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THE MACROECONOMICS OF THE MEXICAN CRISIS: A SIMPLE TWO-PERIOD MODEL

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ABSTRACT

The Macroeconomics of the Mexican Crisis: A Simple Two-period Model*

We analyse the events leading to the devaluation of the Mexican peso last year, using a simple two-period model. We view the problem as a race between a foreign investment led demand boom and the potential expansion in supply which might follow; the outcome of such a race is inherently uncertain. If, in an exchange rate based stabilization programme, supply does not keep pace with demand, competitiveness problems will eventually result in lower output, and consequently the government might be tempted to devalue. In Mexico it would also appear that the costs and benefits of maintaining the regime were adversely affected by a reduction in the amount of external financing available.

JEL Classification: F31, F32, F41
Keywords: macroeconomic stabilization, Mexico, exchange rate crisis, capital inflow

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NON-TECHNICAL SUMMARY

This paper presents a general discussion and a formal theoretical analysis of the events leading to the devaluation of the Mexican peso and the ensuing crisis in December 1994. We use a simple two-period model; although highly stylised, the simplicity of this model allows a variety of issues and mechanisms to be examined.

In the early 1990s Mexico enjoyed a boom with the implementation of the NAFTA trade agreement. This led to a large reduction in the risk premium on capital and the resulting surge in investment caused a large shock to aggregate demand. The commitment to the fixed exchange rate led to an inability to choke off this boom by monetary tightness; the result was rising costs and prices, which, most critically, reduced exports and promoted imports, ultimately lowering aggregate demand and thus output.

At the same time the investment boom led to a potential expansion in supply capacity, which would work against the above mentioned tendency for rising costs and prices, but only gradually. As in real business cycle theory, such capacity expansion takes 'time to build'.

One can in fact think of the initial reduction in risk premia as setting up a race between the demand boom and time to build. The essential claim of the analysis is that the outcome of such a race is uncertain. If the supply expansion is not large enough or quick enough then macroeconomic outcomes and policies which look sustainable turn out not to be.

One mechanism available to correct such a slump is devaluation. The Mexican government would resist such a move to avoid losing credibility, however. As with all such regime-choice questions, the decision to depreciate involves a cost-benefit calculation: beyond a certain point, soldiering on with a fixed exchange rate is too costly an option. This appears to be the best explanation of the underlying forces which were at work in Mexico last year: that the loss of export demand, caused by uncompetitiveness, rendered maintenance of the fixed regime too costly.

The difficulty of sustaining the fixed exchange rate appears to have been compounded by a reversal of capital flows. With the rise in costs and prices and the uncompetitiveness of the export sector, capital flowed out, further exacerbating a reduction in asset values and in aggregate demand. These problems were made worse by political instability during 1994; asset holders,

fearing the possibility of abandonment of the policy reforms, began to require a risk premium, further depressing demand. On top of this, the rise in US interest rates increased the foreign rate on which the risk premium had to be applied.

In our two-period model we formalise these issues; our approach is to solve for the range of realisations for the state variable – which determines the extent of the supply expansion in the second period – over which the government is willing to maintain the fixed exchange rate regime. We then develop the basic model and focus on how unanticipated exogenous factors can lead to the imposition of an external financing constraint, with the reversal in capital flow during the second phase of the analysis. This implies a limit on the extent to which the government can run a current account deficit (or perhaps the government might have to run a surplus) at the same time as the government is facing competitiveness problems. These factors combined, significantly alter the costs and benefits of maintaining the fixed regime, and increase the extent of the supply expansion necessary to induce the government to maintain the fixed rate.

Upon entering the fixed regime, as part of a wide-ranging policy reform package, we can presume that the Mexican government anticipated a sufficiently large and rapid supply expansion in the second phase to facilitate the transition of the economy. It seems apparent, however, that the government did not anticipate the exogenous reduction in the availability of external finance, which significantly altered the costs and benefits of maintaining the fixed regime. With hindsight, and a knowledge of the deterioration in the amount of external finance available, it would seem unlikely that there could be a sufficiently timeous supply expansion; with *hindsight* it would therefore appear that the Mexican position was *not* sustainable.

Our analysis suggests that a government, in the first stages of an exchange rate based reform, should attempt to dampen consumption expenditure so as to 'make way' for non-inflationary investment, thus reducing the competitiveness problem in the second phase. We also suggest that it would be beneficial for the government to promote direct investment rather than portfolio investment; direct investment is likely to be more stable and hence the economy will be less vulnerable to a reversal in capital flow in the second phase.

