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DEVALUATION IN A DOLLARIZED ECONOMY
Theoretical models in the Mexican context

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A B S T R A C T

Devaluation has usually been seen as a measure to adjust the trade balance through changing the relative price of tradeables and non-tradeables. But this perspective needs to be modified considerably in a "dollarized" economy where significant amounts of financial instruments are denominated in dollars. In such an economy, the exchange rate has an equally important role as the relative price of co-existing financial instruments. The models in this paper emphasize the following effects of such a situation:

a) wealth redistribution from net dollar-debtors to net dollar-holders.

b) income redistribution caused by the revaluation of foreign currency interest payments

c) the dynamic effects in the medium-rum of these changes.

As an introduction to these models, the Mexican crisis of 1981-82 is discussed from a financial perspective.

R E S U M E N

Los efectos de una devaluación tradicionalmente han sido analizados desde el punto de vista de un cambio en los precios relativos de bienes comerciables y no comerciables. Pero en el contexto de una economía caracterizada por una dolarización de instrumentos financieros, este enfoque debe ser modificado. Los modelos en este documento demuestran los efectos financieros que pueden resultar de una devaluación, incluyendo lo siguiente:

a) redistribución de la riqueza de los agentes que poseen pasivos netos en dólares a aquellos con activos netos en dólares;

b) redistribución del ingreso causada por una revaluación de pagos de interés en moneda extranjera;

c) los efectos dinámicos en el mediano plazo de estos efectos.

Como introducción a los modelos, la crisis económica de México de los años 1981 y 1982 es discutida desde el punto de vista financiero.

Introduction

This paper is an intermediate report of a study designed to examine the effects of devaluation in an economy where a significant proportion of financial obligations and receipts are denominated in foreign currency. The fact that financial payments are by their nature completely inelastic suggests that such an economy will respond quite differently to a devaluation than one where only payments for goods are in foreign currency. This paper is intended to demonstrate that Mexico was (and is) a "dollarized" economy in this sense and takes inspiration from the Mexican case to begin to probe the implications for devaluation using some simple theoretical models. This is as a prelude to the completion of a general equilibrium model for the Mexican economy based on the "pre-crisis" structure of 1981, which will attempt to examine in a more comprehensive sense the effect of the devaluation and other policy measures of 1982, and what would have been the results of alternative policies.

The experience of Mexico from 1977-82 also suggests another perspective from which to view the objective of this study. It will be argued that this experience was in many respects a classic example of a financial boom and crash. Thinking of the devaluation as part of the collapse, and the dollarization process as part of the expansion, this study may be seen as describing the

real effects of a financial crash, given the structure of the preceding boom.

Dollarization in Mexico

To demonstrate the extent to which Mexican financial instruments were becoming dollar-denominated prior to the crisis of 1982, the results of a flow-of-funds exercise for 1981 are presented here. These results are arranged in a matrix of flows by type of asset and by type of agent, including beginning and ending stocks. The matrix, which is called a Financial Accounting Matrix (FAM) for easy reference, is part of a larger matrix, not reproduced here, which integrates the real data with the financial data, in the manner of a Social Accounting Matrix, and is called a Financial Social Accounting Matrix (FSAM). The only real data included in the present matrix is the financial surplus of each sector, which is equivalent to its saving minus its investment in real goods in the national income accounting sense.

Briefly stated, the structure of the matrix is to equate each sector's financial surplus to its accumulation of financial assets, classified by type, minus its accumulation of financial liabilities, classified by type. Since it is only the "effective flows" that go into this identity, the revaluation of instruments through exchange rate changes must be subtracted on both the liability and asset side.[1] This has the advantage of highlighting the capital gains and losses experienced by the

different agents. The other identity represented in the matrix is that the gross change (i. e. including revaluation) in a particular type of asset held by a particular agent plus the beginning stock will equal the ending stock. Thus the beginning and ending stocks of financial instruments appear at the margins of the matrix.

The financial instruments in the matrix are classified into peso, mexdollar, and dollar instruments. The first represents peso-denominated assets and liabilities of the Mexican banking system. The second designates dollar-denominated instruments in the Mexican banks. In view of the subsequent history of these dollar-denominated loans and deposits, it seems best to consider them as being denominated in a third "currency", the "mexdollar", which is capable of being "devalued" against the dollar. This is of course exactly what happened to them in 1982. The fact that mexdollar accumulation has very different implications for the balance of payments than dollar holding is another justification for keeping them separate.

Note that all domestic financial transactions that are not mediated through the banking system are ignored. This seems justified both because of the overwhelming importance of the banking system and because within-sector (i.e. between agents of the same type) transactions do not show up in the matrix anyway.

The third classification is dollar financial assets which, strictly speaking, need be neither financial nor in dollars. Rather, on the asset side this refers to any type of asset purchased outside of the country, be it Florida real-estate or deposits in a bank in New York, Zurich, or London. The distinction between real and financial is immaterial (for our purposes) for these external assets, since all will show up in the balance of payments in the same way. On the liability side, the concept refers primarily to external debt denominated in foreign currency.

The agents detailed in the matrix are of five types:

1) households, a broad term which due to data limitations probably includes some non-corporate enterprises,

2) firms, meant to be all private enterprises.

3) public sector, all public enterprises and state, local, and federal governments.

4) banking sector, all banking institutions public and private including Banco de Mexico.

5) external sector, all institutions, and residents outside Mexico,

6) residual sector, representing assets and liabilities of the banking system which could not be classified in the five categories above.

This matrix, then, has the advantage of giving us a "snapshot" of the extent of dollarization at the end of 1981, as well as showing the pace of dollarization during the year, for each of the sectors[2]. Table 1 gives us the share of total liabilities of each sector given by each type of instrument. While households managed to keep their relatively small liabilities in pesos, private enterprises and the public sector relied heavily on dollar financing. The public sector had fully 60% of its debt denominated in dollars, while private firms had only a slightly lesser percentage. The banks did not rely quite as heavily on dollars, but it is still surprising to see a banking system which had only 60% of its resources denominated in the national currency. Recall that these figures date from before the major devaluations which would raise the dollar percentages considerably.

