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MSc Economics

Do Balance-Sheet Effects Matter for Brazil?

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1. Introduction

The past ten years have seen a number of currency crises, typically followed by a sharp drop in output in the countries involved. An explanation advanced for both the crisis and the recession is that firms in these countries had a large amount of debt indexed in foreign currency (Krugman, 1999). The exchange rate devaluation left the firms insolvent, reducing credit and production in the economy. Apart from crisis, balance-sheet effects have been advanced as an explanation for the “fear of floating” detected by Calvo and Reinhardt (2000) in developing economies in normal times.

In the set of countries recently stricken by currency crisis, Brazil seems to be the odd case. In the year after their respective crisis, output has dropped in real terms 7% in Korea, 11% in Thailand, 11% in Argentina, 5% in Russia, but in Brazil it actually grew approximately 1%. This happened despite the fact that the external debt to GDP ratio in Brazil was about 30% of the GDP, roughly the same as Korea and Russia before their respective crisis¹. Comparable data for Brazilian GDP after the depreciation of the *real* during 2002 is not available yet, but other indicators such as industrial output would suggest that the impact was not significant. Apparently, Brazilian policy-makers should not worry about balance sheet effects.

This essay aims to verify the claim that balance sheet effects do not have a significant influence in Brazilian output and to advance an explanation why this is so. To do this, one has to understand what are features that make an economy financially vulnerable to swings in the exchange rate. According to Céspedes, Chang and Velasco (2000) (hereafter CCV) an economy is financially vulnerable when unexpected changes in the real exchange rate lead to an increase of the risk spread paid by the country. An empirical result of this essay is that this is indeed the case for the Brazilian economy. It turns out that its resilience is linked to the low responsiveness of output to variations in the risk spread. This involves another condition for financial robustness not identified by CCV, the leverage of the economy. In the terms of

¹ These data were collected from World Development Indicators Online (<http://devdata.worldbank.org/dataonline/>). The years are 1998 for Korea and Thailand, 1999 for Russia and Brazil and 2002 for Argentina.

Aghion, Bachetta and Benarjee (2000) (hereafter ABB), Brazil benefits from a low level of financial development.

The next two chapters lay out the theoretical foundations for the empirical analysis. In chapter 2, the discussion focuses on the microeconomics of balance sheet effects. A general framework is laid out which allows for the comparison of different approaches. Chapter 3 discusses the conditions for financial vulnerability. Chapter 4 gives the main empirical results and offers an interpretation based on the theory presented in the previous chapters. Chapter 5 concludes.

For consistency, I will use the notation and conventions in CCV. Following the literature, the foreign currency will be referred to as dollar and foreign denominated assets as dollarized liabilities. The national currency will be referred to as *real*.

2. Balance Sheet Effects

Balance sheet effects have been advanced as an explanation for the persistence of macroeconomic shocks on output². The basic idea is that borrowing by firms is limited by their wealth or net-worth. If the net-worth of the firms falls because of a bad realization of their investment project, it will be more difficult for them to borrow in the subsequent period and they will be forced either to pay a higher interest rate for an equal sized investment or not do such a large investment at all. Less investment means less output so that the net-worth remains depressed, propagating the shock.

If firms hold dollarized liabilities, their net-worth depends on the exchange rate. This explains why after large devaluations, many countries suffer a recession and take a long time to recover. The reasons that lead a firm to have foreign denominated assets are various and can usually be related to some imperfection in the domestic credit market (see for example, Caballero and Krishnamurty 2000). A thorough discussion of these reasons is beyond the scope of this essay, and the fact that firms find it optimal to have at least a part of their debt dollarized will be taken as given.

Different micro-foundations are consistent with balance sheet effects³. Eaton, Gersovitz and Stiglitz (1986) point out that the main difficulty in international lending is that contracts are not easily enforced. If the borrower decides not to pay, there is not much the lender can do about it. The borrower, however, has to pay a penalty in form of lost reputation. For balance sheet effects to emerge, I impose the additional assumption that the penalty is proportional to the investment made. This assumption is reasonable, as larger firms that make larger investments are more likely to need new access to financial markets⁴. This makes them more concerned about their reputation. In this set-up, firms borrow abroad to invest and sell their (non-tradable) product at home. The value of investment is the sum of the wealth or net-worth invested by the firm and the loans contracted. Assuming that all debts are contracted for a single period, the firm repays the debt if the repayment is smaller than the penalty, that is,

$$(1 + \rho)(1 + \eta)D \leq p(N + D) \Leftrightarrow \frac{N + D}{N} \leq \frac{(1 + \rho)(1 + \eta)}{(1 + \rho)(1 + \eta) - p} \quad (1)$$

² See Bernanke and Gertler (1989) and Kiyotaki and Moore (1997) among others

³ The term “Balance sheet effects” will be used in this essay to refer specifically to effects caused by exchange rate variations.

