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Firms' Responses to Relative Price Changes in Côte d'Ivoire

The Implications for Export Subsidies and Devaluations

John L. Newman
Victor Lavy
Raoul Salomon
and
Philippe de Vreyer

Firms in Côte d'Ivoire would sell more to the foreign market when it is more profitable to do so. Exports would respond positively to increases in export prices and negatively to increases in import prices.

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Since the early 1980s, export subsidies have been proposed as a way to counteract the adverse effects of an exchange rate overvaluation among member countries of the West African Monetary Union. It was felt that one way to alter the relative price of traded to nontraded goods was to attempt to mimic devaluation by raising import tariffs and export subsidies by the same proportion.

Arguments on both sides of the issue were not based on extensive empirical evidence. This paper models the short-run response of firms to exogenous changes in export and import prices, taking into account the possibility that firms may sell to both domestic and foreign markets.

Contrary to prior expectations, the results suggest that firms in Côte d'Ivoire do sell more to the foreign market when it is more profitable to do so. Exports respond positively to increases in export prices and negatively to increases in import prices.

But the fact that exports would be lower if an export subsidy were combined with an import tariff is not an argument for introducing an export subsidy alone. Firms producing tradable goods suffer from an overvalued exchange rate not only because they would receive a lower price for their exports but also because they must compete against lower priced imports.

Introducing an export subsidy alone would be insufficient to increase output in the tradable goods sector. The combination of an export subsidy with an import tariff, which comes closer to mimicking the effects of devaluation, would serve to counteract some of the adverse effects on output of an overvalued exchange rate. What the longer run effects would be remain to be seen.

Two methodological results emerged. First, the exercise of estimating firms' output supply and input demand functions using flexible functional forms was successful. The estimates satisfied theoretical curvature properties and the price effects were estimated precisely.

Second, estimating supply and demand jointly leads to considerably different estimates of export and output supply responses than estimates based on supply alone.

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Firms' Responses to Relative Price Changes in Côte d'Ivoire: The Implications for Export Subsidies and Devaluations*

by
John L. Newman, Victor Lavy,
Raoul Salomon, and Philippe de Vreyer

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1. *INTRODUCTION*

The ability of firms to expand their output and exports in response to changes in relative prices has been central in the debate regarding the use of export subsidies as a trade policy instrument. Since the early 1980s, the introduction of export subsidies has been proposed as a way to counteract the adverse effects of an exchange rate overvaluation among member countries of the West African Monetary Union. Despite deteriorating terms of trade and mounting external debt, these countries and France have opted not to change the CFA exchange rate with the French Franc.

Faced with an exchange rate out of equilibrium, the economy must adjust - either through adjustments in quantities (output and employment) or in prices. As quantity adjustments typically involve higher foregone consumption during the adjustment period, adjustments generated by changing the relative price of traded to nontraded goods are generally preferred. In the absence of a nominal devaluation, one way to attempt a real devaluation would be to reduce nominal wages through tight monetary and fiscal policies.

An alternative means of altering the relative price of traded to nontraded goods is to attempt to mimic a devaluation by raising import tariffs and export subsidies by the same magnitude. This is, indeed, the policy that has been proposed for Côte d'Ivoire. There has been some disagreement over whether the plan has been implemented as proposed. While an export subsidy alone might be thought sufficient for expanding exports and improving the balance of payments, such a policy would not increase the price of imported goods and, thus, would not have as large effects on relative prices as that of a devaluation. In order to address the major concern of expanding output and employment in the tradeables sector, proponents of the tariff cum subsidy scheme argued that it was necessary to mimic the effects of a devaluation more completely and increase import prices as well.

Even with the increase in both export subsidies and import tariffs, this policy will still not mimic exactly a nominal devaluation. A devaluation would affect services and capital movements as well. Moreover, export subsidies will lead to higher export prices only if firms choose to participate and take advantage of the subsidy program. If, due to lack of credibility of the program or high transaction costs, firms do not participate, their export prices will not rise. Finally, the budgetary consequences of the subsidy cum tariff policy could be substantially different from that of a devaluation.