One final message might be to avoid exchange rate based stabilization altogether. That is, it may be better to float the exchange rate and then to base macroeconomic discipline around a tight regime for monetary aggregates (or around an explicit inflation target). Although there are problems with this

alternative as well, we would argue that exchange rate based stabilization programmes are to some extent intrinsically vulnerable to collapse, and therefore might often be inappropriate.

1. Introduction

There may be a general lesson to learn from the problems which engulfed Mexico in December last year. A number of "emerging market" economies - such as Indonesia and Argentina - have undergone similar economic reform programs in recent years, and may yet face similar problems. Furthermore, the issues involved may be of relevance elsewhere, including eastern Europe.

The representative emerging market is a low-wage developing country in which macroeconomic stabilisation has been put in place, providing a new guarantee of stability. Against the background of such macroeconomic policies, the returns to inward investment, which had previously been risky, come to seem high. The prospect of high returns on such activities leads to an inrush of funds and a demand boom. This leads to a loss of competitiveness and a current account deficit. That deficit may in turn endanger the stabilisation, if it has been based on a fixed exchange rate.

In this paper we present a theoretical analysis of the macroeconomics of these issues concentrating on one key aspect: the sustainability of the fixed exchange rate. We view the problem as a "race" between the demand stimulus produced by the investment boom, and the supply expansion which the investment will bring on stream. If all goes well then supply keeps pace with demand. But it may not do so. We focus on the macroeconomic policy choices facing a government in this uncertain environment. We ask: is a fixed exchange rate likely to be sustainable in the face of an inrush of funds and then its reversal?

We use a simple 2-period model, the basic version of which is outlined in section 3; although highly stylised, the simplicity of this model allows a variety of issues and mechanisms to be formally examined. The central idea is that there is uncertainty about the extent to which the supply expansion will catch up with the initial demand boom. If it does not do so sufficiently, then the competitiveness problem resulting from the demand expansion in the first period, will cause a slump in aggregate demand and output in the second period. This might provoke the government into abandoning the fixed exchange rate in search of higher output through a monetary expansion.

In sections 4 and 5, we consider two possible extensions, along the lines of the work by Ozkan and Sutherland (1994) and Obstfeld (1994). In these stories the shortfall in aggregate demand can be exacerbated by expectations of devaluation provoking interest rate increases, and by anticipatory wage increases further squeezing competitiveness. We reject these as not fundamental to the Mexican case. Instead, in section 6 we consider our own preferred development of the basic model, in which government policy is constrained by an external financing or balance of payments requirement in the second period. This makes the necessary reduction in aggregate demand more severe. In section 7 we examine the conditions under which the government might face a binding constraint of this sort. Section 8 concludes.

2. Some Stylised Facts: An Outline of the "Mexico Story"[3]

The joining of NAFTA put the seal on a program of macroeconomic stabilisation in Mexico, which led to a very big reduction in the risk premium on capital. Investments which had been affected by policy risk now had a guarantee of macroeconomic stability. The result was a surge in investment, causing a large shock to aggregate demand; between 1989 and 1992 investment increased by 28% in real terms.[4]

The commitment to a fixed exchange rate - the stabilisation in Mexico was exchange rate based - led to an inability to choke off this boom by monetary tightness and exchange rate appreciation; there was neither the experience nor the institutional mechanism to deal with it by fiscal contraction. In addition, as Feldstein (1995) notes, the savings rate actually fell; consumers, expecting personal incomes to grow in the future, were naturally tempted to cut their saving and spend more straight away.

The result of the boom was rising costs and prices, which, most critically, reduced exports and promoted imports, reducing aggregate demand and thus output. Between 1988 and 1992, wholesale prices rose by 96% in Mexico, contributing to an approximate 24% appreciation in the real exchange rate *vis-a-vis* the U.S. dollar.

At the same time, the investment boom led to potential expansion in supply capacity. Such an enhanced supply capacity would work against the above mentioned tendency for rising costs and prices, but only gradually. As in real business cycle theory, such capacity expansion takes "time to build"

One can in fact think of the initial reduction in risk premia as setting up a race between the demand boom and time to build: between the cost raising consequences of the demand boom - which depressed net exports - and the cost reducing consequences of the supply expansion - which expanded them. The essential claim of the analysis presented here is that the outcome of such a race is uncertain. If the supply expansion is not large enough or quick enough then macroeconomic outcomes and policies which look sustainable turn out not to be. This is essentially Hayek's version of real business cycle theory (see Hicks, 1967).

It appears that, ex-post, time to build did badly: too little, too late. As a result, entering into what we might call the second period of our analysis, the economy had an uncompetitive cost structure, an emerging reduction in net exports, and low demand; basically, the economy was facing a slump.

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[3] For a very clear account of the facts of the case see Sachs, Tornell and Velasco (1995).