⁴ For example, because they have lower mortality rates than smaller firms.

where D is the nominal value of the debt, N is the net-worth in real terms, $D+N$ is the investment, p is the penalty rate, $(1+\rho)$ the interest rate on a safe asset and $(1+\eta)$ the risk premium paid by the firm. Given the interest rate and the risk spread, lenders set the loan so that the above inequality is satisfied and in absence of uncertainty, borrowers never default. The pairs of investment to net-worth ratio and interest rate in which the borrower would be just willing to repay the debt are depicted in the CC curve in graph 1. This curve has a negative slope. Points above of the curve cannot be an equilibrium, because under these conditions the borrower defaults and the lender does not get anything. An increase in the penalty rate shifts the CC curve upwards, so that for a given interest rate and net-worth, it is possible to make a larger loan.

Suppose now that returns on investment yield a stochastic rate of return ω . There is a $\bar{\omega}$ below which the borrower will be unable to pay his dues. This satisfies:

$$\bar{\omega}(N + D) = (1 + \rho)(1 + \eta)D \quad (2)$$

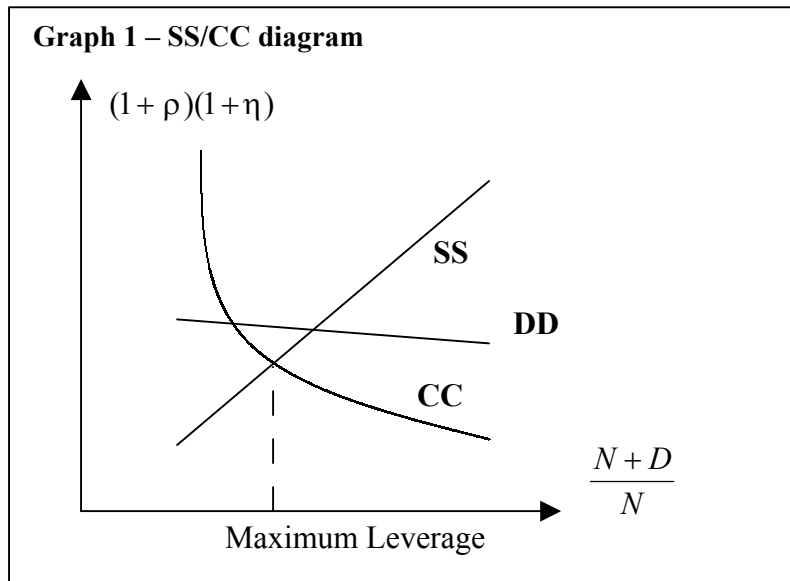
In case of default, the lender does not receive anything. If lenders are risk neutral, in a competitive market the risk spread must be such that the expected return on the loan is the same as on a safe asset. That is,

$$(1 + \rho) = (1 + \rho)(1 + \eta)P \left[\omega \geq (1 + \rho)(1 + \eta) \left(1 - \frac{N}{N + D} \right) \right] \quad (3)$$

Where $P[.]$ is the probability of the event in brackets. The equilibrium risk spread solves the above expression given the safe interest rate, the debt and the net-worth of the firm. Its existence and uniqueness will depend on the probability distribution of ω ⁵. If it exists, the risk spread increases with the proportion of investment to net-worth. This is the SS curve in graph 1. Between them, the two curves describe the supply-side of the credit market in this simplified framework. SS is the supply curve, which reflects the borrower's ability to pay. The CC curve reflects the borrower's willingness to pay. It puts an upper limit to the possible rate of investment to net-worth or leverage given the SS curve. This limit is the intersection of the two curves. The model is completed with the introduction of a demand curve for debt, DD. If, as depicted in the graph, SS and DD cross each other above the CC

⁵ Appendix 1 provides a discussion of existence and uniqueness for the case of a uniform distribution and of the slope of the SS curve below.

curve, the leverage will hit the maximum and the investment will take place below marginal cost.



If all debt is to be paid after one period and capital depreciates completely, the net-worth of a given firm in real terms at any time t is:

$$N_t = \delta \left[\alpha Y_t - (1 + i_t) \frac{P_{t-1}}{P_t} D_t^c - (1 + \rho_t)(1 + \eta_t) \frac{E_t}{E_{t-1}} (D_t - D_t^c) \right] \quad (4)$$

where Y_t is total output, α is the capital share of income, which under a Cobb-Douglas production function is constant, E_t is the *real*/dollar real exchange rate, D_t^c the amount of domestic debt and D_t the total amount of debt contracted in $t-1$ to be paid in t . The time indexes on the interest rates refer to the rate paid on time t and contracted in $t-1$

One approach taken by the literature is to assume that firms are always able to pay their debt, so there is no uncertainty and no risk spread. The SS curve is flat. Firms try to invest up to the point where the marginal return on investment equals the interest rate. However, this might not be possible as they may touch the ceiling. In this case they will have marginal returns above the interest rate and investment is simply a multiple of equation 4. This is the approach taken by Krugman and ABB, where the latter assume that because of constant returns to capital, the constraint is always binding.

