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A Structural Model for Developing Countries' Manufactured Exports

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A dynamic structural econometric model is developed to analyze movements in manufactured exports and to capture lags in the adjustment to equilibrium. The model is estimated with pooled cross-section time-series data for a representative sample of fifteen developing countries grouped according to their export market power. The results suggest that prices, domestic productive capacity, and external economic activity are critical determinants of manufactured exports from developing countries. The structural parameter estimates are used to infer the effects of changes in destination country income, distinguishing between the short-run and long-run export volume and export revenue effects. The results indicate that domestic economic policies that promote investment and capacity in export-oriented activities are likely to play a key role in increasing foreign exchange earnings in developing countries, even if growth in external demand is slow.

The expansion of exports, particularly manufactured exports, has been a major concern for economists and policymakers alike. Through trade, countries can gain access to the critical inputs they need to develop, fostering specialization and increasing factor productivity. Manufactured exports are believed to play a prominent role in this process because of early country experiences linking industrialization and development, and because of the lessons and indirect benefits of industrial expansion—including industrial management, technology acquisition, marketing, and product design and development. Later experience has shown that there may have been an overemphasis on industrialization, however, as several countries achieved high growth of per capita income for long periods on the basis of producing and exporting food, raw materials, or services.

But manufactured exports have continued to gain importance in world trade, propelled by the higher income elasticity of demand for manufactures than for primary products, and by the changes in the economic structure associated with increases in per capita income. In the period 1965–85, manufactured exports

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from all World Bank member countries grew at 7.4 percent a year in volume terms, compared with 5.6 percent for merchandise trade. Manufactured exports from developing countries grew at much faster rates—averaging 12.2 percent a year—as these countries increased their market shares in manufactures trade from 7.3 percent in 1965 to 17.4 percent in 1985 (World Bank 1987). In 1986, for the first time, developing countries earned more foreign exchange from manufactured exports than from exports of agricultural or mining products, including fuels (GATT 1987).[1]

Despite this importance, simple models explaining export behavior in developing countries are far from abundant, though the literature is growing rapidly. Recent empirical studies discussing aggregate and manufactured export behavior in developing countries include those of Bond (1985), Marquez and McNeilly (1986), and Balassa and others (1986). This article expands this literature by using a simple model to assess the likely impact of a change in external economic activity on export revenues for developing economies—a key concern for the highly indebted countries and a topic which has been the subject of recent debate in the international trade literature.

The plan of the article is as follows. Section I presents the structural model and discusses the export supply and demand equations and the dynamic specification adopted. Section II presents the empirical estimates for two groups of developing countries—distinguished by the magnitude of the price elasticity of demand—using pooled cross-section time-series data. The short-run and long-run estimates of the foreign income multiplier are discussed in section III, and section IV summarizes the main conclusions.

I. The Model

This section develops a simple stuctural export model, identifying separately the manufactures export supply and demand equations which characterize the long-run equilibrium. It then presents a dynamic adjustment mechanism which captures short-run deviations from this equilibrium path. Finally, it discusses the reduced form associated with the complete structural model.

A Structural Model of Export Behavior

Export Supply. The supply specification assumes that producers base their production decisions on two main factors: domestic capacity and the relative profitability of producing manufactured exports vis-à-vis producing other goods (including other exports, import substitutes, and home goods).

The empirical measurement of domestic capacity presents great difficulties because sectoral capital stock data are usually not available. Three measures have been predominantly used in the literature as proxies for domestic capacity.

1. GATT (1987, pp. 143–4) and World Bank (1987, pp. 197–99) differ in their definition of developing countries.

The first, which I adopt, assumes that time or any other trend factor (such as trend gross domestic product, y^*) can be taken as an indicator of aggregate capacity (Goldstein and Khan 1978, Bond 1985). This measure implicitly assumes that domestic resources are mobile across sectors.[2] The second measure assumes that a sectoral production index can be used as a proxy for domestic capacity (Donges and Riedel 1977, Balassa and others 1986). This measure has been criticized on the grounds that the production and export of industrial goods are jointly determined and are both affected by demand factors. Thus industrial production cannot be assumed to be exogenous in the structural estimation of an export model (Faini 1985). A capacity utilization index is a third measure, normally defined as deviations from trend output, $y - y^*$. This approach is equivalent to adding aggregate output (y) as an additional explanatory variable, with a further assumption about the coefficients of these two variables. The inclusion of y was tested in a preliminary version of the present model, but it proved statistically insignificant in all equations and was thus eliminated from further consideration. Note that the omission of aggregate demand can be justified if the country does not consume the good it exports, or if production is characterized by constant returns to scale.

Relative profitability is usually measured by the ratio of export prices for manufactures to an aggregate price index for the whole economy, such as the gross domestic product (GDP) deflator. In the present analysis, however, two separate measures of price effects are used. These are (1) the real exchange rate, which indicates the relative profitability of producing tradables versus nontradables (a determinant of the size of tradables in total production), and (2) the ratio of manufactured exports prices to other tradable goods prices, which indicates the profitability of exporting manufactures relative to other traded goods (thus influencing the share of manufactures in total exports). This specification is slightly more general than the approach commonly adopted (because it does not restrict the price elasticities to take particular values) and has proven useful in the estimation of import functions. It has not been tested, however, in the context of export equations.

A linear version of the export supply equation can be written in the form:

$$x_t^s = \alpha_0 + \alpha_1 (PX/PT)_t + \alpha_2 (PH/PT)_t + \alpha_3 y_t^* \tag{1}$$

$$\alpha_1 \geq 0, \alpha_2 \leq 0, \alpha_3 \geq 0$$

with x_t^s = the quantity of manufactured exports supplied; PX_t = the price of manufactured exports (a unit value index); PT_t = the price of domestic tradables; PH_t = the price of nontradables (home goods); y_t^* = an index of domestic capacity (trend output); and t = time.

