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DID THE DEBT CRISIS OR THE OIL PRICE DECLINE CAUSE MEXICO'S INVESTMENT COLLAPSE?

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ABSTRACT

This paper proposes a simple investment model that permits a test of the relative importance of Mexico's terms of trade decline, the reversal in net capital inflows, and the debt overhang, in explaining Mexico's investment decline in the early 1980's. The paper uses previously unexploited sectoral investment data between 1981 and 1985 to estimate the quantitative importance of these explanations. The data indicate that the main microeconomic mechanism driving the investment decline was the rise in the relative price of investment goods, and further that the deterioration in Mexico's international terms of trade explains most of the increase in this relative price. Our preferred estimate is that about two-thirds of the investment decline was attributable to the terms of trade decline, while the termination of capital inflows explains the remaining third. The paper finds little evidence in favor of other debt crisis effects such as the debt-overhang effect or several other more subtle effects that have been proposed in the literature.

Did the Debt Crisis or the Oil Price decline Cause Mexico's Investment Collapse?

Andrew M. Warner[1]

1. Introduction.

Economists would not necessarily be surprised to learn that investment declined in a country during a period when the world price of its key export declined by about 50 percent. Yet the investment decline in Mexico in the early 1980s is almost universally attributed to some aspect of the international debt crisis or to general uncertainty rather than to the decline in the price of oil. The possibility that the oil price decline would have reduced investment even in the absence of the debt crisis is rarely seriously considered. Instead, the usual argument is that the oil price decline helped cause the debt crisis, and then some phenomena related to the debt crisis, such as the debt overhang situation, or uncertainty about policy reforms led directly to the investment decline.

Sorting out the role of the decline in the price of oil versus the debt crisis is important because many continue to debate the merits of debt relief and some argue that relief is a necessary condition for an investment rebound in heavily indebted less developed countries. There is relatively little empirical work estimating the magnitude of the effect of the debt crisis on investment after controlling for other determinants of investment, and there is a more general lack of empirical studies on investment determination in small open economies like Mexico.

This paper addresses these issues by using data from a sector-level investment survey conducted in Mexico between the first quarter of 1981 and the last quarter of 1985, which has not yet received much attention. We propose and estimate an investment model that can discriminate between the oil price decline and several other debt crisis effects.

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[1]The author is a staff economist in the Division of International Finance. This paper represents the views of the author and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or other members of its staff. I am grateful to Susan Collins, David Howard, Steve Kamin, Yves Maroni, Jeffrey Sachs, Carlos Sales, Oscar Sanchez, Larry Summers and Jeffrey Williamson for helpful discussions and comments. Errors remain my own.

We begin with an assumption that concedes ground to the debt crisis side of this debate. That is, we will assume that the sudden termination of international capital flows to Mexico in 1982 was exogenous rather than being partly endogenous with respect to the continued decline in the price of oil which began in the middle of 1981. This assumption will lead us to underestimate the magnitude of the oil price effect, because we are ruling out any effect of the oil price decline working through the capital flow variable. The paper will show that despite this assumption, the data suggests that the effect of the oil price decline was large.

This paper is organized as follows. Section 2 surveys the main facts for Mexico. Section 3 presents an investment model. Section 4 spells out how the terms of trade decline and the debt crisis relate to this investment model. Section 5 describes the data in more detail and discusses some econometric issues. Section 6 presents the results and section 7 concludes.

2. A survey of the main facts for Mexico

Mexico's debt problems in 1982 are usually attributed to the combined effect of high world real interest rates, falling oil prices, and an inability of Mexican policy makers and their international creditors to adjust to these new realities. The main facts are as follows. Between 1980 and 1982, world real interest rates were very high by any measure. In July of 1981, world oil prices began to decline. In February of 1982, Mexico devalued the peso by 46 percent and devalued again in August of 1982. Throughout early 1982, macro economic reforms were repeatedly announced but only partially implemented. Through July of 1982, international creditors were still lending heavily to Mexico. Sometime in 1982, investment began to decline. On August 12, 1982, Mexico announced to the surprise of the international community that it could not meet its short term obligations falling due in the following week. By 1983, new capital inflows had virtually stopped, Mexico was transferring resources abroad, and investment and growth were sharply lower than the levels achieved in 1980 and 1981.

A longer-run perspective on the investment decline is displayed in Figure 1. This figure clearly

shows the investment collapse after 1981: average annual real investment in the 3 years following the initial debt-crisis year of 1982 was 63 percent of the 1981 level. But the figure also shows that it is not obvious whether it is the high investment levels of the early 1980's or the lower investment levels post-1982 that are historically abnormal.

Figures 2 and 3 plot two key variables that are leading candidates to explain the investment data, the terms of trade and net capital inflows to Mexico. Both will be assumed to be exogenous in this paper[2]. The capital inflow variable in figure 2 is the sum of net capital inflows from the capital account, net interest payments, and the errors and omissions, all measured in millions of dollars and all deflated by the U.S producer price index (1982= 1.0). The errors and omissions are included as a rough way to account for capital flight. It is important to make some correction for capital flight because it is well known that much of the official capital inflows to Mexico in 1981 and early 1982 simply left the country in capital flight, and visual inspection of the errors and omissions data in 1981 and 1982 clearly reveals this. Figure 2 shows that between the first quarter of 1981 and the last quarter of 1985, net capital inflows declined by about 3.6 billion dollars.

Figure 3 plots the decline in the terms of trade, defined as the ratio of export prices to import prices. Driven by the decline in the price of oil, the terms of trade fell by 40 percent between the first quarter of 1981 and the last quarter of 1985, and then fell a further 23 percent in 1986. The decline in the terms of trade started in the middle of 1981, clearly preceding the debt problems of August, 1982.

3. The micro model of investment.

This section presents a microeconomic investment model to organize the analysis. We choose a

[2]Regarding the capital flow variable, we make this assumption more for the sake of the argument than for realism. The capital flow reversal was probably caused both by the continuing fall in the price of oil as well as the sudden realization on the part of Mexico's creditors that Mexico was probably insolvent. In contrast, the assumption that Mexico's terms of trade are exogenous is easier to defend because world oil prices are the key variable driving this index and Mexico only produces about 4 percent of world oil output.

model which highlights the role of relative price movements in investment determination because we think that relative price movements provide the main alternative hypothesis to the various debt theories. Since we have investment data at the sector level, the model focuses on the decision of a representative firm at this level. The firm is assumed to be a price taker[3], and to make the problem tractable, we also assume static expectations about the path of future prices. Costs of adjustment are given by the function C(I), with $C_I(I) > 0$ and $C_{II}(I) > 0$. The production function is assumed to exhibit constant returns to scale.

The firms objective is to maximize the present discounted value of future cash flows. Time and sector subscripts are left out to simplify the notation.

(1) $$Max \int_t^{\infty} e^{-rs} [\, pF(K,L) - wL - p^I C(I) \,]\, ds$$

(2) $$\dot{K} = I - \delta K$$

where r is the real interest rate, p is the product price (more precisely, value added), w is the wage rate, and p^I is the price of capital goods. The variable q, introduced below, is the present discounted value of the stream of future profits generated by the marginal unit of capital. In our notation, q/p^I is Tobin's q. Maximization yields four relevant equations.

(3) $$p\, F_L(K,L) = w$$

(4) $$p^I\, C_I(I) = q$$

[3]Price taking behavior is assumed in order to solve and motivate the investment model. It is tested in the empirical section.

(5) $$\dot{q} - (r+\delta)q = -p\, F_K(K,L)$$

(6) $$\lim_{s\to\infty} e^{-(r+\delta)s}\, q = 0$$

Equation (4) establishes that investment is increasing in q, and decreasing in p^I, the price of investment goods. The solution for q at time t can be derived by substituting optimal employment, L, from equation (3) into equation (5) and then integrating equation (5) forward from t to ∞ using (6).

To provide an estimable investment function, we posit a Cobb-Douglas production function, $F(K,L) = K^{\alpha} L^{1-\alpha}$, and a quadratic investment cost function, $C(I) = I^2/2$, yielding a relatively simple expression for q:

(7) $$q = A\, \frac{p^{\theta} w^{1-\theta}}{r+\delta}$$

where $A = \theta^{(\theta-2)}(\theta-1)^{(1-\theta)}$ and $\theta = 1/\alpha > 1$.

Substituting equation (7) into (4), yields an investment function increasing in p, and decreasing in w, (because $\theta>1$, and therefore $1-\theta<0$), $r+\delta$, and p^I.