The other approach is the one followed by CCV. In their model, there is no upper ceiling to the amount a firm can borrow, so the CC curve is inexistent. This happens because they suppose that the contract is enforceable so that not paying the debt is not an option for the borrower. In case of default to enforce the contract the lender incurs in a monitoring cost, which is proportional to the investment. The micro-foundations are different from the ones presented above, but the result that the risk spread is an increasing function of the relation between investment and net-worth is maintained. In particular, they assume that this function has a constant elasticity μ .

If the constraint given by CC is not binding, risk neutral capitalists invest up to the point where the expected return on investment equals the domestic interest. If the uncovered interest parity condition holds this is exactly the same as the interest rate on external debt times the expected exchange rate devaluation. If there are no surprises in the exchange rate and in output, capitalists pay their debtors the marginal productivity of capital and have exactly the same return on their net-worth as if they had lent to other capitalists at the current market rate. This is an important difference to models based in quantitative restrictions. The cancelling out of the expected devaluations comes about because the capitalists invest at marginal cost. If they are forced to invest below marginal cost, exchange rate variations are important even if expected.

CCV derive the following log-linearized equation around the steady state of their model:

$$\eta'_{t+1} - \eta'_t = \mu \{ (q_t - p_t + k_{t+1} - y_t) + \psi [(e_t -_{t-1} e_t) - (y_t -_{t-1} y_t)] \} \quad (5)$$

where the lower case letters represent percentage deviations from the steady state, the apostrophe denotes absolute deviation from the steady state level and $\psi = [(QK / SD) - 1]^{-1}$, k_{t+1} is the capital stock on $t+1$, which because of the assumption of full depreciation in the model is equal to investment at t and q_t is the cost of investment. The variables without time subscript refer to their steady state level.

The first term on the left-hand-side of the equation refers to investment in proportion to output. Given the net-worth, if one invests more in relation to output than the steady state level, the risk premium increases. The variables in the second term refer to the net-worth in relation to output. Given investment, a drop in the net-

worth leads to an increase in the risk spread. Only unexpected exchange rate and output variations take the net-worth out of its steady state level. *Ceteris paribus*, an unexpected exchange rate depreciation leads to an increase in the risk spread, which in turns makes investment less profitable, depressing output. Hence the balance sheet effect. In a general equilibrium framework, variations in the exchange rate also affect the other variables and the net effect might be ambiguous. The direction of the total effect determines the degree of financial vulnerability of the economy.

Summing up, there are two distinct approaches to modelling credit constraint and balance sheet effects. One supposes that there is no uncertainty in the outcome of the debt contract but there is a ceiling on the size of the debts. The emphasis is on willingness to pay. The other approach assumes that this ceiling is not important but that, given the net-worth, the risk premium grows with the debt, the emphasis lying in ability to pay. Those approaches are not mutually exclusive as it was shown in the model construed in the beginning of the chapter. The interaction between the two approaches will be helpful in understanding the present state of the Brazilian economy.

3. Financial Vulnerability

Although theoretically plausible, balance sheet effects are not necessarily important. Balance sheet effects are typically identified as a specificity of developing countries⁶, which means that there are certain characteristics that make certain countries more vulnerable than others.

One obvious feature of this vulnerability is the possession of debt denominated in foreign currency. Developing countries cannot issue foreign debt in their own currency⁷. Therefore, they have a large share of foreign denominated debt and are naturally more vulnerable. However, this is insufficient to explain Brazil's apparent robustness. As discussed in the introduction to this essay, on the eve of its crisis Brazil had roughly the same external debt as a percentage of the GDP as South Korea and yet had a much milder crisis.

Krugman (1999) points out that it is useful to think about balance sheet effect together with the classic transfer problem. For simplicity, Krugman supposes that the dollar value of national exports is independent of exchange rate variations⁸. CCV, who also incorporate this dimension, add the assumption that a constant fraction of consumption and of investment expenditure is made in domestic goods and that this fraction is the same for both. The national accounts identity is:

$$P_t Y_t = \gamma Q_t (K_{t+1} + C_{t+1}) + S_t X_t \quad (6)$$

where γ is the fraction of consumption and capital expenditure made in domestic products, C_t is total consumption expenditure, S_t is the nominal *real*/dollar exchange rate and X_t are exports. Q_t is the average price of capital expenditure which because of the assumption that the fraction of imported goods is the same in both cases is the same as for consumption

If we suppose as in CCV that only workers consume domestic products, that they consume their whole income, and that the aggregate production function is Cobb-Douglas, then domestic consumption is a constant fraction of output given by

⁶ See for example Eichengreen (2002)

⁷ This point has been called "the original sin of developing countries". According to Eichengreen et al. (2002), the main determinants of "Original Sin" are market size and transaction costs.

⁸ Sufficient conditions for this are that the elasticity of substitution of foreign demand for national products is unitary and that consumption of national products is a negligible share of foreign consumption.

the fraction of income appropriated by workers. Furthermore, by noting that the average price of consumption and investment is a weighted average of domestic prices and the exchange rate (foreign prices are normalized to 1), we have:

$$K_{t+1} = \frac{[1 - \gamma(1 - \alpha)]Y_t - EX_t}{\gamma E_t^{1-\gamma}} \quad (7)$$

Given output, investment decreases with the real exchange rate. This is the transfer problem. If there are less capital inflows in the economy, investment falls and, given output, the exchange rate rises to fill the balance of payment gap. Alternatively, if the exchange rate rises, because a constant share of investment expenditure is made abroad, investment becomes more costly and falls⁹.