All variables are expressed in logarithms and pertain to one country. Note

2. For an alternative indicator that assumes that resources are sector-specific in the short run, see Aspe and Giavazzi (1982).

that $(PX/PT) = PX - PT$ because the price ratio is one variable. (A formal description of the variables and data sources is included in appendix C.)

The export price indexes were obtained from the United Nations and are probably the best data available using a comparable methodology for a large number of countries. They contain two major shortcomings, however, which are important to note. First, the price indexes were constructed on the basis of export unit values at the four-digit Standard International Trade Classification (SITC) level, using the Paasche formula. Even at this level of disaggregation, the unit values used will sometimes reflect variations in product quality and composition rather than variations in prices. From an empirical standpoint this is unfortunately unavoidable, but it should be borne in mind when interpreting the price and quantity figures (Moran and Park 1986). Second, the price indexes well reflect "border prices," but exclude the effective taxes and subsidies received (or paid) by local producers and consumers. This exclusion of domestic taxes and subsidies (due to lack of relevant data) probably would limit the price responsiveness of the export estimates obtained here.

Three further caveats about the export supply equation 1 should be noted. First, the equation omits variable costs (that is, wages and intermediate inputs). Although part of these costs (such as wages) are captured in the price of home goods, a more detailed study of all variable costs will be needed in the future to test explicitly for their importance in the export supply equation. Second, the proxy variable used for domestic capacity (trend GDP) is also correlated with other structural effects which tend to evolve slowly—such as "learning by doing," entrepeneurial talent, and the quality of infrastructure (particularly in transportation and communications). Although I was not able to disentangle explicitly these effects in the present study—for no reliable data for them are yet available—I will interpret the significance of the domestic capacity variable as implying that these structural effects are important in the explanation of exports. A more detailed study at the country level will be needed to confirm the validity of this interpretation (see Keesing 1979 for a discussion of these effects). Third, the model developed here can only be understood in partial equilibrium terms in order to justify the exogeneity of the real exchange rate in the export supply equation.

Export Demand. The export demand specification assumes that external buyers make their decisions on the basis of relative prices and the growth of external demand (captured by a real scale variable).

Relative prices are measured by the ratio of a country's manufactured exports prices to the price of manufactured exports in world markets, PX/PX^w. The real scale variable, y_t^w, captures the growth of external demand for each country, reflected in a simple weighted average of real economic activity (GDP) for the country's main export markets. It assumes, implicitly, that the exporting country moves into other markets only with a lag, and hence the geographic distribution of its exports needs to be considered in the definition of external demand.

A linear version of the demand equation can be written in the form:

$$x_t^d = \beta_0 + \beta_1 (PX/PX^w)_t + \beta_2 y_t^w \tag{2}$$

with $\beta_1 \leq 0$, $\beta_2 \geq 0$ and x_t^d = the quantity of manufactured exports demanded; PX_t^w = the world price (based on a unit value index) of manufactured exports; y_t^w = an index of external demand for the country's exports; and t = time. Again, all variables are expressed in logarithms.

Two assumptions need to be noted in the specification of equations 1 and 2. First, I have written both equations in log linear form, and thus assume constant elasticities. This assumption has been justified in the context of import behavior (Thursby and Thursby 1984) but has not been tested in export models. I adopt it here mostly because it simplifies the interpretation of the estimated coefficients. Second, both equations are written in terms of relative prices, and hence assume that there is no "money illusion" on the part of producers and consumers of manufactured exports. This homogeneity assumption follows naturally from the assumption that economic agents are rational and optimize utility.[3]

Dynamic Adjustment. Equations 1 and 2, which can be characterized as long-run equilibrium relations, represent the basic structural export model used in the present study. To allow for the presence of short-run disequilibra, however, I assume that export prices and quantities react with a lag to changes in the exogenous variables. Export quantities are assumed to respond positively to the suppliers' desire to increase exports, whereas export prices are assumed to respond positively to excess demand.

$$\Delta x_t = \gamma (x_t^s - x_{t-1}),\ 0 \leq \gamma \leq 1 \tag{3}$$

$$\Delta PX_t = \lambda(x_t^d - x_t),\ \lambda \geq 0 \tag{4}$$

where Δ is the first difference operator. (See Browne 1982 for a comparison of this adjustment mechanism with other approaches suggested in the literature.)

Equation 3 arises from constraints on domestic production, such as fixed factors of production in the short run, which may prevent domestic suppliers from moving along the long-run supply curve when the price changes. This equation emphasizes the importance of domestic factors in the determination of export quantities (see Draper 1985, Winters 1985). Equation 4 accounts for the slow adjustment of prices to excess demand, caused by contracts or delivery lags, for example, which may prevent an instantaneous adjustment of prices to excess demand even if there are no constraints on domestic production.

