Debt and Currency Crises – Complements or Substitutes?

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Revised, January 2007

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JEL classification: F3, F4

Keywords: Currency Crisis, Debt Crisis, Double Crisis

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Abstract

Debt and currency crises are closely interlinked through the government's intertemporal budget constraint. The default tax and the inflation/devaluation tax can be considered as alternative means of financing. Our empirical analysis finds that high debt countries choose default rather than inflation/devaluation for financing, while a high money stock reduces the probability of debt crises. We further find strong evidence that debt and currency crises share common fundamental causes. Finally, there is a Granger causality running from debt crises to currency crises, but only weakly for the other direction.

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1. 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 been confronted with severe debt problems at the same time, with recent examples including Argentina, Ecuador and Russia.

The literature has so far typically treated currency and debt crises as isolated events. The currency crises models of the first generation analyze how in a fixed exchange rate regime an expansionary fiscal policy induces an incompatible monetary policy thereby giving rise to a successful speculative attack against the exchange rate peg (Krugman 1979, Flood and Garber 1984). The second generation of currency crises models adds the insight that governments in a strategic decision weigh the costs and benefits of a fixed exchange rate when deciding to honor the peg or to renege on its promise to fix the exchange rate (e.g. Obstfeld 1994).

In an analogous way, debt crises have been analyzed in the context of welfare-maximizing governments that base their decision whether or not to honor their debt on a cost-benefit-calculus. They are willing to service their debt only if the costs of a default, e.g. negative output effects or reputation losses, exceed the benefits of a default, i.e. avoided debt service (see e.g. Eaton and Gersovitz 1981, Grossman and van Huyck 1988, Cole, Dow and English 1995, Dooley 2000b). Many of these models also give rise to multiple equilibria and extensive research

has focused on the question whether sovereign liquidity crises are mainly driven by economic fundamentals or by sudden shifts in private creditors' default expectations (see e.g. Calvo 1988, Alesina, Prati and Tabellini 1990, Detragiache 1996, Cole and Kehoe 1998, and Detragiache and Spilimbergo 2004).

From the perspective of escape clause models, financial crises can be interpreted as decisions of a welfare-maximizing government to devalue its currency or to default on its debt coming due. What kind of interrelations could then exist between defaults and devaluations? First, debt and currency crises could occur simultaneously because they have common roots. There might be common macroeconomic factors that at the same time undermine a government's resolve to pay back its debt and to defend its exchange rate peg. Secondly, these twin crises could be caused by contagion effects running e.g. from debt to currency crises as the economic situation worsens due to the default making also a currency crisis more likely. Evidently, contagion effects could also spread in the opposite direction from currency to debt crises. In these cases defaults and devaluations are complements. Third, devaluations and (partial) defaults can also be substitutes if the focus is on financing a given volume of public expenditures. 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:

- 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 currency and debt crisis).

According to this view, the occurrence of a currency crisis should reduce the finance requirements of the government, thereby making a debt crisis less likely.[3] Correspondingly, a debt crisis should lower the likelihood of a currency crisis. In contrast, currency and debt crises are complements if self-fulfilling expectations and contagion from one type of crisis to the other are prevalent.

The question remains why a government should choose a double currency and debt crises with moderate default and devaluation rates instead of a single debt or currency crisis with a high default or devaluation rate. When deciding whether to devalue or not, a government considers the variable as well as the fixed costs of a currency crisis (see Obstfeld 1994). The variable costs increase with the depreciation rate and include among others loss in GDP due to trade disruption and negative balance sheet effects as well as political costs for the government such as loss of reputation (IMF 1998, Frankel 2005). In a similar way, the government is likely to consider the variable and fixed costs of a default (see e.g. Rose (2005) for trade-related costs). Especially with large finance requirements, a situation might arise in which it is beneficial for the government to choose the double currency and debt crisis with relatively low default and devaluation rates albeit the fixed costs of both crises, in order to avoid the higher variable cost of a single debt (currency) crisis with a high default (devaluation) rate.

In our analysis we want to empirically analyze the decisions to default and/or to devalue as part of a wider menu of policy choices. Goldstein et al. (1998), Reinhart (2002), and Sy (2003) provide first steps to an empirical analysis of twin debt and currency crises. Goldstein et al.

[3] Only in the borderline case where government debt is completely denominated in foreign currency, the government revenues are denominated in domestic currency only, purchase power parity holds instantaneously and the economy is completely inflation-indexed are the public finance requirement unchanged.

