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Trade Reform, Uncertainty, and Export Promotion: Mexico 1982-88

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Abstract

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This paper examines the impact of trade reform on export performance using Mexico's 1983-88 liberalization as a case study. Using a simple mean-variance portfolio optimization framework, we analyze firm export and production decisions when returns to both the domestic and external markets are not known with certainty. This "portfolio" model captures changes in relative uncertainty between domestic and external markets, nests the direct impact of the import liberalization on costs, and can capture the traditional structuralist concern with cyclical income effects. Using firm level export data in a dynamic panel context we test the impact of these three variables on the level and price elasticity of exports and find that reform measures and a credible outward reorientation of the economy were export promoting. We also introduce the recent Levin and Lin tests for unit root stationarity in panel data.

I. Introduction

The dramatic Mexican liberalization experiment from 1982-88 provides a window on the interplay between trade reform and export performance.[1] In a two year period, 1985-1987, the De la Madrid government undertook a restructuring of the external sector preceded in magnitude only by Chile's reforms of the mid-1970's. Import licensing was cut to a quarter of previous levels while maximum import tariffs fell 50% and became more unified. As importantly, the reforms occurred in a climate of conscious break with the past: Mexico was to become an open economy.

Across the same period, exports boomed, growing 43% in 1986, 40% in 1987 and slowing to a still highly respectable 17% in 1988. The graphs on the following pages present a more disaggregated look at exports and relative prices for 9 manufacturing sectors. A cursory glance suggests that for at least 6 sectors, the 40% depreciation of the peso against the dollar appears to be highly correlated with export movements, albeit with about a one year lag. Relative price changes do seem to have an undeniable impact. What is perhaps of more interest is that the response of exports to the 1985 depreciation seems of a much greater magnitude than that of 1982 which was arguably the larger of the two, but which occurred prior to the liberalization program. Cohen (1990) has suggested that this implies some measure of "structural break" in the price-export relationship or, alternatively, that other non-price factors enter in the export supply function. This paper examines three possible non-price effects: domestic or foreign income effects in the structuralist tradition, and two reform-related variables; the liberalization of intermediate imports, and the reduced uncertainty about operating in the external market due to the commitment by the government to a more outward orientation.

To address the last issue of uncertainty, we develop a simple mean-variance portfolio optimization model of a risk averse firm operating in two markets where "returns"--prices adjusted for all intermediate transaction costs-- are not known with certainty at the time that production and export commitments must

[1] See Buffie (1990) Dornbusch(1988) and Ortiz(1991) for good surveys of trends across this period.

Chart 1: Selected Mexican Export Series

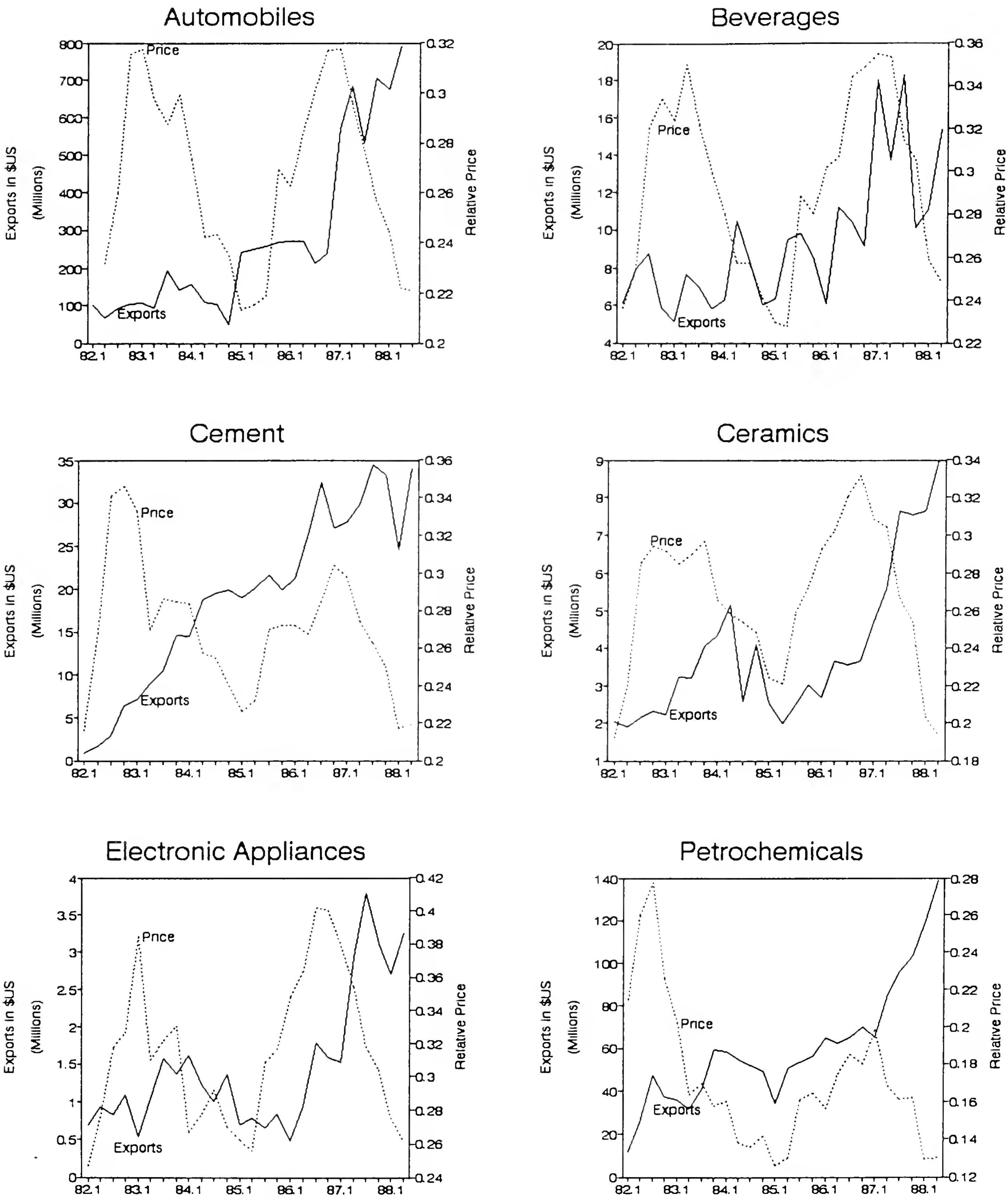
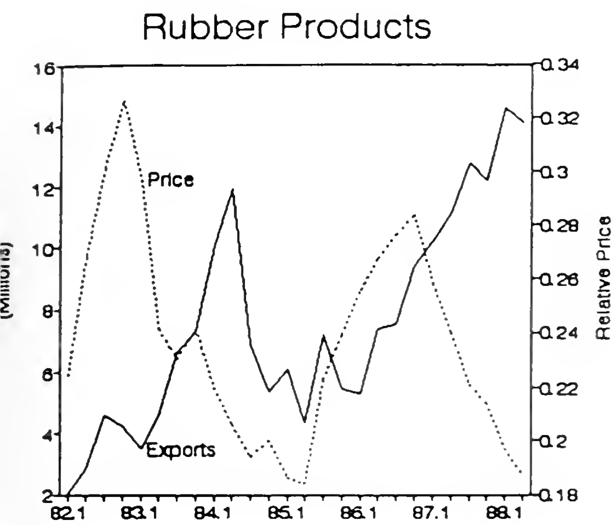
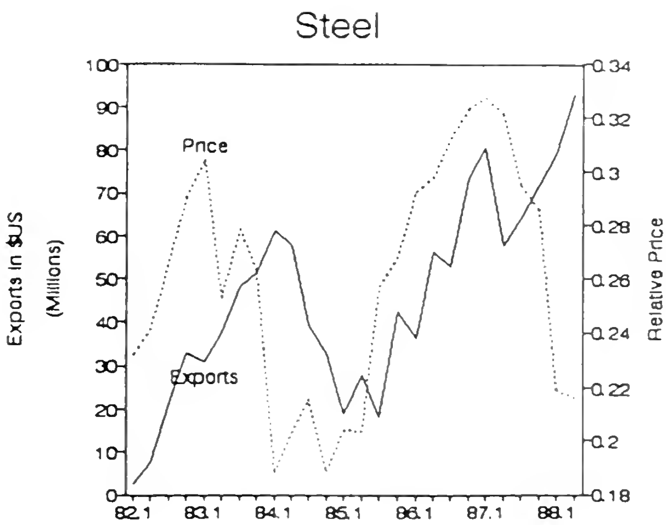
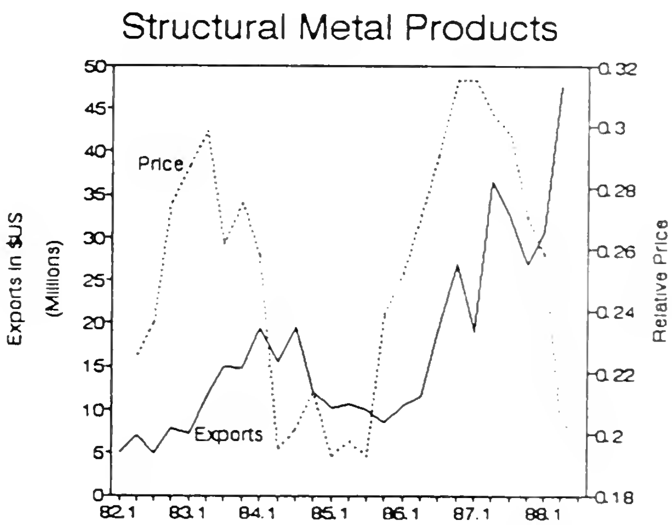


Chart 1: Selected Mexican Export Series Cont.