Differences in the speed of adjustment between suppliers and consumers may have important consequences in the dynamic structure of the model, however. Two cases are distinguished here, and will be explicitly tested. The first case,

3. Note that individual prices are introduced in the export supply specification for the Republic of Korea in Balassa and others (1986), but there is no attempt to test explicitly the price homogeneity hypothesis.

labeled model A, assumes that both sources of disequilibrium are important in adjustment toward long-run equilibrium. Noting that $(PX/PX^w)_t = PX_t - PX_t^w$, $\Delta x_t = x_t - x_{t-1}$, and $\Delta PX_t = PX_t - PX_{t-1}$, this model can be derived by substituting equation 1 into equation 3 and equation 2 into equation 4 to obtain

$$(5) \qquad x_t = a_0 + a_1 (PX/PT)_t + a_2 (PH/PT)_t + a_3 y_t^* + a_4 x_{t-1} + u_{1t}$$

$$(6) \qquad PX_t = b_0 + b_1 PX_t^w + b_2 y_t^w + b_3 x_t + b_4 PX_{t-1} + u_{2t}$$

where $a_0 = \gamma\alpha\phi$; $a_1 = \gamma \alpha_1 \geq 0$; $a_2 = \gamma \alpha_2 \leq 0$; $a_3 = \gamma \alpha_3 \geq 0$; $0 \leq a_4 = 1 - \gamma \leq 1$; $A = 1 - \lambda\beta_1$; $b_0 = \lambda\beta_0/A$; $0 \leq b_1 = -\lambda \beta_1/A \leq 1$; $b_2 = \lambda \beta_2/A \geq 0$; $b_3 = -\lambda/A \leq 0$; $0 \leq b_4 = 1/A \leq 1$; $u_{1t} = \gamma v_{1t}$; $u_{2t} = \lambda v_{2t}$; and v_{1t}, v_{2t} are the error terms of equations 1 and 2, respectively. I assume that these error terms have 0 means, constant variances, and may be contemporaneously correlated but are otherwise independent across time.[4]

The second case, labeled model B, assumes that the adjustment on the demand side is fairly rapid and completed within one year (the period of analysis in this study) but that the adjustment of domestic producers is only partially completed within a year. This hypothesis seems attractive, as buyers can change their purchases from a particular country to other potential suppliers with relative ease. Suppliers, however, are likely to respond only slowly to changes in the exogenous variables, particularly if this response involves a large transfer of resources in or out of the manufacturing sector. Under this condition, the export supply equation (5) will continue to be valid, but the equilibrium export demand curve (equation 2) will replace the lagged adjustment equation (6). Equations 5 and 2 thus constitute the structural model B.

The Reduced Form

The endogenous variables—export quantities and prices—in the export models A and B are written in terms of all the exogenous variables. To simplify the notation they are presented in matrix notation (see appendix A for the general expressions for the reduced form parameters of the models in terms of the structural coefficients). In the case of model B, which reflects lagged supply adjustment but rapid demand response, lagged prices do not appear explicitly and there is a restriction on the parameters of the reduced form for export volumes.

A case of particular interest for developing countries occurs when the export demand curve is assumed to be infinitely elastic, so that export prices can be treated as exogenous in equations 1 and 5. This is the traditional "small-country" assumption and implies that domestic suppliers are pricetakers in international markets. Each of the models presented here (A and B) allows

4. Tests for the eventual presence of autocorrelation in estimates for four countries provided no evidence of autocorrelation, so that problem is ignored in the estimates for the pooled sample.

differentiation between countries which face very large price elasticity, and those that face downward-sloping demand curves.

II. Empirical Estimates

The estimation strategy tests first for the validity of the small-country assumption, using the estimates of the reduced form for each country. If this hypothesis cannot be rejected, then I presume that the country faces a demand curve with a relatively large (possibly infinite) price elasticity. These countries are put into group I. If the small-country assumption can be rejected, however, this is evidence that the country faces a much smaller demand price elasticity. These countries are put into group II. The export supply and demand equations for each country group are then estimated using pooled cross-section time-series analysis. This strategy seemed attractive because it uses the data to split the sample into two groups which presumably exhibit different structural characteristics, and hence avoids forcing equality of parameters across countries.

Country Groupings

The price elasticity of export demand (β_1) is a key parameter in the specification of the appropriate model, for it permits the adoption of the small-country assumption. Export prices can be regarded as exogenous in the export supply equation only if the export demand curve is infinitely price elastic.

To test this assumption, the reduced form of model A, the most general model, was estimated for each of the fifteen countries in the sample. The F values associated with the general and restricted reduced-form expressions for the price and quantity equations were calculated. Under the null hypothesis, the reduced-form parameters are restricted to those shown in rows 2 and 4 of the table in appendix A. Large values of F indicate that the small-country assumption ($\beta_1 \rightarrow -\infty$) can be rejected by the data. The calculated F values are shown in appendix B.

The results of this test show that for six out of the fifteen countries in the present study the small-country assumption could clearly be rejected, at a conventional significance level of 5 percent. (At a 10 percent level, Argentina and Mexico would be classified in group II.) Thus, for these countries, there is strong evidence of a finite and relatively small demand price elasticity. These countries may have market power in the manufactured goods they export and could, in principle, use this advantage to gain market shares by offering a reduced price for these goods. For the remaining nine countries, the small-country assumption could not be rejected. These countries presumably face a much larger (possibly infinite) demand price elasticity.

Structural Estimates

In the structural estimates of the export supply and demand equations I used two-stage least squares for the pooled sample and allowed for differences in the intercept terms across countries, but I assumed that the slopes (elasticities) are the same for all countries in each group. The observations were appropriately weighted to correct for heteroskedasticity in the variance of the error terms across countries (which was detected using Bartlett's test).

Table 1 shows the export supply estimates. The first thing to note from this table is that all the parameters have the appropriate signs. The values of the short-run price elasticities (a_1 and a_2) are generally small, oscillating around 0.2, and they are not statistically significant at conventional significance levels.[5] The long-run price elasticities (α_1 and α_2) are greater, as expected—varying from 0.4 to 2.5—although they also are not statistically significant. In both cases the real exchange rate elasticity (α_2) is somewhat smaller than the direct price elasticity (α_1). Most of the other estimates (a_3, a_4) proved to be statistically significant. The short-run capacity elasticities (a_3) vary between 0.1 and 0.4, and the long-run estimates (α_3) fluctuate around 1.2–1.5.