(1998) report evidence that currency crises are closely associated with the probability of sovereign defaults. Reinhart (2002) finds that sovereign credit ratings usually are downgraded after currency crisis and that these downgradings help to predict defaults. That is to say, currency crises increase default risk. However, Reinhart (2002) does not directly control for the possibility that currency and debt crises might be caused by common factors. In contrast, Sy (2002) concludes for a smaller sample of 13 emerging markets during the period 1994 – 2002 that currency crises are not linked to the probability of sovereign default. However, these empirical works have not explicitly examined whether the interaction between currency and debt crises was influenced more by common factors, contagion or the intertemporal budget constraint.

Our paper aims to fill this gap. We use a reduced-form Bivariate Probit model to estimate these components in a joint framework. In this model, we include macroeconomic indicators that either represent common factors or proxy for intertemporal budget constraint. Moreover, we include lagged crisis dummies to examine Granger causality between currency and debt crises, with contemporary contagions captured by the correlation across the unobservable residuals for currency and debt crises.

Our empirical analysis is based on a sample of 128 developing economies for the period from 1975 to 2005. Our two-equation Probit analysis finds strong evidences consistent with the operation of the intertemporal budget constraint: high foreign debt is associated with high likelihood of debt crises but low likelihood of currency crises, while higher money stock reduces the probability of debt crises. This empirical finding of the intertemporal budget constraint, to the authors' knowledge, has been missing so far in the current literature. We further find evidence that debt and currency crises share common fundamental causes. Lower reserve over imports ratio and lower domestic GDP growth rate increase the likelihood of debt and currency crises.

Finally, we find that one-year lagged debt crisis strongly Granger causes currency crises, but little evidence for the causality to run the other direction.

The paper is organized as follows. Section 2 presents the data used in our empirical analysis and provides some summary statistics. Section 3 discusses the statistical model and the main empirical findings. Section 4 concludes.

2. Variables of Interest

2.1 Financial crises

There are two basic approaches to define currency crises. Frankel and Rose (1996) define a currency crisis as a nominal depreciation of the currency of at least 25 per cent p.a. and a change in the rate of depreciation that is at least 10 per cent. Following Eichengreen et al. (1995) and Kaminsky and Reinhart (1999), Glick and Hutchison (1999) define currency crises according to an average of exchange-rate and reserve changes to account for successful as well as unsuccessful speculative attacks. We follow Frankel and Rose (1996)'s definition because our theoretical model focuses on successful currency attacks.

To identify debt crises we refer to the date of Paris Club debt rescheduling (treatments). In analogy to currency crises, where we only consider successful speculative attacks, i.e. realized currency crises, we only account for realized debt crises and not for pressure to default. The Paris Club is an informal group of official creditors whose role is to find coordinated and sustainable solutions to the payment difficulties experienced by debtor nations (see Paris Club 2003). While the Paris Club only handles official debt its credit decisions are co-ordinated with other debtors in particular with the private debtors of the London Club to insure equal treatment of all debt. In the Paris Club debtor countries can initiate negotiations to reschedule their debt,

which is typically concluded within six months. Rescheduling is a means of providing a country with debt relief through a postponement and, in the case of concessional rescheduling, a reduction in debt service obligations. To account for the negotiation process between the onset of the debt crisis and the reschedulings we use one–year ahead treatment as an indicator for the debt crisis in the current year. So if there is a treatment in 2001, then we record the year 2000 as having a debt crisis.

In our sample, we look at all developing countries over the period from 1975 to 2005, subject to data availability.[4] Overall, there are 222 currency-only crises, 257 debt-only crises, and 48 twin crises, where a double currency and debt crisis is the contemporaneous occurrence of a currency and debt crisis (Table 1a). As evident from Table 1a, a debt crisis is much more likely to occur when there is a contemporary currency crisis and vice versa. A debt crisis occurred in 10 per cent of the cases when there was no currency crisis, while it occurred in 18 per cent of the cases where there was a currency crisis. Accordingly, the likelihood of a currency crisis was 9 per cent if there was no debt crisis and 16 per cent in case of a debt crisis. We also look at the frequency of debt crises conditioned on whether there is a currency crisis in year t-1 (Table 1b), and the frequency of currency crises conditioned on whether there is a debt crisis in year t-1 (Table 1c). We find that currency crises tend to lead debt crises, while a reverse link also has strong support. In Tables 1a-c, we treat consecutive crises as different crises. In Tables 2a-c, we treat consecutive crises as a single event. Reassuringly, Tables 2a-c convey similar messages as Table 1a-c.

[4] That is, we exclude advanced economies, which, according to the IMF classification, include Austria, Belgium, Canada, Cyprus, Denmark, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, UK, and US.