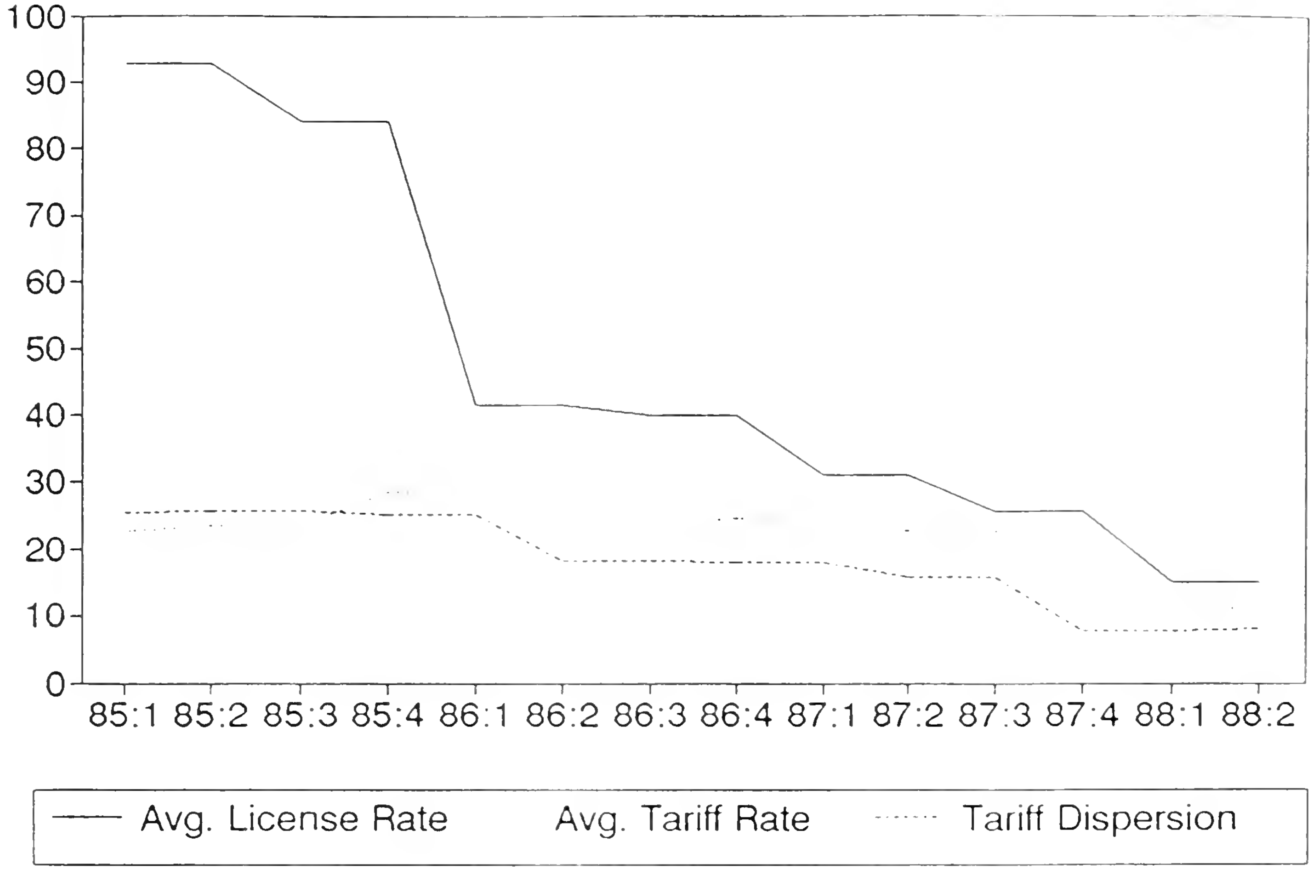




Graph 2

Tariff and License Coverage

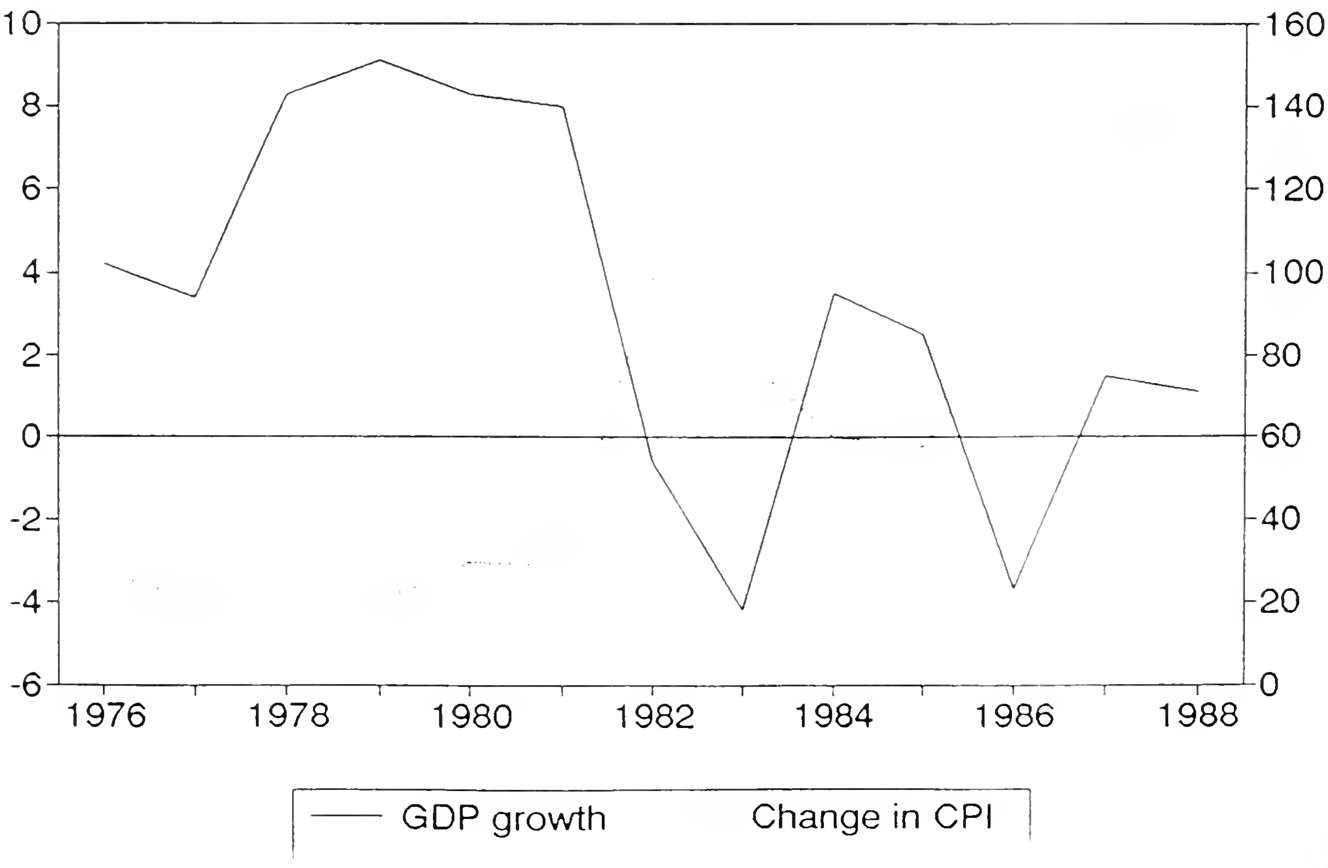
Mexico



Graph 3

Growth and Inflation

Mexico



be made. Differences in the variance of returns becomes a source of non-substitutability between markets that cause firms to look at relative expected returns *adjusted for risk* when making decisions rather than relative prices alone as is traditionally assumed. This "portfolio" model in addition to neatly nesting both income effects and the liberalization of imports also offers a tentative bridge between traditional neo-classical and structuralist approaches particularly with regard to the efficacy of depreciations and their possible contractionary effects. We estimate the model using firm level manufacturing export data using dynamic panel techniques. Of particular interest, we introduce the use of the new Levin and Lin(1992) tests for unit root non-stationarity in a panel context.