The strong and lingering influence of past export levels on current supply is indicated by the relatively large values for a_4 in all cases. Relatedly, the values of the "lag parameter" (γ), which measures the speed of adjustment, are reported for completeness, where $\gamma = 1 - a_4$. The variable γ, as a consequence, is rather small for both groups. The mean lag before full adjustment is 2.3 years for country group I and 9 years for group II. This explains the much larger long-run price elasticities for group II than for group I, even though the short-run elasticities are similar for both country groups.

These estimates are similar to those obtained in the literature. Donges and Riedel (1977) report price elasticities of manufactured export supply in the range of 0 to 3.0, whereas Balassa and others (1986) estimate price elasticities for Greece and the Republic of Korea of between 1.5 and 2.0. The specification of domestic capacity has varied in the literature, but its estimated coefficients generally receive a similar interpretation. Balassa and others (1986) estimated capacity coefficients at 1.5 to 3.0 for Greece and Korea, whereas the estimates of Donges and Riedel (1977) varied between 0.5 and 3.0, with a median of 1.2–1.7.

Table 2 shows the preferred estimates of the export demand curve. In this case, the parameters not only have the expected signs but are also highly significant. The strategy adopted was to obtain first estimates of the general model, equation 6. This is the preferred equation reported for country group I (equation 1, table 2). When the lag parameter, λ, could not be properly identified (that is, when λ was not statistically different from 0), I assumed that the adjustment to the export demand curve was completed within one year and

5. The Wu-Hausman test for exogeneity of the price term in the supply equation was performed for both country groups. This test measures the distance between the ordinary least squares (OLS) and two-stage least squares (2SLS) estimators for a_1, standarized by a consistent estimate of the variance of this difference. The results of the test showed that the exogeneity hypothesis was clearly rejected for both country groups—indicating that the OLS estimates are indeed biased. See Thurman (1986) for a discussion of this test.

Table 1. *Export Supply Estimates*

$x_t = a_0 + a_1(PX/PT)_t + a_2(PH/PT)_t + a_3\, y_t^* + a_4\, x_{t-1} + \Sigma_i\, c_{oi}D_{it};\ \alpha_1 = a_1/(1 - a_4);\ \alpha_2 = a_2/(1 - a_4);\ \alpha_3 = a_3/(1 - a_4);\ \gamma = 1 - a_4$

Group	*Equation number*	a_0	a_1	a_2	a_3	a_4	α_1	α_2	α_3	γ	$\bar{R}^2$ *F*	*DF*
I	1	−1.40	0.19	−0.12	0.36	0.70	0.63	−0.41	1.22	0.30	0.999	144
		(−1.49)	(1.20)	(−0.75)	(3.22)	(13.27)	(1.27)	(−0.75)	(4.68)	(5.60)	≥ 10^4	
	2	−3.32	0.16	—	0.35	0.71	(0.54)	—	1.20	0.29	0.998	145
		(−1.41)	(1.04)		(3.17)	(13.48)	(1.10)		(4.63)	(5.58)	$6.5{*}10^3$	
II	3	−0.58	0.22	−0.13	0.14	0.90	2.26	−1.32	1.49	0.10	1.000	98
		(−0.46)	(0.92)	(−0.50)	(0.88)	(13.21)	(0.60)	(−0.50)	(1.76)	(1.40)	≥ 10^4	
	4	−0.56	0.23	—	0.14	0.91	2.55	—	1.49	0.09	0.999	99
		(−0.42)	(0.99)		(0.84)	(13.43)	(0.52)		(1.66)	(1.34)	10^4	

— Not applicable.

Note: Group I countries are those facing price elastic export demand; group II exporters face less elastic demand. Figures in parenthesis are *t* values. *DF* indicates degrees of freedom. D_{it} is a country dummy; all c_{oi} are statistically significant. Period of estimation: 1965–83 for all countries, except India; 1970–83 for India. Method of estimation: two-stage least squares, corrected for heteroskedasticity. The *t* values for the long-run elasticities (α_i) were calculated using the variances and covariances of the short-run elasticities (a_i); see Kendall and Stuart (1974, p. 232), for the formula used.

Source: See appendix C.

Table 2. *Export Demand Estimates*

Model A: $PX_t = b_0 + b_1\,PX_t^w + b_2\,y_t^w + b_3\,x_t + b_4\,PX_{t\text{-}1} + \Sigma_i\,c_{oi}\,D_{it}$; $\beta_1 = b_1/b_3$; $\beta_2 = -b_2/b_3$; $\lambda = b_3/b_4$.
Model B: $x_t = \beta_0 + \beta_1(PX/PX^w)_t + \beta_2\,y_t^w + \Sigma_i\,c_{oi}\,D_{it}$

Group	*Equation number*	*(model[a])*	b_0	b_1	b_2	b_3	b_4	β_1	β_2	λ	$\bar{R}^2(F)$	*DF*
I	1	(*A*)	−4.02	0.57	0.34	−0.10	0.42	−5.69	3.34	0.24	0.960 ($\geq 10^4$)	144
			(−1.55)	(4.97)	(1.90)	(−4.62)	(5.32)	(−6.30)	(1.79)	(2.75)		
II	2	(*B*)	−19.49	—	—	—	—	−1.36	1.80	—	0.997 ($\geq 10^4$)	100
			(−6.89)					(−2.48)	(9.26)			

Note: Group I countries are those facing elastic export demand; group II exporters face less elastic demand. Figures in parentheses are t values. *DF* indicates degrees of freedom. D_{it} is a country dummy; all c_{oi} are statistically significant. Period of estimation: 1965–83 for all countries except India; 1970–83 for India. Method of estimation: two-stage least squares, corrected for heteroskedasticity.