Opponents of the tariff cum subsidy policy claimed that it is doomed to fail because: (i) producers in Africa are slow to adjust to a change in market signals (ii) the short run export supply elasticity is very small since African exporters cannot compete and capture international markets due to their high labor cost compared to their competitors and to the protectionist policies of the developed countries (iii) the export subsidies will lead to a comparable increase in domestic prices, leaving unaltered the relative profitability of exporting (iv) the import surcharges will not raise enough revenue to finance the export subsidies, implying a heavy fiscal burden on other revenue sources. The expected long run nonsustainability of this deficit will undermine from the beginning the credibility of the program and will discourage firms from responding to it.

These views have not been based on extensive empirical evidence, as evidence on export and output supply response is even more scarce for African countries than it is for other developing countries. One of the few studies is by Balassa (1987) who presents results suggesting that the response of exports of goods and agricultural products to price changes is actually greater in Sub-Saharan African countries than in other developing countries. (for evidence on other developing countries see, for example, Balassa et al 1986; Nogues 1989; Milanovic 1986; Artus and Rosa 1978; Goldstein and Khan 1978; Bauman and Braga 1988).

The objective of this paper is to address the first three issues (i-iii) above and to provide empirical evidence on export and output supply responses that could inform policy discussions on the tariff cum subsidy scheme introduced in Côte d'Ivoire in 1986. We base the empirical work on data from two sources for the six years that preceded the implementation of the program (1980-85). Information on sector level output, exports, domestic sales, capital, and variable input use is obtained by aggregating information from individual firm-level panel data obtained from the Banque des Données Financières. The individual data was aggregated because export, import, domestic output, and input price indices obtained from the Ministère du Plan et de l'Industrie are available only at the sectoral (3 digit) level.

The paper models the short-run response of firms to exogenous changes in export and import prices, taking into account the possibility that firms may sell to both domestic and foreign markets. In such a framework, firms may alter sales in response to the relative profitability of the two markets. The net output response depends on the response in both markets. In world markets, Ivorian industries are assumed to be price takers. In the domestic market, even if individual firms face exogenous prices, the

industry demand curve will be downward sloping, making the domestic price endogenous from the viewpoint of the industry. Allowing for the endogeneity of the domestic price requires a model of the domestic demand for the output of the manufacturing sectors. Thus, we model jointly firm output supply and input demand functions and domestic demand for domestically produced goods.

The short-run focus of this study is motivated by methodological as well as policy considerations. First, analyzing the long run response implies treating the capital stock as endogenous and modeling investment behavior and credit markets. This task is further complicated by difficulties in measuring the price of capital services. Second, from a policy point of view, the uncertainty associated with this particular policy reform in Côte d'Ivoire suggests that a sensible approach is first to evaluate the immediate short-run effects.

On the supply side, our empirical model follows closely the production theory framework of Diewert and Morrison (1988) (see also Kohli, 1978). The major new element that we introduce to their framework is the modeling of the demand side. Recent studies such as Zilberfab (1980), Aspe and Giavazzi (1982), and Faini (1988) have discussed the role of domestic market conditions and relative prices in modeling export supply, but have not treated domestic prices as endogenous and identified empirically the influence of exogenous export and import prices on domestic prices. Our work also differs in that we use sector-level data aggregated from individual firm records, whereas Diewert and Morrison use aggregate data. We also allow for non-constant returns to scale.

We compare results from a model that estimates only the supply side with one that estimates jointly supply and demand. We simulate the model to yield domestic supply and export supply elasticities, as well as measures of the sensitivity of the domestic price and domestic demand to exogenous variation in export and import prices. The empirical results are very sensitive to the assumption regarding the endogeneity of the domestic price and to the inclusion (or exclusion) of the demand function in the model. Not allowing for domestic prices to change and affect the relative profitability of exporting versus selling domestically leads to a large bias in the estimate of the export elasticities.