Uncertainty and Export Decisions

The last two decades have brought recognition of the importance of uncertainty to export behavior. That producers should be risk averse is plausible particularly in the developing world. Managers are frequently owners with large shares of their wealth tied up in the enterprise. In the absence of complete capital markets, even non-managing shareholders are unable to diversify away all risk so that the variability of the firm's profits, as well as their level, remains important. This variability can arise from a variety of sources. The vast movements in output and prices visible in many adjusting countries during the 1980's introduced unprecedented uncertainty for entrepreneurs about the state and future of their home market. Operating abroad has presented a wide variety of risks. Institutions that have emerged in industrialized countries to cover exporters risk are largely absent in LDC's: there are, in general, no forward exchange markets to cover unexpected currency movements, export import banks to insure payment default by foreign contractors, or futures markets to stabilize commodities prices. Even were such institutions the norm in LDC's, exports are frequently undertaken on a consignment basis which leaves both price and quantity sold conditional on short term foreign market conditions and often capricious government trade policies. Facing unhedgable uncertainty in both markets, the producer must choose a level of output and the markets to direct it to before returns are known.

Both empirical and anecdotal evidence support the idea that uncertainty should be integrated in a well-specified export model. Sergio de la Cuadra(1988), one of the architects of the forerunner of Mexico's reform program in Chile, confirms the findings of numerous empirical studies[2] that exchange rate unpredictability has a negative impact on exports and that individual entrepreneurs are willing to trade return for reduced risk:

> Arguably, more significant (to Chile's export performance) than the boost provided by the temporary higher-than-equilibrium exchange rate were the expectations of a realistic exchange rate being maintained over the medium term. Businessmen at the time argued more for a stable, realistic rate than for an artificially high one.[3]

In the same spirit, the Chilean government adopted a policy of price stabilization bands for tradable agricultural commodities

> "to isolate the national market from the erratic fluctuation of the international market and *not* to increase the average level of the internal price.. thereby *reducing the risk* to this activity ... in the context of a commercial opening." [4]

These considerations were clearly important in the Mexican case as well. Throughout the structural reform process, entrepreneurs reported that they would accept lower levels of protection if the government would credibly commit not to tamper with the regime again.[5] As Ortiz notes, the commitment was made plausible by the oil shock of early 1986, "...which made the immediate concern of the government...to protect the balance of payments rather than to arrest inflation or sustain growth...[6] The pursuit of the Mexican-American Free Trade Agreement and petition to join GATT with the explicit goal of reducing uncertainty

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[2] Empirical studies by Abrams (1980), Cushman (1983, 1986, 1988), De Grauwe (1988), Kenen and Rodrick (1984, 1986), Koray and Lastrapes (1989), and Thursby and Thursby (1985, 1987) have found a significant negative impact of exchange rate variance on trade flows using industrial country data sets in the floating rate period. Pozo (1992) finds a similar relation in U.K.- U.S. trade from 1900-1940. Coes (1981) has shown an increase in Brazilian exports upon moving from a floating cruzeiro to a more predictable crawling peg, and Paredes (1990) reports a negative relationship between exchange rate volatility and export elasticities in Latin America.

[3] De la Cuadra(1988) P. 179

[4] Chacra and Jorquera, Central Bank of Chile, 1991, p. 2.

[5] Cohen, interviews with firms in the course of negotiating the Free Trade Agreement, 1991-92.

[6] Ortiz(1991) P. 288

about U.S. barriers to trade [7] also signaled, with the continuing dismantling of protection measures, a longer term commitment to maintaining a pro-export orientation.

Progress in reducing risk in the external market was accompanied by a deteriorating situation domestically. The severe oil shock in 1986, equivalent to 6.5% of GDP, required a massive readjustment. GDP fell 3.8% and inflation jumped to historic highs on top of a secular fall in economic growth from about 6% in 1975-81 to virtual stagnation afterwards. Whatever may be happening to relative prices across this period, exporters saw the domestic market as far less predictable than previously and the external more promising.

II. A Framework for Export Decisions Under Uncertainty

Numerous authors (Batra 1975, Helpman and Razin 1978, Pomery 1984, and Grinols 1987, among others) have introduced uncertainty in standard general equilibrium trade models. However, research at the firm level is, surprisingly, far less developed given the number of questions traditionally framed in a partial equilibrium context. [8] Particularly conspicuous by its absence is the stochastic analogue to the problem of a firm choosing both a level of output and its distribution between two markets, one domestic and one external. De Grauwe(1988), Hooper and Kohlhagen(1978), Katz, Paroush and Kahana(1982), and Paredes(1989) model risk averse exporters or importers operating in two markets, but assume that the domestic market is absent of any uncertainty. Coes introduces uncertainty in both markets, but assumes total production to be exogenously determined. Neither the assumption of a single stochastic market nor exogenous output is critical to motivating the adverse effects of uncertainty on exports the authors seek to derive. However, they do seem unrealistic in light of the vast fluctuations in both domestic prices and output observed in many countries in the 1980's and restrict the range of questions that uncertainty-based partial

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[7] Tomato producers report that waiting time at U.S. customs varied from hours to weeks constituting an unpredictable non-tariff barrier to trade that could drive their return negative due to spoilage, this uncertainty discouraging them from selling to the northern market.

[8] Goldstein and Khan's (1985) comprehensive survey of "Income and Price Effects in Foreign Trade" in the Handbook of International Economics includes no mention of efforts to integrate price uncertainty into the production and export decisions of the firm. Nor has the analogous problem been studied in the industrial organization literature (see for example, the Handbook of Industrial Organization).

equilibrium models might address.

We employ a simple mean-variance portfolio optimization framework where output is determined endogenously and **both** domestic and foreign market "returns" are not known with certainty at the time that production and export commitments must be made. Maximizing expected profits therefore involves both choosing a level of output and an optimal "portfolio" of markets to direct it to. Sandmo (1971) provides the reference work on a risk averse firm's behavior when the output decision must be taken, perhaps due to production lags, prior to the sales date when the market price becomes known. The firm's beliefs about the sales price can be summarized in an exogenous subjective probability distribution,[9] and it therefore remains a price taker, but in a probabalistic sense. For any utility function displaying risk aversion, output levels in a competitive market will be below what they would with price certainty. [10]

The two market analogue of Sandmo's problem can be written as

$$\max_{\{x_d, x_f\}} E\,[U(\pi)] \tag{1}$$

where the firm maximizes expected utility of profits π by choosing a level of output x and its allocation between the domestic market, x_d, and the foreign market, x_f. The analysis becomes more tractable if a negative exponential utility function is assumed

$$U(\pi) = \alpha - \beta \exp(-\gamma\pi) \tag{2}$$

where gamma is the coefficient of risk aversion which has the property of constant absolute risk aversion as profits increase.[11] The return to a unit sold in the foreign market, P_f, is a function of the price in foreign currency, the exchange rate, tariffs levied domestically and externally, transport costs, etc. P_d represents the

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[9] Davidson's (1991) argument that modeling uncertainty as a subjective probability implies more knowledge than agents often have is a reasonable criticism of this approach, especially in cases of far-reaching structural reform.

[10] Leland (1972) has extended this result to a more general formulation of random demand where firms have monopoly power. Coes (1977) proved Sandmo's intuition that a marginal increase in uncertainty will lead to a decrease in output.