[4] The source of all figures quoted in this paper is *International Financial Statistics*, except where otherwise indicated.

Between 1988 and 1992 the current account deficit rose from -$2.4b to -$24.8b (as a proportion of GDP the current account deficit rose from 1.4% to 7.6%). By 1993 the rate of real growth in GDP had slowed to 0.6%, compared with 4.4% in 1990.

One mechanism available to correct the competitiveness problem is devaluation. It is true that a government committed to a fixed exchange rate *vis-a-vis* the U.S. dollar, as part of a wider set of policy reforms, would want to resist devaluation, in order to avoid losing credibility. An initial calculation of the costs and benefits of the reform strategy might well have argued in favour of the credibility benefits of a fixed exchange rate, even if such a regime involved a tying-of-the-hands of monetary policy, preventing it being used to stabilise shocks such as the one just described. But like all such regime-choice questions this involves a cost-benefit calculation: beyond a certain point, soldiering on with a fixed exchange rate is too costly an option. This appears to be the best explanation of the underlying forces which were at work in Mexico last year: that the loss of export demand, as a result of uncompetitiveness, caused maintenance of the fixed exchange rate to become too costly.

The difficulty of sustaining the fixed exchange rate appears to have been compounded by a marked slowdown in the inflow of capital which, with hindsight, looked inevitable. With the rise in costs and prices, and the uncompetitiveness of the export sector, the prospects for capital worsened. These problems were exacerbated by domestic political turmoil during 1994; asset holders, fearing the possibility of abandonment of the policies of reform, began to require a risk premium. This depressed demand further, making the slump worse, and so making it more difficult for the government to soldier on. On top of this, rising U.S. interest rates increased the foreign rate on which the risk premium had to be applied, leading to further pressure.

In sum, the intrinsic features of the above-described process are:

i) a large boom in aggregate demand, causing an increase in output and prices, intrinsically leading to a subsequent reversal in a "second phase" - this then set in train the temptation to allow the fixed exchange rate to collapse;

ii) an expansion in aggregate supply of uncertain speed and size, which if it is not fast or large enough fails to prevent the slump in output in the second stage, and thereby fails to save the regime; and,

iii) a slowdown or perhaps even reversal in the capital inflow, making collapse in the second phase more likely.

In addition:

iv) additional unexpected negative shocks - in this case domestic political events and U.S. interest rate rises - can tighten the capital inflow constraint, making collapse more likely.

This account sees evidence of the collapse of the peso as an issue of policy choice for the government: abandoning a commitment to the fixed exchange rate in the face of internal developments which make it vulnerable to adverse external circumstances.

3. The Basic Model

The model has the following features:

i) In the first period there is a demand shock (denoted δ) which expands output for *one period* only.[5] This boom causes inflation, and some of this inflation will be carried through to the second period.

ii) First period inflation and the lagged effect on second period inflation causes a competitiveness problem in the second period.

iii) In the second period there is a realisation of a random variable (denoted λ) which determines the extent to which the period 1 demand shock feeds through to an expansion of aggregate supply in period 2.

iv) The government faces an exogenously fixed political cost of devaluation.

The demand and supply equations which form the basis for the model in each period are:

(1) $$y_1 = \sigma(e_1 - p_1) - \gamma_1 + \delta$$

(2) $$p_1 = p_0 + \phi(y_1 - \bar{y})$$

(3) $$y_2 = \sigma(e_2 - p_2) - \gamma_2$$

(4) $$p_2 = p_1 + \phi(y_2 - \bar{y} - \lambda\delta) + \xi(p_1 - p_0)$$

[5] Some choices are necessary to fit the model into two periods - we wish here to capture the fact that the extra investment is a temporary stock adjustment rather than a permanent additional flow.

where y is the output level (the subscript denotes the relevant period); e is the nominal exchange rate; p is the price level; i is the nominal interest rate; and, $\bar{y}$ is the natural rate of output

In this section, we assume that the domestic interest rate equals the exogenously fixed foreign interest rate:

(5) $\quad i_2 = i_2^*$

We make the following simplifying assumptions:

i) $\quad i_1 = i_1^* = 0$

ii) $\quad e_1 = e_0 = p_0 = 0$

iii) $\quad \bar{y} = 0$

Note that we are effectively assuming that the government maintains the fixed rate with certainty in the first period. To justify this we require the satisfaction of a period 1 rationality condition *i.e.* that it is rational for the government to enter and maintain the fixed agreement with certainty in period 1, before the period 2 realisation of λ. We take it as given that such a rationality condition is satisfied (we will return to this point later).

