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Empirical investigation of one OPEC country's successful non-oil export performance

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Abstract

This study examines Indonesian non-oil export success between 1975 and 1994, with a focus on the role of exchange rate management and trade policy in export performance across sectors. To examine the link between export quantity and changes in policy, I estimate structural export supply functions that are derived from utility and profit maximization behavior. The results indicate that non-oil exporters respond positively to improved price incentives, including exchange rate devaluation, with the strongest impact in textiles, garments, and sawnwood. The study offers a richer description than previous work of the relationship between price incentives and export performance. © 1998 Elsevier Science B.V.

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1. Introduction

Unlike other OPEC members and major international debtors, Indonesia successfully prevented stagnation in agriculture and manufacturing during and after

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the 1970s oil boom, and it maintained punctual repayments of large foreign debt obligations in the 1980s when oil earnings collapsed. Non-oil export growth constitutes the highlight of Indonesia's recent trade experience. Led by plywood, textiles, and garments, real average manufactured export growth of at least 28% annually during the 1980s helped non-oil exports to surpass oil and gas as the main contributor to export earnings. Rapid expansion of Indonesia's non-oil exports contributed to an average real GDP growth rate of 5.5% annually during the 1980s, compared to 0.5% for other OPEC members and 1.7% for severely indebted countries (World Bank, 1992: 220–221).

This study examines Indonesian non-oil export success between 1975 and 1994, with a focus on the role of exchange rate management and trade policy in export performance across sectors. To examine the link between export quantity and changes in policy, I estimate structural export supply functions that are derived from utility and profit maximization behavior. The sample covers Indonesia's principal non-oil export sectors, as measured by export shares: textiles, garments, plywood, sawnwood, coffee, and rubber. This disaggregated analysis, which allows for differentiation in industry structures, prevents misleading generalizations of producer responsiveness to export policies and price conditions based on aggregated data. The results indicate that non-oil exporters respond positively to improved price incentives, including exchange rate devaluation. However, the response across sectors varies considerably in magnitude, with the strongest impact in textiles, garments, and sawnwood.

With its emphasis on the role of prices in the determination of the quantity of exports, this paper's methodology is consistent with existing empirical trade studies on the determinants of developing country trade. [1] Although this literature has excellent coverage across regions, data constraints limit most studies to the use of aggregate trade or pooled country data. [2] In addition, the developing country studies often fail to control for policy and economic shocks, and few explicitly incorporate market power by sellers into their models. This study constitutes one of few empirical studies on developing country exports at the sectoral level, and the first to estimate sectoral trade elasticities for Indonesia. [3] Moran (1988) estimates manufactured export elasticities for a pooled developing country sample that includes Indonesia, and Arize (1990) estimates Indonesia's aggregate export

[1] A rapidly expanding literature on cost-markup models examines the *price* of exports in imperfectly competitive markets (e.g., Ohno, 1989; Athukorala, 1991; Buschena and Perloff, 1991; and Aw, 1993). The requirement of reliable and detailed data on domestic currency export prices, wages, and other input costs renders these models infeasible for examining Indonesian exports across sectors.

[2] Developing country aggregate export studies include Khan (1974), Bond (1985), Bahmani-Oskooee (1986), Sundararajan (1986), Riedel (1988), Tegene (1989), and O'Neill and Ross (1991).

[3] Developing country studies of disaggregated export demand include Lucas (1988), Marquez and McNeilly (1988), and Kellman and Chow (1989).

elasticities. Neither the pooled nor aggregate results provide knowledge of policy outcomes across Indonesia's export sectors, and both previous studies utilize a restrictive partial adjustment model. The present study addresses each of these drawbacks to provide a richer and more precise description of the relationship between export policy and export performance.

2. Background: exchange rate and trade policy [4]

Indonesian exchange rate policy since 1970 corresponds with three distinct stages of microeconomic policy evolution and oil market conditions. In the *Restricted Market Entry* Period from 1970 to 1981, the government tightened import and investment restrictions as the country experienced booming oil revenues. It passed few measures to promote non-oil exports. However, in a largely unexpected move, the government devalued the rupiah by almost 50% in 1978 to reverse the harmful effects of real exchange rate appreciation on non-oil exports. It also changed the exchange rate regime from a fixed rate to a managed float with periodic large devaluations, and it pegged the rupiah to a basket of trade partner currencies.

During the *Mixed Signals* Period from 1982 to 1985 as the oil price plunged, the government took some preliminary steps to reform taxes, deregulate the financial sector, and promote non-oil exports. The oil shock and rising debt service costs prompted a second major devaluation of 39% in 1983. At the same time though, the government enlarged the scope of trade and investment restrictions. For example, it phased out tropical log exports to promote domestic value added in downstream industries, especially in plywood and furniture. The government progressively raised export taxes on logs and allocated export quotas on a restricted basis; after 1985, it completely banned Indonesia's log exports.

In the *Structural Overhaul* Period from 1986 to the present, the government has undertaken extensive deregulation in the trade, industrial, and financial sectors. It devalued the rupiah again by one third in 1986, and it set up an innovative duty drawback and exemption system to provide exporters with access to imported inputs at world prices. Successive policy reform packages have changed the direction of import substitution policies by continuing to reduce non-tariff barriers and reforming the tariff code.

[4] For more detailed accounts of Indonesian policy reform, economic performance, and trade patterns, see Woo and Nasution (1989), Barichello and Flatters (1991), Booth (1992), Bresnan (1993), and Rodgers (1993).