The main and somewhat surprising result is that manufacturing producers in Côte d'Ivoire are able to expand their exports in the short run in response to an increase in export prices. However, most of this expansion comes at the expense of sales in the

domestic market. The net short run output and employment responses are small. A second important and less surprising result is that the domestic supply curve is much more sensitive to price changes than the export supply function. This implies that any exogenous shocks that lead to an increase in domestic demand, such as an increase in import prices, will have a sizable effect on domestic sales and output, and a contractionary effect on exports. Finally, increases in export prices alone were estimated to have a much smaller effect on output and employment than would increases in both export and import prices, as would occur in a devaluation or in the tariff cum subsidy program.

2. *EMPIRICAL SPECIFICATION*

As has been observed elsewhere, the evidence from Côte d'Ivoire indicates that firms tend not to specialize in exporting but to sell their products in both domestic and foreign markets. Between 1980 and 1985 about a third of all manufacturing firms exported to foreign markets. Of those who exported, roughly sixty percent of the value of their sales was to the domestic market. We therefore model firm behavior by allowing firm and industries to produce two different products in a joint production process. The products could be identical or differentiated from each other. Often export products will be similar to the product destined for the domestic market, but distinguished by being of a higher and more uniform quality.

Our empirical specification of joint production is based on the production theory approach employed by Diewert and Morrison (1988) in their study of aggregate export supply and import demand functions in the U.S. In their approach, one specifies a single profit function and derives supply functions to domestic and foreign markets by partially differentiating the profit function with respect to the output price in the respective market. Our work differs in two main respects. First, we work with sectoral rather than aggregate data. It is not our intention to model the complete trade balance, but rather to model short run responses to price changes among firms in the manufacturing sector. Second, we model the domestic demand for domestically produced goods and imports.

Firms are assumed to operate under perfect competition in factor markets. Thus, all input prices are treated as exogenous. Export prices are also assumed to be exogenously determined. We consider two alternative ways of accounting for the

endogeneity of domestic prices. In the first approach, we simply instrument for the endogenous price of domestic goods and estimate how input demands and outputs supplied to domestic and foreign markets vary as functions of the instrumented domestic prices and exogenous export and input prices. In the second approach, we explicitly model the domestic demand for domestic output and for imports. Domestic demand and import demand functions are then estimated jointly with the domestic output supply, export supply, labor demand and intermediate goods demand functions. The domestic market equilibrium condition for domestically produced goods determines the domestic price level and the quantity sold.

The advantage of the first approach is that the estimation procedure is simpler, being very similar to the procedure under the assumption of exogenous domestic prices. Using instrumented domestic prices purges the system of simultaneous equations bias and allows one to estimate the model as a system consisting only of output supply and input demand equations[1].

The main disadvantage of this approach is that the simulations obtainable from this approach do not tell us exactly what we would like to know. Either under the assumption of exogenous domestic prices or with instrumented prices, it is only possible to obtain estimates of the change in domestic supply or export supply with a change in export prices, ***holding domestic prices constant.*** However, one would not expect domestic prices to remain constant.

Export supply and domestic supply functions are derived holding the output price in the other market constant. Thus, an increase in export prices that increases the relative profitability of exporting will shift the domestic supply function to the left. If domestic prices are assumed exogenous, the leftward shift of the domestic supply curve will not lead to any change in domestic prices. However, if as argued earlier, it is more reasonable to assume that the industry demand curve is downward sloping, then the shift in the domestic supply function will lead to an increase in domestic prices. As domestic prices change, this would call forth a leftward shift of the export supply function. The net result after the domestic price adjustment would be a smaller substitution away from domestic sales to exports and, consequently, a smaller increase in exports than if there had been no adjustment.

---

[1] Properly speaking, errors in the first-stage estimation (the instrumenting equation) should be taken into account in the calculation of the second stage standard errors (see for example, Duncan, 1987; Pagan, 1986).