A "flow" perspective on the dollarization process is given in table 2. The table gives the net financial surplus of each sector (savings minus investment) for 1981 as it is allocated or financed. It is clear that part of the reason for the reliance on dollar financing by public and private firms is the preference of households for dollar assets during 1982. Preliminary estimates show fully 50% of their saving being directed to these assets, and of this amount eight-tenths went to external assets and was lost to the economy. The result was that, in the net sense, private firms could only finance 21% of their financial deficit in pesos,

T a b l e 1

Share of total liability accounted for by each instrument
End of 1981

	(1)	(2)	(3)	(2) + (3)
	Peso	Mexdollar	Dollar	
useholds	.880	.120	0	.120
rms	.420	.206	.374	.580
blic Sector	.398	.295	.307	.602
nking Sector	.616	.145	.240	.385

Table 2

	Net Saving	Net Peso Accumulation	Net Mexdollar Accumulation	Net Dollar Accumulation	Residual
Household (Share)	634.8	310.7 (.497)	62.9 (.101)	251.4 (.402)	9.8
Firms (Share)	-145.5	-31.1 (.214)	-43.3 (.298)	-71.1 (.489)	0
Public Sector (Share)	-778.5	-231.3 (.297)	-321.4 (.413)	-225.8 (.290)	0
Banking Sector	0	-34.4	275.6	-229.2	-12
External	289.2	-0.3	12.9	274.7	1.9
Residual	0	-13.6	13.3	0	0.3

while the government only managed 30%. The vulnerability of these agents to a devaluation is clear.

While the private sector firms appear equally vulnerable to the public, however, note that the private enterprise reliance on all types of credit is much less, despite their investment being higher. Unlike the public sector, these companies financed a substantial share of their investment with their own saving. In both stock and flow terms, leverage is much lower in the private than in the public sector.

A summing up of the dollarization and capital flight can be given by examining the savings-investment identity.

For 1981 the identity can be given as follows.

	Household Saving			Foreign Saving
	634.8		+	289.2
	Enterprise Deficit			Public Deficit
=	145.5		+	778.5

This identity seems to reveals that 31% of the combined deficit was financed with external resources. However, this understate the role of external resources. Recall that 40% of household saving was diverted abroad, which amount had to be replaced by external lending to maintain the same current account deficit. [3]

Thus the actual savings-investment deficit for 1981 was the following

Available Household Saving		Available Foreign Saving		Total deficit
383.4	+	540.6	=	924

So the role of external resources in financing the deficits of public and private enterprises and government was nearly 60%. If we consider just the public deficit and aggregate the private sector to get net private saving, the share of external financing of the public deficit becomes 70%. Thus both "dollarization" and "externalization" were proceeding rapidly in 1981, setting the stage for a strong redistributive impact when the devaluation came.

This redistributive impact can be seen in embryo through the mild devaluation that took place in 1981. In the net capital losses line of the FAM, we see that even this small "deslizamiento" of 1981 was enough to cause a major redistribution from the public sector and private firms to households and to the external sector. However this redistribution was more than compensated for by the lower interest charges on dollar instruments (unlike 1982) so that this redistribution cannot be seen as anything more than a precursor of things to come.

Before proceeding to some simple models analyzing the devaluation's impact, it is useful to place these phenomena in the setting of the cycle of financial boom and crash.

The Mexican case as a "classic" financial crisis

The Mexican experience of 1977-82, whatever else one might say about it, was in many ways an example of the standard type of financial expansion and crisis that has been historically documented by economists from Walter Bagehot to H. Minsky and C. Kindleberger.[4] As described by Kindleberger, a typical boom-crash cycle follows these stages: 1) a "displacement" occurs, some exogenous event generating great optimism for at least one sector of the economy 2) expansion of investment and production financed by some means of rapid credit growth 3) euphoria, characterized by overestimates of profits, excessive leverage, possibly pure speculation on price rises, and the proliferation of fraudulent schemes. 4) "financial distress or "hesitation", a dawning awareness that the boom cannot continue, with the most well-informed or well-placed 'getting out while they can". 5) "revulsion of credit" and crash, the creditors financing the boom abruptly stop lending, everyone rushes to get into "safe assets" and the prices of the objects of previous speculation collapse.

It is clear how Mexico fits into this scheme. The displacement was the revelation of massive petroleum resources, leading to a great expansion of government and private investment, financed by a rapid growth in lending from abroad. The euphoria

seemed to come during 1979-80 when petroleum resources seemed unlimited, foreign lenders were willing to lend seemingly any amount and there was confidence the peso would not be devalued for a long, long time. The peso in some sense was the "object of speculation" as it continued to appreciate in real terms with borrowers and investors betting that its rate was sustainable.

Corruption apparently flourished as well during these halcyon days. But with the softening of the price of petroleum during 1981, doubts began to set in and the "hesitation" period began. Individuals inside Mexico began to "get out", triggering the massive out-flow of capital experienced. Nevertheless, foreign lenders continued to pour in money, financing an even larger share of public and private investment. The uneasy period of hesitation lasted until August 1982, punctuated but not resolved by the devaluation of February of that year.

The crash finally came in August, precipitated by the rise in basic goods prices and the splitting of the exchange market. Everyone from mexdollar holders to foreign lenders finally realized the game was up and the rush into safe liquidity was on. The crisis did not bottom out until the peso, the object of previous confidence, had been devalued six-fold, various exchange restrictions were imposed and a quasi-lender of last resort appeared in the form of the U.S. Federal Reserve and the I.M.F.[5]

This view of the Mexican crisis as a financial phenomenon, with its emphasis on abrupt changes in expectations and the instability of credit, gives considerable insight into the dramatic events that took place in 1982. However, there are some special features of the crisis which should be particularly noted, as they fit in with the emphasis of this paper.