3. The model

This section derives structural export demand and supply functions from utility and profit maximization behavior. The supply function contains the key parameter of interest, the price elasticity of export supply. A strongly positive estimate for this parameter would support the main hypothesis of this paper, that relative price incentives (which include exchange rate devaluation) have a large effect on export competitiveness, and that this occurs through large supply price elasticities.

The following exposition draws on Lord (1991), which features a model of monopolistic competition in which many countries produce an export commodity, X, that is differentiated by country-specific variations in quality or transaction characteristics. [5] Note that commodity refers to the general classification of a good (such as rubber or coffee), and product refers to the same commodity produced by different countries. Products are imperfect substitutes for each other, and each exporting country faces a downward sloping demand curve for its product. Also, there is free entry in the world market for each commodity, and countries compete in price, not quantity. Finally, the model assumes that purchasers of Indonesian exports do not have market power. Panels A and B of Table 1 indicate that Japan and the U.S, Indonesia's principal trade partners, are large but not exclusive importers in world markets for products which Indonesia sells. All available information suggests that buyer-side market power is quite unlikely. [6]

On the demand side, importers utilize a two-step procedure when they decide how much of a commodity to import from the home country (Indonesia). First, they allocate their expenditures between the commodity and all other goods, based on their income and the commodity's relative price. Next, given their expenditure on the commodity, importers decide how much to purchase from the home country (h) and from competitor countries (c). With this separability assumption, the export demand function will contain only one relative price term: the price of home country exports relative to competitor country exports. Separability implies that home country exporters compete directly with other exporters, but not with producers in destination countries. This aspect of the model is particularly relevant for Indonesia, which faces more competition from exporters of similar products than from producers in the mostly industrialized, temperate climate destination countries.

Once importers have decided how much to consume of a particular commodity, they decide how much to purchase from each exporter. All importers have

[5] The export supply and demand equations for the home country are based on the larger model of price and quantity in world commodity markets of Lord (1991). See also Adams and Behrman (1976) and Hwa (1985) for commodity market models based on international supply and demand.

[6] See Just and Chern (1980) and Love and Murniningtyas (1992) for models that explicitly incorporate market power on the buyer side.

Table 1
Trade shares in world markets by commodity, in percent (selected years and period average, 1975–1993)

Commodity	SITC	1975	1980	1985	1990	1993	Avg.
Panel A: Japanese share in world imports							
Coffee	071	3.7	5.3	6.2	5.8	7.3	5.8
Rubber	23	6.3	9.4	9.0	7.1	8.5	8.1
Sawnwood	24	7.0	14.0	12.9	17.4	23.2	14.5
Plywood	63	2.1	2.5	3.2	8.4	13.4	4.9
Textiles	65	3.2	3.4	4.0	3.5	3.6	3.8
Garments	84	3.4	3.9	4.3	6.3	8.6	5.4
Panel B: U.S. share in world imports							
Coffee	071	33.2	30.2	28.9	18.6	19.1	26.5
Rubber	23	14.7	13.6	17.9	12.5	16.8	15.4
Sawnwood	24	15.2	14.0	26.2	13.6	23.0	19.1
Plywood	63	14.6	14.2	24.1	10.8	14.4	16.6
Textiles	65	5.1	5.0	9.9	5.5	7.6	6.7
Garments	84	16.2	17.7	34.3	19.4	24.5	23.3
Panel C: Indonesian share in world exports							
Coffee	071	2.2	5.0	5.0	4.1	4.3	4.2
Rubber	23	10.5	13.1	11.0	9.1	11.8	11.2
Sawnwood	24	0.8	2.1	2.5	1.3	1.7	1.9
Plywood	63	0.0	0.9	13.6	15.9	23.0	9.5
Textiles	65	0.0	0.1	0.5	1.1	2.4	0.6
Garments	84	0.0	0.3	0.9	1.5	2.7	0.8
Panel D: Sectoral share in Indonesian non-oil exports							
Coffee	071	5.6	10.7	9.6	2.6	1.3	7.7
Rubber	23	20.1	19.0	12.2	5.9	3.6	13.3
Sawnwood	24	1.9	4.3	4.0	1.9	1.5	3.4
Plywood	63	0.1	1.2	16.2	21.0	18.9	11.3
Textiles	65	0.1	0.7	4.1	8.5	9.7	4.0
Garments	84	0.1	1.6	5.8	11.3	12.9	5.4

Source: Indonesian Bureau of Statistics; United Nations.

identical utility functions, so the exposition drops a destination country subscript. For a given commodity, importers maximize the following CES utility function subject to the expenditure constraint:

$$\max\left[\lambda X_{\mathrm{h}}^{\alpha} + (1-\lambda) X_{\mathrm{c}}^{\alpha}\right]^{1/\alpha} \text{ s.t. } P_{\mathrm{h}} X_{\mathrm{h}} + P_{\mathrm{c}} X_{\mathrm{c}} = Y^{\mathrm{M}}, \qquad (1)$$

where $\alpha < 1$ and $0 < \lambda < 0.5$. The notation X_{h}, X_{c} represents the quantity of export products from the home country and from competitor countries; P_{h}, P_{c} denote the dollar price of export products from the home and competitor countries; and Y^{M} denotes total expenditures by importers allocated toward the commodity.

The parameter λ is constrained to $1/2$ or less to prevent a relatively large market share for the home country. Panel C of Table 1, which shows that Indonesia does not monopolize the world market for any of its major exports, supports this assumption.