[11] The CARA utility function is preferred to the popular quadratic function which predicts that as entrepreneurs make higher profits, they become more risk averse.

return received in the domestic market. If it is further assumed that

$$P_d \sim N(\mu_d, \sigma_d^2) \qquad P_f \sim N(\mu_f, \sigma_f^2) \tag{3}$$

their distribution can be summarized completely with the first and second moments.[12]

The firm's maximization problem becomes

$$\max_{\{x_d, x_f\}} E[U(\pi)] = \max_{\{x_d, x_f\}} \{\alpha - \beta \exp[-\gamma\pi^e + \frac{\gamma^2}{2}\sigma_\pi^2]\} \tag{4}$$

or equivalently

$$\max_{\{x_d, x_f\}} x_d\mu_d + x_f\mu_f - \frac{\gamma}{2}(x_d^2\sigma_d^2 + x_f^2\sigma_f^2 + 2x_d x_f \sigma_{df}) - c(x_f + x_d) \tag{5}$$

The variance of the portfolio of markets depends on three things--the variance of each return, the covariance of the two returns, and the quantity of output dedicated to each market. In general, an increase in production to either market increases total variance, the cost of which must be weighed against the resulting increase in expected profits. First and second order conditions for exports, symmetric for production directed to the domestic market, yield

$$E[U(\pi)]_{x_f} = \mu_f - \gamma(x_f\sigma_f^2 + x_d\sigma_{df}) - c_x = 0 \qquad E[U(\pi)]_{x_f x_f} = -\gamma\sigma_f^2 - c_{xx} < 0 \tag{6}$$

The second term in the f.o.c. has an intuitive interpretation as the marginal increase in risk premium with respect to output. For a risk averse individual, the expected utility of randomly varying profits can be written in the general case as the utility of expected profits minus a risk premium

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[12] Assuming a normal distribution admits the possibility of a negative realized return. This is not unreasonable if we consider transport costs and the possibility of default or other barriers to sale. Consider the losses of Chilean grape exporters when at the U.S. border, inspection agents refused entry of a shipment on spurious grounds and caused its spoilage. The Chilean government is currently suing the U.S. Government in the world court to recover the losses.

$$E[U(\pi)] = U[\pi^e - rp(\pi^e,x)] \tag{7}$$

which can be derived by a second order Taylor expansion to be [13]

$$rp(\pi^e,x) = \frac{1}{2}\sigma_\pi^2 \frac{U''(\pi^e)}{U'(\pi^e)} = \frac{1}{2}\gamma\sigma_\pi^2 = \frac{1}{2}\gamma\,[x_d^2\sigma_d^2 + x_f^2\sigma_f^2 + 2x_d x_f \sigma_{df}] \tag{8}$$

The derivative of the last term is therefore the marginal risk premium for the negative exponential function. As equation (6) shows, it drives a wedge between marginal costs and marginal revenue and leads, as Leland and Sandmo showed for the general case, to output falling below what it would be in the non-stochastic case.

While incorporating the covariance term can, under certain circumstances, be theoretically very important and yields some completely counterintuitive results (see Maloney 1992), these are not the effects we are emphasizing and we abstract from it here in the interest of clarity. If we also temporarily assume constant marginal costs, we see that

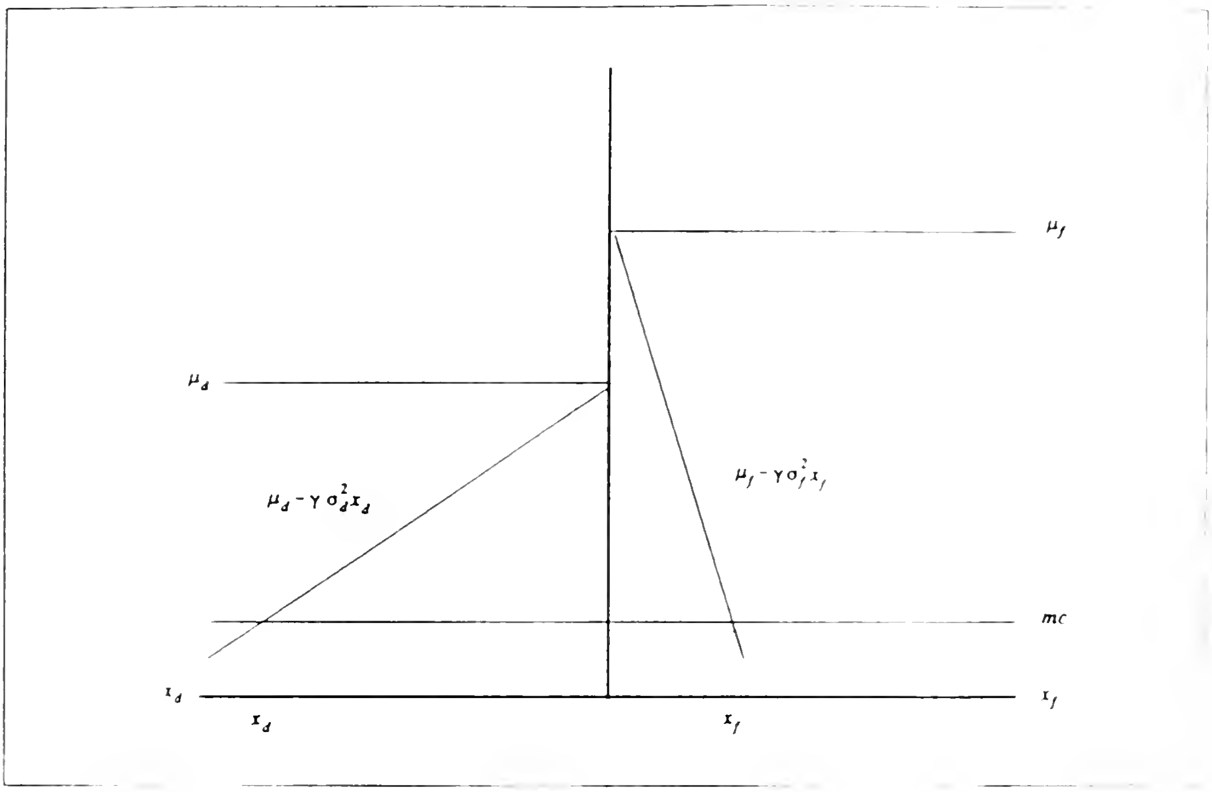
$$x_f = \frac{\mu_f - c}{\gamma\sigma_f^2} \tag{9}$$

Remembering that an entirely symmetric equation exists for output directed to the domestic market, it is clear that the quantity directed to each market can be solved entirely independently with no interaction between markets through a common upward sloping marginal cost curve. Unlike the non-stochastic competitive case, the f.o.c. in line (6) indicates that as long as the marginal risk premium is an increasing function of output, an equilibrium level of output exists since risk adjusted expected marginal revenue is downward sloping and will intersect the horizontal marginal cost line as illustrated in Graph 4.[14] Here, it is assumed that there is more variance in the external market so the diagonal is steeper and output to that market is lower. What emerges is that the decision of how much to produce for each market depends positively on the net return and negatively on the price variance in that market and the degree of risk aversion. Return variance introduces

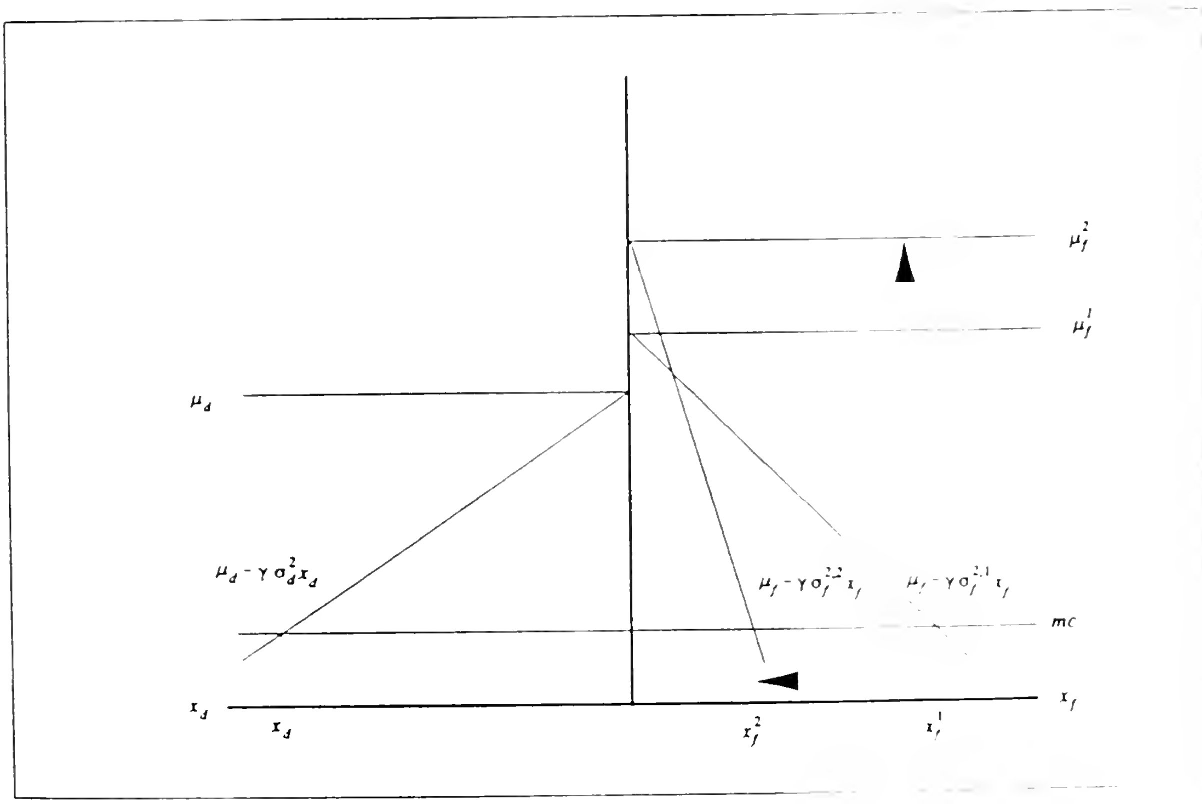
[13] See Copeland and Weston (1983), p. 88, for a complete derivation.