Using the above assumptions, we can re-write the model:

(1)' $\quad y_1 = \sigma(-p_1) + \delta$

(2)' $\quad p_1 = \phi y_1$

(3)' $\quad y_2 = \sigma(e_2 - p_2) - \gamma i_2^*$

(4)' $\quad p_2 = (1+\xi)p_1 + \phi(y_2 - \lambda\delta)$

3.1. Solving the Basic Model

In this model the first period aggregate demand shock causes inflation and hence a competitiveness problem in the second period. If the government chooses to maintain the fixed exchange rate then output will fall. This negative effect on second-period output may be offset by what we might call the "structuralist" type feed through of first period investment to an

outward shift in aggregate supply in the second period. The government trades off the output consequences of the fixed rate against the political cost of devaluation.

The basic model can be solved to give the following:

(6) $y_1 = M\delta \qquad where \qquad M = 1/(1+\sigma\phi)$

(7) $p_1 = \phi M\delta$

(8) $y_2 = M\left[\sigma e_2 - \sigma\phi(1+\xi)M\delta + \sigma\phi\lambda\delta - \gamma i_2^*\right]$

(9) $\Delta p_2 = \phi M\left[(\xi - \sigma\phi)M\delta - \lambda\delta + \sigma e_2 - \gamma i_2^*\right]$

In the second period output increases with an exchange rate devaluation (this is the government policy variable). Output decreases with the size of the first period demand shock, as this has a negative effect on competitiveness, but this might be offset by the structuralist feed-through from the higher investment in the first period to supply expansion in the second. Higher foreign interest rates dampen aggregate demand and hence depress output.

The problem now is to find the range of λ shock realisations over which the government will maintain the fixed exchange rate agreement. The approach is to find trigger values, λ^T, at which point the government is indifferent between regimes.

Consider the following utility function:

(10) $U_G = -(y_2)^2 - Z(e_2)$

$where \quad Z(e_2) > 0 \quad if \quad e_2 \neq 0$

$Z(e_2) = 0 \quad if \quad e_2 = 0$

In this model the government cares only about the minimisation of output deviations around a constant natural rate.

Clearly, if the government floats it will set the exchange rate so that $y_2 = 0$. This implies the following exchange rate policy:

(11) $e_2 = \frac{\gamma}{\sigma} i_2^* + \phi(1+\xi)M\delta - \phi\lambda\delta$

Under the fixed regime we can determine the output level by setting $e_2 = 0$ in equation (8) to get the following:

(12) $$y_2 = M\left[-\gamma i_2^* - \sigma\phi(1+\xi)M\delta + \sigma\phi\lambda\delta\right]$$

By substitution of these equations for output into utility function (10), we can determine the utility level of the government under each regime. By equating these functions and solving for λ we can determine the trigger points at which the government would switch between regimes:

(13) $$\lambda^T = \left(\frac{1+\xi}{1+\sigma\phi}\right) + \frac{1}{\sigma\phi\delta}\left[\gamma i_2^* \pm (1+\sigma\phi)\sqrt{Z}\right]$$

Note that there are two roots for λ^T. If λ is lower than the negative root the government quits the regime and devalues to boost aggregate demand. If λ is higher than the positive root then the government quits in order to appreciate and *dampen* aggregate demand (it does so because the supply expansion is so large that output exceeds the target). If λ is between the positive and negative roots the government will choose to maintain the fixed regime.

In the following discussion we concentrate on the negative root; the notion that a government might be forced to quit the fixed exchange rate agreement because it is over-expansionary does not fit well with the Mexican experience.

We can make a number of inferences about the negative root which provide the central findings from the basic model:

i) The trigger is increasing in ξ as this implies a greater competitiveness problem and hence output loss in the second period under the fixed regime.

ii) The trigger is increasing in the foreign interest rate as this implies a further depression in aggregate demand in the second period, which the government will be unable to offset under the fixed regime.

iii) The trigger is decreasing in Z; clearly a higher fixed cost of quitting the exchange rate regime acts as a disincentive to devalue.

iv) The effect of higher δ appears to be ambiguous. It is clear that higher δ increases the competitiveness problem in the second period relative to the political cost of switching regime, and so this raises the trigger. On the other hand, higher δ reduces the relative effect of higher foreign interest rates and so this lowers the trigger (but this is really a scaling effect).