First, unlike most other instances, both the boom and the crash were at the economy-wide level, rather than being confined to one sector or object of speculation. Second, the "hesitation period" included a long period after the realization by one group of investors-mainly individuals inside México - that trouble was ahead before the same realization by foreign lenders.[6] The result was that one group managed to prepare themselves for the crisis, but the withdrawal of their capital made even more vulnerable the other groups still in the game. This particular structure greatly affected the type of real shocks experienced when the crisis came. Finally, the crisis did not (at least immediately) result in significant bankruptcies of borrowers or loan loss for lenders. This was in accordance with the rules of the game of international lending, that the countries involved must guarantee the credit of individual firms and "countries cannot go bankrupt". Rather the process of "rescheduling" is resorted to. While sometimes sneered at by political figures in the U.S. as a euphemism for default, rescheduling usually maintains (or even raises) the present value of the foreign obligations. The consequence of this is that the financial structure in existence at the moment of the crisis is entirely preserved,

becoming one of the determining factors of the type of adjustment realized. In contrast, bankruptcy and default cleanse the system of the past mistaken decisions, and get rid of those firms who miscalculated. Unfortunately, the severe effect this would have on new lending makes default impractical for indebted countries.

With its peculiar characteristics, the Mexican case is an excellent example of a financial boom whose particular features would determine the type of adjustment to the crash that followed it. To these types of adjustment we now turn, using some simplified models to isolate the essential elements.

Devaluation in a Dollarized Economy

As already mentioned, the impact effect of the devaluation can be expected to depend on the financial structure prevailing. In a "dollarized economy", some of the financially-based effects we could expect are the following:

1) The leverage effect

The devaluation increases the ratio of debt to capital if debt is sufficiently dollar-denominated. Firms may try to work back to the desired leverage by cutting capital spending.

2) The cash flow effect

The devaluation increases the outflow of cash due to interest payments on external debt. The effect may be

a fall in investment as firms are not as able to finance as high a level as before.

3) The government budget effect

The devaluation also increases the government's external interest payments. If this happens in the context of an austerity program with a lid on government spending, then some residual item in the budget will have to fall, be it transfers, government consumption or public investment.

4) The capital gains effect

Holders of sufficiently large dollar assets will, at least momentarily, benefit from the devaluation. Their consumption may increase if they decide to spend some part of their capital gains.

In addition to these "financial effects", there are of course the usual real effects of gains by exporters, fall in the real wage, stimulation of tradeables production, etc. In what follows, these effects are minimized to focus on the financial effects. The real issue is how all of the devaluation-induced shocks on balance affect the economy, a question which can only be decided by a general equilibrium model. The issue is very complicated, since in practice different exchange rates were applied to different types of payments and rescheduling agreements postponed some payments. The confrontation with reality is not

attempted in this essay, however, the models that follow being intended only to illustrate possible effects.

The leverage effect

The simple model used here concentrates upon the adjustment in investment provoked by an unwanted (and unexpected) increase in leverage through a devaluation. Suppose private firms in the economy use imported and domestic capital goods in fixed proportions, the import share being δ. They finance their investment by their own savings, which is given by a share γ of their profits rPK (r is the profit rate, P the domestic price level and K the capital stock), by domestic borrowing L and foreign borrowing eL^*. When there are no changes in prices, this gives us the following:

$$(1) \quad (e\delta + P(1 - \delta))\, dK = \gamma r\, PK + dL + edL^*$$

Now the enterprise wants to borrow only the amount which will allow it to remain at (or to move to) its desired leverage. Thus the changes in loans must satisfy the following requirement.

$$(2) \quad \frac{L + dL + edL^* + eL^*}{P_I dK + P_I K} = 1 - \bar{h}$$

where $\bar{h}$ is the desired ratio of net worth to capital and $P_I = e\delta + P(1 - \delta)$.

Substituting (2) into (1) we get the following expression for dK:

$$(3) \quad dK = \frac{\gamma r \, PK}{\bar{h} \, P_I} - K + \frac{N}{P_I \bar{h}}$$

where N is net worth and we have used the relation $N = PK - L - eL^*$. Now dividing by K to give growth rates, we have

$$(4) \quad g = \frac{\gamma \, r}{\bar{h} \, q} + \frac{h}{\bar{h}} - 1$$

where $q = P_I/P$ and $g = dK/K$. The intuitive explanation of this expression is that the first term represents the steady-state capital growth rate which maintains the desired leverage, while the term $(h - \bar{h})/\bar{h}$ adjusts for any excess or deficiency of the net worth ratio.[7]

This is a rather extreme view of the adjustment of investment to maintain a desired leverage, but it serves to throw into sharp relief the effect of this consideration in investment planning. The heavy reliance on self-financing in Mexico and other LDC's (for example, as shown in the FAM, Mexican private firms had a net financial deficit in 1981 of only 145.5 billion pesos, although private investment was over 900 billion pesos) and the lack of efficient equity markets means the Modigliani-Miller theorem about the irrelevance of firm leverage will not apply in these cases.

From the investment expression, we can see that if deval-

uation causes a sufficient capital loss to make the net worth ratio fall, this will negatively affect investment. As the theme of this paper has suggested, the result depends on the financial structure. The net worth ratio is given by the following:

$$(5) \quad h = \frac{1}{q}\,(q - \ell - \bar{e}\,\ell^{*})$$

Where $\ell = L/PK$, $\bar{e} = e/P$, $\ell^{*} = L^{*}/K$.