Solving this optimization problem results in the following demand schedule for the home country's export product, X_h:

$$X_h^d = C_1\left(\frac{P_h}{\bar{P}}\right)^{\epsilon} Y, \tag{2}$$

where $C_1 = [\lambda/(1-\lambda)]^{-1/(\alpha-1)}$; $\bar{P} = \{[\lambda/(1-\lambda)]^{-1/(\alpha-1)} P_h^{\alpha/(\alpha-1)} + P_c^{\alpha/(\alpha-1)}\}^{(\alpha-1)/\alpha}$, a weighted average of competing country export prices; $Y = Y^M/\bar{P}$; and $\epsilon = 1/(\alpha-1)$. Hence export demand depends on the home country's export price (P_h), competitors' prices $(\bar{P})$, and destination country export-price-deflated expenditures on imports (Y). Note that the competing countries export price $\bar{P}$ contains the home country export price P_h as a result of combining the first-order conditions for X_h and X_c and simplifying the notation in the derivation of X_h. [7] By construction, the own price elasticity of demand, ϵ, is negative, and the expenditure elasticity equals one.

On the supply side, home country export firms specialize in exports, and they maximize profits. All exporters have identical production functions, and the market supply curve is the sum of individual supply curves. Product differentiation by country within a commodity class does not depend on variations in production schedules. The following exposition drops the home country subscript, h. Each exporter operates according to a restricted form of the generalized CES production function:

$$X = A(L^{\beta} + K^{\beta})^{\phi/\beta}, \tag{3}$$

where $\beta < 1$, $\phi > 0$, and $A = \exp(\eta_0 + \eta_1 T + \eta_2 Z)$. The term X denotes the quantity of the home country's export product; L and K denote the quantity of labor and capital; T is a time trend that reflects increases in total factor productivity due to, say, improvements in technology and financial deepening; and Z denotes a sector-specific shock, such as a major policy change. The term Z facilitates the incorporation of distinctive features of the Indonesian experience into the model's structure. The model allows for constant $(\phi = 1)$, increasing $(\phi > 1)$, or decreasing $(\phi < 1)$ returns to scale.

Firms minimize their production costs $(C = wL + rK)$ subject to the production function, as follows:

$$\min wL + rK \text{ s.t. } A^{\beta/\phi} L^{\beta} + A^{\beta/\phi} K^{\beta} = X^{\beta/\phi}, \tag{4}$$

[7] An appendix with mathematical derivations is available upon request.

where w denotes the wage rate and r denotes the rental rate of capital. Solving this cost minimization problem yields the following cost schedule $C(X)$:

$$C(X) = A^{-1/\phi}X^{1/\phi}\left[w^{\beta/(\beta-1)} + r^{\beta/(\beta-1)}\right]^{(\beta-1)/\beta}. \tag{5}$$

To determine the export supply schedule, I use the first-order condition from the producer's objective of maximizing domestic currency profits:

$$\max P(X)\cdot E\cdot X - C(X), \tag{6}$$

where $P(X)$ denotes the dollar export price as a function of quantity; E denotes the nominal exchange rate (home country currency/dollar); and $C(X)$ is the cost schedule. An exchange rate devaluation in the home country, holding other prices fixed, raises the per unit domestic currency proceeds of exports and increases the incentive to produce exports. The resulting home country export supply function is:

$$X^s = C_2\left(\frac{P\cdot E}{D}\right)^{\tau}\exp(\gamma_1 T + \gamma_2 Z), \tag{7}$$

where $C_2 = \phi^{\phi/(1-\phi)}\exp[\eta_0/(1-\phi)](1+1/\epsilon)^{\phi/(1-\phi)}$; $D = [w^{\beta/(\beta-1)} + r^{\beta/(\beta-1)}]^{(\beta-1)/\beta}$, a deflator based on input costs; $\tau = \phi/(1-\phi)$; $\gamma_1 = \eta_1/(1-\phi)$; and $\gamma_2 = \eta_2/(1-\phi)$. Hence export supply depends on the export's domestic currency price $(P\cdot E)$, domestic costs in domestic currency (D), the state of technology (T), and a sector-specific shock (Z).

Through manipulation of the exporter's objective function and cost schedule, the constant C_2 includes the price elasticity of demand ϵ. This approach ensures that the export supply curve is consistent with a framework of perfect competition as well as monopolistic competition. If the firm sells in a market that is characterized by perfect competition (that is, the price elasticity of demand approaches negative infinity), then the term $(1+1/\epsilon)^{\phi/(1-\phi)}$ has no effect on the constant C_2. In this case the price and quantity equilibrium for X^s is the same as the marginal cost schedule. If the firm sells in a market that is characterized by monopolistic competition, then the term $(1+1/\epsilon)^{\phi/(1-\phi)}$ has a positive effect on the constant C_2, and the price and quantity equilibrium for X^s lies above the marginal cost schedule. The constant C_2 is undefined if the price elasticity of demand is inelastic, or $0 > \epsilon > -1$. This last situation is consistent with the theory that a firm facing a downward sloping demand curve should not charge a price in the inelastic region of the demand curve.

The key parameter of interest τ, which represents the price elasticity of export supply, can be positive or negative depending on the value of ϕ. If the exporter operates under conditions of decreasing returns to scale $(0 < \phi < 1)$, then the relative price elasticity of supply τ is positive, and the supply schedule slopes upward. The higher the value of τ, the greater the support for the main hypothesis of this paper, that relative price incentives have a large effect on export competitiveness. The model predicts that if returns to scale are decreasing and lower in agriculture than in manufacturing, then agricultural exports will have smaller supply-price elasticities. The parameter γ_1 is positive, as exports generally increase with the improvements in technology and financing opportunities reflected in T. The sign of γ_2 depends on whether the export sector experiences a positive or a negative shock Z.