Source: See appendix C.

estimated the notional demand curve (equation 2) directly. This is the preferred equation reported for country group II (equation 2, table 2). As expected, the price elasticity of export demand (β_1) differed considerably between country groups: it was much larger for country group I (–5.7) than for country group II (–1.4). But the income elasticity estimates (β_2) were more similar, varying between 1.8 and 3.3. These estimates suggest a strong influence of world economic activity on export demand, but other elements should be considered before calculating the net effect of external activity on export revenues, as discussed below.

The empirical findings reviewed here indicate that prices clearly affect export demand, although they were not statistically significant in the supply equation. This study also suggests that a useful and clear distinction can be made between countries on the basis of the magnitude of the price elasticity of export demand[6]. Export supply is also shown to be significantly influenced by domestic capacity, whereas external economic activity plays a significant role in export demand. Finally, export supply seems to respond with a significant lag to changes in exogenous factors, whereas export demand adjusts relatively rapidly.[7]

III. The Impact of External Demand on Manufactured Exports

Despite its importance, no consensus has yet emerged on the magnitude of the foreign income elasticity of export revenues (Dornbusch 1985). Most studies have presented positive multipliers, but their estimates differ sharply—ranging between 1.3 and 4.7. Marquez and McNeilly (1986) have recently examined the literature on this subject and have concluded that most estimates of this elasticity are subject to biases arising from three sources: (i) use of multilateral trade flows aggregated across countries ("aggregation bias"); (ii) omission of price effects; and (iii) reliance on ordinary least squares for parameter estimation. They obtain a much lower estimate of the foreign income elasticity when they attempt to account for these effects—between 1.3 and 1.6.

Marquez and McNeilly's criticisms are convincing, although their own estimates may be biased, for two main reasons. First, they omit domestic supply factors in developing countries (domestic capacity and domestic prices) and hence their estimates may be biased due to the omission of relevant variables. To test for these factors, I compared the general reduced form estimates of the models discussed here (*A* and *B*) with a variant of these models which omits the domestic supply variables. The export volume equation of the restricted

6. Those countries facing a relatively small demand price elasticity may be exporting goods that can be differentiated by place of origin, whereas those facing a high-demand price elasticity may export relatively homogeneous goods for which close substitutes exist in foreign markets. This hypothesis, however, requires a close examination of the export composition of both country groups.

7. Note, also, that the fit of the models (measured by the adjusted R^2s) is very good. In the case of the supply specification, however, this is probably due to the presence of the lagged dependent variable, x_{t-1}.

Table 3. *The Consequences of a Change in World Income: Export Volume, Export Price, and Export Revenue Multipliers*

	Volume Effect		*Price Effect*		*Revenue Effect*	
Country Group	ϵ^{SR}_{x,y^w}	ϵ^{LR}_{x,y^w}	ϵ^{SR}_{PX,y^w}	ϵ^{LR}_{PX,y^w}	ϵ^{SR}_{R,y^w}	ϵ^{LR}_{R,y^w}
I	0.07	0.95	0.33	0.45	0.40	1.40
II	0.25	1.12	1.13	0.50	1.38	1.62

Note: ϵ^{SR}_{x,y^w} measures the short run (*SR*) impact on export volumes (x) of a unit change in world income (y^w); all other parameters are defined analogously. See appendix D for the formulas used. The estimates used to calculate these multipliers were obtained from table 1 (equations 1 and 3) and table 2 (equations 1 and 2).

model, (which assumes infinite price elasticity of supply) was rejected at the 1 percent level in both cases, when compared with the general reduced-form expressions for each country group in a simple *F* test. These findings underscore the importance of domestic supply factors in export behavior. Second, Marquez and McNeilly fail to distinguish between export volume and export revenue effects of a unit change in external demand. The presence of this bias can be detected by comparing the export volume and export revenue elasticities (see Clavijo, Pritchett, and Semlali 1987), to which I now turn.

The effect of a unit change in world income on export volumes and export prices can be determined in the structural models developed here. The short-run multipliers for model *A* (from appendix table A-1), for example, are

$$\epsilon^{SR}_{x,y^w} = d_{12}; \qquad \epsilon^{SR}_{PX,y^w} = d_{22}$$

and the long-run multipliers are:

$$\epsilon^{LR}_{x,y^w} = [d_{12} + d_{17}\, d_{22}/(1 - d_{27})]/\Omega_1$$

$$\epsilon^{LR}_{PX,y^w} = [d_{22} + d_{26}\, d_{12}/(1 - d_{16})]/\Omega_2$$

where $\Omega_1 = 1 - d_{16} - d_{17}\, d_{26}/(1 - d_{27})$; $\Omega_2 = 1 - d_{27} - d_{26}\, d_{17}/(1 - d_{16})$ and the d_{ij} are the reduced-form coefficients. The general expression of the coefficients in terms of the structural parameters is given in appendix table A-1, rows 1 and 3. (A detailed derivation of these multipliers is given in appendix table A-1.) Similar (but simpler) expressions hold for model *B*. Table 3 presents the estimates of these multipliers for both country groups, using the structural estimates shown in tables 1 and 2.[8]

These results indicate that the short-run export volume effects vary between 0.1 and 0.3, whereas the price effects are significantly stronger, varying between 0.3 and 1.1. Thus most of the increase in revenue in the short run is

8. Because it can be shown that the estimates of the structural models presented in tables 1 and 2 represent stable solutions, it is meaningful to look at the long-run multipliers. Note, also, that the export volume and export price multipliers discussed here are based on the structural parameter estimates, which is preferable to the direct estimation of the reduced form only if the overidentifying restrictions in the structural model are true. I am grateful to an anonymous referee for this point.

likely to come from an increase in prices, according to the estimates presented here. In the long run, however, the opposite is true: the export volume effect oscillates around 1.0, whereas the price effect is lower, at around 0.5, for a total revenue effect of 1.5. It is interesting to note that, despite the differences is the structural estimates and in the final model selected, the long-run multipliers are remarkably similar for both country groups and coincide with the estimates given by Marquez and McNeilly (1986).