4. Interest Rates and Devaluation Expectations

In this section we outline an extension to the basic model presented above. So far we have assumed that the domestic interest rate equals the foreign rate. In this section we replace this assumption with the uncovered interest parity condition and examine the implications for the sustainability of the exchange rate agreement.[6]

Replace equation (5) with the UIP condition:

$$i_2 = i_2^* + E_1(\Delta e_2)$$

where $E_1(\Delta e_2)$ is the expected change in the exchange rate in the second period

Given $e_1 = 0$ implies $\Delta e_2 = e_2$ we can therefore re-write the UIP condition as,

(5)' $$i_2 = i_2^* + E_1(e_2)$$

Solving for the model in the same way as above we get the following pair of output and inflation equations:

(14) $$y_2 = M\left[\sigma e_2 - \sigma(1+\xi)\phi M\delta + \sigma\phi\lambda\delta - \gamma\left(i_2^* + E_1(e_2)\right)\right]$$

(15) $$\Delta p_2 = \phi M\left[(\xi - \sigma\phi)M\delta - \lambda\delta + \sigma e_2 - \gamma\left(i_2^* + E_1(e_2)\right)\right]$$

Once again we consider a government which maximises utility function (10). As before, under floating the government would set $y_2 = 0$, implying the utility level $U_G = -Z$.

Under the fixed regime the output level would be given by,

(16) $$y_2 = M\left[-\sigma(1+\xi)\phi M\delta + \sigma\phi\lambda\delta - \gamma\left(i_2^* + E_1(e_2)\right)\right]$$

[6] Ozkan and Sutherland (1994) consider the effect of endogenous devaluation expectations on interest rates and the sustainability of exchange rate regimes.

This would imply the following utility level:

$$(17) \qquad U_G = -M^2\left[-\sigma(1+\xi)\phi M\delta + \sigma\phi\lambda\delta - \gamma\left(i_2^* + E_1(e_2)\right)\right]^2$$

Now the utility of the government under the fixed regime depends on the devaluation expectations of the private sector. In the discussion of the previous section, we concentrated on the trigger value for λ with the negative root, as we do not consider a situation where there is a positive probability that the government will quit the fixed rate, in order to appreciate and dampen aggregate demand, as appropriate to Mexico. If we now make the explicit assumption that the distribution of λ is such that the government will *never* quit in order to appreciate the currency, then we can assert that the government will only ever devalue, and so devaluation expectations can only reasonably be positive. From equation (17) we can see, therefore, that this extension implies a *lower* utility level for the government under the fixed regime.[7]

To keep the algebra simple, we solve for the trigger value given a fixed private sector devaluation expectation. Using the above equations we can equate utility under both regimes to find (discarding the positive root):

$$(18) \qquad \lambda^T = \left(\frac{1+\xi}{1+\sigma\phi}\right) + \frac{1}{\sigma\phi\delta}\left[\gamma\left(i_2^* + E_1(e_2)\right) - (1+\sigma\phi)\sqrt{Z}\right]$$

It is clear from (18) that a positive devaluation expectation will raise the trigger value for λ. Consequently, the feedback of expectations into interest rates will make it *less* likely that the government will be able to maintain the fixed exchange rate.

Note that to solve for this model properly we should introduce a rational devaluation expectation. This would involve solving for $E_1(e_2)$ as a function of an arbitrary trigger, given a specific form for the distribution of λ. We would then substitute this expectation into the above equation and solve for the "state-consistent" trigger value. This procedure is laborious and does not lead to any alteration in the basic result: the feedback of private sector devaluation expectations into domestic interest rates can make the fixed regime more costly to

[7] Even if we did allow for a small probability that the government might appreciate in exceptional circumstances, we would still expect that overall the private sector expectation would be for a positive rate of devaluation.

sustain and hence increases the likelihood of devaluation. The details of this procedure have therefore been omitted.[8]

It seems clear from the evidence of events leading to the devaluation of the peso, that this sort of mechanism can only have a supporting role in any explanation of the crisis. Only in the days immediately preceding the devaluation was there any increase in the interest rate differential *vis-a-vis* the U.S.. Although this certainly compounded the problems of the Mexican government in those few weeks, it cannot provide a compelling explanation of the crisis itself.

5. Endogenous Wages and Devaluation Expectations

In the formulation for aggregate supply, given in equations (2) and (4) above, there is no forward looking component determining prices. In a more satisfactory model there would be some forward looking component to capture the effect of price expectations on wage levels and hence current prices.

The inclusion of a mechanism of this sort would provide an additional source of destabilising feedback. To the extent that current prices depend on current wage levels, which in turn depend on expectations of future consumption prices, if agents expect a devaluation in the future this will push up the future consumption price, and hence lead to an increase in the inflation rate today. This will worsen any competitiveness problem faced by the government and may increase the likelihood of devaluation.[9]

Inspection of the data for Mexico would suggest that this mechanism did *not* have a significant role in the development of the Mexican crisis - the real consumption wage remained roughly constant throughout 1993 and the first part of 1994. This is perhaps not too surprising as the periodic nature of nominal wage bargaining implies this mechanism can only have a significant impact over the long-term. In the case of Mexico it would appear as though events happened too rapidly to be reflected in spiralling nominal wages.