Certainly, besides Paris Club treatment, there are alternative dating schemes for debt crises. Candidates, for example, may include the onset of arrears of international payments (of interest, principal, or both), or the onset of sovereign defaults as measured by Standard and Poor's. Following Rose (2005), we use the Paris Club treatment which seems to be the most appropriate one to date sovereign default. For instance, Paris Club deals imply a more comprehensive crisis definition as the number of crises is approximately double the number of arrears and triple the number of S&P defaults. Further, arrears are typically accompanied by continued partial debt service which makes it difficult to measure the nature and scope of default. In any case, we use the classification of debt crises by Standard & Poor's (2004) as a further robustness check, which dates the default for 202 countries for the period from 1975 to 2004. According to it, sovereign default is the failure to meet a principal or interest payment on the due date contained in the original terms of the debt issue. Standard & Poor's (2004) distinguish among defaults on local currency debt, foreign currency bond debt and foreign currency bank debt. We focus on the later two defaults. Also, in Standard & Poor's classification, some countries have had prolonged period of defaults. For example, Brazil had had defaults from 1983 to 1994, while Peru had had defaults from 1983 to 1997. Hence, we only look at the onset of the default. The number of debt crises thus defined is presented in Tables 3a-c. We can see that Tables 3a-c tell the same story as Tables 1a-c do.

2.2. Macroeconomic Indicators

Recently, a few theoretical papers have explicitly integrated aspects of debt and currency crises in the framework of an intertemporal budget constraint, e.g. Calvo (1998), Aizenman et al. (2002), Benigno and Missale (2001), Bauer et al. (2003), and Jahjah and Montiel (2003). From this literature two types of variables emerge. First, conventional macroeconomic determinants

that can cause currency and/or debt crises as have been discussed in the literature on these types of crises. Secondly, contagion effects namely the presence of a currency crisis that leads to a (expected) deterioration of the economy thereby triggering a debt crisis, and vice versa.

We examine eight variables relevant to the currency and debt crisis literature that can be common factors to debt and currency crises. It is straightforward to expect pressure on the exchange rate and thus the likelihood of a currency crisis to increase with high growth of domestic credit, overvaluation, low real GDP growth, and a deteriorating budget balance which could lead to political pressure to ease monetary policy. Also a lower reserves over imports ratio weakens the central bank's ability to stabilize the domestic currency. In an analogous way, the likelihood of a debt crisis increases with low domestic real growth and deteriorating fiscal conditions as measured by the budget balance.

While the role of these macroeconomic variables for currency and debt crises is rather straightforward, the effects of external debt over GDP and M3 over GDP have to be discussed in greater detail. Higher external debt over GDP should unambiguously increase the likelihood of a debt crisis. The government has a stronger incentive to default in order to reduce debt service, and because of a broader base of this tax on bondholders, it has a greater incentive to use the tax on bondholders (debt crisis) instead of the inflation tax (currency crisis). At the same time, the effect of external debt on the likelihood of a currency crisis is ambiguous. On the one hand, with debt being denominated in foreign currency, higher external debt points to stronger demand for foreign currency due to the government's debt service and therefore pressure on the exchange rate. On the other hand, the government has a greater incentive to solve its finance problems with a tax on bondholders, i.e. a default, rather than an inflation tax. With an increase in external debt and therefore a wider tax base for the bondholders tax, the government requires a smaller default

rate to finance a given expenditure. As the costs of financial crises are likely to be linked to the marginal default and devaluation rates, an increase in external debt lowers the necessary default rate relative to the required devaluation/inflation rate. This would make the default the more attractive means of finance and lower the likelihood of a currency crisis.

What are the likely effects of an increase in the M3 to GDP ratio? A higher money stock unambiguously diminishes the likelihood of a debt crisis, because the financial needs are reduced, and the incentive for a default is lower as the tax base for the bondholders tax relative to the tax base for the inflation tax is smaller. In contrast, the effects of a higher money to GDP ratio on the likelihood of currency crises is ambiguous. A higher money stock decreases the financial needs while making the inflation tax a more efficient financing instrument. Taken together, the probability of a debt crisis unambiguously rises both with an increase in debt and a reduction in money. In contrast, the effects of money and debt on the probability of a currency crisis are ambiguous.

It is also critical to look not only at individual country variables, but at the global financial and economic environment as well. Global variables potentially include world economic activity, commodity prices, real interest rates, and other financial market shocks. A number of studies have found that adverse developments in industrialized countries can trigger financial crisis in emerging markets (Calvo et al. 1993, Frankel and Rose 1996). In this paper, we focus on the role of real world output growth.

