot \frac{R_t}{1+R_t} \cdot \overline{B}$ or $\overline{B} > \frac{\alpha + D_t - \alpha \cdot d - c \cdot \frac{d}{1+d} \cdot \frac{M_{t-1}}{P_{t-1}}}{c \cdot \frac{R_t}{1+R_t}}$.

III. neither to devalue nor to default (0/0) is preferable to both to devalue and to default (1/1) as long as $-c \cdot \frac{R_t}{1+R_t} \cdot \overline{B} > \alpha \cdot d + c \cdot \frac{d}{1+d} \cdot \frac{M_{t-1}}{P_{t-1}} - A_t - D_t$ or $\overline{B} < \frac{A_t + D_t - \alpha \cdot d - c \cdot \frac{d}{1+d} \cdot \frac{M_{t-1}}{P_{t-1}}}{c \cdot \frac{R_t}{1+R_t}}$.

IV. to devalue but not to default (1/0) is preferable to both to devalue and to default (1/1) as long as $\alpha \cdot d + c \cdot \frac{d}{1+d} \cdot \frac{M_{t-1}}{P_{t-1}} - A_t - b \cdot d \cdot \overline{B} - c \cdot \frac{R_t}{1+R_t} \cdot \overline{B} > \alpha \cdot d + c \cdot \frac{d}{1+d} \cdot \frac{M_{t-1}}{P_{t-1}} - A_t - D_t$ or $\overline{B} < \frac{D_t - \alpha \cdot d - c \cdot \frac{d}{1+d} \cdot \frac{M_{t-1}}{P_{t-1}}}{c \cdot \frac{R_t}{1+R_t} + b \cdot d}$.

V. to devalue but not to default (1/0) is preferable to not to devalue but to default (0/1) as long as $\alpha \cdot d + c \cdot \frac{d}{1+d} \cdot \frac{M_{t-1}}{P_{t-1}} - A_t - b \cdot d \cdot \overline{B} - c \cdot \frac{R_t}{1+R_t} \cdot \overline{B} > -D_t$ or $\overline{B} < \frac{D_t - \alpha \cdot d - c \cdot \frac{d}{1+d} \cdot \frac{M_{t-1}}{P_{t-1}}}{c \cdot \frac{R_t}{1+R_t} + b \cdot d}$.

VI. both to devalue and to default (1/1) is preferable to not to devalue but to default (0/1) as long as $\alpha \cdot d + c \cdot \frac{d}{1+d} \cdot \frac{M_{t-1}}{P_{t-1}} - A_t - D_t > -D_t$ or $\alpha \cdot d + c \cdot \frac{d}{1+d} \cdot \frac{M_{t-1}}{P_{t-1}} > A_t$.

The inequalities I to V can be plotted in a coordinate system with the term $R/(1 + R)$ on the x-axis and the debt level $B$ on the y-axis. This is done below in the figures 8 to 12. The labeling as curve I, II, etc. corresponds to the numbering in the above list of inequalities. The sixth inequality, (0/1) vs. (1/1), does not depend on $\overline{B}$ or $R_t$ and cannot be plotted like this. Instead, it must be interpreted as a case differentiation depending on whether the fixed costs of a devaluation $A_t$ exceed the benefits of a devaluation $\alpha \cdot d + c \cdot \frac{d}{1+d} \cdot \frac{M_{t-1}}{P_{t-1}}$. 

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Figure 8: 0/0 vs. 0/1.

R/(1+R)

0/0 is preferable to 0/1.

0/1 is preferable to 0/0.

Curve I

Figure 9: 0/0 vs. 1/0.

B

0/0 is preferable to 1/0.

1/0 is preferable to 0/0.

Curve II

Figure 10: 0/0 vs. 1/1.

R/(1+R)

0/0 is preferable to 1/1.

1/1 is preferable to 0/0.

Curve III

27
Figure 11: 1/0 v. 1/1.

Figure 12: 1/0 vs. 0/1.
A.2 Derivation of the figures 5 and 6

Based on table 3 for case a (the investors do not expect a default on the new debt \(B_{t+1}\) and demand an interest rate of \(R_t = r_t\) for the debt roll over unless the government defaults on the old debt at the beginning of period \(t\))

I. neither to devalue nor to default (0/0) is preferable to not to devalue but to default (0/1) as long as \(\overline{B} < \frac{D_t}{c \cdot 1 + r_t}\).

II. neither to devalue nor to default (0/0) is preferable to to devalue but not to default (1/0) as long as \(\overline{B} > \frac{1}{b \cdot d + c} \cdot (\alpha \cdot d + c \cdot \frac{d}{1 + d} \cdot \frac{M_{t-1}}{P_{t-1}} - A_t)\).

III. neither to devalue nor to default (0/0) is preferable to both to devalue and to default (1/1) as long as \(\overline{B} < \frac{A_t + D_t - \alpha \cdot d - c \cdot \frac{d}{1 + d} \cdot \frac{M_{t-1}}{P_{t-1}}}{c \cdot 1 + r_t}\).

IV. to devalue but not to default (1/0) is preferable to both to devalue and to default (1/1) as long as \(\overline{B} < \frac{1}{b \cdot d + c} \cdot D_t\).

V. to devalue but not to default (1/0) is preferable to not to devalue but to default (0/1) as long as \(\overline{B} < \frac{1}{b \cdot d + c} \cdot (D_t - A_t + \alpha \cdot d + c \cdot \frac{d}{1 + d} \cdot \frac{M_{t-1}}{P_{t-1}}),\) and

VI. both to devalue and to default (1/1) is preferable to not to devalue but to default (0/1) as long as \(\alpha \cdot d + c \cdot \frac{d}{1 + d} \cdot \frac{M_{t-1}}{P_{t-1}} > A_t\).

In an analogous manner as we did it above, all these six inequalities can be plotted in a \(d-B\)-coordinate system. Figure 5 illustrates the relevant parts of the respective policy relevant curves.

Based on table 4 for case b (the investors expect a default on the new debt \(B_{t+1}\) and do not roll over the debt, \(R_t = \infty\))

I. neither to devalue nor to default (0/0) is preferable to not to devalue but to default (0/1) as long as \(\overline{B} < \frac{D_t}{c}\).

II. neither to devalue nor to default (0/0) is preferable to to devalue but not to default (1/0) as long as \(\overline{B} > \frac{1}{b \cdot d + c} \cdot (\alpha \cdot d + c \cdot \frac{d}{1 + d} \cdot \frac{M_{t-1}}{P_{t-1}} - A_t)\),
III. neither to devalue nor to default (0/0) is preferable to both to devalue and to default
(1/1) as long as $B < \frac{A_t + D_t - \alpha d - c}{c} \cdot \frac{d}{1+d} \cdot \frac{M_t-1}{T_t-1}$.

IV. to devalue but not to default (1/0) is preferable to both to devalue and to default
(1/1) as long as $B < \frac{D_t}{c+b+d}$.

V. to devalue but not to default (1/0) is preferable to not to devalue but to default
(0/1) as long as $B < \frac{D_t - A_t + \alpha d + c}{c+b+d} \cdot \frac{d}{1+d} \cdot \frac{M_t-1}{T_t-1}$, and

VI. both to devalue and to default (1/1) is preferable to not to devalue but to default
(0/1) as long as $\alpha \cdot d + c \cdot \frac{d}{1+d} \cdot \frac{M_t-1}{T_t-1} > A_t$.

These six inequalities can be plotted in a $d$-$B$-coordinate system as well. Figure 6
shows the relevant parts of the respective policy relevant curves.
References


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