In Krugman's analysis, the relationship between the balance sheet effect and the transfer problem generates multiple equilibria. In the "good" equilibrium, creditors expect the exchange rate to be low and the net worth of the firms to be high, so loans are large. The capital inflow fulfils the low exchange rate expectation. The firms have plenty of credit available and invest up to the point where returns on capital equal the (foreign) rate of return on assets. In the "bad" equilibrium, lenders expect the exchange rate to be high, net-worth of the firms to be low and stop lending. The lack of inflows in the capital account leads to an exchange rate depreciation, fulfilling the expectations. In this equilibrium firms do not have access to any credit and investment stops. The economy falls into recession even if all its financial indicators were sound in the previous moment¹⁰.

Apart from high level of foreign debt, the vulnerability conditions identified by Krugman in his simplified model are high leverage and low marginal propensity to import. Leverage is important because if firms can borrow a high proportion of their wealth, small variations in the net-worth lead to high variations in the absolute amount of borrowing. Low marginal propensity to import means that if capital stops flowing in, one needs a large drop in income and a large increase in exchange rate for the current account to adjust.

⁹ As pointed out by CCV, if all investment is made with foreign investment goods, there is no transfer problem because all capital inflows are spent abroad buying capital goods.

¹⁰ A similar argument can be made to explain currency crisis even if there are no credit constraints. Reif (2001) show that such a crisis can take place if investment good is complemented in the production function by some tradable good, so that expected increases in the real exchange rate reduce the expected return on investment. By assuming that a share of investment goods is bought abroad, CCV incorporate this argument in their model.

One can also extract vulnerability conditions from ABB. Balance sheet effects seem to suggest that governments should use monetary policy to smooth the exchange rate and thus output fluctuations. However, interest rate hikes also have deleterious effects on output. This trade-off is analysed by ABB and the authors identify the exact condition in their model under which it is desirable to increase the interest rate in response to a potential depreciation due to a productivity shock. Economies for which this condition is satisfied suffer more from exchange rate variations than from variations in the interest rate. This condition could be interpreted as a definition of financial vulnerability.

In ABB, higher interest rates keep the exchange rate from dropping through the uncovered interest parity condition. The policy trade-off is that on the one hand an increase in the interest rate leads to a lower exchange rate and keeps the net-worth of the firms from dropping, but on the other hand it decreases the capacity of the firms to borrow by pushing the SS curve up¹¹. ABB show that in their model it is optimal to “fear float” if the economy has a high leverage, if the leverage is not very sensitive to changes in the interest rate and if foreign denominated debt represent a high proportion of total debt. The authors stress that these are not features of low financial development but of “intermediate levels of financial development” (ABB, p. 737). If there are no credit markets in an economy, it is not financial vulnerable, for there is no debt to be concerned with.

Equation 7 is derived from CCV’s model. This means that investment can be substituted for exports in equation 7. CCV derive the following equation:

$$\eta'_{t+1} - \eta'_t = -\mu \left(\frac{1-\lambda}{\lambda} \right) (x_t + y_t - e_t) + \psi \mu [(e_t - e_{t-1}) - (y_t - y_{t-1})] \quad (8)$$

$$\text{Where } \lambda = \frac{\alpha \gamma \delta}{(1 - \gamma - \alpha \gamma)}$$

The effect of an unexpected increase in the exchange rate is ambiguous. The reason is that it reduces the net-worth of the capitalists, but also leads to less investment because of the transfer problem. CCV define an economy as financially

¹¹ Recall that in ABB the SS schedule is flat and firms invest as much as they can. Its value is given by the monetary policy.

vulnerable if the net effect is negative, otherwise it is classified as financially robust¹². The presence of exports to GDP ratio on the right hand side is comforting, as this is normally used as an indicator of financial vulnerability. A high export to output ratio means that, given the net-worth output ratio, investment is not too large so risk premium can be lower. It is not, however, a question of liquidity in foreign currency, which is what usually leads economists to include export to output ratio as an explanatory variable for country risk.

The parameter for the first term is lower if import share is lower or if saving rate is higher¹³. As in Krugman, financial vulnerability emerges as a feature of economies that have low levels of imports, but for different reasons. In Krugman, low import share creates the possibility of a high exchange rate depreciation giving way to multiple equilibria. In CCV, low imports and high saving rates mean that investment expenditure represents a high fraction of non-consumption output expenditure in the steady state. This means that exchange rate depreciations have to go a long way to crowd out investment and reduce the risk premium. The second parameter rises with steady state level of debt per net-worth¹⁴. This seems to reflect the leverage as in Krugman, but this is misleading. In Krugman, the leverage is the point of maximum borrowing per net-worth, where CC and SS curves intersect. Here, it is a steady state variable, which reflects the point where in the steady state the SS and DD curves meet.