IV. Conclusions

Several findings emerge from this study which are important for the specification and application of models of manufactured exports from developing countries. First, the specification of a complete structural model, with identification of supply and demand functions, requires analysis of all the channels through which relative prices and income influence export behavior. This avoids bias in the estimated coefficients due to the omission of relevant variables.

Second, two price coefficients seem to play an important role in manufactured exports supply: the own-price elasticity (the parameter associated with the price ratio of manufactured exports to domestic tradables), and the real exchange rate elasticity (the parameter associated with the price ratio of domestic tradables to home goods). Estimates of these elasticities were found to be lower in the short run (with the own-price elasticity oscillating around 0.2, and the real exchange rate elasticity oscillating around –0.1) but larger in the long run (varying from 0.6 to 2.3, and –0.4 to –1.3, respectively). The price elasticities were generally statistically insignificant, however, probably because of deficiencies in the export prices used. The elasticity estimates are clearly within the range reported by other authors and suggest that price changes are likely to elicit a response only after a considerable lag.

Third, domestic capacity clearly affects the supply of manufactured exports. The elasticity associated with this variable was generally significant, and it varied between 0.1 and 0.4 in the short run and between 1.2 and 1.5 in the long run. Note, however, that the proxy variable used for this purpose—a simple time trend—captures a host of other structural factors that tend to evolve slowly through time (such as learning by doing and the quality of infrastructure). The importance of domestic capacity, therefore, suggests that adjustment programs designed to encourage exports should promote domestic investment, improve the quality of infrastructure (particularly in transportation and communications), and provide other services essential for exports.

Fourth, when analyzing the demand curve for manufactured exports, a clear distinction needs to be made between countries facing a relatively high-demand price elasticity and those facing a relatively low-demand price elasticity. A simple test, based on the reduced form of the model, was used here to discriminate between these two groups of countries. The estimated price elasticity of export demand for those facing low-demand elasticity (a group that broadly coincides with the newly industrializing countries) varies between −1.0 and −1.5, and the price elasticity of export demand for the remaining countries varies between −5.5 and −6.0.

Fifth, although the income elasticity of export demand obtained from this study is relatively high, varying between 1.8 and 3.3, this parameter does not capture the full effects of external economic activity on manufactured export revenues. To calculate this effect, one needs to include both volume and price effects and to distinguish between the short and long runs. Because of the lagged adjustment of export supply, the response of export volume to an increase in world income is likely to be smaller in the short run but to increase in the long run. Export prices, however, would be expected to change quickly, but to level off soon thereafter as resources are shifted to increase production.

The export volume multiplier calculated here is about 1.0 for both groups of countries, whereas the total long-run effect of a 1 percent change in external economic activity on export revenues is about 1.5. The latter result is remarkably robust to the alternative specifications adopted and is generally smaller than the estimates in previous studies, which range from 1.3 to 4.7. If accurate, this estimate has important consequences for highly indebted countries, for it implies that they cannot rely on external growth alone to generate enough resources to service their debts. Alternatively, they may still find ways to increase export revenues, despite the slow growth of economic activity in industrial countries. In essence, therefore, domestic economic policies (particularly those encouraging investment in export-oriented activities, and exchange rate policies) will need to play a key role in their strategy to increase foreign exchange earnings.

Appendix A. Derivation of the Reduced Form Models

To simplify the notation, I first write model A (equations 5 and 6) in matrix form as follows:

$$BY_t = \Gamma Z_t + U_t$$

where

$$B = \begin{bmatrix} 1 & -a_1 \\ -b_3 & 1 \end{bmatrix}$$

$$\Gamma = \begin{bmatrix} a_0 & 0 & -(a_1 + a_2) & a_2 & a_3 & a_4 & 0 \\ b_0 & b_1 & 0 & 0 & 0 & 0 & b_4 \end{bmatrix}$$

$$Z_t' = (1, PX_t^w, y_t^w, PT_t, PH_t, y_t^*, x_{t-1}, PX_{t-1})$$

$$Y_t' = (x_t, PX_t)$$

$$U_t = (u_{1t}, u_{2t})' .$$

Appendix Table A-1. Export Models: Reduced Form Coefficients in Terms of the Structural Parameters