(8) $$I = A\, \frac{p^{\theta} w^{1-\theta}}{p^I(r+\delta)}$$

We have data on investment, product prices, and wages at the sector level, but we do not have sector-specific data on the price of investment goods, interest rates, or depreciation. Therefore, we will estimate an equation close to a log version of equation (9) below, allowing the constant, A, to differ across sectors to pick up differences in technology, size or anything else that varies across sector but not across time.

Letting "j" denote sectors,

$$I_j = A_j \frac{p_j^{\theta} w_j^{1-\theta}}{p^I (r+\delta)} \tag{9}$$

The key issue to discuss now is how exogenous variables such as the terms of trade and capital inflows, and a more general phenomena such as the debt crisis relate to equation (9). We will distinguish three possibilities which are not mutually exclusive. The first possibility is that the terms of trade decline caused the investment decline by affecting the prices on the right hand side of (9). The second possibility is that the debt crisis caused the investment decline by affecting the prices on the right hand side of (9). The third possibility is that the debt crisis caused the investment decline by working through a variable that is not present on the right hand side of (9).

4. The mechanisms behind the terms of trade and debt effects.

This section will specify the channels through which we allow the debt crisis and the terms of trade decline to affect the investment equation (9) above. Briefly, we model the terms of trade decline and the capital flow variable as working through the prices on the right of (9), using a straightforward demand and supply framework familiar from Dutch Disease models, and allow other debt crisis effects such as the debt overhang to enter through dummy variables added to equation (9). The rest of this section explains the reasoning in more detail.

There is first of all a direct and obvious relationship between the terms of trade and prices in export and import sectors. Because the terms of trade is measured as p^x/p^m, shocks to world export prices will induce a positive correlation between domestic export prices and the terms of trade, and shocks to import prices will induce a negative correlation.

Apart from this direct relationship between the terms of trade variable and prices in traded sectors, a terms of trade improvement represents an increase in wealth which may stimulate demand and therefore

affect product prices in non-traded sectors. This kind of effect is familiar from Dutch Disease models (for example, Neary and Van Wijnbergen, 1986) where a rise in the terms of trade raises spending on home goods and increases the relative price of non-traded goods. We also want to allow capital flows to have a similar effect on domestic spending. Accordingly, we write the following simple demand and supply equations for any given product market, indexed by the "j" subscript.

(10) $$p_j = d\left(y_j , \frac{p^x}{p^m} , CF \right)$$

(11) $$p_j = s\left(y_j , w_j \right)$$

In equations (10) and (11), p is the product price, y is output, p^x/p^m is the terms of trade, CF is the capital flow variable and w is the wage. The sectoral wage in turn is determined in the simplest possible neoclassical labor market, described by equations (12) and (13) below.

(12) $$w_j = d\left(p_j , L_j \right)$$

(13) $$w_j = s\left(L_j \right)$$

Equations (10) to (13) can be solved to obtain reduced form equations relating non-traded product prices and sectoral wages to the terms of trade and the capital flow variable[4].

[4]Adding a labor market modifies the familiar result from Dutch Disease models that a terms of trade improvement will raise the relative price of non-traded goods. This result obtains in the model above if the elasticity of labor supply is not too large.

(14) $$p_j = g\left(\frac{p^x}{p^m}, CF\right)$$

(15) $$w_j = h\left(\frac{p^x}{p^m}, CF\right)$$

The important point for this paper is just to establish that such reduced forms exist, in order to motivate our regressions of prices on the terms of trade and capital flows. A potentially confusing point is that, to avoid non-stationarity problems, we actually estimate regressions with p_j/CPI and w_j/CPI on the left rather than p_j and w_j as in equations (14) and (15). Furthermore, since it turned out not to matter for the main point we wished to make, and to simplify the exposition, we actually report regressions of weighted average product prices and wages, $\Sigma\omega_j p_j$/CPI and $\Sigma\omega_j w_j$/CPI, where the ω_j are investment shares. However, if reduced forms exist for sectoral prices, they also exist for functions of sectoral prices such as these price indexes. We do assume arbitrarily in the estimation that the functional form is log linear.

Although our primary purpose is to estimate these reduced form relationships, whatever they are, rather than to establish priors on the signs, we will discuss the latter issue briefly. If p_j is a non-traded price and the price of oil exports falls, we expect both numerator and denominator, p_j and CPI, to fall, yielding an ambiguous relationship between p_j/CPI and p^x/p^m. If the non-traded component in the CPI is large, as it probably is, we expect the coefficient to be close to zero.

If p_j is the price of imported machinery, and the price of oil exports falls, we expect the numerator to remain fixed while the denominator falls, yielding a negative coefficient. Similarly, if p_j is the price of a non-oil export sector, and the price of oil exports falls, we again expect the numerator to remain fixed while the denominator falls, yielding a negative coefficient. If p_j is oil, we expect both numerator and denominator to fall, yielding an ambiguous but probably small coefficient. Similar reasoning applies to the capital flow variable.

The remainder of this section discusses the debt theories, and argues that although these theories postulate a variety of mechanisms, they agree on the fundamental point that the events of August 1982 triggered the investment decline. Hence, they can be tested as a group by introducing a 0/1 intercept dummy to the basic investment equation. The debt theories typically do not argue that the level of debt by itself depressed investment, instead they argue that either inefficiencies associated with partial solvency, international credit rationing, or maladjustment to the sharp reversal in capital inflows in 1982 caused the investment crisis.

Krugman (1988) and Sachs (1988) advanced the idea that the debt overhang can account for the investment decline. Following the terminology in Krugman (1988), a debt-overhang is said to exist when the expected present value of future resource transfers is less than the face value of the external debt. The argument is that a debt-overhang creates a situation where creditors can siphon off some of the additional output resulting from investment. In this situation a social planner choosing national investment will be faced with an investment disincentive relative to the case where the country is fully solvent because the models assume that creditors can take part of the additional output raised by the investment. This is the formal mechanism linking high debt to low investment in the models of Sachs (1988), Krugman (1988), Froot (1988), and Bulow and Rogoff (1989), although the last two papers do not necessarily advocate the debt-overhang view.

A related argument is that the overhang leads to international credit rationing. In Sachs (1988), the passage of a country from solvency to a debt-overhang places indebted countries in a situation analogous to a domestic insolvent firm. Lending is restricted essentially because semi-insolvency exacerbates creditor debtor agency problems.

In addition, Krugman (1988) and Helpman (1988) also argue that a debt overhang causes investors to fear higher investment taxes, reducing investment demand. Ize (1989) and Rodrik (1989) stress that the debt crisis has introduced unprecedented policy uncertainty, again reducing investment

demand by risk averse investors. Dixit (1989), and Rodrik (1989), following ideas in Bernanke (1983) and Cukierman (1980) argue that even without risk aversion, investors postpone investment projects in the face of greater uncertainty since the investment decision is irreversible. So there are several ways in which greater uncertainty associated with the debt crisis can also explain the investment decline.

The key point for this paper is that these effects are all triggered by the perception that an overhang exists. Further evidence supports the view that this event happened for Mexico in the Summer of 1982. Solis and Zedillo (1985) report that Mexico's solvency was first questioned during negotiations for a 2.5 billion dollar "jumbo" loan to the Mexican government in June 1982. The issue of the Economist magazine published just after the August incident reports that creditors were still lending heavily to Mexico in the spring of 1982. Earlier issues of the Economist in 1982 fail to mention Mexico's impending payments problems. Furthermore, the price of a Mexican government bond traded in New York did not exhibit any unusual decline until the week of the August announcement, suggesting that Mexico's problems were not anticipated by the international financial community. Kraft (1985) provides an excellent blow by blow account.

5.Data and Econometric issues.

The sectoral investment data comes from a firm-level investment survey conducted by the Bank of Mexico between 1981 and 1985. This data set was published in the Bank of Mexico's monthly publication Indicadores Economicos in more aggregated form during 1987 and 1988. The more disaggregated data used here is available from the internal files of the Bank of Mexico. This data has not yet been examined at this level of disaggregation in print. The key features of the investment data are enumerated below.

* Real investment spending: constant 1970 pesos.

* 4 kinds of investment goods: transport equipment, machinery and operating equipment, buildings and structures, and office furniture and equipment.

* 68 sectors, mostly mining and manufacturing.

* 20 quarters: 1981:1 to 1985:4.

* Coverage includes 56,053 public and private firms; does not include "maquiladora" or "in-bond" firms operating in tariff-free export enclaves; does not include Agriculture, Forestry or Fishing.