Equilibrium in the market for home country exports, as characterized by $X^{\mathrm{d}} = X^{\mathrm{s}}$, may not hold if incomplete information and adjustment costs cause consumers and firms to experience delays in their response to any changes. Use of quarterly data to test the model makes it more likely that adjustment within the period will not hold, and different sectors have different adjustment lags. Junz and Rhomberg (1973) discuss a number of lag types, including delays in recognition, decision, delivery, the replacement of inventory and equipment, and in the production of additional output, that can affect exporters' responses to changes in profit opportunities. Natural growing constraints for primary commodities can further delay export supply responses. Lawrence (1990) provides a theoretical basis for incorporating such production lags into an export supply model by utilizing a Lucas (1967) type of adjustment-costs approach. In Lawrence's model, firms cannot immediately and freely change their output because changing production levels involves costs associated with investment in capital. Capital is a fixed input in the short run but variable in the long run, where each firm's marginal costs of adjustment to the capital stock are positive and rising. The model's essential implication is that export supply exhibits smaller elasticities in the short run than in the long run.

4. Empirical estimation

Taking logs of both sides of the export demand function in Eq. (2) and dropping the h subscript yields the base estimation equation for the home country's export demand schedule:

$$x_t^d = a_0 + a_1(p - \bar{p})_t + a_2 y_t + \Theta_t, \tag{8}$$

where lower-case variable names represent natural logs of the respective variables, $a_0 = \log C_1$, $a_1 = \epsilon$, and $a_2 = 1$. Taking logs of both sides of the export supply function in Eq. (7) yields the base estimation equation for the home country's export supply schedule:

$$x_t^s = b_0 + b_1(p + e - d)_t + b_2 T_t + b_3 Z_t + \Phi_t, \tag{9}$$

where $b_0 = \log C_2$, $b_1 = \tau$, $b_2 = \gamma_1$, and $b_3 = \gamma_2$. The stochastic error terms Θ_t and Φ_t, which are generated by unobservable exogenous shocks, enter additively with distributions that have the usual i.i.d. assumptions.

The supply shock term Z_t, which represents an array of observed shocks across sectors, requires more elaboration. Because world oil price fluctuations had such a strong influence on macroeconomic policy and performance, supply equations for every sector include the preceding period's world oil price. In the textile and garment estimations, I include an intercept dummy that equals one for the years following 1982. This variable, although an imperfect measure, proxies for the policy reform packages the government passed after 1982 that lowered input costs for garment and textile exporters, including the Bapeksta duty drawback and exemption facility. [8] This term should also capture the effects of the Multifiber Arrangement (MFA), which led Indonesian producers to shift toward higher-value-added exports as they reached quota ceilings on items such as cotton shirts and trousers. Next, the government's log export ban increased the domestic log supply and depressed the log price. Because the plywood sector benefitted most from the lower input costs, the plywood equation includes the value of log exports as a proxy for the log export ban. The sawnwood equation includes an intercept dummy that equals one for the years following 1989. This variable proxies for the prohibitive export taxes which the government placed on many types of sawnwood to encourage greater production in other wood processing industries. The coffee equation controls for the 1977 world price surge following a Brazilian frost. Finally, inclusion of the oil price in the rubber equation also controls for competition from synthetic rubber substitutes, whose prices move with the world oil price.

Clearly the home country's export price and quantity are simultaneously determined in the model. I utilize two-stage least squares to estimate structural export supply functions across sectors, where instruments for the export price include all exogenous variables in the reduced-form equation (e_t, d_t, T_t, Z_t, $\bar{p}_t$, and y_t). [9] To maintain focus on the role of price incentives and economic shocks in supply and to limit the profusion of tables, I perform but do not report demand-side estimations. [10] Hausman χ^2 statistics are reported to test the quality of the instruments, and regressions are run with a heteroskedasticity-consistent covariance matrix. I re-estimate with the Cochrane–Orcutt iterative technique any equation with autocorrelated disturbances according to Durbin–Watson and Breusch–Godfrey test statistics.

[8] Ideal proxies for the duty drawback system and for MFA effects include the value of imported inputs processed through the facility, and quota utilization ratios. However, complete time series data are not available for the necessary years. I did try a measure of imported inputs into textiles and garments as a share of total output, but the variable yielded an imprecisely estimated coefficient and was dropped. See Hill (1991) for more detail on Indonesia's textiles and garments production and trade.

[9] See McCarthy (1972) on the risks in using two-stage least squares, and McCarthy (1996) on why FIML procedures may be preferable. Because of these considerations the results must be considered preliminary.

[10] Demand-side results, available upon request, indicate that the relative price coefficient has the expected negative sign in all sectors except plywood. The import expenditures coefficient has the expected positive sign across sectors.

Endogeneity may characterize the domestic cost term, D, if a devaluation raises input costs. Devaluation could have a direct effect through higher import prices, and an indirect impact depending on industrial capacity. If the economy is operating close to full capacity, then an export expansion resulting from the devaluation could lead to inflationary pressure. Devaluation will have little or no impact on the domestic deflator if trade is a small share of GDP and the economy has excess capacity. During the sample period, imports were not a large share of Indonesian GDP (16%, compared with the U.S. at 9%, the East Asian tigers at 28%, and West Europe at 30%); the industrial sector, like that of many developing countries, experienced excess capacity; and Indonesia had a large non-tradeables sector. Hence I assume that feedback effects from devaluation on domestic costs in each sector are small enough to consider D exogenous.

One empirical approach in treating the adjustment lag problem is to add a polynomial distributed lag (PDL) structure to the base estimation equations. The low degrees of freedom limit me to adding the PDL structure only to the relative price term, and to constraining the maximum lag number to four quarters. I choose the optimal lag length by minimizing Akaike's final prediction error criterion, overfitting and underfitting the specification, and performing likelihood ratio tests for optimality. The long-run coefficients are calculated by summing the current and lagged price coefficients.