[14] This is the special case that Paredes investigates and the analysis in Graph 4 is similar to his.

Graph 4: Equilibrium with Uncertainty
Constant Marginal Costs, No Covariance



Graph 5. Contractionary Depreciation
Non-Credible, No Covariance



an imperfect substitutability between markets, rather than goods, that guarantees that even if price differentials exist, some portion of output is likely to be devoted to each market.

Since

$$\frac{\partial x_f}{\partial \mu_f} = -\frac{\partial x_f}{\partial c} = \frac{1}{\gamma \sigma_f^2} \tag{10}$$

it is also clear that the magnitude of the response of output directed to a particular market to price or cost changes is an inverse function of the degree of uncertainty in that market. It is this result that underlies Paredes' empirical work on Brazil, Chile, and Peru where he finds the supply price-elasticity estimates for manufactured exports to be positively correlated with real exchange rate risk. In the case that a rise in return is accompanied by a perceived increase in the variance of that return, both the magnitude and direction of output change to that market are indeterminate and could be even negative. If, for example, a large devaluation increases the expected return received in the external market, but the sustainability of this change is questioned, then the perceived variance of that return will also rise. As Graph 5 illustrates, it is not clear which effect dominates, and it is entirely possible that the quantity of exports, and consequently therefore output, falls, particularly if agents are very risk averse, thus providing another supply side source of contractionary depreciations (Faini and De Melo 1990, Edwards 1985, Krugman and Taylor 1978, and Cooper 1971). Further, if both the external return and the marginal risk premium rise equivalently there should be no reallocation of quantities sold, no upward pressure on domestic prices, and no pass-through. Export decisions may remain fundamentally unaltered, causing the trade balance to remain in the hook of the J-curve until agents grow confident that the devaluation is permanent.

Cyclical Income Effects

The imperfect substitutability induced by differences in return variance provides a tentative bridge from neo-classical to structuralist models of trade which emphasize the ineffectiveness, under some conditions, of changes in relative prices in promoting exports. Goldstein and Khan, in addressing the role of cyclical income measures in export supply functions, summarize one strand of the argument:

> Most of the empirical work in this area (cyclical demand effects) is based on the twin premises that when domestic demand pressure increases, selling in the home market becomes more profitable than selling abroad, and that this increased profitability is *not* fully captured by movements in the ratio of domestic to export prices. This cyclical tilt toward the domestic market might reflect the better quality of domestic customers (eg, larger purchase volume, stronger brand allegiance) *or a perceived higher risk associated with export sales.*(italics ours)[15]

The last point, in italics, is our previous one: relative prices, when adjusted for the risk premium arising from the high level of uncertainty characterizing the export market, may dictate concentrating on the domestic market. Free trade agreements, forward markets in currency, government agencies that subsidize the costs of collecting information on foreign markets, or any other measure that reduces the uncertainty of selling abroad would therefore seem a logical part of an export promotion policy. Brand allegiance and purchase volume can be viewed as questions of uncertainty when we consider that they influence the probability that a good placed on the domestic market at a given price will be sold. The same logic can be applied to the cyclical effects themselves, whether domestic or foreign. If prices adjust sluggishly and demand falls in a market without a corresponding fall in the relative price, the market will not clear and there is a higher probability of unsold production. This would lead to both a lower expected return and a higher variance. The relative price variable customarily included in export supply equations will therefore be a poor proxy for the risk adjusted expected return that exporters are really looking at. Adding cyclical income, by capturing this dimension of uncertainty, improves the specification.

Licensing and Tariff Reduction: Increasing Marginal Costs

We can model the reduction of import licensing either as the release of a binding constraint on one factor or as the lowering of the scarcity price if rationed goods are traded freely, in the context of a two factor CRS Cobb-Douglas production function with one factor constrained,

[15] Summary in Goldstein and Khan (1985) p. 1061.

$$x = k\left[\alpha\frac{P}{w}\right]^{\frac{\alpha}{1-\alpha}} \tag{11}$$

Here, x is the total output of the firm, k, the constrained factor, in our case, the licensed imported intermediate input, w the cost of a variable intermediate input, again possibly the domestically traded licensed factor, and α the importance of the variable input in the production process. In either case, a reduction in licensing will increase both the quantity of exports and production overall.[16] After integrating the implied increasing marginal cost function into our portfolio framework, the results of the previous section will continue to hold although the intuition is less straightforward. The fact that a rise in output to one market increases costs of production in both markets creates an interdependence between markets.

The first order condition with respect to exports can be written

$$\mu_f - \gamma x_f \sigma_f^2 - \frac{w}{\alpha}\left[\frac{(x_d + x_f)}{k}\right]^{\frac{1-\alpha}{\alpha}} = 0 \tag{12}$$

To make the analysis more transparent but without losing the central point, the constrained and free factors' shares are set equal, thereby constraining marginal costs to be linearly increasing in output, or

$$\mu_f - \gamma x_f \sigma_f^2 - \frac{2w}{k}(x_d + x_f) = 0 \tag{13}$$

Letting $\theta = 2w/k$ yields

$$x_f = \frac{\mu_f(\theta + \gamma\sigma_d^2) - \mu_d\theta}{\gamma[\theta(\sigma_d^2 + \sigma_f^2) + \gamma\sigma_d^2\sigma_f^2)]} \tag{14}$$

As expected, both the return and the variance of the domestic market enter in determining the level of production for the export market due to the shared cost function. Since the denominator is positive and

[16] Another possibility exists that some intermediate inputs may in fact allow for a fundamental transformation of the product, making it competitive in the world market where before it was not. Mexican electric motors may be seen as of insufficient quality to sell in the U.S. market despite the overall competitiveness of a refrigerator. Using imported motors may transform the product into one that is competitive abroad.

$$\frac{\partial x_f}{\partial \sigma_d^2} = \frac{\theta[\mu_d(\theta + \gamma\sigma_f^2) - \mu_f\theta]}{\gamma[\theta(\sigma_d^2 + \sigma_f^2) + \gamma\sigma_d^2\sigma_f^2]^2} \tag{15}$$

where $x_d > 0$ constrains the numerator to be positive, the signs of the derivatives with respect to returns and variances are as expected. An increase in return or a decrease in the variance of prices in one market increases production directed to that market and decreases production directed to the alternate market. An additional unit produced for the domestic market raises the marginal cost of producing x_f above its return. The resulting contraction of output directed to the external market will decrease marginal costs through θ and the risk premium through its own variance until, again, risk adjusted expected returns equal marginal costs. Total output behaves as in the non-stochastic case with

$$\frac{\partial x}{\partial \mu_f} = \frac{\sigma_d^2}{[\theta(\sigma_d^2 + \sigma_f^2) + \gamma\sigma_d^2\sigma_f^2)]} \tag{16}$$

which is always positive.

Deriving one of the cross-price responses yields another departure from the non-stochastic case.

$$\frac{\partial x_f}{\partial \mu_d} = -\frac{1}{\gamma}\left[\sigma_d^2 + \sigma_f^2 + \frac{\gamma\sigma_d^2\sigma_f^2}{\theta}\right]^{-1} \tag{17}$$

If there is any uncertainty in the system, the vexing problem of unobserved extreme reallocations of output in response to small changes in relative price predicted by the competitive model is eliminated. Despite the fact that marginal costs are rising in both markets and return only in the external, the simultaneous reduction of the risk premium and marginal costs leads to a lower equilibrium output for the domestic market, but not a zero level. As marginal costs grow steeper, the cross derivative becomes greater since the larger rise in marginal costs with a increase in exports requires a larger decrease in risk premium in the domestic market, but will never become infinite.