A nominal devaluation, of course, may affect the price level P. If we write the elasticity of the price level with respect to e as Θ:

$$\frac{dP}{P} = \Theta\,\frac{de}{e}$$

Then the effect on the real exchange is

$$(6) \quad \frac{d\bar{e}}{\bar{e}} = (1 - \Theta)\,\frac{de}{e}$$

and the effect on q is

$$(7) \quad dq = \bar{e}\,\delta(1 - \Theta)\,\frac{de}{e}\,.$$

Θ here can be thought to depend on policy actions, e.g. whether the government accompanies the devaluation with a wage hike. Using (6) and (7), we can now solve for the change in net worth occasioned

by the devaluation:

$$(8) \quad dh = \frac{(1 - \theta)\ (\bar{e}\ \ell\ \delta - (1 - \delta)\ \bar{e}\ell^{*}) + \theta\ell q}{q^2} \quad \frac{de}{e}$$

To interpret this relation, it is useful to consider two special cases. First, suppose that the line is held on domestic wages and prices, i.e. that $\theta = 0$ and P does not rise. Then (8) becomes as follows:

$$(9) \quad dh = \frac{\bar{e}\ \ell\ \delta - (1 - \delta)\ \bar{e}\ \ell^{*}}{q^2} \quad \frac{de}{e}$$

From (9) dh will be negative if the following holds

$$(10) \quad \frac{\bar{e}\ \ell^{*}}{\ell} > \frac{\bar{e}\ \delta}{1-\delta}$$

The net worth ratio will fall if the ratio of dollar to peso loans is greater than the ratio of imported to domestic capital stock. Since capital is valued at replacement cost,[8] its revaluation will depend on the proportion of the equipment imported. If dollarization is sufficiently advanced to give a higher proportion of credit which is dollar-denominated, then the firm will be a net loser. It is apparent from (4) that for a given profit rate, investment will contract as a result.[9]

The other case is if devaluation is matched completely by a domestic price increase ($\theta = 1$).

In this case (8) becomes simply

$$(11) \quad d\bar{h} = \frac{\ell}{q} \frac{de}{e}$$

Thus, net worth is guaranteed to increase from the devaluation, the amount depending on the share of domestic loans in capital financing. q does not change as the exchange rate, the price of capital, and the domestic price level all increase in the same proportion. What has happened is that the burden of dollar debt has not changed, while the price increase has made domestic debt less burdensome. Devaluation with inflation benefits debtors if their debt is in domestic currency, a fact that has been taken advantage of many times in history to resolve "debt crises".[10] We can see from (4) that investment will increase in this case.

It is now clear that (8) gives the weighted average of the two extremes (9) and (11), the weight being the price elasticity θ. The higher the degree of "dollarization", the more likely firms will suffer a capital loss, for fixed θ. To look at it another way, the higher is the dollar debt burden, the larger is the price increase needed to avoid a capital loss and investment contraction.

We are now ready to insert the investment function into a small macro model. We let private saving (by individuals) be equal to the amount of profits remitted, following the extreme Cambridge assumption:

(12) $S_p = (1-\delta)\ r\ PK$

Firm saving, as we already noted, is equal to $\gamma\ r\ P\ K$. Foreign saving is given by imports, which we assume to be limited to investment goods, minus exports which are priced at domestic prices:

(13) $S_f = e\ \delta I - P\ X$

If prices are given by a mark-up rule over wages:

(14) $P = (1+t)\ b\ w$

then profits are given by $t\ b\ w\ y$ (y is output) and the relation of the profit rate to output will be as follows:

(15) $$r = \frac{t\ b\ z\ y}{P\ K} = \frac{t}{1+t}\ \frac{y}{K}$$

Thus r is linearly related to "capacity utilization" Y/K. So we can discuss the behavior of r in order to analyze whether the economy is contracting or expanding[11]

The savings-investment identity, summing up the components of saving and dividing all terms by PK, is

(16) $(1-\gamma)\ r + \gamma\ r + \bar{e}\ \delta\ g - x = (\bar{e}\ \delta + (1-\delta)\ )\ g$

Substituting from (4) and solving for r we get:

$$(17) \qquad r = \frac{\bar{h}\, q\, (x + (1-\delta)\left[\frac{h}{\bar{h}} - 1\right])}{\bar{h}\, q - (1 - \quad)\, \gamma}$$

It is clear that to have a positive Profit rate (and output) we must have:

$$(18) \qquad \bar{h}\, q > (1-\delta)\, \gamma$$

This says that the target ratio of N/PK (= $\bar{h}\, q$) must be greater than the domestic share of the capital stock times the share of profits retained by the firm. This is necessary to insure that an increase in r in the savings-investment identity does not generate more investm than saving.

Using (17) we can now consider the total effect on the econom of a devaluation.

$$(19) \qquad d\, r = \Big[r\, (\phi - 1) \quad (1 \quad - \theta) + \phi\, x\, (1 - \theta)\, E_x$$

$$+ \quad \frac{(1-\delta)}{\bar{h}\, q^{\,2}} \left((1-\theta)\, (\bar{e}\, \ell\, \delta \quad - (1-\delta)\, e\, \ell^{*}) + \theta\, \ell\, q\right)\Big] \frac{de}{e}$$

where $\phi = \frac{\bar{h}\ \bar{q}}{\bar{h} - \bar{q}(1-\delta)\gamma}$, $\xi = \frac{\bar{e}\ \delta}{e\delta + (1-\delta)P}$ and $E_x = \frac{\partial x}{\partial \bar{e}} \frac{\bar{e}}{x}$

This expression can be decomposed as follows.

The first term give the negative effect on r of the deteriorating terms of trade for imports, i.e. a J- curve effect. The second term gives the positive effect originating in the stimulation of exports. The third term is the effect via investment spending of the change in the net worth ratios.

Once again note the special role of the financial parameters. The higher is the share of domestic peso loans and lower the dollar loans the more likely is expansion. The response of the price level also still plays a key role. A fully responsive price level ($\theta=1$) will mean the first two terms are wiped out and the third term becomes unambiguously positive, output increasing because of the stimulation to investment. It is obvious from (13) that the trade balance will worsen, since investment imports increase and the volume of exports is unchanged. So devaluation with inflation relieves the debt burden temporarily but does nothing for trade imbalance problems.