[8] This approach is developed in Ozkan and Sutherland (1994), Obstfeld (1994) and Davies and Vines (1995).
[9] Obstfeld (1994) discusses this sort of mechanism.

6. An External Financing Constraint

We now turn to an alternative development of the model in which the government faces an external financing constraint during the second period; this limits the ability of the government to run a current account deficit, or requires the government to run a current account surplus. The severity of this constraint is determined, in part, by the size of the first period current account deficit.

In this section we will assume that this constraint is binding; it is this constraint rather than any shortfall in aggregate demand which restricts output in the second period (we consider when the constraint might be binding in the following section). Thus, in the second period there is a trade-off between maintaining the fixed exchange rate and the low output necessary to choke off imports and satisfy the balance of payments constraint.[10] Once again, a structuralist effect of higher supply capacity might reduce the output consequence of the fixed rate.

The second period BP constraint can be written as follows:

(19) $$\sigma(e_2 - p_2) - \mu y_2 \geq k\left[\mu y_1 - \sigma(e_1 - p_1)\right]$$

given $$-\infty < k(i_2^*) \leq (1 + i_2^*)$$

where μ is the propensity to import; and, k determines the severity of the BP constraint

The term on the left is the current account surplus in the second period. The term in square brackets on the right hand side is the current account deficit in the first period. The parameter which determines the severity of the BP constraint, k, is assumed to be an increasing function of the foreign interest rate; if the foreign interest rate increases then the value of foreign debt shall rise and so we will assume that the BP constraint becomes stronger.

The severest constraint which can be imposed is when $k = (1 + i_2^*)$. In this case the current account deficit in the first period must be matched by an appropriate surplus in the second. On the other hand, as $k \to -\infty$ this condition effectively imposes no constraints on the second

[10] In our conclusion we support this approach by arguing that international capital markets are to some extent segmented. Implicit within our argument, therefore, is the assumption that the government is able to raise domestic interest rates, curtail absorption expenditure, and in this way maintain the fixed exchange rate, given a binding external financing constraint.

period policy of the government. We assume that the function k is exogenously given, but sufficiently high for the constraint to be binding [and so we treat (19) as an equality].

In this development of the model the BP constraint effectively replaces the second period aggregate demand equation. Given this, we solve for the model in the same way as in section 3.1 above.

By substitution of y_1 and p_1 into the BP constraint, and with $e_1 = 0$, we can solve for second period output as:

$$y_2 = \frac{\sigma}{\mu}(e_2 - p_2) - \frac{k}{\mu}\left[\mu M\delta + \sigma\phi M\delta\right] \tag{20}$$

This equation, together with equation (4)', gives us a pair of simultaneous equations for output and prices in the second period. We can solve for output to get:

$$y_2 = \left(\frac{1}{\mu + \sigma\phi}\right)\left[\sigma e_2 - \sigma\phi(1+\xi)M\delta - k(\sigma\phi + \mu)M\delta + \sigma\phi\lambda\delta\right] \tag{21}$$

Output decreases with the first period demand shock for two reasons: firstly this causes inflation and hence competitiveness problems; secondly, this leads to an increase in imports and hence a higher first period current account deficit to be reversed in the second. As before this might be offset by a positive structural effect on output. Higher foreign interest rates reduce output as this implies a higher k and hence a stronger BP constraint.

The equation for second period inflation is given by:

$$\Delta p_2 = \left(\frac{\phi}{\mu + \sigma\phi}\right)\left[\sigma e_2 + (\mu\xi - \sigma\phi)M\delta - k(\sigma\phi + \mu)M\delta - \mu\lambda\delta\right] \tag{22}$$

As in the basic model, under floating the government will set the exchange rate so that it achieves the output target, $y_2 = 0$. This implies a utility level of $U_G = -Z$.

Under the fixed regime we can set $e_2 = 0$ in equation (21) to solve for the output level:

$$y_2 = \left(\frac{1}{\mu + \sigma\phi}\right)\left[-\sigma\phi(1+\xi)M\delta - k(\sigma\phi + \mu)M\delta + \sigma\phi\lambda\delta\right] \tag{23}$$

This implies the following utility level for the government under the fixed regime:

$$U_G = -\left(\frac{1}{\mu + \sigma\phi}\right)^2 \left[-\sigma\phi(1+\xi)M\delta - k(\sigma\phi + \mu)M\delta + \sigma\phi\lambda\delta\right]^2 \tag{24}$$

Equating the utility level under each regime and solving for λ^T gives:

$$\lambda^T = \left(\frac{1}{\sigma\phi\delta}\right)\left[\sigma\phi(1+\xi)M\delta + k(\sigma\phi + \mu)M\delta \pm (\mu + \sigma\phi)\sqrt{Z}\right] \tag{25}$$

Higher Z increases the spread between the positive and negative roots, increasing the probability of the government maintaining the fixed exchange rate regime. The government will devalue if λ is below the negative root and appreciate the currency if λ is higher than the positive root.