2.3. Lagged currency and debt crisis (internal contagion)

As discussed above, the literature on twin currency and debt crises looks into the relation between these two types of crises. Seen from such an integrated point of view, currency crises and debt crises could be complements or substitutes. Currency and debt crises are complements

if the focus is on expectations and internal contagion effects. (The expectation of) A currency crisis and the economic problems in its aftermath can also trigger a debt crisis, e.g. via increased interest rates and/or lower real growth and therefore a deteriorating fiscal position. In a similar way, (the expectation of) a debt crisis and the subsequent economic turmoil could cause contagion from debt to currency crisis, e.g. via capital flight and higher political costs of defending the exchange rate. However, currency and debt crisis could be complements if the financing aspects of these crises are accounted for. From this point of view, an increase in the money stock, i.e., an inflation tax on money holdings which implies a devaluation of the currency (currency crisis), lowers the financing requirements of the government and therefore makes a debt crisis less likely. In analogous way, a (partial) default on public debt, i.e. an implicit tax on bond holders, lowers public financing requirements thereby making a currency crisis less likely.

3. Statistical Model

3.1. The model

In this section we analyze the role of common macroeconomic factors and internal contagion from one type of crisis to the other for the occurrence of double crises, i.e. the simultaneous occurrence of debt and currency crises. We also test for the Granger-type causality between debt and currency crises.

Denote y_{1t} and y_{2t} as dummy indicators for currency and debt crises respectively. We assume there are two latent variables for the currency crisis (y_{1t}^{*}) and the debt crisis (y_{2t}^{*}) respectively. A currency crisis occurs $(y_{1t}=1)$ when $y_{1t}^{*}>0$, a debt crisis occurs $(y_{2t}=1)$ when $y_{2t}^{*}>0$, and a twin crisis $(y_{1t}=1 \& y_{2t}=1)$ occurs when both $y_{1t}^{*}>0$ and $y_{2t}^{*}>0$. Moreover,

$$
\begin{aligned}
y_{1t}^{*} &= \alpha_0 + \alpha_1 X_{t-1} + \alpha_2 y_{1t-1} + \alpha_3 y_{2t-1} + \varepsilon_{1t} \\
y_{2t}^{*} &= \beta_0 + \beta_1 X_{t-1} + \beta_2 y_{1t-1} + \beta_3 y_{2t-1} + \varepsilon_{2t}
\end{aligned} \tag{1}
$$

where the shock terms ε_{1t} and ε_{2t} are assumed to follow the stationary normal distribution

$$
\begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} \sim \mathrm{N}\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix} \right).
$$

Suppose that no serial correlation exists between the shock terms, which is not a strong assumption if we include enough lags of X_t, y_{1t} and y_{2t}. y_{1t-1} and y_{2t-1} are the lagged currency and debt crises indicators, X_{t-1} are lagged macroeconomic factors. X_{t-1} include the variables discussed in the theoretical model above which can be grouped into :

- debt conditions: ratios of external debt over GDP, and debt service over GDP;
- monetary conditions: domestic credit growth rate, real exchange rate overvaluation, foreign reserves over imports ratio, and money supply over GDP ratio;
- other macroeconomic indicators: government deficit over GDP, domestic and world GDP growth rate.

Macroeconomic variables are collected from the World Bank's World Development Indicators. The construction of the exchange rate overvaluation is similar to Frankel and Rose (1996). Overvaluation is defined as the deviation from purchasing power parity which is measured as the country-specific average bilateral real exchange rate with the US dollar over the sample. Possible endogeneity may come from the correlation between X_t and ε_{1t}, or the correlation between X_t and ε_{2t}. To control for the endogeneity, all the macroeconomic variables are then taken with one-year lag unless specified otherwise.

A maximum likelihood estimation of the above two-equation Probit model is performed to efficiently estimate the parameters. Compared with the separate estimation of two single

equation Probit models, the joint estimation accounts for the correlation between the shock terms ε_{1t} and ε_{2t}, and thus uses more information and provides more efficient estimators. More importantly, this correlation captures the contemporary internal contagion between debt and currency crises, as well as potential common factors that are missing from the explanatory variable set.

3.2. Estimation results

Financial crises include both consecutive and non-consecutive crises. Among currency crises, about 19 per cent crises are consecutive ones; while for debt crises, about 8 per cent are consecutive ones. In the baseline case, we treat events that happen in consecutive year as a single event.[5] Doing so means that we look only at the onset of crises, rather than the continuation of crises. In the robustness check, we will treat events that happen in consecutive years as different events to capture the serial correlation among financial crises.

Our baseline results are reported in Table 4. Since Probit coefficients are not easily interpretable, we will report the marginal effects of regressors on the probability of crises, evaluated at the average of the explanatory variables. The results can be summarized as follows.