Table 1 describes the sectors, and reports the investment levels by sector in the first year of the survey, 1981, and then reports two measures of the extent of the investment decline by sector. The first measure simply takes the ratio of average annual investment for the period 1983 - 1985 to investment in 1981. This ratio is reported in column 2. The second measure of the decline fits a trend to log investment sector by sector. The coefficients and T-statistics from this regression are reported in columns 3 and 4.

Table 1 shows that by any measure the investment collapse was severe. Investment rose in only 3 of the 68 sectors included in the table. Investment declined severely in the largest export sector, petroleum and gas mining, as well as in import competing sectors such as auto frames, trains, boats and motorcycles. Investment declined in sectors controlled by public enterprises such as the mining sectors as well as the privately owned sectors such as plastics, glass, cement and ceramics. Cross-correlations did not reveal any statistically significant correlation between the investment decline and ownership status of these sectors; nor were we able to find any relationship between the investment decline and import or export shares. The one statistically significant correlation that does emerge from this data is that sectors which invested heavily in machinery in 1981 did have more severe subsequent investment declines. This correlation is consistent with the econometric results to be presented in section 6.

Table 2 presents the means and standard deviations of the rest of the data used in this paper. There are 9 price indices for value added by sector. These 9 price sectors correspond to groups of investment sectors presented in table 1. The appendix describes the matching. There are also 9 wage indices by sector. The wage data is defined as the mean cost of a man-hour of labor in the sector.

Figures 4, 5, 6, and 7 display the movements over time of the machinery price index, the price and wage data and the real interest rate in Mexico. All the price and wage data are scaled by the domestic CPI to focus on relative price movements. The most salient feature of this data to notice is the dramatic rise in the price of machinery relative to the CPI over this period.

Figures 5 and 6 plot an average of the price and wage indices. In contrast to the dramatic rise in the relative price of machinery, figure 5 shows that on average the product prices show no significant trend. The pictures for the sector level price data would look similar to this, because none of the sectoral indices show any dramatic trends either. Figure 6 shows that real wages fell by about 30 percent over this period. The declines in real wages by sector are very similar.

Figure 7 shows that the domestic real interest rate also declined dramatically after the debt crisis in 1982. The plotted interest rate is the nominal 3 month return on deposits minus contemporaneous CPI inflation. We found that other methods of calculating expected inflation produced a similar picture.[5] The drop in real interest rates provides evidence against the widely held view that the debt crisis has caused domestic interest rates to rise by restricting capital inflows.

The key equations that will be estimated are log linear versions of the investment equation, (3), and the reduced form price and wage equations. Since we do not have data on depreciation, we ignore this term in the econometrics. Product prices, p, machinery prices, p^I, and wages, w, are all deflated by the CPI but not written explicitly that way in equation (16) to save space.

$$\ln(I)_{jt} = \alpha_{0j} + \alpha_1 D_t + \alpha_2 \ln(p)_{jt} + \alpha_3 \ln(w)_{jt} + \alpha_4 \ln(p^I)_t + \alpha_5 r_t + \varepsilon_{jt} \tag{16}$$

[5]For example, we tried fitted values from a time series AR(4) model and also used the average of two leads of inflation. We also examined whether the interest rate coefficients in the investment equation were sensitive to the measurement of expected inflation. It turns out that the qualitative conclusions we draw from the estimated interest rate coefficients are not sensitive to this. In practice, we report interest rate coefficients that are in the middle of the range of estimates.

(17) $$\ln(\frac{p_j}{CPI})_t = \phi_{0j} + \phi_{1j}\ln(\frac{p^x}{p^m})_t + \phi_{2j}CF_t + \varepsilon_{jt}$$

(18) $$\ln(\frac{w_j}{CPI})_t = \theta_{0j} + \theta_{1j}\ln(\frac{p^x}{p^m})_t + \theta_{2j}CF_t + \varepsilon_{jt}$$

(19) $$\ln(\frac{p^I}{CPI})_t = \beta_0 + \beta_1\ln(\frac{p^x}{p^m})_t + \beta_2 CF_t + \varepsilon_{jt}$$

The various channels through which we allow the terms of trade reduction and the debt crisis to affect investment can now be spelled out in terms of the parameters in these equations. The terms of trade effects are allowed to operate through machinery prices, product prices and wages, with the full effect on investment given by the terms $\beta_1\alpha_4$, $\phi_1\alpha_2$, and $\theta_1\alpha_3$. The debt crisis is allowed to operate through two channels. The first is through movements in the capital flow variable and relative prices, given by the terms $\beta_2\alpha_4$, $\phi_2\alpha_2$, and $\theta_2\alpha_3$. The second is through debt overhang and/or uncertainty effects, given by the parameter α_1.

The investment equation (16) will be estimated on a group of sectors which are in the private sector. A private sector is defined as a sector which had less than 25 percent of its output produced by public enterprises in 1980. This selection reduced the number of sectors in the sample from 68 to 48. Another 6 sectors were eliminated for lack of price data, leaving 42 sectors in the sample. For this group of sectors, the change in log investment between 1981 and 1985 was -1.05, whereas for the entire sample it was -.65. Therefore we are examining a group of sectors which experienced a more severe investment decline than average. The intercept α_0 varies by sector to pick up effects which vary across sectors but not across time. The error term in (16) is assumed to be heteroscedastic.

We will present and compare both least squares and instrumental variables estimates of equation (16). The model we have presented assumes that the terms of trade, capital flows and the domestic interest rate are exogenous. If in addition, the errors in the three price equations are uncorrelated with the error in the investment equation, then least squares estimates of the investment equation will be consistent. However, it is unclear whether this assumption is credible. There could be standard supply and demand simultaneity between investment and either the machinery price or the domestic interest rate. On the other hand, Mexico imports much of its machinery, and capital flows freely across the border with the U.S., so that Mexico may be a price taker in both markets.

We will use three instruments in an attempt to deal with this issue: the terms of trade, the capital flow variable, and the LIBOR interest rate. The first two instruments are clearly suggested by the model above. It also seemed natural to include an international interest rate in the instrument list because we want to instrument for a domestic interest rate.[6] Since we have three instruments, the order condition constrains us to have no more than three right-hand-side endogenous variables.

6. Results

Table 3 presents the least squares estimates of the investment equation and table 4 presents the instrumental variables estimates. The main result from these tables is that the debt overhang or uncertainty dummy is small in magnitude and usually insignificant. The largest point estimate for this debt effect is the -0.068 (standard error=0.030) obtained in table 3 when the wage variable is omitted. But this estimated 6.8 percent drop is small in comparison to the fact that investment declined by over 50 percent during this period. This effect is surprisingly small in light of the substantial attention paid to debt overhang and uncertainty effects in the literature.

The signs on three of the other four main variables are as anticipated. A rise in product prices

[6]Several forms of the interest parity relationship imply that international interest rates can be treated as instruments for domestic interest rates.

stimulates investment while a rise in machinery prices or real interest rates depresses investment. On the other hand, the positive coefficient on the wage variable is puzzling. We had anticipated that holding other prices constant, a rise in wages would reduce expected profits and depress investment. Instead, the positive coefficient could be an indication that labor and capital are substitutes, or that there is positive correlation between some excluded variable in the wage equation and the investment equation. This positive correlation could arise if wage bonuses and animal spirits are both pro-cyclical. Note that the instrumental variable results are consistent with this latter interpretation, since a positive correlation between the error terms would result in a positive bias on the wage coefficient estimated by least squares, and indeed the estimated wage coefficient falls in magnitude when the wage effect is estimated by instrumental variables. Although the wage coefficient remains positive, it is insignificant in the instrumental variables estimation.

The most important result reported in tables 3 and 4 is the large estimated machinery price elasticity. The point estimates indicate that this elasticity is -2.0 or higher in absolute value. Since the relative price of machinery rose by about 40 percent over the sample period, this is one of the key variables in accounting for the investment decline.

The estimated real interest rate coefficients range from -0.0015 estimated by least squares to the -0.0039 estimated by instrumental variables. We prefer the instrumental variables estimate because we believe that the least squares estimate is biased towards zero. The -0.0039 estimate indicates that a point increase in real interest rates would reduce investment by 0.39 percent. Note that both the real interest rate coefficient and the machinery price coefficient move away from zero when estimated by instrumental variables. This is the pattern we would expect if conventional supply and demand simultaneity biases the least squares estimates toward zero. Therefore, we prefer the IV estimates in table 4 because this pattern seems intuitive, although a Hausman test for mispecification of the least squares estimates in table 3 does reject mispecification (F[3,790]=0.33 with a significance level of 0.80).