Focusing on the negative root we can make a number of inferences, which provide the central findings from the extended model:

i) The trigger is increasing in k - a harsher balance of payments constraint implies a greater output sacrifice if the fixed exchange rate is to be maintained.

ii) The trigger is increasing in ξ as this implies a worse competitiveness problem in the second period.

iii) The trigger is also increasing in the foreign interest rate as this implies a higher k and hence a harsher balance of payments constraint.

iv) Finally, the trigger is increasing in δ; higher δ implies a larger current account deficit in the first period and a greater competitiveness problem in the second.

7. A Combined Analysis

In this section we combine the analysis of both the basic model and the external financing constraint extension, and examine the conditions under which this constraint becomes binding.

The devaluation trigger points from sections 3 and 6 can be re-written as:

① $$\lambda^T = (1+\xi)M + \frac{\gamma}{\sigma\phi\delta} i_2^* - \frac{\sqrt{Z}}{\sigma\phi\delta M}$$

② $$\lambda^T = (1+\xi)M + \frac{M}{N\sigma\phi} k - \frac{\sqrt{Z}}{\sigma\phi\delta N}$$

where $M = 1/(1+\sigma\phi)$ $N = 1/(\mu+\sigma\phi)$

In figure 1 below we represent both of these schedules in (λ, k) space.

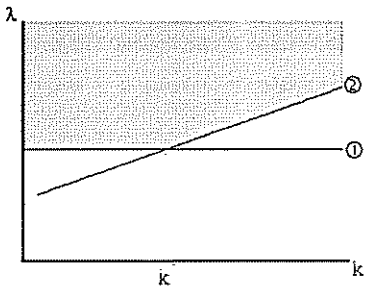

Figure 1

In figure 1 the no devaluation range is shown by the shaded area. For $k \geq k^*$ the balance of payments constraint is binding; as k increases beyond this point the range of λ realisations sufficient to allow the government to maintain the fixed regime shrinks.

Note that $\bar{k}$ is the level of k for which output in the basic model equals that in the external financing constraint extension (at the appropriate trigger point). For $k \geq k^*$, which implies a more severe BP constraint, output must be constrained by external financing considerations, rather than any shortfall in aggregate demand. We can solve for k^* to get:

(26) $$k^* = \frac{(1+\sigma\phi)}{\delta(\mu+\sigma\phi)}\left[\gamma i_2^* - (1-\mu)\sqrt{Z}\right]$$

We can see that k^* is increasing in the foreign interest rate (this is possibly misleading - see below), but decreasing in Z and δ. It is therefore more likely that the BP constraint will be binding (for a given value for k) when the political cost of devaluation increases and the size of the initial demand shock itself increases.

An increase in foreign interest rates has both a direct and an indirect effect in this diagram. Firstly, we can see from the above equations that schedule ① will shift upwards. In figure 2 below we can see that this will cause the no-devaluation region to shrink and so it will be less likely that the government can maintain the fixed regime.

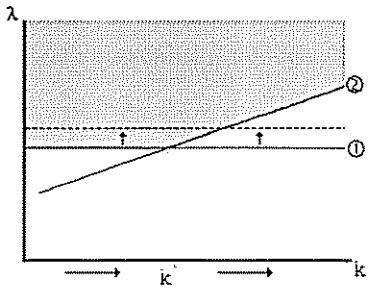

Figure 2

Secondly, we have already argued that k will be increasing in the foreign interest rate. Consequently, it will become more likely that the BP constraint is binding and so this will likewise reduce the possibility that the government is able to maintain the fixed exchange rate.

8. Conclusion

We would argue that the combined analysis of the basic model and the external financing constraint extension, presented in section 7, offers the most compelling basis for an understanding of the Mexican crisis. As has already been suggested, the interest rate and endogenous wage extensions, presented in sections 4 and 5, provide only limited insight.