Or the other hand, if θ is close to zero and there is a high degree of dollarization, the devaluation will improve the trade balance only too well, as investment plunges pulling down imports along with it. Unless the export elasticity is very high, the result will be a sharp investment-led contraction.

The cash flow effect

This may be thought of as the corresponding flow effect to the stock effect demonstrated above. The investment function we use is similar in its concern for leverage, but in terms of new flows rather than stock adjustment. The investment function will be

$$(20) \qquad g = go + g_1 \frac{\gamma \Pi}{PK}$$

Where Π is firm profits net of interest payments, and γ is the retention ratio as before[12]. To see how leverage changes, consider the equation for the evolution of the net worth ratio n (=N/PK):

$$(21) \qquad \dot{n} = \frac{\gamma \Pi}{P K} - n \left(go + g_1 \frac{\gamma \Pi}{P K}\right)$$

The steady-state value of n will thus be:

$$(22) \qquad n = \frac{\frac{\gamma \Pi}{P K}}{go + g_1 \frac{\gamma \Pi}{P K}}$$

This is a general form which allows varying degrees of adjustment to changes in the profits picture. If go = 0, the adjustment is total, so that we always move towards the net worth ratio $n = 1/g_1$. If g1 = 0, there is no investment adjustment for

profit fluctuations, so that leverage will fluctuate depending on profit. The relative size of go and g_1 depend on how constrained enterprises are in terms of leverage.

The effect on real investment of a devaluation will depend on what happens to real profits π/P. The price equation in this model is given as

$$P = (1 + t)\ (b\ w + m\ e)$$

Where bw represents unit labor cost, m the import coefficient and e the exchange rate. This model emphasizes intermediate in place of investment imports. Profits can then be given as follows:

$$(23) \qquad \Pi = t\ (b\ w + m e)\ y - i\ L - i^*\ e\ L^*$$

where y is output, i is the domestic interest rate and i^* the foreign interest rate.

In addition to the effect of the exchange rate on prices through the import coefficient, we also allow some response of the wage rate to inflation:

$$(24) \qquad \frac{d\ w}{w} = \theta\ \frac{d\ p}{p}$$

This may represent "real wage resistance" by unions, or government policy actions, as before. This means the total effect on prices of devaluation will be:

$$(25) \qquad \frac{d\,p}{p} = \frac{1 - \alpha}{1 - \theta\,\alpha}\,\frac{d\,e}{e}$$

Where α is the wage share in costs (= wb/(eb + em)).

Using the above equations, we can now solve for the devaluation's effect on Π/PK (for given y) as follows:

$$(26) \qquad d\left(\frac{\Pi}{PK}\right) = \left(\left(i\,\ell + i^{*}\,\bar{e}\,\ell^{*} \right) \left(\frac{1 - \alpha}{1 - \theta\,\alpha}\right) - i^{*}\,\bar{e}\,\ell^{*} \right) \frac{d\,e}{e}$$

As before, we will consider two special cases of (20). The first is full wage compensation for inflation, i.e. $\theta = 1$. Then (20) simplifies to

$$(27) \qquad d\left(\frac{\Pi}{PK}\right) = i\,\ell\,\frac{d\,e}{e}$$

As with the leverage effect, a devaluation improves the firms position if it is accompanied by matching inflation. The devaluation raises all revenues and costs equally except for the financial obligations fixed in domestic currency.

In the case where wages are held constant, it is a different story. (26) then will be

$$(28) \qquad d\left(\frac{\Pi}{P\,K}\right) = \left(\left(i\ell + i^{*}\,\bar{e}\,\ell^{*} \right)(1 - \alpha) - i^{*}\,\bar{e}\,\ell^{*} \right)\frac{d\,e}{e}$$

The end result will depend on the degree of dollarization. Real profits will decline if

$$(29) \qquad \frac{i^{*}\,\bar{e}\,\ell^{*}}{i\ell + i^{*}\,\bar{e}\,\ell} > (1 - \alpha)$$

That is, profits fall if the share of dollar interest payments in the firm's total financial obligations exceeds the share of imports in costs. It is when "financial dollarization" exceeds "real dollarization" that devaluations can severely affect profits and investment.

In general, as is evident from (26), firms prefer the more liberal wage policy (higher θ) regardless of financial structure. But for a given θ, the higher the dollarization as represented by ℓ^{*}, the more adverse for firms is the devaluation in this simplified model.

To put the investment function in context, a simple macro model can be sketched out as followes. Once again it is assumed Cambridge-style that all remitted profits and interest are saved, so private saving is:

$$(30) \qquad sp = \frac{Sp}{PK} = (1 - \gamma)\,(r - i\ell - i^{*}\,\bar{e}\,\ell^{*}) + i^{*}\,\bar{e}d^{*} + i\ell$$

where $d^* = D^*/K$ are foreign assets held by individuals (part of the reason underlying the dollarization in firms' portfolios) and $i\ell$ are the interest receipts from the domestic loans made to firms. Corporate saving will be

$$(31) \qquad S_c = \gamma(r - i\ell - i^* \bar{e}\, \ell^*)$$

Foreign saving is given by

$$(32) \qquad S_f = \frac{\bar{e} m\ (1 + t)}{t}\ r - x + i^* \bar{e}\ (\ell^* - d^*)$$

where the first term is intermediate imports, the second is exports and the third are net interest payments to foreigners. Note that no restrictions are placed on the current account balance - the closure used here is the "open window" closure where as much as necessary can be borrowed to cover external deficits.[13]

Summing up savings and using (14) the following savings-investment identity results.

$$(33) \qquad r + \frac{\bar{e}\ m\ (1 + t)}{t}\ r - x = go + g_1\ \gamma\ (r - i\ell - i^* \bar{e}\ \ell^*)$$

Solving for r:

$$(34) \qquad r = \frac{t\ (x + go - g1\ \gamma\ (i\ \ell + i^* \bar{e}\ \ell^*))}{t + \bar{e}\ m\ (1 + t) - t\ g_1\ \gamma}$$

Note the denominator must be positive to have a positive r, which is just the usual existence-stability condition that the slope of the savings function (with respect to r here) exceed that of the investment fuction.