The instrumental variables estimates reported in table 4 use the terms of trade, the capital flow variable, and LIBOR as instruments for the wage variable, the machinery price variable, and the domestic real interest rate variable. We had three available instruments and therefore could choose at most three endogenous right hand side variables without violating the order condition. To check robustness, we also tried specifications where product prices, wages, and real interest rates were endogenous. The estimated coefficients in this case all had the same signs as the estimates reported in table 4, and the magnitude of the debt dummy, wage, machinery price and real interest rate coefficients were quite similar. However all standard errors were higher, especially for the product price elasticity. The high standard error on the price coefficient probably reflects a poor fit from the first stage regression. The Hausman test again rejected mispecification (F[3,790]=0.34 with a significance level of 0.79).

Table 5 examines the impact of changes in each of the right hand side variables on investment between 1981 and 1985. The first column of numbers reports the change in the independent variables, the second column reports the estimated coefficients from the IV estimation, and the final column reports the product of these two columns. The table reports the effects of all variables, regardless of whether they have the wrong sign (wage variable) or are insignificant (debt dummy, wage variable, and real interest rate). The main result of the table is that the rise in the relative price of machinery of about 32 percent can account for a decline in investment of 105 percent by itself. This effect easily swamps the impact of all of the other variables. The debt overhang effect can account for only a 2 percent decline in investment, while the fall in real interest rates of 7.5 points explains a rise of investment of 2.9 percent. This table provides strong evidence that the rise in the relative price of machinery was the key variable explaining the investment decline.

The estimates of the price, wage, and machinery price equations are presented in table 6. Rather than report 18 separate regressions corresponding to each of the 9 price and wage sectors, we report summary equations where average prices and wages (weighted by investment shares) are regressed on the

exogenous variables. The 18 separate price and wage equations were estimated, but the main insights can be obtained by examining the two regressions on averages together with the machinery price equation.

Table 6 shows that there is no evidence that the terms of trade decline or the capital flow reversal had any effect on relative product prices. On the other hand, there is evidence that the terms of trade reduction served to depress real wages. The absence of any effect on product prices probably indicates that there is little difference in the traded goods content of the product price indexes in the numerator, and the CPI in the denominator. In 1980, the sectors covered by this data exported only about 6 percent of their output on average.

Table 6 provides strong evidence that the terms of trade decline and the capital flow reversal served to increase the relative price of machinery in Mexico. In contrast to the low traded goods content on the product side, about 50 percent of machinery investment in Mexico is imported. Machinery can be thought of as a traded good whose price is determined abroad. Therefore, a demand contraction caused by the oil price decline can be expected to reduce the CPI, with its high non-traded content, relative to the price of machinery and yield a negative relationship between p^x/p^m and p^I/CPI. Note that in the machinery price equation, the coefficients on both variables are negative, the terms of trade coefficient is easily significant, and the capital flow coefficient is marginally significant. The table supports the view that the terms of trade decline has played an important role in explaining the rise in the relative price of machinery.

How much of the observed movements in these relative prices can be attributed to each of the two exogenous variables? To answer this, table 7 presents simple simulations which split up the change in the fitted value of the dependent variable into the part that is attributable to changes in each of the independent variables. Given the large estimated effect of machinery prices on investment over this period, it is of most interest to focus on the determinants of the machinery price variable. The simulations in the third column of the table indicate that 67 percent (.252/.379) of the machinery price increase can be attributed to the terms of trade decline, while the capital flow reduction can account for the remaining

third.

7. Conclusions

This paper has developed and estimated an investment model which distinguishes three ways in which the debt crisis and Mexico's terms of trade decline could have affected investment in Mexico. The model allows the capital flow reversal and the terms of trade reduction to affect aggregate demand and relative prices, and ultimately to affect investment through these prices. The model also allows debt overhang effects or uncertainty effects to depress investment directly.

One of the main findings from this analysis is that we find very little evidence in favor of debt overhang or uncertainty effects. If they were present at all during the 1982 -1985 period, our estimates indicate that they can explain at most a 6 percent decline in investment.

The evidence instead indicates that the main proximate cause of the investment decline was the rise in the relative price of machinery between 1981 and 1985. This variable easily dominates the other variables in accounting for the investment decline. The argument to explain this rise is based on the fact that machinery is essentially a traded good in Mexico. As spending declined in response to the terms of trade decline or the capital flow reversal, this demand contraction reduced other product prices relative to this price, depressing investment demand.

The econometric evidence indicates that both the terms of trade reduction and the capital flow reversal played a role in increasing this relative price. Simulations using the estimated coefficients and the actual changes in these two variables between 1981 and 1985 suggest that about two-thirds of the machinery price increase can be attributed to the terms of trade decline, and the other third to the capital flow reversal.

Finally, Warner (1991) presents out-of-sample forecasts of Mexican (and other country's) investment data over the period 1982 to 1989. These generally show that much of the drop in investment as a ratio to GDP can be forecasted by equations that have only the terms of trade and world real interest

rates on the right. This evidence is consistent with the evidence in this paper that the terms of trade decline can explain a large fraction of Mexico's investment decline in the early 1980s.

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TABLE 1

SUMMARY MEASURES OF MEXICO'S 81-85 INVESTMENT DECLINE, BY SECTOR

NUMBER AND SECTOR	1981 1 INVESTMENT	RATIO OF 83-85 ANNUAL AVERAGE INV. TO 1981 INV.	ESTIMATED QUARTERLY GROWTH RATES b	T for b=0
5 COAL MINING	465.5	0.21	-.082	-3.24
6 PETROLEUM AND GAS MINING	20369.5	0.27	-.094	-2.67
7 IRON ORE MINING	759.6	0.33	-.089	-5.21
8 MINING OF NON-FERROUS METALS	1666.2	0.56	-.063	-4.06
9 MINING OF STONE, SAND AND GRAVEL	64.9	0.38	-.061	-1.99
10 MINING OF OTHER NON-METALLIC MINERALS	418.0	0.49	-.059	-2.71
11 MILK AND MEAT PRODUCTS	446.7	0.50	-.036	-2.01
12 CANNED FRUITS AND VEGETABLES	76.7	0.41	-.067	-2.54
13 WHEAT PRODUCTS	185.3	0.95	.016	0.66
14 CORN PRODUCTS	33.2	0.78	.010	0.26
15 COFFEE	66.2	0.48	-.039	-1.46
16 SUGAR AND SUB PRODUCTS	723.7	0.20	-.082	-4.18
17 EDIBLE OIL PRODUCTS	71.5	1.06	-.002	-0.09
18 ANIMAL FOODS	186.5	0.29	-.068	-2.84
19 DESSERTS, FISH, RICE, OTHER FOODS	481.4	0.48	-.052	-2.29
20 ALCOHOLIC BEVERAGES	65.4	0.75	-.032	-1.68
21 BEER	496.5	0.26	-.106	-6.12
22 BOTTLED REFRESHMENTS	755.0	0.43	-.046	-2.15
23 TOBACCO AND TOBACCO PRODUCTS	96.7	0.56	-.043	-1.53
24 COTTON AND LINEN FIBERS	1224.5	0.20	-.068	-2.05
25 SISAL AND OTHER DURABLE FIBERS	40.7	0.08	-.110	-1.91
26 OTHER TEXTILES	68.4	0.24	-.102	-3.29
27 CLOTHING	61.3	0.82	.004	0.15
28 LEATHER AND LEATHER PRODUCTS	117.4	0.29	-.075	-3.90
29 LUMBER, BOARDS, PANELS	228.7	0.20	-.090	-3.75
30 WOOD FURNITURE AND OTHER	101.0	0.40	-.038	-1.20
31 PAPER AND CARDBOARD	839.2	0.38	-.154	-6.47
32 PRINTING AND PUBLISHING	972.4	0.06	-.209	-4.63
33 PETROLEUM REFINING	12.0	0.99	-.007	-0.26
34 BASIC PETROCHEMICALS	3902.8	0.26	-.052	-1.23
35 BASIC CHEMICALS	1559.2	0.20	-.114	-6.89
36 FERTILIZERS	105.1	3.12	.150	1.83
37 SYNTHETIC RESIN AND ARTIFICIAL FIBERS	1167.5	0.19	-.087	-3.02
38 MEDICAL PRODUCTS	653.0	0.70	-.000	-0.01
39 SOAP, DETERGENTS, PERFUMES, AND COSMETICS	143.2	0.90	-.008	-0.47
40 PAINT, INK, GLUE, OTHER CHEMICAL PRODUCTS	254.9	0.50	-.030	-2.39
41 TIRES, INNER TUBES, OTHER RUBBER	350.6	0.36	-.073	-3.28
42 PLASTICS	426.3	0.25	-.080	-3.68
43 GLASS AND GLASS PRODUCTS	373.3	0.56	-.044	-3.26
44 CEMENT	1729.0	0.30	-.098	-4.72
45 DISHES, CERAMICS, BRICK PRODUCTS	549.8	0.28	-.061	-2.25
46 PROCESSING OF IRON AND STEEL	3780.8	0.60	-.067	-3.39
47 PROCESSING OF NON-FERROUS METALS	222.2	0.46	-.065	-2.90
48 METAL FURNITURE AND ACCESSORIES	137.7	0.17	-.081	-3.08
49 METAL PRODUCTS FOR STRUCTURES	54.7	0.43	-.072	-1.90
50 KNIVES, SCREWS AND OTHER METAL PRODUCTS	481.8	0.37	-.059	-3.28
51 NON-ELECTRIC MACHINERY	966.5	0.29	-.080	-3.14
52 ELECTRIC MOTORS, GENERATORS, ETC.	375.6	0.32	-.065	-2.99
53 DOMESTIC ELECTRIC APPLIANCES	164.2	0.14	-.137	-6.15
54 RADIOS, TV'S, RECORDS, RECORDING TAPE	340.8	0.62	-.028	-1.10
55 BATTERIES, LIGHTS, OTHER ELECTRIC EQPMT.	740.4	0.36	-.104	-4.32