First, we find strong evidences that support the theory on intertemporal budget constraint. According to Table 4, higher M3 over GDP ratio reduces the likelihood of debt crises while having no significant impact on currency crises. This is consistent with our theoretical implication that a higher money stock reduces the financing requirements while making inflation/devaluation a more efficient means of finance through the larger base for the inflation tax. So the effect of a higher money stock on the default rate is unambiguously negative, while

[5] Detragiache and Spilimbergo (2002) use a four-year window for the debt crisis, because they want to distinguish the beginning of a new crisis from the continuation of the preceding one.

the effect of money on the optimal inflation rate/devaluation rate can be ambiguous. We want to emphasize that the M3 over GDP ratio is related to the money stock, not to the net change of money stock, i.e, the flow. Consistent with the previous literature, higher domestic credit growth rate does significantly increase the likelihood of currency crises (Table 4).

We also find that higher debt over GDP ratio is associated with lower likelihood of currency crises. Moreover, higher debt over GDP ratio is associated with higher likelihood of debt crises. This finding supports our theoretical argument that higher debt increases the finance requirements, and thus increases the likelihood of both currency and debt crises. In addition, the higher external debt implies a larger tax base for the bondholders tax so that a smaller default rate is needed to finance a given expenditure. As discussed above, the costs of financial crises are linked to the marginal default and devaluation rates. An increase in external debt lowers the necessary default rate relative to the required devaluation rate, which should make the default the more attractive means of finance and thus lower the likelihood of a currency crisis. Then the net effect of higher debt on currency crises can be negative or positive, while the net effect on debt crises is unambiguously positive.

Secondly, we find strong evidence that debt and currency crises share fundamental causes. We find that higher reserves over imports ratio and domestic GDP growth rate help avoiding both currency and debt crises. Foreign reserves can be regarded in principle as a negative debt. But because the government cannot default on the reserve, there is no substitution effect for the reserve in the default and devaluation trade-off. Instead, only the income effect exists. As a result, reserves have unambiguous effects on debt and currency crises. Certainly, there are macroeconomic factors that affect one crisis but not the other. For example, we find that higher

debt service increases the likelihood of debt crises, while having no impact on currency crises.[6] On the other hand, we find that overvaluation and domestic credit growth only affect currency crises. Budget deficit over GDP, a potential candidate for common factor, turns out to have no significant impact on either debt or currency crisis. Since the inclusion of budget deficit shrinks the sample size by about one third, we then exclude it from the baseline table.

Thirdly, our results indicate that currency and debt crises are complements in the sense that the occurrence of a debt crisis increases the likelihood of a future currency crisis. We find strong evidence for a Granger-type causality from debt crises to currency crises, but only weak evidence for the other direction (see Table 4). The predicted probability of a currency crisis is 7 per cent at the average of the sample data. Based on Table 4, if there is a debt crisis this year, then the predicted probability of a currency crisis next period will rise to 19 per cent.

Finally, the correlation ρ (rho) across the two shock terms ε_{1t} and ε_{2t} is as high as 0.21, significantly different from zero. This suggests that there may be strong contemporary correlation between debt and currency crises. In this case, the probability of a twin crisis cannot be expressed as the multiplication of the probability for currency crises and the probability for debt crises. Doing so would significantly underestimate the occurrence of twin crises. The significance of ρ also suggests that our Bivariate Probit estimation provides an important efficiency gain, compared with single-equation Probit estimations.

3.3. Sensitivity analyses

In Table 4, we only look at the onset of crises. Now we treat consecutive crises as different events to capture the serial correlation among them. The new results are reported in Table 5.

[6] This finding is consistent with Detragiache and Spilimbergo (2004), who also find that the debt service due is a significant factor for the debt crisis.

Overall, we get the picture similar to Table 4. We still find strong evidence of intertemporal budget constraint: money stock lowers the occurrence of debt crises, while debt stock decreases the likelihood of currency crises. We also find that Granger causality runs from debt to currency crises but not the other way around.

To get a better sense of the role of the common factors relative to the direct linkages between the two types of crises, we re-estimate Table 4 without including lags of crises as predetermined explanatory variables. Results are presented in Table 6. We can see that there are changes in the significance level of some explanatory variables. Most noticeably is the debt stock over GDP in the currency crisis equation. The debt stock now becomes insignificant, although it was significant back in Table 4. This may appear to contradict the claim that the intertemporal budget constraint is in operation. But probing deeper, it actually supports the claim. According to the previous table (Table 4), debt stock affects the currency crisis through two channels: directly affecting the currency crisis through intertemporal budget constraint; or indirectly affecting the currency crisis through its impact on the debt crisis (debt crises then affect currency crises through either Granger causality or contemporary contagion). In Table 4, the coefficient of debt stock measures the direct effect. In Table 6, as we remove lagged debt crises from the currency crisis equation, the coefficient of debt stock now measures the net effect, which sums up the direct and indirect effects. Because the direct and indirect effects move in opposite directions, not surprisingly, the next effect is insignificant. This may explain why the previous literature, such as Frankel and Rose (1996), does not find a significant impact of debt stock on currency crises.[7]

[7] According to Table 1 of Frankel and Rose (1996), debt stock/GNP reduces the likelihood of currency crises in the next period. But the effect is not significant at the traditional 5% level.