Finally, taking the derivative with respect to costs yields

$$\frac{\partial x_f}{\partial \theta} = \frac{-[\mu_d(\sigma_d^2\sigma_f^2) + \mu_f\sigma_d^4]}{[\theta(\sigma_d^2 + \sigma_f^2) + \gamma\sigma_d^2\sigma_f^2]^2} \tag{18}$$

which is clearly negative as in the non-stochastic case. A reduction of tariffs or QRs on imported intermediate goods will increase the production of exports. Since an entirely symmetric equation exists for output to the domestic market, it is clear that, as in the non-stochastic case, total output must fall with a rise in marginal costs.

Structural Change in Elasticities with Reform

It is common to estimate export supply functions in logs thereby allowing the coefficients to be interpreted as elasticities. Though we have shown that level and derivative with respect to return of exports should rise with the reduction in import restrictions or uncertainty, it is not obvious that the elasticity with respect to return should increase as well. Taking logs of expression (11) yields an elasticity completely independent of either the quantity of the fixed factor, usually capital but here intermediate inputs, or the price of the variable factor. The intuition is straightforward: while the first derivative is higher, so is the overall level leaving the percentage changes constant. The same basic result and intuition follow with the simple uncertainty case in equation (9). Taking logs indicates that raising or lowering uncertainty only effects the level and derivative with respect to return, not the elasticity. Because of the complex interplay of increasing costs, uncertainty, and differing returns, our uncertainty model provides a case where price elasticities may vary with levels of uncertainty or structural reform. Here

$$\eta_{\mu_f} = \frac{(\theta + \gamma\sigma_d^2)}{\mu_f(\theta + \gamma\sigma_d^2) - \mu_d\theta} \qquad \eta_{\mu_d} = \frac{\theta}{\mu_f(\theta + \gamma\sigma_d^2) - \mu_d\theta} \tag{19}$$

In addition, it appears that the impact of a rise in relative price caused by a rise in external return is not symmetric to a fall in domestic.

III. Estimation

A fully specified export supply equation should therefore include two return variables, two variance measures, all relevant cost variables, and perhaps measures of domestic and foreign income plus interactive terms for all since a first order expansion would yield complex elasticities such as those above for all variables. This is clearly not feasible where degrees of freedom are limited. Our base specification is then

$$x_f = \beta_0 + \beta_1 \frac{\mu_f}{\mu_d} + \beta_2 \frac{\sigma_f}{\sigma_d} + \beta_3 y_d + \beta_4 y_f + \beta_5 lic + \beta_6 \frac{\sigma_f}{\sigma_d} * \frac{\mu_f}{\mu_d} + \beta_7 y_d * \frac{\mu_f}{\mu_d} + \beta_8 y_f * \frac{\mu_f}{\mu_d} + \beta_9 lic * \frac{\mu_f}{\mu_d} \quad (20)$$

This formulation allows us to nest the traditional relative price equation cum cyclical income effect common in the literature while also capturing uncertainty and reform effects on both the level of exports and the price elasticity. The constraint that the individual return and variance coefficients be equal is, from our theoretical derivation above, unjustifiable. However, it should be remembered that both our utility and production functions are first order approximations to unknown functions and should be relied on principally for indicating the direction of change. Since the major adjustment to real wages happened in 1982, at the very beginning of our sample, and since capital cost measures are unreliable, these were ommitted from the specification. Although single equations like (20) are frequently estimated in the literature, a simultaneous equations framework to avoid simultaneity bias might be preferred to eliminate any impact Mexican exports would have on world prices. In many sectors, we can consider Mexico to be small, however, and our world price variable is in fact the exchange rate and is not likely to affected by a output changes at a sectoral level. More importantly, in all cases we are less interested in gaining unbiased estimates of individual coefficients than documenting how they may change with liberalization.

The Mexican Ministry of Commerce collected firm level export data from 1982 to mid-1988. To maximize degrees of freedom, we pool the firm level data using a fixed effect panel estimator for 9 sectors where graphical analysis suggests that firms behave relatively similarly across the period. The fixed effect estimator transforms the data by taking deviations from the time averages to avoid bias stemming from potential unobserved individual effects that are correlated with included explanatory variables that differ across firms (see Hsiao 1990). It implicitly assumes that coefficients are identical across all cross sections within the sector, but permits intercepts to vary by firm.

In the past, it has been impossible to address issues of non-stationarity and spurious correlation in a panel context. The concern in the original literature pioneered by Granger and Newbold(1974) was that a time series containing a unit root component, perhaps following a random walk,

$$y_t = \rho y_{t-1} + \epsilon_t \qquad \rho = 1 \tag{21}$$

when regressed on another "integrated" series, was likely to yield spurious correlations, that is, the null of no correlation would be rejected too often. However, in a recent working paper, Levin and Lin (1992) have derived the necessary theory to apply the tools customarily used in the analysis of single time series to the panel context. They show that the panel regression estimators in the presence of a unit root are super consistent, converging faster than is the case with stationary panel data and that, in contrast to the asymptotic properties for a single time series data, they have a limiting normal distribution. The standard unit root test statistic, the Dicky-Fuller test, translates easily to the panel context although in samples of moderate size and in the presence of either intercept, time trend, or individual specific fixed effects, a strong small sample bias is introduced which decreases the power of the test against stationary alternatives. For these cases, the relevant critical values depend on both the time series and cross section dimensions of the panel and Levin and Lin tabulate them based on Monte Carlo simulations. The simulations also demonstrate very large increases in the power of the test relative to the single series case even in small samples(n=10,t=25). In the presence of serial correlation, the authors show that the Augmented Dicky-Fuller test

$$\Delta y_{it} = \beta_0 + \beta_1 t + \beta_2 y_{it} + \sum_{j=1}^{p} \beta_{2+j} \Delta y_{it-j} + \eta_i + e_{it} \tag{22}$$

which adds several lags of the differenced dependent variable to the standard Dicky-Fuller test shares a similar distribution. Here β_0 is a constant, t is a time trend, β_2 = (ρ-1), and η_i is an individual specific fixed effect. Table 1 presents the values of β_2 for our data using equation (22). All of the export series appear trend stationary and the presence of a unit root component, $\beta_2 = 0$, is consistently rejected at the 1% level. This finding was confirmed by the fact that first difference specifications in most sectors showed signs of over-differencing with Durbin-Watson statistics near 3.[17]

It would be possible to make the export series stationary by extracting a linear time trend. A time trend in itself, however, lacks any economic content, while by contrast, both the U.S. GDP and licensing variables also trend strongly with time and have a legitimate a priori theoretical claim to be causing the movement in exports. In practice, it proved impossible to separate the impact of each when both are included as explanatory variables: as is classically the case with multicollinearity, standard errors are large and results are not robust to small changes in specification. Including one or the other alone consistently yields satisfactory specifications with relative prices and variances entering with the correct sign and significantly in most regressions. However, the exaggerated values for the U.S. GDP elasticity when licensing was omitted, often between 7 and 20, seemed unsatisfactory given our own time series estimates of aggregate exports from 1960-91 which yielded values around 3.5 and which corroborated the Truett and Truett(1989) estimate of 3.3 with aggregate manufacturing data. We therefore constrained the coefficient to be 4, to be safe, except in those sectors where no satisfactory specification using U.S. GDP was found originally. In practice, the preferred specifications often changed little from the original ones including only licensing suggesting some robustness to the value chosen for the foreign income elasticity. [18]

Ideally, we would simultaneously include perhaps six lags of all eight variables and proceed to a more parsimonious specification through testing. Our limited degrees of freedom are compounded by the difficulties of handling dynamics in a panel context; it must be remembered that each additional lag implies a loss of a degree of freedom *for each cross section* in the panel.[19] We therefore follow a sequential process of

[17] Customarily, approximations to functions such as equation (14) yield a first differenced log form. However, the high Durbin Watsons preclude this. We let the data dictate.

[18] The assumption that the elasticity remains unchanged after liberalization while indefensible, is relatively benign as the impact will be picked up the liberalization variable itself.