(Table continues on next page)

TABLE 1. (Continued) SUMMARY MEASURES OF MEXICO'S 81-85 INVESTMENT DECLINE, BY SECTOR

NUMBER AND SECTOR	1981 1 INVESTMENT	RATIO OF 83-85 ANNUAL AVERAGE INV. TO 1981 INV.	ESTIMATED QUARTERLY GROWTH RATES b	T for b=0
56 AUTOS AND TRACTORS	2620.7	0.44	-.044	-1.53
57 AUTO FRAMES, MOTORS AND SPARE PARTS	1085.8	0.25	-.088	-5.02
58 TRAINS, BOATS, MOTORCYCLES	182.9	0.31	-.135	-4.92
59 WATCHES, JEWELRY, MATCHES, CANDLES	141.5	0.58	-.035	-1.94
60 CONSTRUCTION	856.5	0.20	-.130	-4.33
61 ELECTRICITY, GAS AND WATER	19754.9	0.54	-.030	-3.09
62 COMMERCE	8638.5	0.87	-.047	-0.79
63 RESTAURANTS AND HOTELS	594.7	0.47	-.069	-2.37
64 TRANSPORTATION	3633.4	0.68	-.031	-1.22
65 COMMUNICATIONS	2942.3	0.79	-.010	-0.90
66 FINANCIAL SERVICES	2223.3	0.77	.002	0.09
67 REAL ESTATE	1325.9	0.19	-.120	-7.93
68 PROFESSIONAL SERVICES	563.6	0.48	-.048	-1.91
69 EDUCATION	9260.0	1.27	-.277	-2.03
70 MEDICINE	70.1	0.64	-.008	-0.25
71 ENTERTAINMENT	282.5	0.83	.006	0.18
72 OTHER SERVICES	1210.1	0.25	-.084	-4.13
ALL SECTORS	104960.2	0.53	-.065	-4.10
42 SECTORS USED IN INVESTMENT EQUATION	21112.0	0.35		

Notes:
1: The investment data is in millions of 1970 pesos.
2: The table reports the estimates of b from the regression $\ln(I_t) = a + b\,T_t + e_t$, where I is quarterly investment (81:1-85:4) and T is a linear time trend. Thus b is an estimate of the quarterly growth rate.

TABLE 2

MEANS AND STANDARD DEVIATIONS OF KEY VARIABLES

	Mean	Standard Deviation
Price indices:		
P_1/CPI	61.99	2.39
P_2/CPI	62.88	3.14
P_3/CPI	59.13	4.62
P_4/CPI	64.33	4.13
P_5/CPI	65.21	4.13
P_6/CPI	68.40	5.25
P_7/CPI	60.13	3.10
P_8/CPI	66.13	3.51
P_9/CPI	58.25	6.72
Wage indices:		
W_1/CPI	67.33	14.78
W_2/CPI	66.79	13.59
W_3/CPI	70.66	17.52
W_4/CPI	71.02	15.77
W_5/CPI	74.09	13.65
W_6/CPI	72.41	22.80
W_7/CPI	77.87	16.00
W_8/CPI	71.28	15.81
W_9/CPI	78.82	16.64
P^I/CPI	3.71	0.57
CF	-339.07	1659.42
π	57.77	47.14
i^D	46.98	29.03
LIBOR	11.84	3.36
px/pm	78.87	15.30

TABLE 3

LEAST SQUARES ESTIMATES OF INVESTMENT EQUATION

DEPENDENT VARIABLE: Ln of Investment in Machinery

Variable	Estimates and Standard Errors			
Debt Dummy	-0.016	(0.030)	-0.068	(0.030)
Ln Product Price	0.687	(0.372)	1.060	(0.381)
Ln Wage	1.709	(0.227)	---	---
Ln Price of Machinery	-2.000	(0.231)	-3.290	(0.156)
Real Interest Rate	-0.0015	(0.0008)	-0.0044	(0.0007)
Quarterly Dummies:				
Q1	-0.518	(0.059)	-0.548	(0.061)
Q2	-0.442	(0.072)	-0.128	(0.061)
Q3	-0.354	(0.062)	-0.199	(0.060)
RBAR2	0.516		0.478	
SEE	1.000		1.005	
N-K	790		791	
DW	1.658		1.600	

These are GLS estimates allowing for differing error variances for each sector. The debt dummy takes the value 0 from 1981:1 up to and including 1982:3, and 1 thereafter. These equations are estimated with separate intercepts for each sector, which are not shown above.

TABLE 4

INSTRUMENTAL VARIABLES ESTIMATES OF INVESTMENT EQUATION

DEPENDENT VARIABLE: Ln of Investment in Machinery

Variable		Estimates and Standard Errors	
Debt Dummy		-0.024	(0.033)
Ln Product Price		1.037	(0.533)
Ln Wage		0.512	(1.253)
Ln Price of Machinery		-3.253	(1.320)
Real Interest Rate		-0.0039	(0.0027)
Quarterly Dummies:			
	Q1	-0.536	(0.063)
	Q2	-0.210	(0.249)
	Q3	-0.226	(0.148)
RBAR2		0.496	
SEE		1.020	
N-K		790	
DW		1.628	
Hausman test	F(3,790)=0.33	Significance level = 0.80	

The instruments are the log of the terms of trade, the capital inflow variable, and the LIBOR interest rate. The endogenous variables are the wage, the price of machinery and the domestic real interest rate. As with the least squares estimates, these estimates allow for differing error variances for each sector. The debt dummy takes the value 0 from 1981:1 up to and including 1982:3, and 1 thereafter. These equations are also estimated with separate intercepts for each sector, which are not shown above. The reported specification test tests whether the wage, machinery price and interest rate coefficients in this table equal the corresponding least squares estimates in table 3, and fails to reject this hypothesis.

TABLE 5

DECOMPOSING THE IMPACT OF THE RIGHT HAND SIDE VARIABLES ON INVESTMENT

Variable	Change between 1981 and 1985 (1)	Estimated Coefficient (IV estimates) (2)	Full impact (1)*(2)
Debt Dummy	1.000	-0.024	-0.024
Ln Product Price	0.018	1.037	0.018
Ln Wage	-0.335	0.512	-0.171
Ln Price of Machinery	0.324	-3.253	-1.054
Real Interest Rate	-7.460	-0.0039	0.029
Sum			-1.200

The change in column (1) is defined as the 1985 annual average minus the 1981 annual average. The dependent variable is measured in natural logs.

TABLE 6

ESTIMATES OF REDUCED-FORM PRICE AND WAGE EQUATIONS

Dependent Variable	Independent Variables		
	Ln of Terms of Trade	Capital Inflows (In Billions of 1982 $)	RBAR2
	-----Estimates and Standard Errors-----		
Ln(PBAR/CPI)	-0.051 (0.163)	0.0020 (0.0078)	0.040
Ln(WBAR/CPI)	1.057* (0.339)	0.0072 (0.0180)	0.642
Ln(P^I/CPI)	-0.836* (0.265)	-0.0263 (0.0139)	0.734

These regressions are OLS estimates of equations 17-19 in the text. PBAR is a weighted average of the sectoral price indices, and WBAR is a weighted average of the wage indices. A * denotes statistical significance at the 5 percent level. The reported standard errors are heteroscedasticity and serial correlation robust standard errors computed by the method recommended in Wooldridge (1990). This is similar in spirit but computationally simpler than the robust errors in White (1984). All equations are estimated on quarterly data between 1981:1 and 1985:4.