Equations	*Row*	d_{i1}	d_{i2}	d_{i3}	d_{i4}	d_{i5}	d_{i6}	d_{i7}
MODEL A								
Quantity Equation (i = 1)								
General expression	1	$\frac{-\gamma\lambda\beta_1\alpha_1}{A} \geq 0$	$\frac{\gamma\lambda\beta_2\alpha_1}{A} \geq 0$	$\frac{-\gamma(1-\beta_1)(\alpha_1+\alpha_2)}{A} \gtrless 0$	$\frac{\gamma\alpha_2(1-\lambda\beta_1)}{A} \leq 0$	$\frac{\gamma\alpha_3(1-\lambda\beta_1)}{A} \geq 0$	$\frac{(1-\gamma)(1-\lambda\beta_1)}{A} \geq 0$	$\frac{\gamma\alpha_1}{A} \geq 0$
Small-country assumption ($\beta_1 \rightarrow -\infty$)	2	$\gamma\alpha_1 \geq 0$	0	$-\gamma(\alpha_1+\alpha_2) \gtrless 0$	$\gamma\alpha_2 \geq 0$	$\gamma\alpha_3 \geq 0$	$(1-\gamma) \geq 0$	0
Price equation (i = 2)								
General expression	3	$\frac{-\lambda\beta_1}{A} \geq 0$	$\frac{\lambda\beta_2}{A} \geq 0$	$\frac{\gamma\lambda(\alpha_1+\alpha_2)}{A} \gtrless 0$	$\frac{-\gamma\lambda\alpha_2}{A} \geq 0$	$\frac{-\gamma\lambda\alpha_3}{A} \geq 0$	$\frac{-(1-\gamma)\lambda}{A} \leq 0$	$\frac{1}{A} \geq 0$
Small-country assumption ($\beta_1 \rightarrow -\infty$)	4	1	0	0	0	0	0	0
MODEL B								
Quantity equation (i = 1)								
General expression	5	$\frac{-\gamma\beta_1\alpha_1}{B} \geq 0$	$\frac{\gamma\alpha_1\beta_2}{B} \geq 0$	$\frac{\gamma\beta_1(\alpha_1+\alpha_2)}{B} \gtrless 0$	$\frac{-\gamma\beta_1\alpha_2}{B} \leq 0$	$\frac{-\gamma\beta_1\alpha_3}{B} \geq 0$	$\frac{-(1-\gamma)\beta_1}{B} \geq 0$	—
Small-country assumption ($\beta_1 \rightarrow -\infty$)	6	$\gamma\alpha_1 \geq 0$	0	$\gamma(\alpha_1+\alpha_2) \gtrless 0$	$\gamma\alpha_2 \leq 0$	$\gamma\alpha_3 \geq 0$	$(1-\gamma)\beta_1 \geq 0$	—
Price equation (i = 2)								
General expression	7	$\frac{-\beta_1}{B} \geq 0$	$\frac{\beta_2}{B} \geq 0$	$\frac{\gamma(\alpha_1+\alpha_2)}{B} \gtrless 0$	$\frac{-\gamma\alpha_2}{B} \geq 0$	$\frac{-\gamma\alpha_3}{B} \leq 0$	$\frac{-(1-\gamma)}{B} \leq 0$	—
Small-country assumption ($\beta_1 \rightarrow -\infty$)	8	1	0	0	0	0	0	—

— Not applicable.

Note: The coefficients are estimated from the following: quantity equation: $x_t = d_{10} + d_{11}PX_t^w + d_{12}y_t^w + d_{13}PT_t + d_{14}PH_t + d_{15}y_t^* + d_{16}x_{t-1} + d_{17}PX_{t-1}$; price equation: $PX_t = d_{20} + d_{21}PX_t^w + d_{22}y_t^w + d_{23}PT_t + d_{24}PH_t + d_{25}y_t^* + d_{26}x_{t-1} + d_{27}PX_{t-1}$; and in the coefficients; $A = 1 + \lambda(\gamma\alpha_1 - \beta_1)$: and $B = \gamma\alpha_1 - \beta_1$. For the quantity equation of model *B*, the following restriction applies: $d_{13} = -(d_{11} + d_{14})$.

The reduced form of model A can then be expressed as $Y_t = B^{-1}\Gamma Z_t + B^{-1} U_t = DZ_t + W_t$, where $D = B^{-1} \Gamma$, $W_t = B^{-1}U_t$. Rows 1 and 3 of appendix table A-1 present the general expression for the reduced-form parmeters of model A (the coefficients of the matrix D) in terms of the structural coefficients. A similar procedure was used to derive the reduced form of model B (equations 5 and 2). Rows 5 and 7 present the general expression for the reduced-form parameters of this model in terms of the structural coefficients.

Rows 2 and 4 (model A) and 6 and 8 (model B) show the reduced-form coefficients when infinite price elasticity of demand is assumed.

Appendix B. F Values Used to Classify Countries into Groups I and II

	F values		
Country	*Quantity equation*[a]	*Price equation*[b]	*Country group*
Argentina	2.90	2.61	I
Brazil	4.08	7.88	II
Chile	0.53	14.44	II
Colombia	1.21	0.35	I
Côte d'Ivoire	1.57	2.12	I
India[c]	0.07	2.19	I
Indonesia	1.66	3.94	II
Korea, Rep.	1.03	3.40	II
Mexico	2.51	2.40	I
Peru	0.61	2.11	I
Portugal	2.47	12.89	II
Senegal	1.73	1.66	I
Thailand	5.44	5.38	II
Turkey	2.65	1.30	I
Yugoslavia	1.31	2.19	I
Critical values	F3,10	F7,10	
($\alpha = 5\%$)	3.71	3.14	

a. Reduced-form quantity equation: $x_t = d_{10} + d_{11} PX_t^w + d_{12} y_t^w + d_{13} PT_t + d_{14} PH_t + d_{15} y_t^w + d_{16} x_{t-1} + d_{17} PX_{t-1}$. H_0: $d_{12} = d_{17} = 0$; $d_{13} = -(d_{11} + d_{14})$.

b. Reduced-form price equation: $PX_t = d_{20} + d_{21} PX_t^w + d_{22} y_t^w + d_{23} PT_t + d_{24} PH_t + d_{25} y_t^* + d_{26} x_{t-1} + d_{27} PX_{t-1}$. H_0: $d_{22} = d_{23} = d_{24} = d_{25} = d_{26} = d_{27} = 0$; $d_{21} = 1$.

c. The critical F values for India are higher than those shown at the bottom of the table because the period of estimation is shorter.