We also control for other potential explanatory variables, such as trade openness and financial openness. The empirical literature so far has provided mixed evidences on the impact of openness on crises (e.g., Frankel and Cavallo (2004)) and Edwards (2004)). Here, we use de facto measurements of openness: trade openness is measured as the sum of imports and exports over a country's GDP; while financial openness is measured as the sum of external assets and liabilities, from Lane and Milesi-Ferretti (2006), over a country's GDP. Note that we take the external debt out of the external liabilities, in that we have already included debt stock as our explanatory variable. Due to potential endogeneity issues as discussed in Frankel and Cavallo (2004), we then take the one-period lag of these two variables as explanatory variables. We re-examine Table 4, and find that trade openness significantly reduces the probabilities of debt and currency crises. However, financial openness turns out to have no effect on the currency or debt crisis. Reassuringly, our key results still carry through.[8]

Above, we define overvaluation as the deviation from Purchasing Power Parity, which was measured as the country-specific average real exchange rate (RER) over the whole sample period. One might be concerned that this calculation spans a long time period (30 years). Hence, as a robustness check, we base the calculation of the country-specific average RER on a much shorter backward looking horizon, i.e., the past 5 years. With the new series of overvaluation, we then re-examine Table 4. We find that our main results still hold, with all key variables keeping their signs and significances. Alternatively, we drop overvaluation from the explanatory variable set, and re-examine Table 4. Again, we find that new results are very similar to Table 4.

[8] One minor difference is that debt stock is now significant at the 7% level in the currency crisis equation, while in Table 4, the significance level was at 1%.

One may argue that debt crises have different severities, and severer debt crises may be associated with more frequent currency crises. To test this, we construct a debt crisis severity variable: the US dollar amount of each Paris Club treatment divided by that country's total external debt. We then define severe debt crises as the cases where the treatment is more than 10 per cent of the total external debt, which amounts to top 25 per cent of Paris Club treatments. We realize that this is a rough measurement of the severity of default, because for each treatment, the treatment terms could be different on interest rate, maturity, cancelled claims, grace period, etc. Nonetheless, it could potentially serve as a robustness check. So we re-examine Table 4, and report the new results in Table 7. From there, we can see that severe debt crises lead to more currency crises, while currency crises do not lead to severe debt crises. Also, money stock now does not significantly reduce the probability of severe debt crises. This is intuitive in that when the fundamental is so weak, even the operation of intertemporal budget constraint cannot save the country from default.

Finally, we adopt Standard and Poor's definition of debt crises, and treat consecutive defaults as a single default. Results are presented in Table 8. Again, higher money stock significantly reduces the likelihood of debt crises, which confirms the operation of intertemporal budget constraint.

4. Conclusion

In this paper, we have systematically investigated the potential linkages between debt and currency crises. Our starting point was the question whether the strong contemporary association between these two types of crises is caused by linkages between the debt and currency crisis or by common macroeconomic factors.

We find strong evidence of the operation of intertemporal budget constraint. Because of income and substitution effects, higher foreign debt is associated with higher likelihood of debt crises and lower likelihood of currency crises. For similar reasons, higher money stock is associated with lower likelihood of debt crises, while having no significant effect on currency crises. We also find some Granger-type causality between debt and currency crises. Lagged debt crises significantly help predict currency crises, but currency crises have no power in predicting debt crises. Moreover, our empirical results indicate that debt and currency crises have common roots. Low foreign reserves relative to imports and low GDP growth rate all increase the likelihood of debt and currency crises. These results are a first indication that common macroeconomic fundamentals play an important role for the occurrence of twin crises. This broader view on both debt and currency crises strengthens the role of sound macroeconomic policies. By pursuing stability orientated policies, governments can earn a double dividend of lowering the likelihood of debt as well as currency crises.

The results presented in this paper are a first step in evaluating and understanding the complex linkages between debt and currency crises which can give rise to twin crises. Evidently, examining how the government deals with crises and how this affects default and devaluation expectations helps to better understand when single crises give rise to twin crises.