Summing up, the main financial fragility conditions identified by the different authors are high steady state level of foreign liabilities, low import share in expenditure and high leverage. The latter condition is identified by ABB, but do not appear in CCV, so CCV's criterion is from that sense incomplete. It is nevertheless a useful criterion and it will be used as a point of departure for the empirical discussion in the next session.

¹² As opposed to Krugman, there is no scope here for multiple equilibria. The reason is that in CCV net-worth is not affected by expected exchange rate devaluations, so surprises but not the expectations themselves are important in defining the equilibrium. Put another way, expectations cannot become self-fulfilling

¹³ Higher saving rates appear in CCV as a high saving rate of the capitalists and a low income-share of the workers, because workers do not save.

¹⁴ In this economy, all debt is foreign debt. So $\psi = \left(\frac{QK}{SD} - 1\right)^{-1} = \left(\frac{QK - SD}{SD}\right)^{-1} = \frac{SD}{ND}$

4. Do Balance Sheet-Effects Matter for Brazil?

Following CCV, balance sheet effects can be broken down in two stages. On the first stage, if the economy is financially vulnerable, unexpected exchange rate depreciations increase the risk premium. On the second stage, the higher risk premium leads to lower investment and lower output. The empirical strategy is to look at the two stages in turn. For the first stage, I estimate equation 8 and check the coefficients for financial vulnerability. The second stage is tested by a Granger Causality test, i.e., a test to see if variations in output are preceded by variations in the risk premium.

I use monthly data ranging from January 1999, when the *real* was devalued, to December 2002. Because the CCV model is made for an economy that does not grow, the series for output and exports were detrended using a Hodrick-Prescott filter. All the series that had seasonality were deseasonalized using a ratio to moving average technique. All variables are in logarithms.

The risk spread, CBOND, can be read out directly from the spread on the Brady Bonds issued by the Brazilian government at the renegotiation of its sovereign debt in 1993. These bonds have long maturity, are very liquid and are indexed by the exchange rate. Their spread over equivalent maturity American treasury bonds reflects only the possibility of the Brazilian government defaulting on its external debt and not exchange rate expectations. In particular, I use the spread on the C-Bond, which is the Brady Bond with highest liquidity. The data refers to the spread on the day 7 of each month.

The output-gap series Y was constructed using the industrial output series as published by the “Instituto Brasileiro de Geografia e Estatística” (IBGE). The series was deseasonalized and detrended using the methods mentioned above.

For the dollar value of exports, X , which in the model is considered exogenous, I used the monthly series published by the Brazilian Secretary of Foreign Commerce (SECEX). The series was also deseasonalized and detrended.

The real exchange rate series E was calculated using the logs of the monthly average nominal exchange rate series published by the Central Bank of Brazil (BCB) and the log of the General Price Index (IGP) published by the “Fundacao Getulio

Vargas” (FGV), also deseasonalized. The real exchange rate is the difference between the two. It was assumed that there is no trend for the steady state value of the real exchange rate, so the series was not detrended¹⁵.

The expected variables EF and YF for exchange rate and output respectively were calculated by estimating an ARMA model on the actual series such that there was no auto-correlation in the errors, the mean-square error was minimized and the bias and variance part of the Theil-Index were as small as possible. These criteria assure that the forecasts are consistent with rational expectations. The results for these equations as well as the forecast evaluation are in Appendix 2. The series are the result of the one period ahead forecast made using the models.

The effect of an unexpected exchange rate variation on the risk spread can be tested by estimating equation 8 and looking at the parameters. Before it is interesting to allow for the possibility that the second term in the equation does not cancel out if there are no unexpected devaluations, as this provides a test for CCV’s model. This can be done by rewriting equation 8 as:

$$\Delta\eta'_{t+1} = \beta_1 + \beta_2x_{t-1} + \beta_3e_{t-1} + \beta_4y_{t-1} + \beta_5({}_{t-2}e_{t-1} - e_{t-2}) + \beta_6\Delta e_{t-1} + \beta_7({}_{t-2}y_{t-1} - y_{t-2}) + \beta_8\Delta(y_{t-1}) \quad (9)$$

The variables on the right hand-side are lagged one period in comparison to the original equation. This is because by the convention adopted by CCV, η_{t+1} is the interest rate for loans contracted in t to be paid on $t+1$. Because the CBOND series refers to values on the beginning of each month, it makes more sense to regress it on the values assumed by the other variables on the preceding month than in the current month. Moreover, this has the advantage of avoiding endogeneity problems.

The unit root hypothesis is rejected for all the variables in the above equation. The errors in the regression were auto-correlated and ARMA terms were included. The standard errors were corrected for heteroskedasticity using the White approach. The result of the regression is presented in the upper part of table 1.