TABLE 7

DECOMPOSING THE IMPACT OF THE TERMS OF TRADE DECLINE AND THE CAPITAL FLOW REVERSAL ON PRICES AND WAGES

Variable	Change between 1981 and 1985 (1)	Estimated Coefficient (2)	Full impact (1)*(2)
		AVERAGE PRODUCT PRICES	
Ln Terms of trade	-0.302	-0.051	0.015
Capital Inflows	-4.832	0.002	-0.010
Sum			0.005
		AVERAGE WAGES	
Ln Terms of trade	-0.302	1.057	-0.319
Capital Inflows	-4.832	0.007	-0.035
Sum			-0.354
		MACHINERY PRICE	
Ln Terms of trade	-0.302	-0.836	0.252
Capital Inflows	-4.832	-0.0263	0.127
Sum			0.379

These are simple simulations of the form: change in y equals estimated coefficient times change in x.

APPENDIX

SECTORAL CLASSIFICATION OF INVESTMENT PRICE AND WAGE DATA
FOR THE SECTORS USED IN ESTIMATING THE INVESTMENT EQUATION

DESCRIPTION OF SECTOR	INVESTMENT SECTOR NUMBER	PRICE SECTOR NUMBER	WAGE SECTOR NUMBER
MILK AND MEAT PRODUCTS	11	1	1
CANNED FRUITS AND VEGETABLES	12	1	1
WHEAT PRODUCTS	13	1	1
CORN PRODUCTS	14	1	1
COFFEE	15	1	1
EDIBLE OIL PRODUCTS	17	1	1
ANIMAL FOODS	18	1	1
DESSERTS, FISH, RICE, OTHER FOODS	19	1	1
ALCOHOLIC BEVERAGES	20	1	1
BEER	21	1	1
BOTTLED REFRESHMENTS	22	1	1
TOBACCO AND TOBACCO PRODUCTS	23	1	1
COTTON AND LINEN FIBERS	24	2	2
OTHER TEXTILES	26	2	2
CLOTHING	27	2	2
LEATHER AND LEATHER PRODUCTS	28	2	2
LUMBER, BOARDS, PANELS	29	3	3
WOOD FURNITURE AND OTHER	30	3	3
PAPER AND CARDBOARD	31	3	4
PRINTING AND PUBLISHING	32	3	4
BASIC CHEMICALS	35	4	5
SYNTHETIC RESIN AND ARTIFICIAL FIBERS	37	4	5
MEDICAL PRODUCTS	38	4	5
SOAP, DETERGENTS, PERFUMES, AND COSMETICS	39	4	5
PAINT, INK, GLUE, OTHER CHEMICAL PRODUCTS	40	4	5
TIRES, INNER TUBES, OTHER RUBBER	41	4	5
PLASTICS	42	4	5
GLASS AND GLASS PRODUCTS	43	5	6
CEMENT	44	5	6
DISHES, CERAMICS, BRICK PRODUCTS	45	5	6
PROCESSING OF NON-FERROUS METALS	47	6	8
METAL FURNITURE AND ACCESSORIES	48	6	8
METAL PRODUCTS FOR STRUCTURES	49	6	8
KNIVES, SCREWS AND OTHER METAL PRODUCTS	50	6	8
NON-ELECTRIC MACHINERY	51	7	8
ELECTRIC MOTORS, GENERATORS, ETC.	52	7	8
DOMESTIC ELECTRIC APPLIANCES	53	7	8
RADIOS, TV'S, RECORDS, RECORDING TAPE	54	7	8
BATTERIES, LIGHTS, OTHER ELECTRIC EQPMT.	55	7	8
AUTOS AND TRACTORS	56	8	8
AUTO FRAMES, MOTORS AND SPARE PARTS	57	8	8
WATCHES, JEWELRY, MATCHES, CANDLES	59	9	9

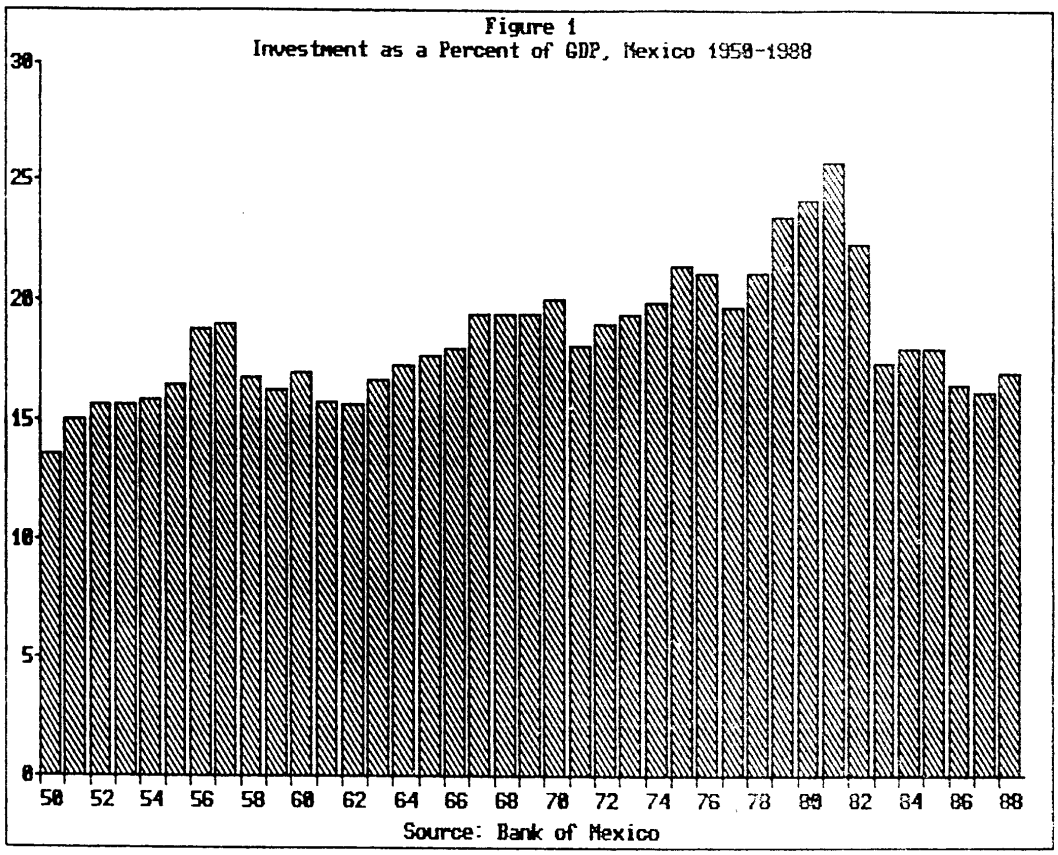
Figure 1
Investment as a Percent of GDP, Mexico 1950-1988
30
25
20
15
10
5
0
50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88
Source: Bank of Mexico