A more traditional approach is to add a partial adjustment specification. Unlike the PDL, the partial adjustment model multiplies each short-run coefficient by the same adjustment factor. Also, the partial adjustment model imposes a distributed lag structure with geometrically declining weights, while the PDL has fewer restrictions on the lag's shape. To construct the long-run coefficients, I divide the estimated coefficients by the partial adjustment parameter, calculated from the coefficient on lagged exports. I calculate standard errors following the method in Kendall and Stuart (1977).

The sample includes individual time series for Indonesia's six highest-ranked non-oil export sectors, as measured by export shares: textiles, garments, plywood, sawnwood, coffee, and rubber. [11] Table 1, Panel D reports each sector's share in total non-oil exports. Empirical measures for the export price and quantity variables originate from an extensive data set of Indonesia's non-oil exports, by sector and quarter from 1975 to 1994, which I constructed from trade data provided by the Indonesian Bureau of Statistics (BPS). [12] In addition, disaggregated wholesale price indices proxy for domestic costs across sectors. Trade

[11] The only exception is sawnwood. Its average export share ranks slightly lower than fish and shrimp, vegetable oils, and tin. Sawnwood is chosen for its policy relevance and comparatively with plywood.

[12] Most data processing and aggregation took place at the Harvard Institute for International Development project on Customs and Economic Management in Jakarta, Indonesia. I worked under the supervision of Jeffrey Lewis and Michael Roemer.

weighted competitor price and import expenditure variables are constructed from readily available sources. The Appendix A describes in more detail the empirical measures that correspond with the explanatory variables, the data sources, and methods used to construct each variable.

5. Econometric results

Tables 2 and 3 present structural export supply functions estimated with the partial adjustment and PDL specifications. For each sector the tables first present the short-run estimation results, then the calculation for the long-run price elasticity, and finally information about the regressions. One interprets the coefficients on the natural log variables (in lower case type) in both tables as elasticities of export supply. For example, Table 2's coefficient on the short-run relative price, $(p+e-d)_t$, for textiles indicates that on average the quantity of textile exports rises 1.21% in the short run following a one percent increase in the relative price. One interprets the coefficients on the linear variables (in upper case type) in both tables as the proportionate rate of change in export supply per unit change in the independent variable. Hence Table 2's coefficient on the time trend, T_t, for garments indicates that on average the quantity of garment exports grows 3.0% in every quarter, ceteris paribus. Also note that two equations require re-estimation to correct for autocorrelated disturbances: plywood in Table 2 and garments in Table 3. Finally, the Hausman χ^2 specification test statistics indicate that the instruments perform fairly well in every sector except coffee, where neither Table 2 nor Table 3 reports a significant χ^2 test result. Measurement error in the instruments or coffee cartel behavior with the International Coffee Agreement from 1980 to 1989 could both explain this test result.

Overall the two lag types produce similar coefficient estimates in terms of sign and magnitude. However, the PDL specification yields more precisely estimated coefficients, particularly for the long-run price elasticities. Given the similarities between the two tables but higher precision of the PDL estimates, the remaining discussion focuses on Table 3. Results in Table 3 indicate that every sector responds positively to improved price incentives in the long run. Textiles, among the fastest growing of all non-oil exports, experience the strongest long-run response to the relative export price. Although the plywood sector's long-run price elasticity has a higher magnitude, it is not statistically significant. The insignificant coefficient on relative prices for plywood might be explained by the importance in some periods of non-price incentives to increase plywood production. The government allocated logging and plywood licenses by a variety of criteria, some unrelated to plywood prices. For example, between 1980 and 1985 the government structured its log export ban by allocating export quotas only to those logging concessions which also had the infrastructure to process the wood.

Table 2
Structural export supply estimates (partial adjustment)

Variable	Textiles	Garments	Plywood	Sawnwood	Coffee	Rubber
$(p+e-d)_t$	1.214**	0.371***	0.239	0.753***	0.148	0.306**
	(0.529)	(0.117)	(0.253)	(0.230)	(0.128)	(0.142)
T_t	0.015*	0.030***	0.003	−0.006	0.009***	0.006***
	(0.008)	(0.007)	(0.006)	(0.004)	(0.003)	(0.001)
x_{t-1}	0.487***	0.417***	0.837***	0.455***	0.333***	0.001
	(0.133)	(0.113)	(0.053)	(0.126)	(0.123)	(0.120)
POIL_t	0.004*	0.007***	0.003	0.004*	0.001	−0.001***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.000)
Z_t	0.862***	0.212**	0.000	−0.712***	−0.065	–
	(0.257)	(0.099)	(0.000)	(0.145)	(0.123)	
Constant	−5.352**	−1.244**	−0.815	−1.056	1.643**	3.060***
	(2.446)	(0.468)	(1.050)	(0.722)	(0.636)	(0.545)
Long-run	2.369	0.638**	1.466	1.381*	0.222	0.306*
$p+e-d$	(1.502)	(0.264)	(1.677)	(0.694)	(0.209)	(0.165)
Sample size	79	79	77	79	79	79
R^2	0.965	0.986	0.976	0.800	0.671	0.794
D–W Statistic	1.564	2.199	2.008	1.530	1.927	1.974
F Statistic	240.8	638.8	473.4	33.15	17.86	39.05
Hausman χ^2	35.11***	35.62***	6.306*	4.907	3.647	38.15***

Significance levels are *** = 1%, ** = 5%, * = 10% (two tail tests). The parentheses contain standard errors. Lower case variable names indicate natural logs. The regressions are estimated with two-stage least squares and a heteroskedasticity-consistent covariance matrix. Breusch–Godfrey tests led to re-estimation with the Cochrane–Orcutt iterative technique for plywood. I make corrections for seasonality with quarterly dummies.