The bias in the estimate of the net export and output responses from neglecting to account for the adjustment of the domestic price is illustrated in Figure 1. An increase in the export price from P_0 to P_1 leads to firms to move along the export supply function and to reduce the amount they are willing to supply to the domestic market at a given price, a leftward shift in the domestic supply function from S to S'. Even if all firms take prices as given, the reduction in the industry supply curve will lead to an increase in the domestic price if the industry demand curve is downward sloping. The increase in the domestic price leads to a shift of the export function from X to X'. The new domestic price and output will be at P_1 and S_2, while exports will be at E_2.

If the domestic price is forced to remain at P_0, then the export and domestic responses can be seen to be upwardly biased (cf. E_1 versus E_2 and S_1 versus S_2) and the increase in total output will be downwardly biased. The magnitude and the importance of these biases will be demonstrated later in the discussion of the empirical results.

Despite the bias, it is still useful to consider the simpler model as it provides an upper bound to the expected size of the export supply response to export price changes. If there is no observed response of export supply to changes in export prices when domestic prices are held constant, it is unlikely that there will be any response once the influence of export prices on domestic prices is taken into consideration. Thus, we first specify the model using only the production relations and then indicate how this approach is modified to take account of the demand side.

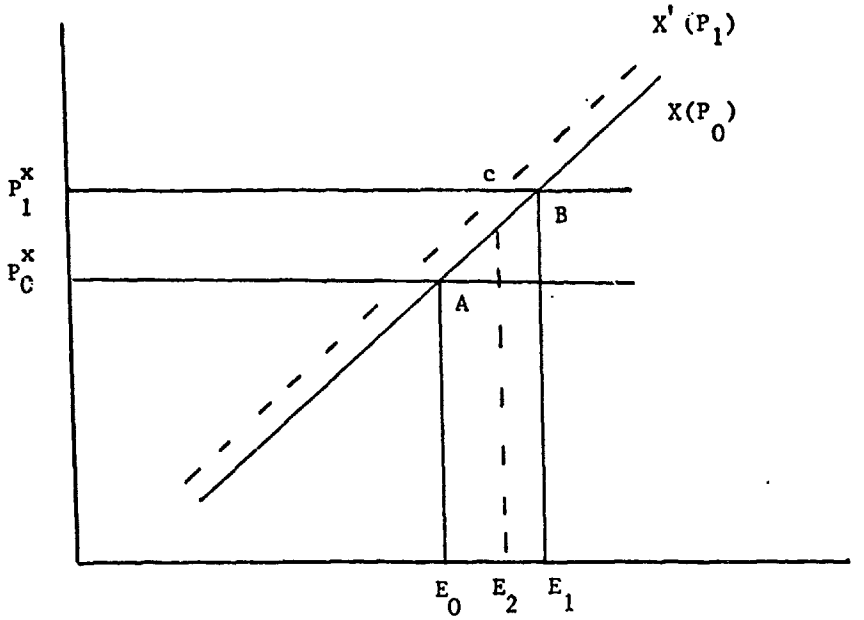
2.A. THE SUPPLY SIDE

We derive econometric specifications of producer supply and input demand functions, consistent with profit-maximizing behavior, from a generalized McFadden restricted profit function of the type employed by Diewert and Morrison (their eq. 8.4). This form of the profit function is one of the class of flexible functional forms and can be specified with or without an assumption of constant returns to scale.[2,3] For a non