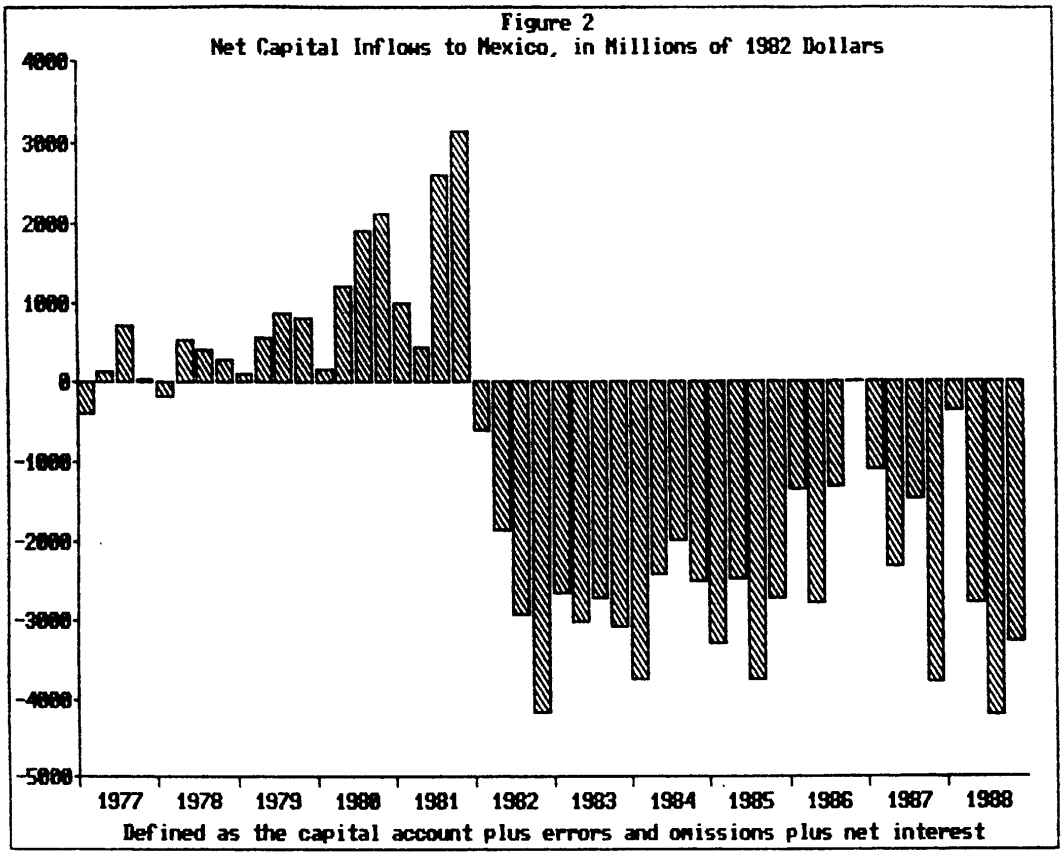
Figure 2
Net Capital Inflows to Mexico, in Millions of 1982 Dollars
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
Defined as the capital account plus errors and omissions plus net interest

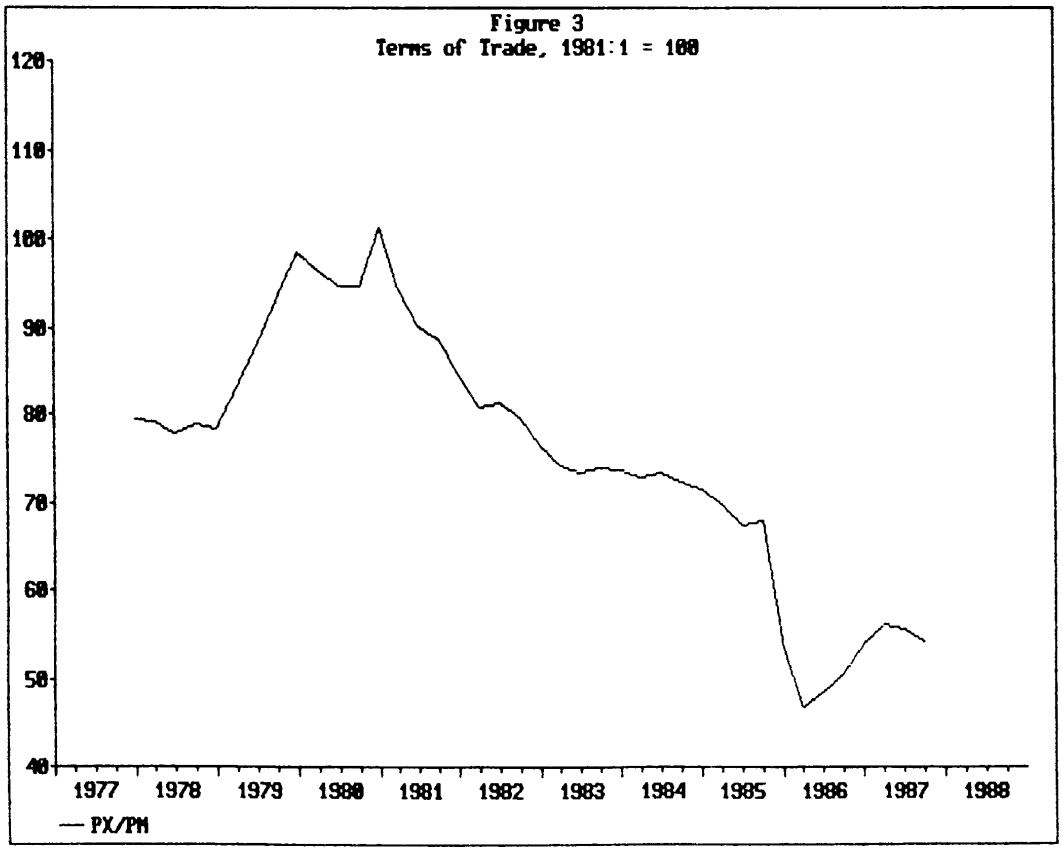
Figure 3
Terms of Trade, 1981:1 = 100
120
110
100
90
80
70
60
50
40
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
— PX/PM

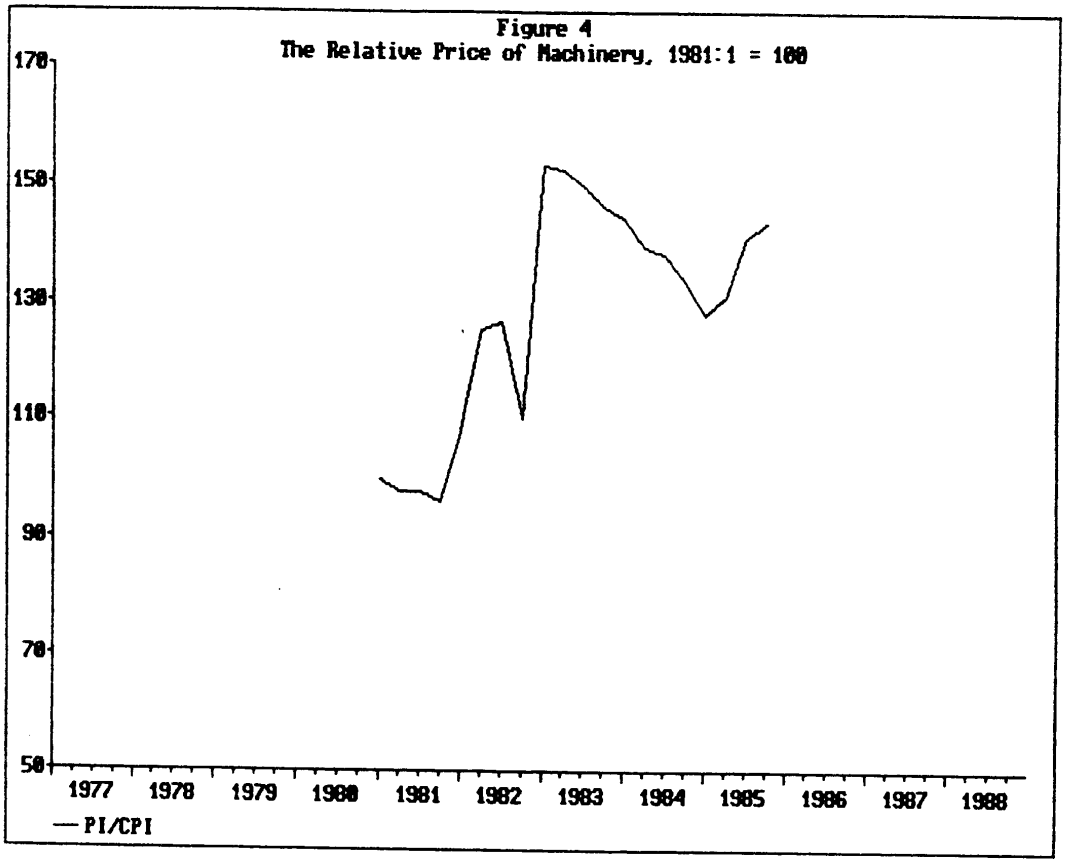
Figure 4
The Relative Price of Machinery, 1981:1 = 100
170
150
130
110
90
70
50
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
— PI/CPI