Table 3
Structural export supply estimates (polynomial distributed Lag)

Variable	Textiles	Garments	Plywood	Sawnwood	Coffee	Rubber
$(p+e-d)_t$	3.292**	−0.010	3.970*	1.693***	0.281	0.506
	(1.313)	(0.293)	(2.060)	(0.586)	(0.417)	(0.323)
$(p+e-d)_{t-1}$	−2.465**	0.594**	−1.616	−0.656	−0.640	−0.370
	(1.120)	(0.234)	(1.140)	(0.702)	(0.472)	(0.352)
$(p+e-d)_{t-2}$	1.049**	–	0.094	0.223	0.655***	0.151
	(0.468)		(0.814)	(0.180)	(0.223)	(0.133)
$(p+e-d)_{t-3}$	–	–	−0.536	0.123	–	–
			(0.563)	(0.220)		
$(p+e-d)_{t-4}$	–	–	–	−0.165	–	–
				(0.190)		
T_t	0.041***	0.055***	0.040*	−0.012**	0.015***	0.006***
	(0.009)	(0.006)	(0.021)	(0.006)	(0.002)	(0.001)
POIL_t	0.008**	0.011***	0.023***	0.006***	0.001	−0.001***
	(0.003)	(0.002)	(0.006)	(0.002)	(0.001)	(0.000)
Z_t	1.414***	0.342**	0.000	−0.999***	−0.228	–
	(0.213)	(0.153)	(0.000)	(0.111)	(0.174)	
Constant	−8.473***	−1.909**	−8.441	−1.067	2.250***	3.138***
	(2.514)	(0.735)	(5.213)	(0.998)	(0.621)	(0.443)
Long-run	1.875***	0.585***	1.913	1.217***	0.297**	0.287***
$p+e-d$	(0.518)	(0.186)	(1.192)	(0.234)	(0.129)	(0.105)
Sample size	78	77	77	76	78	78
R^2	0.924	0.957	0.733	0.587	0.666	0.792
D–W Statistics	1.573	2.006	1.675	1.706	1.548	2.050
F Statistic	90.03	638.8	15.48	4.560	15.04	32.85
Hausman χ^2	6.070	3.342	49.59***	16.97*	3.552	12.68**

Significance levels are *** = 1%, ** = 5%, * = 10% (two tail tests). The parentheses contain standard errors. Lower case variable names indicate natural logs. The regressions are estimated with two-stage least squares and a heteroskedasticity-consistent covariance matrix. The garments equation was re-estimated with the Cochrane–Orcutt iterative technique due to a low Durbin–Watson statistic. I make corrections for seasonality with quarterly dummies.

Textiles' long-run price coefficient of 1.88 (0.52) indicates that a higher rupiah export price, relative to the sector's domestic costs, has a more than proportionate impact on the supply of textile exports. Sawnwood and garment exports also have high and precisely estimated long-run supply-price elasticities. To the best of my knowledge, no previous estimates of disaggregated supply-price elasticities exist for developing country manufactured exports to serve as bench-marks. Magnitudes of the textile, garment, plywood, and sawnwood long-run price elasticities do fall in the range of estimates for a broad aggregate of LDC manufactured exports in Moran (1988) and for total Indonesian exports in Arize (1990). However, Table 3's estimates have greater precision than results based on the more restrictive partial adjustment model in Moran and Arize.

The relative price results for garments and textiles differ by a surprising amount, possibly because the MFA constrained the supply response of garments more than textiles to improvements in profit opportunities. Because Indonesian garment producers turned toward higher value items within the MFA's fixed quantity quotas, a focus on quantity may yield misleading results. However, alternative supply regressions for textiles and garments with value as the dependent variable produce similar estimates. [13] Using value on the left-hand side may not improve the garment results because price and quantity have different determinants, so the estimates could be picking up unidentified interaction effects between supply and demand (Goldstein and Khan, 1985: 1056). A closely related explanation for the difference in price elasticities between garments and textiles is measurement error in the price variable. Figures in Rodgers (1993) illustrate that Indonesian unit values track world price series rather closely, except for manufactured products such as textiles and garments. Using unit value ($/kg) to measure price probably biases downward the supply-price elasticity for garments more than textiles, given the move toward higher value garment exports, but no other price data for Indonesian exports are available. Another possible reason why the relative price response is lower for garments than for textiles is that during much of the period, the Indonesian quota allocation and transfer system often worked poorly in making quotas available. This made it difficult for producers to get the extra quota they needed to expand production of 'hot' items for which demand and unit revenues were high. The effect of such an institutional problem would be just as the results suggest: an apparent unresponsiveness to price increases in garments. [14]

As predicted earlier, long-run export supply is more elastic with respect to price for the manufactured exports than for the primary commodities rubber and coffee.

[13] In estimations with value as the dependent variable, the price elasticity of export quantity equals the value elasticity minus one (Goldstein and Khan, 1985: 1056). These alternative estimations indicate that the long-run elasticities of the quantity of textile and garment exports are 2.94 and 0.56 with the partial adjustment model and 1.87 and 0.47 with a PDL structure. All are precisely estimated.

[14] I thank an anonymous referee for this final possible explanation, and for raising the earlier point about plywood incentives.