¹⁵ This assumption is consistent with traditional purchasing power parity theory. One could think of a long-run trend for the real exchange rate as predicted by the Balassa-Samuelson effect, but this trend should be declining. This definitely does not seem to be the case for the Brazilian economy in the last few years

In CCV's model $\beta_5 = -\beta_6 = -\beta_7 = \beta_8$. A Wald coefficient restriction performed on this hypothesis does not reject it, with a p-value of 71.6% for the F statistic. Furthermore the model implies that $\beta_2 = \beta_3 = -\beta_4$. This hypothesis was not rejected with a p-value of 18.2% for the F statistic. The less restrictive hypothesis that $\beta_2 = \beta_3$ is not rejected, either with a p-value of 91.3% for the F statistic. The lower part of table 1 presents the results of the regression with the restrictions.

Table 1 - Regression Results

| Dependent Variable: D(CBOND) | | | |
|-----------------------------------------------|-------------|------------|-------------|
| Sample: 1999:01 2002:12 | | | |
| Unrestricted Model | | | |
| Backcast: 1998:09 1998:12 | | | |
| Variable | Coefficient | Std. Error | t-Statistic |
| C | -0.707 | 0.457 | -1.548 |
| X(-1) | -0.176 | 0.135 | -1.305 |
| E(-1) | -0.157 | 0.100 | -1.571 |
| Y(-1) | 1.191 | 0.617 | 1.929 |
| EF(-1)-E(-2) | -2.020 | 0.495 | -4.080 |
| D(E(-1)) | 2.000 | 0.434 | 4.606 |
| YF(-1)-Y(-2) | 1.192 | 0.660 | 1.806 |
| D(Y(-1)) | -1.187 | 0.920 | -1.291 |
| AR(1) | -0.569 | 0.165 | -3.448 |
| MA(3) | -0.466 | 0.172 | -2.711 |
| MA(4) | -0.525 | 0.184 | -2.854 |
| Restricted Model | | | |
| Backcast: OFF (Roots of MA process too large) | | | |
| Variable | Coefficient | Std. Error | t-Statistic |
| C | -0.341 | 0.224 | -1.525 |
| X(-1)+E(-1) | -0.077 | 0.049 | -1.586 |
| Y(-1) | 1.067 | 0.318 | 3.358 |
| E(-1)-EF(-1)-Y(-1)+YF(-1) | 1.510 | 0.353 | 4.274 |
| AR(1) | -0.463 | 0.178 | -2.596 |
| MA(3) | -0.480 | 0.170 | -2.819 |
| MA(4) | -0.638 | 0.116 | -5.481 |

The above tests show that CCV offer a good description of the evolution of the risk spread, at least on the short run. According to their definition, Brazil is clearly a financially vulnerable economy. In the restricted model a 1% unexpected change in the exchange rate leads to a 1.43% increase in the risk-spread. These results are expected as the import share of output in Brazil is extremely low for international standards (about 8% of GDP) and debt/GDP ratio substantial (about 40% of GDP)¹⁶.

¹⁶ Unless otherwise stated, the source of data given about Brazil is the Banco Central do Brasil database (<http://www.bcb.gov.br>)

The next step is to check if increases in the risk-spread actually lead to crises. Ideally one should estimate a full structural model for the output with the risk spread as one of the explanatory variables. However, such a model would necessarily involve a reasonable amount of lags and of explanatory variables. With a sample of 48 observations there would be very few degrees of freedom and the estimate would not be reliable.

The approach taken was to do Granger Causality tests to see if changes in the C-Bond predate changes in the output gap. One cannot reject the unit root hypothesis for the C-Bond, so the test was done on the variations of the two variables. The number of lags was chosen by estimating a VAR on the two variables and checking which specification minimized the Akaike criterion for the equation with the output gap as the explained variable. For completeness, the procedure was repeated pairing output gap with other variables. The latter estimates were done in levels, as the other variables are all stationary. In all cases the number of lags chosen was 6. The p-values of the test and the long-run coefficients extracted from the VAR estimations are reported in table 2.

Table 2 - Granger Causality Tests and Long Run Coefficients

| H_0 : First variable does not granger cause second variable | | |
|---------------------------------------------------------------|---------|----------------------|
| | p-value | Long-Run coefficient |
| D(CBOND) and D(Y) | 0.15 | 0.053 |
| E and Y | 0.39 | 0.023 |
| E-EF and Y | 0.14 | 3.296 |
| X and Y | 0.48 | 0.075 |

One cannot reject the hypothesis of non-granger-causality at a 10% level for any of the variables including the risk premium. CBOND and E-EF, the unexpected exchange rate, have both p-values close to 10% and one could explain the high p-values as a consequence of the low amount of data. However, the long-run coefficients do not have the expected sign.

One explanation for these results is that unexpected exchange rate variations, which increase the risk premium, also increase exports, offsetting the negative effects of the risk premium on output. The very high p-value for exports suggests that this explanation is not totally satisfactory. A final test can only be made with a full structural model.

Another explanation is that the credit channel is not working in the Brazilian economy, i.e., higher interest rates do not lead to lower output. This possibility is not

present in CCV, where the transmission is taken as a given. To understand this one has to introduce the CC curve, which is not present in CCV model. This curve reflects a credit constraint put by the willingness to pay of the borrower. If borrowers are paying high interest rates this means that the SS curve is very high, so maximum leverage is low and the constraint is likely to be binding. ABB identify financial vulnerability with intermediate levels of financial development, which implies among other things a not very big but not very small leverage. This feature, which is not taken into account in CCV's definition, might be what keeps the Brazilian economy from responding to unexpected exchange rate variations.