[19] In fact, RATS 3.11 is one of the few time series programs capable of intelligently handling dynamics in a panel context. Since the cross sections are concatenated in a single long time series, it cannot not take as a lag observations of the previous cross section but assigns a missing value and drops the observation. Each lag therefore implies a loss of n degrees of freedom.

progressively adding variables. All estimations were begun with six quarterly lags on the relative price variable. Some additional structure was needed since, as is common in time series, a high degree of collinearity across lags permitted identifying important lags but prohibited estimating them precisely. Since graphical and preliminary econometric analysis suggested that often the first few, frequently negatively signed, lags on price were unimportant, they were constrained to be zero, and invariably one lag emerged as significant.[20] We kept three consecutive lags then added six lags of the variance measure and repeated the process until a satisfactory representation was achieved with all non-interactive variables. At this point standard Chow tests would have been interesting to test for structural break in the parameters but given the degrees of freedom consumed by the lag structure of the included variables, dividing the sample in half was not feasible. Instead, we add all the interactive variables were then added at the lag chosen for the price variable, and those found significant were retained and are, by definition, evidence of structural break. In most case where first order serial correlation was detected, we employed a standard Cochrane-Orcutt correction although the LM tests for several sectors indicate the presence of higher order serial correlation that neither seasonal dummies nor alternate specifications could eliminate.[21] The resultant lag structures are reasonably robust to changes in specification.

Encouraging specifications emerged in all sectors with the key variables consistently entering significantly, of the right sign, and of magnitudes congruent with expectations. In some cases it was impossible to choose between two specifications, and both are presented. In all sectors, the relative price variable enters significantly and often with values above 2. Again, relative price changes do seem effective at the firm level in stimulating exports. The variance measure entered significantly and with the predicted sign in 6 sectors bearing out our anecdotal evidence and suggesting that the uncertainty model is a reasonable framework in which to work. Evidence that the reduction in licensing increased exports appears in specifications in all

[20] We can think of this a simply imposing some a priori information on the lag structure as is common in a geometric or polynomial distributed lag. The restriction of the first lags to be zero can be thought of as what is called "pure delay" in the engineering literature where no impact occurs until several periods after the impulse.

[21] Hendry's objection that Cochrane-Orcutt transformations imply the existence of a common factor that should be tested for, not assumed, is legitimate. However, we are constrained by available technology in RATS to levels, first differences, or AR1 specifications.

sectors with broadly similar coefficients with a 1% fall in the percentage of sectors licensed seems to have between a .25 and 1% stimulus to exports. In addition, in 5 sectors it entered in an interactive mode suggesting that the liberalization did in fact have a positive effect on the price elasticity. The domestic GDP variable entered in only three sectors suggesting weak support for cyclical effects interpreted as an excess capacity measure or another dimension of uncertainty.

Conclusion

The empirical results seem to support our portfolio framework and offer some tentative policy conclusions. Credible devaluations do seem effective, but it is also suggested that free trade agreements, forward markets in currency, government agencies that subsidize the costs of collecting information on foreign markets, or any other measure that reduces the uncertainty of working in the external market would seem a logical component of an export promotion policy. It also appears that import liberalization, whether acting directly through reducing costs, or serving as a confirming signal to agents about the permanence of the reforms, or as a proxy for other reforms happening concomitantly have a stimulative impact on exports. Finally, we have suggested that the traditional structuralist concern with domestic cyclical income effects can be viewed as a dimension of the uncertainty producers face but that the importance of this effect may be restricted to a limited number of industries.

Table 1
Levin and Lin Panel Unit Roots Test
Augmented Dicky-Fuller with Intercept and Trend, p=4

Sector	t= 26, N=	Crit.Val. 1%	Exports β_2	Rel. Price β_2
Automobiles	6	-3.44	-6.06	-12.6
Beverages	4	-3.44	-8.30	-8.05
Cement	9	-3.09	-7.50	-8.34
Ceramics	6	-3.44	-8.50	-8.80
Electronic Appliances	6	-3.44	-3.52	-9.34
Petrochemicals	7	-3.44	-10.2	-9.09
Rubber Products	3	-3.96	-5.65	-6.73
Steel	7	-3.44	-5.67	-12.8
Structural Metal Products	20	-2.83	-7.01	-20.5

Augmented D-F with Intercept and Trend: Single Series, p=4

Variable	β_2 Crit.Val. 5% = 3.6
Variance	-3.95
GDP(Mex)	-3.12
GDP(US)	-3.85
Licensing	-1.31

<u>Results</u>

Automobiles (n=6,t=26)

a 2.48RP{0} - .167 VAR{0} - 1.33 VAR*RP{0}
(2.11) (-1.88) (-2.074)

AR1 Rho = .57 (7.59) DW = 2.11 LM(p=4) = 3.53 R2 = .36

b 2.07 RP{0} - .55 LIC{0}
(2.07) (-2.16)

AR1 Rho = .52 (6.86) DW = 2.07 LM(p=4) = 2.56 R2 = .34

No grounds on which to prefer one specification.

Beverages (n=4,t=26)

.75 RP{0} -.33 LIC{1}- .16 LIC*RP{0} - 3.4 GDP{4}
(2.03) (-1.94) (-1.56) (-1.82)

Levels DW = 1.89 LM(p=4) = 3.79 R2 = .09

Cement (n=9,t=26)

2.74 RP{5} - 1.07 LIC{0} - 1.12 LIC*RP{5}
(2.08) (-3.00) (-2.70)

AR1 Rho = .54 (9.01) DW = 1.63 LM(p=4) = 21.6 R2 = .29

Ceramics (n=6,t=26)

a 1.67 RP{3} - .16 VAR{4} - 4.40 GDP{5}
(1.64) (-2.39) (-1.97)

AR1 Rho = .71 (10.4) DW = 2.39 LM(p=4) = 12.3 R2 = .49

b 1.5 RP{5} - .48 LIC{1}
(1.75) (-2.03)

AR1 Rho = .69 (10.5) DW = 2.38 LM(p=4) = 13.42 R2 = .47

No grounds on which to prefer one specification.

Electronic Appliances (n=6,t=26)

5.24 RP{6} - 1.51 LIC + 1.22 Q4
(2.27) (-1.86) (3.0)

AR1 Rho = .49 (5.92) DW = 2.18 LM(p=4) = 7.4 R2 = .39

An almost equivalent formulation replaces the Q4 dummy with domestic GDP but together they are highly collinear suggesting that it is the seasonal component of GDP that is significant. Since this seasonality could also be coming from U.S. GDP we present the Q4 specification.

Petrochemicals (n=7,t=26)

1.20 RP{6} - .17 VAR{2} - .55 LIC{2} - .43 LIC*RP{6}
(1.78) (-1.94) (-1.50)* (-1.80)

AR1 Rho = .63 (10.7) DW = 2.07 LM(p=4) = 16.9 R2 = .33

* Interactive term not significant at 10% if excluded.

Rubber Products (n=3,t=26)

2.39 RP{5} -.52 VAR{3} - 2.18 LIC{2} - 1.08 LIC*RP{5}
(1.84) (-2.78) (-3.64) (- 2.21)

AR1 Rho = .36 (2.85) DW = 2.05 LM(p=4) = 2.87 R2 = .36

Steel (n=7,t=26)

2.33 RP{4} - .29 VAR{4} - .68 LIC{0} - .6.77 GDP{3} - .70 LIC*RP{4}
(2.10) (-2.14) (-2.06) (-1.66) (-1.76)

AR1 Rho = .32 (4.68) DW = 2.11 LM(p=4) =67.8 R2 = .22

The exclusion of GDP leads to t-stats above 2.3 for all remaining coefficients.

Structural Metal Products (n=20,t=26)

2.63 RP{0} - .28 VAR{0} - .68 LIC{2}
(2.21) (-1.97) (-1.88)

AR1 Rho = .53 (12.58) DW = 2.21 LM(p=4) =15.5 R2 = .30

Data

Exports

The Ministry of Commerce(SECOFI) data base records firm level exports by sector quarterly from 1982-88:2 denominated in dollars. Since the U.S. WPI is virtually constant during this period, we interpret this measure as a volume index.

Expected Returns (RP)

As proxies for expected returns we use the price realized in each market. The Mexican central bank tabulates a domestic price index for each of our sectors. Since exchange rate movements swamp any individual goods price movements, we use the exchange rate with the United States, Mexico's principal trading partner as the U.S. return.

Relative Variances (VAR)

It is impossible to capture all the dimensions of uncertainty that a firm may consider. The relative variance variable was constructed with the idea that since both returns and costs moved dramatically due to inflation, the variance of the return relative to costs of production were important. The variable is the variance of the log of the nominal wage over the exchange rate over six months, divided by the variance of the log of the nominal wage over the Producer Price Index. Graph 7 shows that suggests that this relative variance was much lower during the 1985 depreciation than in 1982 and corresponds to Ortiz' observation that the government was perhaps exclusively concerned with the external sector due to the fall in oil prices and demanding debt service commitments.