An additional explanation is that Table 3's 'long-run' estimates for coffee and rubber reflect more immediate decisions to sell on the world market rather than very-long-run decisions to plant new areas or replant existing stands and expand output, when output from new trees may not even begin for five or more years. Quarterly data and limited degrees of freedom constrain the maximum lag number and prevent the estimation of true long-run elasticities. Lord (1991) argues that export-supply price coefficients for primary commodities are typically inelastic in the short run, but elastic in the long run. The price elasticities of 0.30 (0.13) and 0.29 (0.11) for coffee and rubber do fall within the range of short-run coffee and rubber supply elasticities that have been estimated for other countries (e.g., Hwa, 1985, and Lord, 1991).

Overall, Table 3's elasticity estimates support the use of price incentives to stimulate the supply of non-oil exports, although the responses do vary considerably across sectors. [15] Given the importance of devaluation in the Indonesian government's reform agenda, how much of these responses are due to exchange rate changes, commodity market price changes, and domestic cost changes? A decomposition of the relative price variable into the three individual components for each sector indicates that in the short run, the coefficient on the exchange rate has the correct sign and is statistically significant more often than the coefficient on the commodity price and domestic cost terms. Interestingly, the magnitude of the exchange rate elasticity is higher than the other price elasticities, although the difference is not always statistically significant. The more pronounced response to exchange rate changes also holds in the long run for most sectors. That said, one interesting calculation that could be made is for the effects of the September 1986 devaluation and the coincident price changes to be worked out quantitatively using the model's parameter estimates. As a lower bound I use the short run partial adjustment estimates for each sector's relative price elasticity. This decomposition indicates that in the three months following the devaluation, relative price changes explain 5% of the change in exports for coffee, 22% for rubber, 42% for plywood, 74% for garments, and over 100% for textiles and sawnwood. Not only are these quantitative effects in line with the magnitudes of the supply price elasticities, they are also roughly in line with the amount of value added, with the farm products having the least value added and garments and textiles the most. Given the separated price results, it appears that these short run export supply responses reveal primarily the effects of the devaluation. One can then infer that devaluation has a positive impact on domestic value added.

[15] I formally test the variation in price estimates and the importance of a disaggregated analysis by using pooled data to estimate a single supply equation that includes sectoral dummy variables and relative price interaction terms. The results indicate that the relative price coefficients are statistically significant for all sectors.

In addition to price incentives, Table 3 reports some export responsiveness to sector-specific policies (Z_t). In particular, the proxy for the succession of policy reform packages after 1982 in the textiles and garments equations has a positive and highly significant coefficient. Indonesian fiber spinners and textile weavers, who relied heavily on imported cotton and synthetic fibers, benefitted substantially from the drawback facility and from the steady removal of trade restrictions on cotton and synthetic fiber imports. Garment exporters also gained from the relaxation of import restrictions as they expanded their input needs beyond the range of textiles available domestically and relied more heavily on imported fabrics.

As expected, the Z_t measure in the sawnwood estimation, a dummy variable for the prohibitive sawnwood export tax, has a negative and statistically significant coefficient. The sizable drop in sawnwood exports following the exorbitant taxes also helps to explain why sawnwood is the only sector with a negative coefficient on the time trend, T_t. On the other hand, the policy shock variable Z_t in the plywood equation, a proxy for the government's log export ban, has a tiny and statistically insignificant coefficient. This result is surprising for a policy shock variable that anecdotal evidence suggests should have a strong effect. Various alternative proxies for the log export ban, such as the price of logs and a dummy variable for the years in which the government progressively tightened the log export restrictions, produce similarly small and imprecisely estimated coefficients. Overall, the failure to obtain a significant coefficient for the plywood shock variable, and the use of time dummies rather than actual data series to measure policy shocks in other sectors, underscore the need for better data to measure the policy reforms.

Finally, a potential problem with the above analysis is that the export price and quantity series may not be stationary, particularly given the strong growth rates of the Indonesian economy during the period of analysis. First-differenced data series may be necessary to improve the reliability of the estimates. Table A2 in Appendix A reports sensitivity analysis results from regressions using the polynomial distributed lag and first differenced data series. Tests for unit roots indicate that three of the sectors have relative price series that are stationary, and the other three have relative price series that are integrated of order one. All sectors have export quantity series that are integrated of order one except for rubber, where the quantity series is stationary. None of the sectors have price and quantity series that are cointegrated. Estimates for the long run supply price elasticity from first differenced regressions are consistent in sign and in magnitude with the earlier estimates for all sectors but coffee, where the coefficient becomes negative. However, the estimates are markedly less precise across the board. While first-differencing places a lower bound on the precision of my original estimates, this sensitivity analysis does not imply that the original estimates are unreliable. I have already included a time trend in the original results, and I found the Durbin–Watson and Breusch–Godfrey test statistics to be well within the range that would support the conclusion of no serial dependence in the error terms of the autoregressive sort.

6. Concluding remarks

This paper highlights the positive role of export price incentives, including exchange rate changes, in Indonesia's non-oil export success. The results indicate that non-oil exporters' responsiveness to relative price changes varies widely across sectors, with the greatest impact in textiles, sawnwood, and garments. Differences in production functions and in adjustment lags help to explain why the manufactured exports respond more to changes in price incentives than do the primary commodity exports. In particular, the farm products tend to have inelastically supplied inputs (like good quality farm land in the case of coffee), and the manufactured products have few inelastically supplied inputs. The sectoral export elasticities should be useful for Indonesian government officials in predicting export growth following an exchange rate realignment, and for predicting related economic outcomes such as employment growth. With the world's fourth largest population and almost 60% of the population under the age of 25, Indonesia's prospering manufacturing sector offers many new employment opportunities. Of course, high export supply-price elasticities do not necessarily translate into strong employment growth following a devaluation for such capital-intensive sectors as textiles and plywood, and for those sectors with low domestic value added. The major gains may then come in the form of technological diffusion and improvements in quality, but such gains are more difficult to measure.