Table 1a. Number of Debt, Currency and Twin Crises
(Paris Club Data)

	Debt Crises (t)		
Currency Crises (t)	0	1	Total
0	2,331	257	2,588
1	222	48	270
Total	2,553	305	2,858

Note: Developing countries from 1975 to 2005. Consecutive crises are regarded as different episodes.

Table 1b. Conditional Probability of Debt Crisis
(Paris Club Data)

	Debt Crises (t)=0	Debt Crises (t)=1
Currency Crises(t-1)= 0	0.90	0.10
Currency Crises(t-1)= 1	0.80	0.20

Note: Developing countries from 1975 to 2005. Consecutive crises are regarded as different episodes.

Table 1c. Conditional Probability of Currency Crisis
(Paris Club Data)

	Currency Crises (t)=0	Currency Crises (t)=1
Debt Crises(t-1)= 0	0.92	0.08
Debt Crises(t-1)= 1	0.79	0.21

Note: Developing countries from 1975 to 2005. Consecutive crises are regarded as different episodes.

Table 2a. Number of Debt, Currency and Twin Crises
(Paris Club Data, with window)

	Debt Crises (t)		
Currency Crises (t)	0	1	Total
0	2,330	217	2,547
1	177	22	199
Total	2,432	238	2,670

Note: Developing countries from 1975 to 2005. Consecutive crises are regarded as a single crisis.

Table 2b. Conditional Probability of Debt Crisis
(Paris Club Data, with window)

	Debt Crises (t)=0	Debt Crises (t)=1
Currency Crises(t-1)= 0	0.92	0.08
Currency Crises(t-1)= 1	0.84	0.16

Note: Developing countries from 1975 to 2005. Consecutive crises are regarded as a single crisis.

Table 2c. Conditional Probability of Currency Crisis
(Paris Club Data, with window)

	Currency Crises (t)=0	Currency Crises (t)=1
Debt Crises(t-1)= 0	0.94	0.06
Debt Crises(t-1)= 1	0.79	0.21

Note: Developing countries from 1975 to 2005. Consecutive crises are regarded as a single crisis.

Table 3a. Number of Debt, Currency and Twin Crises
(Standard and Poor's Data, with window)

	Debt Crises (t)		
Currency Crises (t)	0	1	Total
0	2,339	58	2,397
1	129	24	153
Total	2,468	82	2,550

Note: Developing countries from 1975 to 2004. Consecutive crises are regarded as a single crisis.

Table 3b. Conditional Probability of Debt Crisis
(Standard and Poor's Data)

	Debt Crises (t)=0	Debt Crises (t)=1
Currency Crises(t-1)= 0	0.97	0.03
Currency Crises(t-1)= 1	0.93	0.07

Note: Developing countries from 1975 to 2004. Consecutive crises are regarded as a single crisis.

Table 3c. Conditional Probability of Currency Crisis
(Standard and Poor's Data)

	Currency Crises (t)=0	Currency Crises (t)=1
Debt Crises(t-1)= 0	0.94	0.06
Debt Crises(t-1)= 1	0.84	0.16

Note: Developing countries from 1975 to 2004. Consecutive crises are regarded as a single crisis.

Table 4: Joint Estimation of Debt and Currency Crises (With Window)

	Currency Crisis		Debt Crisis	
	Effect	P-value	Effect	P-value
Debt crisis (one lag)	0.12*	0.00		.
Currency crisis (one lag)			0.05	0.11
Domestic GDP growth rate	-0.31*	0.01	-0.26*	0.04
World GDP growth rate	-1.31*	0.00	0.68	0.22
Reserve over imports ratio	-0.01*	0.02	-0.01*	0.00
Debt service/GDP	0.16	0.21	0.28*	0.05
Domestic credit growth rate	0.06*	0.00	-0.04*	0.04
Overvaluation	0.08*	0.00	0.00	0.85
External debt over GDP	-0.02*	0.04	0.05*	0.00
M3 over GDP	0.00	0.36	-0.02*	0.00
Rho	0.21*	0.01		
Observations	1898			
R-Square	0.09			

Note: We look at developing countries over the period from 1975 to 2005. Debt crises are based on Paris Club treatments. Consecutive crises are regarded as a single crisis. * indicates significance at 5%.