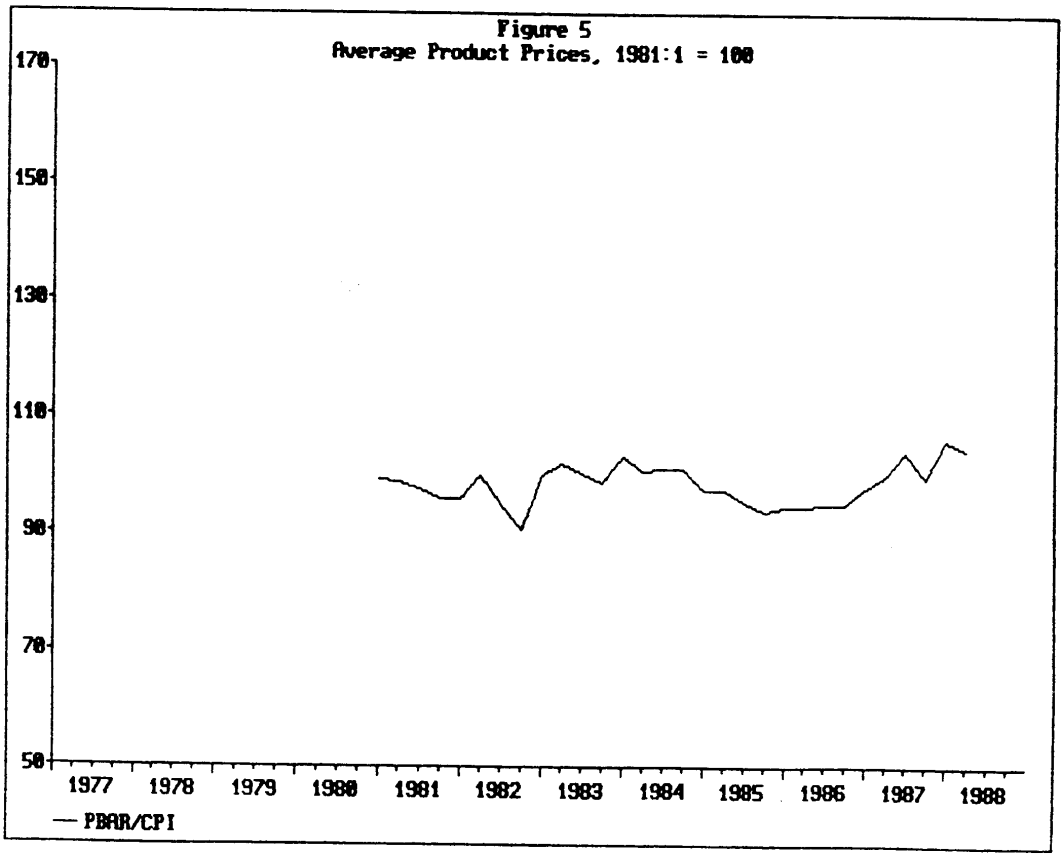
Figure 5
Average Product Prices, 1981:1 = 100
170
150
130
110
90
70
50
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
— PBAR/CPI

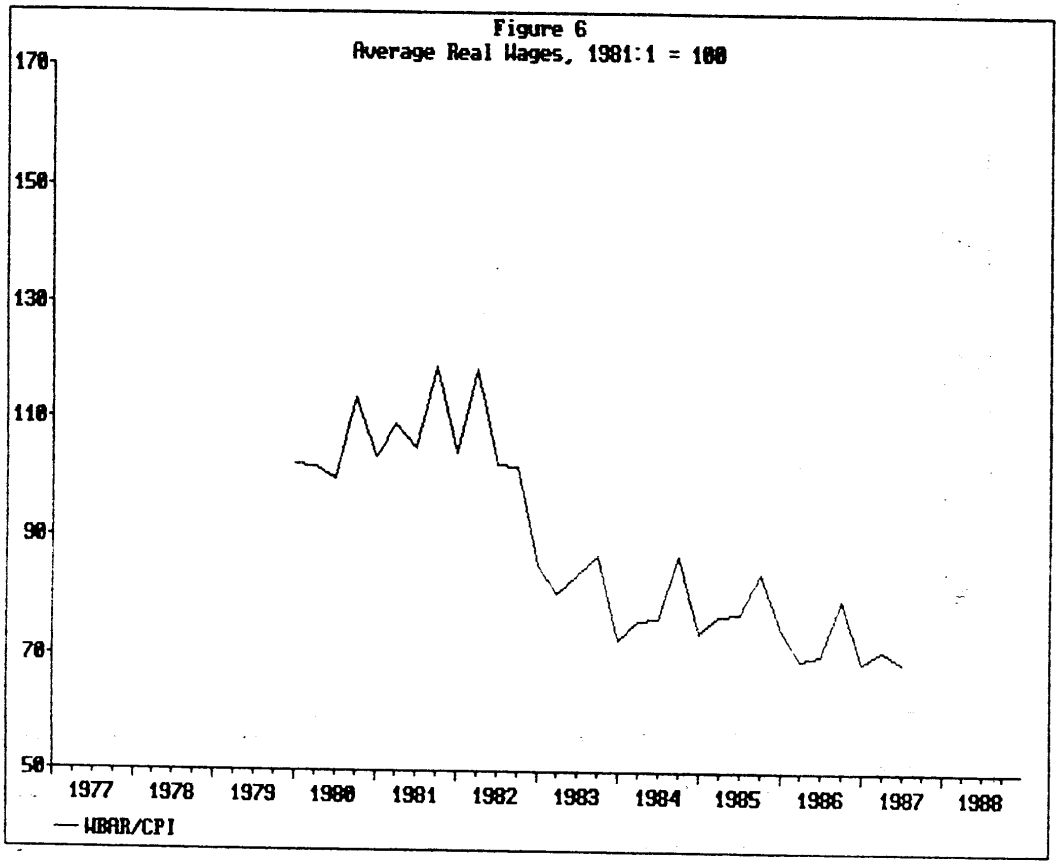
Figure 6
Average Real Wages, 1981:1 = 100
170
150
130
110
90
70
50
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
WBAR/CPI

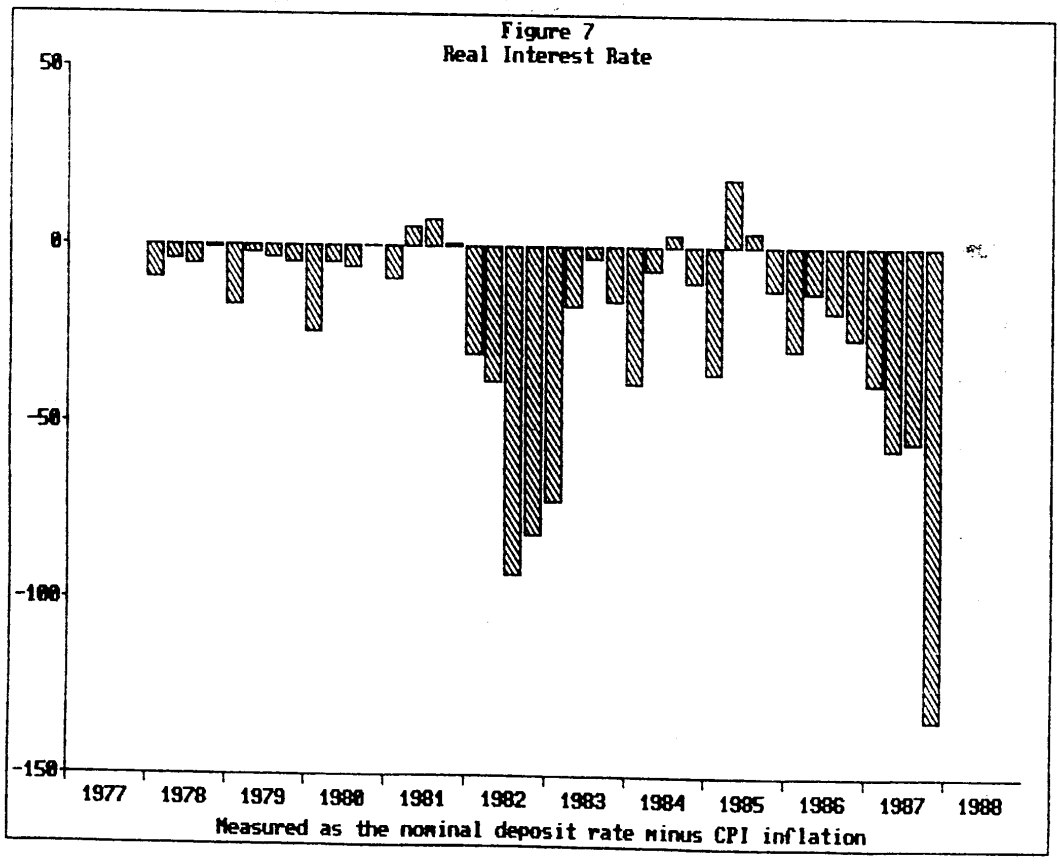
Figure 7
Real Interest Rate
50
0
-50
-100
-150
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
Measured as the nominal deposit rate minus CPI inflation

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