To see the economy wide effect of devaluation, consider the derivative of (34) with respect to the exchange rate, recalling the pri effect (25):

$$(35) \qquad dr = \frac{t}{t + \bar{e}m\ (1+t) - tg_1\gamma} \left[\frac{-rm\bar{e}(1+t)\ (1-\theta)\alpha}{t\ (1-\theta\alpha)} + \frac{xe_x(1-\theta)\alpha}{1-\theta\ \alpha} \right.$$

$$\left. + g_1\ \gamma \left[(i\ \ell + i^*\ \bar{e}\ \ell^*)\ \left(\frac{1-\alpha}{1-\theta\alpha}\right) - i^*\ \bar{e}\ \ell^* \right] \right] \frac{d\ e}{e}$$

The interpretation of this expression is similar to that of the leverage model. The first term records the negative effect of the increase in foreign saving caused by the rise in import prices. The second positive term gives the export response. The last term is the effect on profits (see (26)) filtered through investment to affect the economy. In the event that dollarization is sufficiently high to result in a deterioration of profits with devaluation, the economy will contract unless the export response is powerful enough. What will have happened is that the devaluation will have distributed financial income away from firms, who have some propensity to invest out of that income, to individuals with dollar assets and to foreigners, both of whom have a propensity to save of one. With the added effect of a redistribution from wage-earners

to foreigners via the more expensive imports, the economy will experience an investment-led recession. The trade balance (in dollars) will improve, as the contraction lowers import demand and exports increase because of the relative price shift.

As before, the "wage resistance" coefficient θ plays an important role. If $\theta = 1$, the only effect of devaluation will be the expansive effect through investment occasioned by the lower peso interest payments in real terms. In such an event, there is an opposite transfer from that described above: from high-saving recipient of interest income to high-investing enterprises. Of course, the lower the preference for peso assets by individuals (perhaps because of such transfers in the past?) the lower the effectiveness of this type of redistribution. And this kind of devaluation-cum-inflation will only worsen the external deficit.

Dynamic adjustment to devaluation

It still remains to examine the dynamic response to a devaluation, taking into account the changes in net wealth of individuals, firms, and the external sector. The dynamic behavior of the leverage and the cash-flow models is fairly similar, so only that for the leverage model will be examined here.

Using the corporate savings function given in the model, the dynamic equation for h, the ratio of corporate net worth to the values of the capital stock can be given as:

$$(36) \qquad \dot{h} = \frac{\gamma r}{q} - hg$$

Substituting for r and g from the model, the expression for the evolution of h will be:

$$(37) \qquad \dot{h} = -\left(\frac{(1-\delta)\ \phi + 1}{\bar{h}} \right) h^2 + (1 - x\ \phi + 2\ (1-\delta)\ \phi)\ h$$

$$+ \bar{h}\ x\ \phi - \bar{h}\ (1 - \delta)\ \theta\ .$$

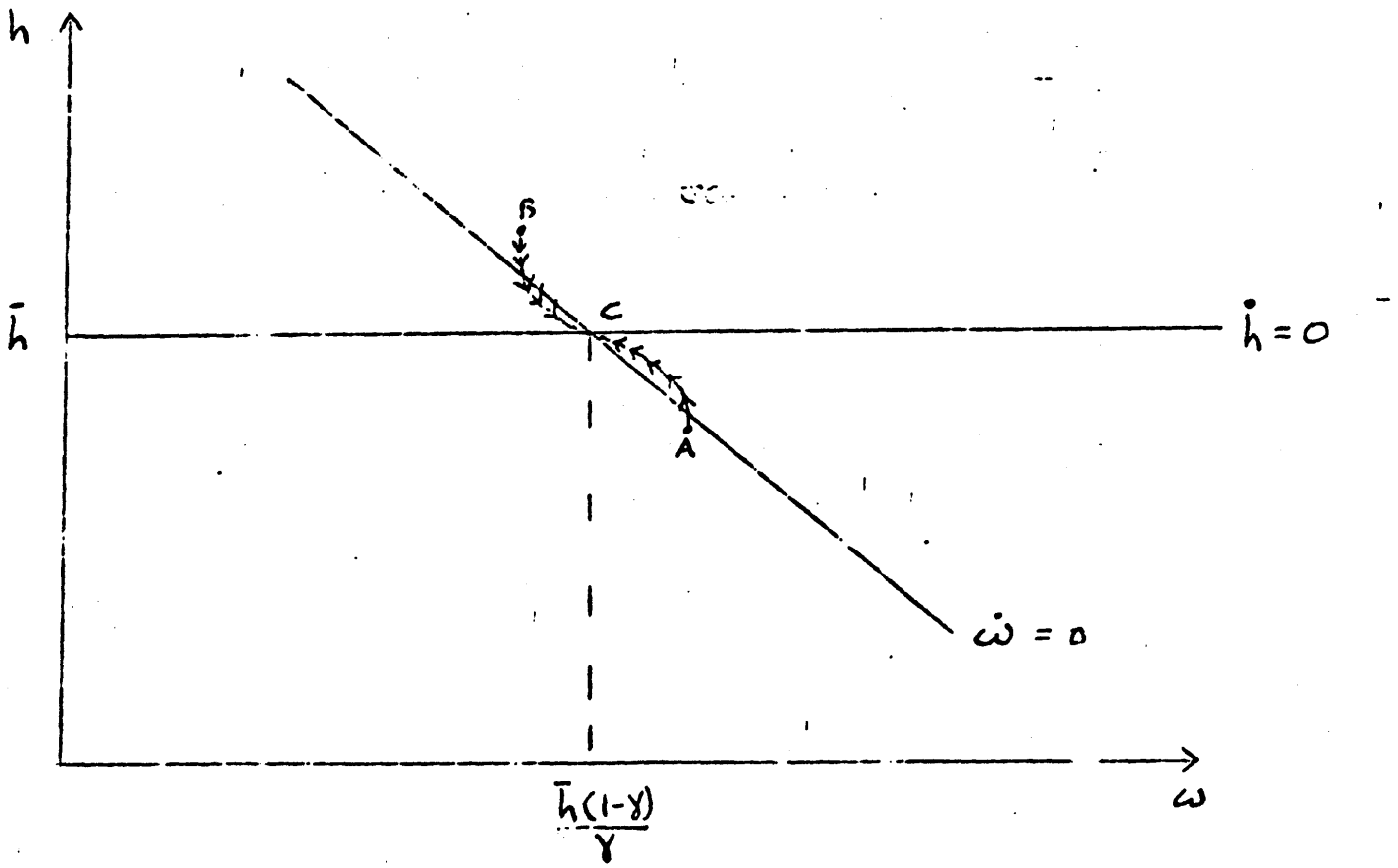
where $\phi = \gamma/(\ \bar{h}\ q - (1 - \delta)\ \gamma)$.