The study illustrates the importance of disaggregating the data, having a more flexible functional form, and controlling for policy shocks to obtain a richer description of the relationship between price incentives and export performance than can be found in previous studies. Data inadequacies, though, contribute to the admittedly weaker evidence for the success of other Indonesian policy reforms in stimulating export supply. Researchers with access to detailed sectoral data for other developing countries are in a particularly good position to further demonstrate the utility of this study's simple yet rigorous approach. Similar disaggregated analyses of other developing countries' trade experiences will improve our understanding of supply-side responses to orthodox policy prescriptions, especially exchange rate devaluation. Policy makers in other countries with then have more information at hand to weigh the benefits of devaluation, primarily export growth across sectors, against the costs, which could include higher inflation.

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Appendix A. Data Sources and Variable Construction

The original trade data, coded from Indonesian customs forms and provided by the Indonesian Bureau of Statistics (BPS), cover individual export and import transactions from 1975 to 1994. The aggregation and classification process resulted in quarterly and annual data on exports and imports, sectoral and aggregate, by value and quantity. I constructed Indonesia's export prices as unit value indices at the two or three digit Standard International Trade Classification (SITC) level, using BPS data on dollar values and metric tons. SITC codes for each sector are: textiles (65), garments (84), plywood (63), sawnwood (24, minus logs), coffee (071), and rubber (23). The exclusion of actual price data, particularly for manufactured goods, constitutes the main drawback to the BPS data.

The study also uses extensive wholesale price data, provided by the Harvard Institute for International Development, to proxy for each sector's domestic costs. I aggregated relevant classifications within the original data, which cover 165 sectors, with 1988 trade weights to match the sample's six SITC classifications. The study uses quarterly data for all variables and converts the data into indices with base year 1985. I interpolate some annual figures into quarters, and construct trade weighted competitor price and import expenditure variables, following Goldstein and Khan (1976, 1978). The following table summarizes the construction and data source of each variable.

A.1. Table A1: Data sources

Code	Variable	Data type or construction	Source
X_h	Home country export quantity	Weight by sector (kg)	BPS
P_h	Home country export price	Unit value ($/kg) by sector	BPS
E	Exchange rate	Nominal exchange rate ($rp/\$$), period average	IMF
D	Domestic price	Indonesian wholesale price indices, constructed from raw data for 165 sectors using 1998 trade weights	BPS
T	Time trend	Linear time trend	–
POIL	Oil price	Unit value of Indonesian oil exports	BPS
Z	Supply shocks by sector	Value of Indonesian log exports; Time dummies for policy reform packages, sawnwood export tax, and 1977 world coffee price surge	BPS
P_c	Competitor country export price	Dollar production costs for each sector's top 3 LDC competitors; trade weighted producer prices converted into dollars with average period exchange rates	WB, UN, IMF
Y^M	Expenditures on imports	Trade weighted expenditures by destination countries on merchandise imports (cif)	WB, UN

Sources: BPS = Indonesian Bureau of Statistics; IMF = International Monetary Fund, International Financial Statistics; UN = United Nations, International Trade Statistics Yearbook; WB = World Bank, World Tables.

A.2. Table A2: Sensitivity analysis results using first differenced data (polynomial distributed lag)

Variable	Textiles	Garments	Plywood	Sawnwood	Coffee	Rubber
$(p+e-d)_t$	0.951	−0.133	0.612	0.682*	−0.202	0.099
	(0.776)	(0.378)	(0.841)	(0.365)	(0.468)	(0.186)
$(p+e-d)_{t-1}$	−0.182	0.564**	0.474	0.317**	−0.233	−0.160
	(0.278)	(0.215)	(0.519)	(0.125)	(0.263)	(0.127)
$(p+e-d)_{t-2}$	1.233***	–	0.718*	−0.033	0.242	0.285*
	(0.367)		(0.403)	(0.100)	(0.192)	(0.169)
$(p+e-d)_{t-3}$	–	–	0.544	0.098	–	–
			(0.389)	(0.104)		
$(p+e-d)_{t-4}$	–	–	–	−0.123	–	–
				(0.104)		
$POIL_t$	−0.004	−0.001	−0.003	−0.006*	0.003	−0.001
	(0.006)	(0.003)	(0.004)	(0.003)	(0.003)	(0.002)
Z_t	−0.027	−0.056	0.000	−0.108	0.345**	–
	(0.096)	(0.054)	(0.000)	(0.071)	(0.140)	
Constant	0.004	0.027	−0.005	−0.070	−0.209***	−0.057**
	(0.122)	(0.083)	(0.098)	(0.063)	(0.063)	(0.022)
Long-run	2.002*	0.432	2.348	0.942*	−0.192	0.225
$p+e-d$	(1.186)	(0.381)	(2.026)	(0.524)	(0.557)	(0.249)
Sample size	77	78	76	75	77	77
R^2	0.129	0.157	0.025	0.315	0.601	0.180
D–W Statistic	2.146	2.599	1.902	2.347	2.561	2.867
F Statistic	0.414	1.842	5.750	2.412	12.813	2.159
Hausman χ^2	3.731	1.767	7.875	5.167*	3.172	0.827

Significance levels are *** = 1%, ** = 5%, * = 10% (two tail tests). The parentheses contain standard errors. Lower case variable names indicate natural logs. The regressions are estimated with two-stage least squares. I make corrections for seasonality with quarterly dummies.

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