Import Licensing (LIC)

Our reform variable is the percentage of imported products covered by licensing requirements as tabulated by SECOFI. It is perhaps also possible to interpret the secular fall in protection as representing an increased confidence in the regime and hence reduced uncertainty.

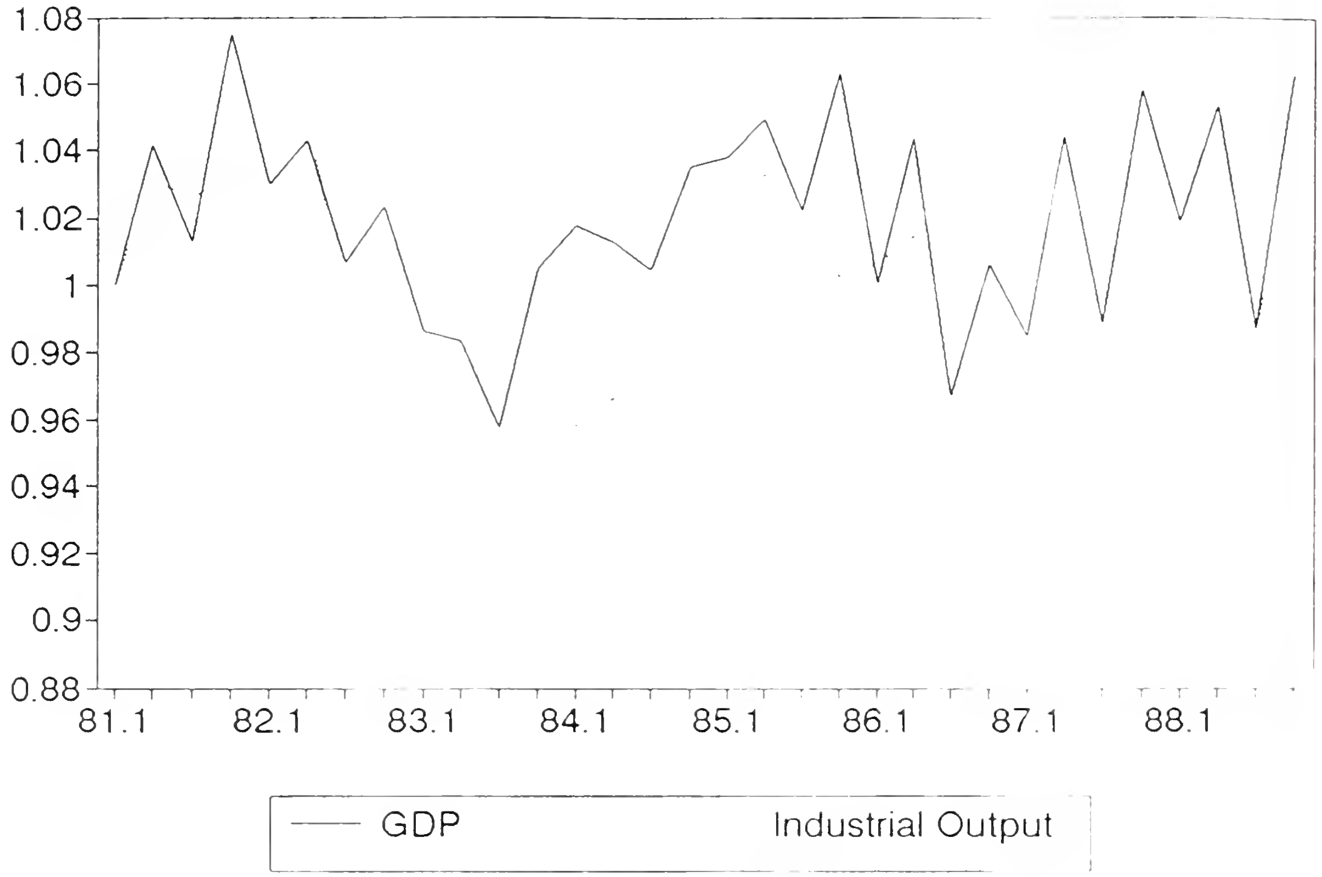
Income (GDP)

Finally, our measure of income is simply the level of GDP, a variable which never reaches its 1980 level and can be considered more or less stationary. Graph 6 shows the behavior of both GDP and the industrial index. We use the U.S. GDP series for world demand.

Graph 6

GDP and Industrial Output

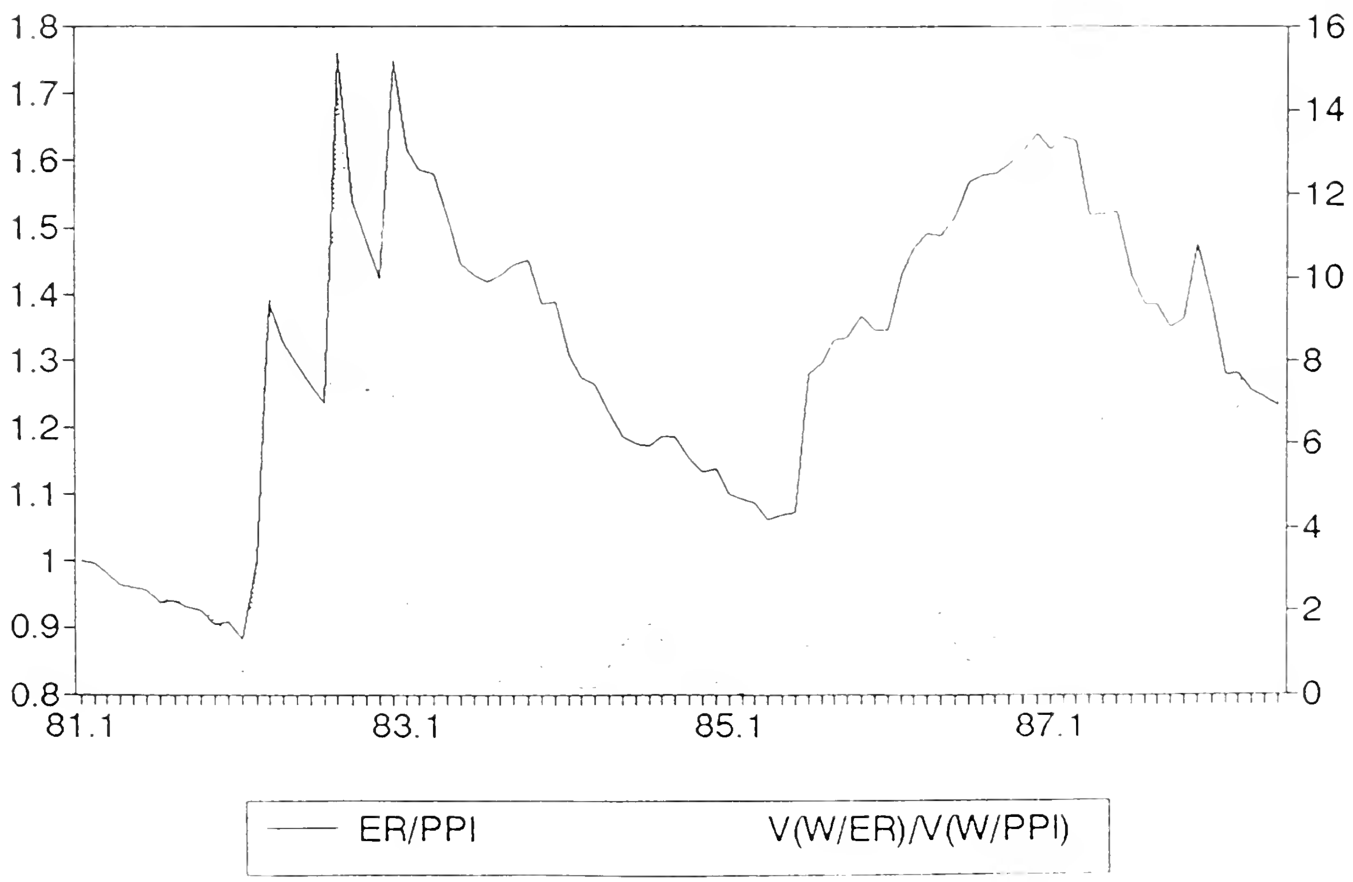
Mexico



Graph 7

RER and Relative Variances

Mexico



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