Note that $\dot{h}$ is a quadratic in h. The steady-state equation $\dot{h} = 0$ accordingly has two roots, one stable and one unstable. The stable root is $h = \bar{h}$ and the unstable $h = \gamma\ (1 - \delta - X)$, as can be confirmed by substituting these values into (37) and into the expression for $d\dot{h}/d\ h$. Note that the existence condition (18) guarantees that the unstable root is less than the stable root. It turns out that the unstable root lies in the region where profits (and output) would be negative, so it need not be considered.

The ratio of household wealth to capital, $\omega = W/P_I K$, also develops over time in accord with household saving. The details are omitted but it can be shown that the steady-state equation

$\dot{\omega} \doteq 0$ gives an inverse relation between ω and h. The situation is as depicted in figure 1. The point C is a stable steady-state. A devaluation which decreases firms' net worth ratio takes the economy to a point such as A, where consumer wealth has increased from A because of capital gains on their dollar assets. The return to the steady-state occurs because firms cut back their investment such that they are financing a larger share with their own saving, leading them back to the desired leverage. In the ensuing contraction, individuals cannot

Figure 1



save at a sufficient rate to maintain the wealth ratio ω temporarily achieved, so ω falls.

When devaluation is expansionary, the shift is to B and the opposite process occurs.

Extensions and Conclusion

The other financial effects of devaluation will not be considered in this paper. Needless to say, if the public sector also adjusts its spending in response to changes in its interest costs, we will get similar results to the above models for the public sector.

The models presented so far seem to indicate that when a devaluation works through "financial effects", the effects will be concentrated on investment. This is in contrast with the traditional models of the real effects of devaluation, which concentrate the contractionary effects of devaluation on consumption.[14] The fact that, for example, the Mexican devaluations of 1976 and 1982 led to a sharper contraction in investment than in consumption, seems to support the financial emphasis. This empirical evidence has given rise to a series of studies also emphasizing devaluation's effect on investment.[15]

As already emphasized, the complete view of devaluations in a particular economy like the Mexican one must await the construction of a general equilibrium model. However, the fragmentary results of the models presented above suggest that the short-run impact of a devaluation in a dollarized economy can be quite a severe one.

Footnotes

1 The terminology of "effective flows" is from Banco de Mexico. The term refers to the change in financial instruments due to new acquisitions as opposed to revaluation of the existing stock.

2 For further information on construction of the matrix and data sources please consult the appendix.

3 As explained in the data appendix, the estimate of household capital flight is rather a speculative one-simply adding the "errors and omissions" to the short-term asset accumulation line in the balance of payments. This may well be an overstatment depending on smuggling and other unrecorded transactions entering in these categories.

4 See the works by Bagehot, Minsky, and Kindleberger listed in the bibliography. Here we rely on Kindleberger (1978).

5 Kindleberger lists 3 ways in which the immediate crisis is resolved.

(1) prices fall so low as to bring people back into the assets from which they fled in the crash.

(2) trade is suspended in the assets in question.

(3) a lender of last resort convinces asset-holders that the demand for "safe liquidity" can be fully met.

Note that all three of these were used in 1982 in Mexico.

6 It is hard to say to what extent enterprises and the public sector realized a reckoning was coming and began to prepare themselves. In any case it was much harder for them to adjust than individuals, since they could not retire their foreign loans. Of course, spending could have been, and was, cut to reduce the level of new external borrowing. But it was too little, too late under the circumstances.

7 The specific treatment of investment here owes much to the formulation of Gil Diaz (1980) who discussed this issue in another context.

8 This method of valuation can be controversial. In effect what we are assuming is that the lack of a significant equity market holds Tobin's q at one, i.e. the opportunity cost of capital is always the price of new capital.

9 This result is similar in some ways to the effect on investment of devaluation discussed by Cordoba-Ortiz (1980).

10 If we think of "debasement of the coinage" as equivalent to a devaluation, this measure is at least as old as the Roman Empire and has been used repeatedly ever since by debt-strapped governments, including the Kings of England and Tsars of Russia. (Evsey Domar has even cited examples in his Russian History class at MIT of the Tsars instituting devaluation to relieve the debts of private individuals, in this case the serf-owning nobles). The historical background led this aspect of a devaluation to be stressed in the economic literature from Adam Smith until relatively recently.

11 I am indebted to Taylor (1983) for this method of formulation.

12 In this model the assumption is dropped that capital is imported, so the whole capital stock is valued at the domestic price P.