Appendix C. The Data

The data used in this study can be defined formally as follows:

x_t = Manufactured exports [Standard International Trade Classification (SITC) 5 to 9–68] in constant dollars; the value data are obtained from the World Bank Trade System and are then deflated by PX_t.[9]

9. The manufactured exports value and price data for India (1970–83) were obtained directly from national sources. I am grateful to Z. Ecevit and R. King for providing me with these data.

PX_t = Manufactures export unit value index, in current U.S. dollars, calculated by the U.N. Department of International Economics and Social Affairs.[10]

PX_t^w = World price of manufactured exports, in current U.S. dollars, obtained from GATT (1987).

PT_t = Price of tradables, in U.S. dollars, calculated as the ratio of value added in current and constant dollars originating in manufacturing, agriculture, and mining, obtained from the World Bank's National Accounts database.

PH_t = Price of home goods, in U.S. dollars, calculated as the ratio of value added in current and constant dollars originating in the remaining sectors (and including construction, electricity, and private and government services) obtained from the World Bank's National Accounts database.

y_t^* = Capacity output, with y_t = GDP at market prices in constant dollars, derived from a log-linear regression against time ($\ln y_t = \alpha + \beta t$, with α and β estimated by OLS), obtained from the World Bank's National Accounts database.

y_t^w = Index of external demand, calculated as a weighted average of economic activity for the country's main trade partners: $\Sigma_i\, w_{it}\, y_t^i$, $w_{it} = (X_{it}/X_t) + (X_{it-1}/X_{t-1})$; y_t^i = GDP at constant market prices for region i, obtained from the World Bank's National Accounts database; and X_{it} = value of exports to region i at time t, $X_t = \Sigma_i\, X_{it}$, obtained from the International Monetary Fund's Direction of Trade database.

Appendix D. The Effect of a Unit Change in World Income: Export Volume, Export Price, and Export Revenue Multipliers

Volume and Price Effects

Consider the reduced form of model A:

(D-1) $$(1 - d_{16}L)\, x_t = d_{12}\, y_t^w + d_{17}L\, PX_t + d_1'\, Z_{1t}$$

(D-2) $$(1 - d_{27}\, L)\, PX_t = d_{22}\, y_t^w + d_{26}L\, x_t + d_2'\, Z_{1t}$$

where L is a lag operator, $Z_{1t}' = (1, PX_t^w, PT_t, PH_t, y_t^*)'$, d_1', d_2' are corresponding vectors of parameters, and all variables are expressed in logarithms. By differentiating equations (D-1) and (D-2), leaving unchanged the vector of exogenous variables (Z_{1t}), one obtains a system of two equations with two unknowns:

(D-3) $$(1 - d_{16}L)\, \frac{d\, x_t}{d\, y_t^w} = d_{12} + d_{17}\, L\, \frac{d\, PX_t}{d\, y_t^w}$$

10. See Moran and Park (1986) for a description of the methodology used to calculate these deflators.

$$\text{(D-4)} \qquad (1 - d_{27}L)\,\frac{d\,PX_t}{d\,y_t^w} = d_{22} + d_{26}L\,\frac{d\,x_t}{d\,y_t^w}$$

To obtain the short-run multipliers, simply let $L = 0$, and get:

$$\text{(D-5)} \qquad \epsilon^{SR}_{x,y^w} = \left[\frac{d\,x_t}{d\,y_t^w}\right]_{\substack{L=0\\ dZ_1=0}} = d_{12}$$

$$\text{(D-6)} \qquad \epsilon^{SR}_{PX,y^w} = \left[\frac{d\,PX_t}{d\,y_t^w}\right]_{\substack{L=0\\ dZ_1=0}} = d_{22}.$$

To obtain the long-run multipliers, let $L = 1$, and get:

$$\text{(D-7)} \qquad (1 - d_{16})\,\epsilon^{LR}_{x,y^w} = d_{12} + d_{17}\,\epsilon^{LR}_{PX,y^w}$$

$$\text{(D-8)} \qquad (1 - d_{27})\,\epsilon^{LR}_{PX,y^w} = d_{22} + d_{26}\,\epsilon^{LR}_{x,y^w}$$

from which,

$$\text{(D-9)} \qquad \epsilon^{LR}_{x,y^w} = \left[\frac{d\,x_t}{d\,y_t^w}\right]_{\substack{L=1\\ dZ_1=0}} = \frac{1}{\Omega_1}\left[d_{12} + \frac{d_{17}\,d_{22}}{1 - d_{27}}\right]$$

$$\text{(D-10)} \qquad \epsilon^{LR}_{PX,y^w} = \left[\frac{d\,PX_t}{d\,y_t^w}\right]_{\substack{L=1\\ dZ_1=0}} = \frac{1}{\Omega_2}\left[d_{22} + \frac{d_{26}\,d_{12}}{1 - d_{16}}\right]$$

with $\Omega_1 = 1 - d_{16} - d_{17}\,d_{26}/(1 - d_{27})$; $\Omega_2 = 1 - d_{27} - d_{26}\,d_{17}/(1 - d_{16})$.

Revenue Effects

$\overline{R}$ is defined as export revenue, $\overline{PX}$ as price, and $\overline{x}$ as volume, so that $\overline{R} = \overline{PX}\,\overline{x}$. All variables in the models here, however, are expressed in logarithms ($x = \ln\overline{x}$), so that for model A,

$$\text{(D-11)} \qquad \epsilon_{R,y^w} = \frac{d\,R}{d\,y^w} = \frac{d\,PX}{d\,y^w} + \frac{d\,x}{d\,y^w} = \epsilon_{x,y^w} + \epsilon_{PX,y^w}$$

The multipliers for model B can be obtained analogously.

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