In Brazil about half of the foreign debt is held by the government. In any country, the government is the most creditworthy borrower. If the government of a country defaults, firms in this country are likely to default as well. The risk of default by the government is a systemic risk, which has to be added to the risk of a given firm having a bad realization of its output¹⁷. This can be incorporated in the model by multiplying the left-hand side of equation 3 by the probability of the government paying its debt. It is easy to show that the SS curve faced by the firms will be higher the lower this probability. This probability, in turn, is smaller if the government pays a higher risk premium. So even if the government is not constrained by the CC curve, this might be the case for firms within the country¹⁸. The risk premium responds to changes in the creditworthiness of the government but it has little impact on the investment of firms, for those are forced to invest at infra-marginal returns anyway.

Data by other studies support this interpretation. In a cross country study made by Levine (2000) including 60 countries, Brazil features the 19th lowest domestic assets of deposit money banks/GDP ratio at 32% as opposed to 55% in Korea and 82% in Thailand. Moreira and Puga (2001) using firm level data show that between 1994 and 2000, only 20% of the growth of Brazilian firms was financed by issue of new debt. Barajas and Steiner (2002) confirm the role of the government on the credit constraint faced by the firms. They show that credit expansions and slowdowns to the private sector in Brazil in the last decade are negatively correlated with lending to the Central Bank. This is not a contradiction to the fact observed

¹⁷ For a model inspired in the Brazilian economy where the risk spread paid by the firms is given by the creditworthiness of the government see Razin and Sadka (2002)

¹⁸ Especially for small firms, which have more difficulty getting credit because of higher mortality rates, rising even further the probability of default. Moreira and Puga (2001) show that indeed smaller firms in Brazil have significantly lower leverage.

above that monetary policy has a small impact on output because of the small importance of credit as a mean to finance firms.

Balance sheet effects do not have significant impact in Brazil because of low leverage. That low leverage is acknowledged as a problem by the new administration, which intends to take steps to increase it by reforming the financial market (see Ministério da Fazenda, 2003). If it succeeds and firms decide to borrow in dollars, the negative effects of the exchange rate on the risk premium might start to be more significant.

Conclusion

Credibility issues mean that balance sheet effects are a potential problem for economies that depend on foreign debt. Different features make an economy vulnerable to balance sheet effects. Low share of imports, high proportion of foreign debt and high leverage seem to be the most relevant ones. With the exception of low shares of imports, these were characteristics of the East Asian economies that collapsed in 1997. They explain the sharp drop in output in these economies after the crisis.

The empirical results in this essay imply that Brazil is not a vulnerable economy because output does not respond to unexpected exchange rate devaluations as implied by the theory. However, they also show that these have a very significant impact on the risk premium paid on debt. One possible explanation is that Brazil's financial robustness is a consequence of its low leverage. Relatively few big firms and the government have access to foreign debt, so the swings in the risk premium are only of concern to those. Most of the firms in the country do not have access to credit for investment or are constrained to a point where changes in the interest rate do not make a difference to them.

This explains the resilience of the Brazilian economy in more than two strong real exchange rate devaluation episodes in the last four years. However, this comes at a cost. Low leverage stifles growth and high interest rates pose a serious problem for the government finance. The new administration has promised to gradually create the conditions that will lead to lower the interest rates and expand access to credit. The results in this essay suggest that if they are successful access to foreign denominated debt will have to be limited and foreign commerce increased, otherwise balance sheet effects will start to matter for the Brazilian economy.

Appendix 1

Let the yield on investment have a uniform distribution with support $[0, \Theta]$. Θ can be interpreted as a measure of the efficiency of the investment project.

$$\text{Let } 1 - \frac{N}{N+D} \equiv \Psi\left(\frac{N+D}{N}\right), \text{ with } \Psi'(\cdot) > 0$$

Then equation 3 can be rewritten as

$$(1+\rho) = (1+\rho)(1+\eta) \left[1 - (1+\rho)(1+\eta) \frac{\Psi}{\Theta} \right] \Leftrightarrow (1+\eta)^2 (1+\rho) \frac{\Psi}{\Theta} - (1+\eta) + 1 = 0 \quad (\text{A.1})$$

$(1+\eta)$ is the solution to the above quadratic equation, i.e.

$$(1+\eta)(1+\rho) = \frac{1 \pm \sqrt{1 - 4(1+\rho) \frac{\Psi}{\Theta}}}{2 \frac{\Psi}{\Theta}} \quad (\text{A.2})$$