13 The "open window" is meant to refer to the open loan window at foreign banks only too eager to lend money. This assumption would apply well to Mexico, Venezuela, Chile and Argentina (and earlier Brazil) before the "debt bomb" came to public attention. Unfortunately, capital can leave by the "open window" as well as come in, to twist the metaphor.

14 The models of Diaz-Alejandro (1964) and Krugman-Taylor (1978) focus on devaluation's redistributive effect from high-consuming workers to high-saving exporters. The model of Dornbusch (1973) also focuses on consumption, but via the real balance effect of the devaluation of money balances. Note that the strength of this real-balance effect depends on the extent of dollarization and the amount which the domestic price level responds.

15 The already-cited work of Cordoba-Ortiz (1980) is important here. A general theoretical model focussing on Tobin's q has been presented by Buffie (1982). Aaron Schwarzmann at M.I.T. is doing some interesting work on the micro foundations of the investment effect of devaluation.

A P P E N D I X

Notes on the Financial Accounting Matrix

1.- All figures are given in thousands of millions of current pesos for 1981.

2.- The sources for the data are as follows:

a) savings-investment data

- from the Sistema de Cuentas Nacionales de Mexico 1979-81

b) financial assets and liabilities held with banks

- from Informes Anuales, Banco de Mexico

c) household-firm breakdown on Financial instruments

- from preliminary estimates from Banco de Mexico

d) external debt of public and private Sector

- from Balance of Payments in Informes Anuales and from press reports and official estimates. It is assumed households owe none of this external debt.

e) foreign asset holdings by households

- this is the most speculative and preliminary of the numbers in the table. For the flow, the "errors and omissions" and "short-term asset accumulation" lines in effect make up the number, since it is a residual o current account balance + new debt accumulation.
The stock number is even more speculative. To get the dollar number, the current account balances over the last 40 years are summed to get the net foreign asset position, which is then added to gross foreign debt to get gross foreign assets, after which bank foreign exchange reserves are subtracted. The historical data come from La Economia Mexicana en Cifras, Nacional Financiera.

It is assumed provisionally that all foreign assets were held by households. This is probably not true, but better estimates will have to await more precise data.

3.- The capital gains and losses on each instrument were taken from Banco de Mexico estimates and from calculations based on the existing stock and exchange depreciation. The net capital losses number was entered as a figure in the "asset accumulation flow" of each sector. The negative of this number was entered under the accumulation of net financial assets (on the liability side of the balance sheet in this set up, despite the name).

4.- The savings less investment of each sector must be equal to the flow of net financial asset accumulation. This flow plus gross liability accumulation, gives the liability accumulation flow. This is equal to the asset accumulation flow, a figure which includes gross asset accumulation plus net capital losses.

5.- The beginning and ending positions for each asset and liability by sector, by currency, are given at the margins of the table. The gross change is given in the same row or column.

6.- I wish to thank Lance Taylor for helpful suggestions on the form and construction of this matrix.

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	Beginning Assets	Net Financial Assets						
		Households	Firms	Public Sector	Banking Sector	External Sector	Residual	Households
Beginning Liabilities		986.1	-518.6	-1393.7	0.0	876.4	-49.5	
Households		634.8						
Firms			-145.5					
Public Sector				-778.5				
Banking Sector					0.0			
External Sector						289.2		
Residual							0.0	
Households Pesos	1001.3							404.2
Mexdollars	180.0							124.4
Dollars	241.7							311.4
Firms Pesos	151.6							
Mexdollars	33.5							
Dollars	0.0							
Public Sector Pesos	147.7							
Mexdollars	30.4							
Dollars	0.0							
Banking Sector Pesos	1430.6							
Mexdollars	603.0							
Dollars	124.9							
External Pesos	1.6							
Mexdollars	10.4							
Dollars	1231.0							
Residual Peso	94.0							
Mexdollars	32.9							
Dollars	0.0							
Capital Gains		80.3	-36.7	-152.6	-12.0	117	+3.8	-80.5
Residual		-9.8	0.0	0.0	12.0	-1.9	-0.3	9.8
Ending Liabilities		1691.6	-700.8	-2324.8	0.0	1280.7	-46.0	
Asset Accumulation Flow								769.3

Financial Accounting Matrix for 1981

Firms	Public Sector	Banking Sector	External Sector	Residual	Households			Firms	
					Pesos	Mexdollars	Dollars	Pesos	Mexdollars
					409.6	27.3	0.0	303.0	126.2
					93.5	41.0	0.0		
								117.6	79.7
86.5									
29.3									
0.0									
	80.0								
	4.5								
	0.0								
		611.6							
		513.5							
		34.0							
			-0.3						
			16.5						
			733.5						
				75.6					
				18.0					
				0.0					
36.7	152.6	12.0	-117.0	- 3.8					
0.0	0.0	-12.0	1.9	0.3					
					503.1	68.3	0.0	420.6	205.9
52.5	237.1	1159.1	C34.6	90.1			0.0		

FINANCIAL LIABILITIES

ars	Public Sector			Banking Sector			External Sector	Residual	
	Pesos	Mexdollars	Dollars	Pesos	Mexdollars	Dollars	Dollars	Pesos	Mexdollars
4.5	717.9	372.4	481.5	1396.2	23[illegible].3	475.0	366.6		
10.7	311.3	391.9	312.4	646.0	19[illegible].7	320.4	345.4	89.2	0.9
75.2	1029.2	764.3	793.9	2042.2	480.0	795.4	712.0		

Accumulation Flow	Ending Assets
769.3	
152.5	
237.1	
1159.1	
634.6	
90.1	
	1405.2
	304.4
	553.1
	238.1
	62.8
	0.0
	227.7
	34.4
	0.0
	2042.2
	1116.5
	158.9
	1.3
	26.9
	1964.5
	169.6
	50.9
	0.0

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