Table 5: Joint Estimation of Debt and Currency Crises
(No Window)

	Currency Crisis		Debt Crisis	
	Effect	P-value	Effect	P-value
Lagged debt crisis (one period)	0.08*	0.00	-0.02	0.15
Lagged debt crisis (two period)	-0.02	0.16	0.08*	0.00
Lagged debt crisis (three period)	-0.02	0.29	0.09*	0.00
Lagged debt crisis (four period)	0.01	0.48	0.09*	0.00
Lagged debt crisis (five period)	0.03	0.19	0.07*	0.01
Lagged debt crisis (Six period)	0.04	0.08	0.03	0.20
Lagged currency crisis (one period)	0.05*	0.04	0.04	0.16
Lagged currency crisis (two period)	0.04	0.09	0.03	0.21
Lagged currency crisis (three period)	0.07*	0.01	0.01	0.55
Lagged currency crisis (four period)	0.01	0.79	-0.04*	0.01
Lagged currency crisis (five period)	0.03	0.16	0.00	0.97
Domestic GDP growth rate	-0.35*	0.00	-0.36*	0.00
World GDP growth rate	-1.58*	0.00	0.40	0.48
Reserve over imports ratio	-0.01*	0.00	-0.02*	0.00
Debt service/GDP	0.16	0.20	0.36*	0.01
Domestic credit growth rate	0.05*	0.00	0.001	0.95
Overvaluation	0.11*	0.00	0.02	0.31
External debt over GDP	-0.02*	0.01	0.02*	0.01
M3 over GDP	-0.006	0.21	-0.020*	0.00
Rho	0.062	0.37		
Observations	1996			
R-square	0.16			

Note: We look at developing countries over the period from 1975 to 2005. Debt crises are based on Paris Club treatments. Consecutive crises are regarded as different episodes. * indicates significance at 5%.

Table 6: Joint Estimation of Debt and Currency Crises
(With Window, No Lagged Crisis)

	Currency Crisis		Debt Crisis	
	Effect	P-value	Effect	P-value
Domestic GDP growth rate	-0.303*	0.00	-0.327*	0.01
World GDP growth rate	-1.305*	0.00	0.727	0.19
Reserve over imports ratio	-0.007*	0.01	-0.010*	0.00
Debt service/GDP	0.163	0.20	0.272	0.06
Domestic credit growth rate	0.042*	0.00	-0.027	0.21
Overvaluation	0.081*	0.00	-0.003	0.87
External debt over GDP	-0.007	0.35	0.048*	0.00
M3 over GDP	-0.009	0.06	-0.019*	0.00
Rho	0.110	0.14		
Observations	1960			
R-square	0.07			

Note: We look at developing countries over the period from 1975 to 2005. Debt crises are based on Paris Club treatments. Consecutive crises are regarded as a single crisis. * indicates significance at 5%.

Table 7: Joint Estimation of Debt and Currency Crises
(Severe Debt Crisis)

	Currency Crisis		Debt Crisis	
	Effect	P-value	Effect	P-value
Debt crisis (one lag)	0.14*	0.01		
Currency crisis (one lag)			0.01	0.68
Domestic GDP growth rate	-0.29*	0.01	-0.09	0.26
World GDP growth rate	-1.37*	0.00	0.50	0.10
Reserve over imports ratio	-0.01*	0.01	0.00	0.40
Debt service/GDP	0.18	0.15	-0.03	0.72
Domestic credit growth rate	0.07*	0.00	-0.03*	0.02
Overvaluation	0.08*	0.00	0.01	0.63
External debt over GDP	-0.02*	0.04	0.02*	0.00
M3 over GDP	-0.01*	0.05	-0.005	0.12
Rho	0.14	0.18		
Observations	1972			
R-Square	0.08			

Note: We look at developing countries over the period from 1975 to 2005. A severe debt crisis is the case where the Paris Club treatment is more than 10 per cent of the debtor's total external debt. Consecutive crises are regarded as a single crisis. * indicates significance at 5%.

Table 8: Joint Estimation of Debt and Currency Crises
(Standard and Poor's Classification)

	Currency Crisis		Debt Crisis	
	Effect	P-value	Effect	P-value
Debt crisis (one lag)	0.13	0.17		
Currency crisis (one lag)			0.02	0.42
Domestic GDP growth rate	-0.30*	0.00	-0.34*	0.00
World GDP growth rate	-1.17*	0.00	-0.71*	0.04
Reserve over imports ratio	-0.01*	0.01	0.00	0.14
Debt service/GDP	-0.05	0.69	0.34*	0.00
Domestic credit growth rate	0.06*	0.00	0.02	0.08
Overvaluation	0.07*	0.00	0.02	0.24
External debt over GDP	0.01	0.20	-0.002	0.75
M3 over GDP	-0.01	0.13	-0.01*	0.03
Rho	0.48*	0.00		
Observations	1745			
R-square	0.10			

Note: We look at developing countries over the period from 1975 to 2004. Debt crises are based on Standard and Poor's classification. Consecutive crises are regarded as a single crisis. * indicates significance at 5%.

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