First of all we should note the conflict between the endogenous interest rate and external financing constraint extensions. Essentially this is a price versus quantity issue; one approach suggests that interest rates will rise with devaluation expectations, whilst the other suggests that external financing will become more scarce. It is clear that in the case of Mexico the most significant element was the external financing constraint. The theoretical explanation for this is credit rationing (Stiglitz and Weiss, 1981) and the international segmentation of capital markets (Feldstein and Horioka, 1980; Feldstein, 1995). The observation to support this is that there was no significant rise in the interest differential prior to the crisis, but there certainly was

a marked decrease in the amount of capital flowing into Mexico in the months leading to the crisis.[11]

In short our formalisation of the Mexican story is the following:

i) In the first period the government did not envisage that it would face a binding external financing constraint in the second period.

ii) Given this first point, the government expected that the supply expansion in the second period would be sufficient for it to maintain that regime (although it may well have been aware that a sufficiently bad realisation might render the fixed exchange rate untenable). In terms of figure 1 the government anticipated $k < k^*$ (perhaps significantly so).

iii) A number of exogenous factors contrived to raise k, with the result that the government, in the end, faced a binding BP constraint in the second period. In terms of figure 1 it turned out that $k > k^*$ (perhaps significantly so).

iv) The supply expansion was insufficient for the government to maintain the fixed regime given that it faced a binding external financing constraint.

Basically, our explanation for the crisis is an exogenous increase in k compounded by a low realisation for λ. The position of the Mexican economy - including the fixed exchange rate - might at one point have looked sustainable (in what we have called the first period); it was the increase in k which changed the costs and benefits of maintaining the regime and ultimately led to the breakdown. With *hindsight*, anticipating the slowdown in the capital inflow, the position of the government might never have looked sustainable at all.

What factors led to the increase in k?

i) The rise in U.S. interest rates; during 1994 the Federal Reserve raised short-term U.S. interest rates five times, from 3% to 4.75%.

[11] The interest differential increased immediately prior to the devaluation of the peso.

ii) Political instability; the problems following the revolt in the Chiapas region were compounded in March 1994 by the assassination of presidential candidate Luis Colosio.

iii) To the extent that we can expect the availability of funds to diminish when investors anticipate a devaluation, the above effects, which increase the likelihood of devaluation, will in turn lead to a further reduction in available funds and thus a further increase in k.

There is one further reason identified by Feldstein (1995):

iv) The Mexican government incorrectly anticipated the continuation of the high capital inflow of previous years, which had allowed the current account deficit to reach the levels which it did - "Much of the ... inflow during the period was presumably intended by foreign investors as a one-time portfolio reallocation, including the repatriation of previous Mexican flight capital"

This final reason for the increase in k, more than any other, would support the hypothesis that the government did not anticipate the binding external financing constraint in the second period.

What are the implications for policy?

First, to the extent that the government is able to influence aggregate demand using fiscal policy, it can be regarded as having some influence over the first period aggregate demand shock. In doing so the government then influences the shape of figure 1 in the second period (schedule ① may shift up or down, whilst schedule ② will shift up with δ). By ensuring a lower δ the government reduces the likelihood that it will face a binding external financing constraint in the second period. We have chosen not to concentrate on fiscal policy questions in this paper, as we do not consider the Mexican government as having been able to exercise sufficient fiscal control to have a significant impact. However, to the extent that the government is able to exercise some fiscal control the policy implications are quite clear: damp consumption to make way for the investment boom.

Secondly, in the early stages of the stabilisation process, the government should closely monitor the source and composition of capital inflows, in an attempt to ascertain the sustainability of the capital flow, and its vulnerability to external events. To the extent that direct investment is less liquid than portfolio investment, a higher proportion of direct investment would imply a capital flow less

susceptible to fluctuations induced by external events. In the case of Mexico, the level of portfolio investment rose substantially during 1993, before collapsing during the first six months of 1994.[12] Over the same period the level of direct investment remained relatively stable. Portfolio investment was the more significant component of the capital flow, however, accounting for, on average, five times as much as direct investment during 1993.

The final message may be to avoid exchange rate based stabilisation. That is, it may be better to float the exchange rate and then to base macroeconomic discipline around a tight regime for monetary aggregates (or around an explicit inflation target). Of course there are difficulties with regimes that involve floating exchange rates: excess volatility (especially with the thin currency markets which emerging market countries are likely to experience), and vulnerability to inflation if the loss of a fixed exchange rate leads to an inability to precommit monetary policy and so an inability to prevent laxity. But our analysis suggests that an exchange rate based stabilisation regime faces perhaps a worse difficulty: it intrinsically carries the risk of undermining itself. At least, with floating, if things work out badly in period two, the currency can depreciate. Even a precipitate downward exchange rate movement may be superior to a collapse of the regime itself.

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[12] Between the first and second quarters of 1994 portfolio investment fell from $7.7b to $1.1b.

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