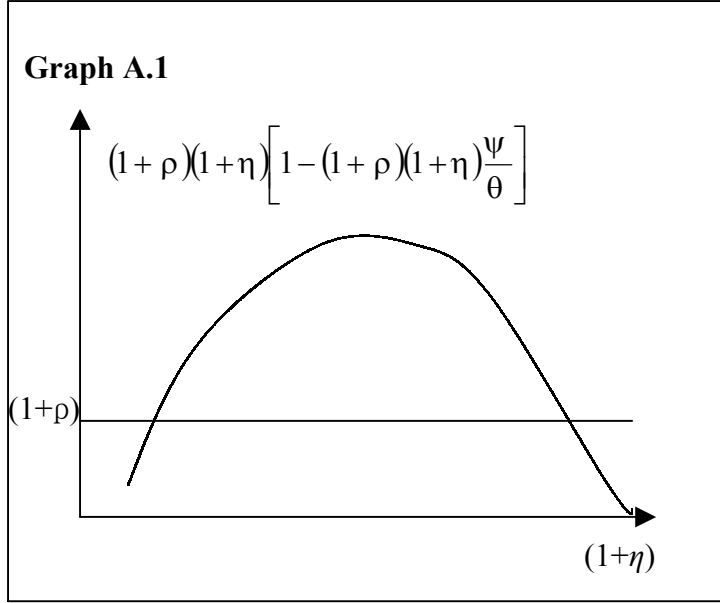
This equation has real solutions if

$$\Theta \geq 4(1+\rho)\Psi \quad (\text{A.3})$$

That is, a solution exists if the investment project is efficient enough and if the investment to net-worth relation and the world interest rate are not too big. Additionally, for the probability of repayment to be positive, the equilibrium risk premium has to satisfy

$$\Theta > (1+\eta)(1+\rho)\Psi \quad (\text{A.4})$$

This is generally less restrictive than A.3, as the risk premium is rarely bigger than 4. In general, if a solution exists it will not be unique. The term under the square root is smaller than 1, so the two solutions yield positive risk spread. One of those can be ruled out. Graphically, the equilibrium is in an intersection of the two curves in Graph A.1



On the horizontal axis is the risk premium offered by the lender. On the vertical axis is the expected return in excess of the safe rate for each possible risk premium. If the market for loans is competitive, the lender will have to offer a risk premium such that she earns on average the same as in a safe asset. There are two possible equilibria. One can rule out the high risk premium one because if it were an equilibrium, some lender could offer a lower risk premium, provide all the loans in the market and have expected revenue above the opportunity cost of lending. Therefore it is cannot be a Nash Equilibrium. With a uniform distribution, if an equilibrium exists it is unique.

The argument above can be generalized. Independent of the form of the expected return curve, for a Nash Equilibrium to exist the expected revenue curve has to cross the horizontal axis from below. Mathematically, around the equilibrium,

$$\frac{\partial G(1+\rho, 1+\eta, \Psi)}{\partial(1+\eta)} > 0, G(1+\rho, 1+\eta, \Psi) \equiv (1+\rho)(1+\eta)P[\bar{\omega} \geq (1+\rho)(1+\eta)\Psi] - (1+\rho) \quad (\text{A.4})$$

Given $(1+\rho)$, equation 3 defines an implicit function of $(1+\eta)$ on Ψ . By the Implicit Function Theorem:

$$\frac{d(1+\eta)}{d\Psi} = -\frac{\frac{\partial G}{\partial \Psi}}{\frac{\partial G}{\partial(1+\eta)}} = -\frac{(1+\rho)(1+\eta) \frac{\partial P[\bar{\omega} \geq (1+\rho)(1+\eta)\Psi]}{\partial \Psi}}{\frac{\partial G}{\partial(1+\eta)}} > 0 \quad (\text{A.5})$$

Hence, the SS curve is upward sloping.

Appendix 2

Estimates for the expected real exchange rate and output gap.

Table A.1

Dependent Variable: E

Sample(adjusted): 1999:01 2002:11

Backcast: 1998:09 1998:12

| Variable | Coefficient | Std. Error | t-Statistic |
|--------------------------------|-------------|------------|-------------|
| C | -4.569 | 0.036 | -125.238 |
| AR(1) | 0.911 | 0.163 | 5.606 |
| AR(2) | -0.310 | 0.165 | -1.877 |
| MA(1) | 0.899 | 0.064 | 14.070 |
| MA(4) | 0.348 | 0.070 | 4.982 |
| Mean Absolute Percentage Error | 0.689 | | |
| Theil Inequality Coefficient | 0.005 | | |
| Bias Proportion | 0.000 | | |
| Variance Proportion | 0.048 | | |
| Covariance Proportion | 0.952 | | |

Dependent Variable: Y

Sample(adjusted): 1999:01 2002:11

Backcast: 1998:09 1998:12

| Variable | Coefficient | Std. Error | t-Statistic |
|--------------------------------|-------------|------------|-------------|
| C | 0.006 | 0.002 | 2.400 |
| AR(1) | 0.353 | 0.141 | 2.500 |
| MA(7) | -0.911 | 0.023 | -38.795 |
| Mean Absolute Percentage Error | 0.017 | | |
| Theil Inequality Coefficient | 0.357 | | |
| Bias Proportion | 0.005 | | |
| Variance Proportion | 0.017 | | |
| Covariance Proportion | 0.978 | | |

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