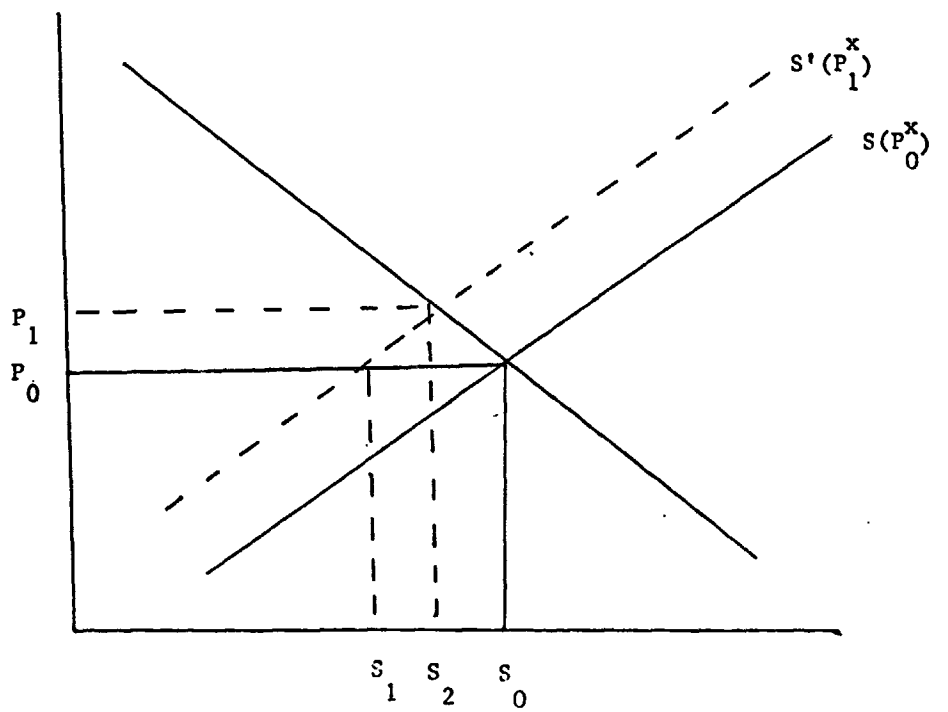
[2] As defined by Diewert (1974) and as stated in Diewert and Wales (1987), a flexible functional form for a cost function is one that would provide a second order differential approximation to an arbitrary twice continuously differentiable cost function that satisfies the linear homogeneity in prices property at any point in the admissible domain. Flexibility of the functional form of a profit function is defined analogously. The expression "restricted" in the restricted profit function refers to capital being fixed.

Figure 1

a. The Export Market



b. The Domestic Market



constant returns to scale technology, the restricted profit function is[4]:

$$
\begin{aligned}
\Pi^t(P_t^d,P_t^e,\omega_t^l,\omega_t^g,K_t) \equiv\ & b_{ss}P_t^dK_t + b_{xx}P_t^eK_t + b_{ll}\omega_t^lK_t + b_{gg}\omega_t^gK_t \\
& + \alpha_sP_t^dt + \alpha_xP_t^et + \alpha_l\omega_t^lt + \alpha_g\omega_t^gt \\
& + b_{st}P_t^dtK_t + b_{xt}P_t^etK_t + b_{lt}\omega_t^ltK_t + b_{gt}\omega_t^gtK_t \\
& + b_sP_t^d + b_xP_t^e + b_l\omega_t^l + b_g\omega_t^g \\
& + \beta_sP_t^dK_t^2 + \beta_xP_t^eK_t^2 + \beta_l\omega_t^lK_t^2 + \beta_g\omega_t^gK_t^2 \\
& + \gamma_sP_t^dt^2K_t + \gamma_xP_t^et^2K_t + \gamma_l\omega_t^lt^2K_t + \gamma_g\omega_t^gt^2K_t \\
& + \tfrac{1}{2}\,b_{sx}\frac{\left(P_t^d\right)^2}{P_t^e}K_t + \tfrac{1}{2}\,b_{lx}\frac{\left(\omega_t^l\right)^2}{P_t^e}K_t + \tfrac{1}{2}\,b_{gx}\frac{\left(\omega_t^g\right)^2}{P_t^e}K_t \\
& + b_{sl}\left(\frac{P_t^d\omega_t^l}{P_t^e}\right)K_t + b_{sg}\left(\frac{P_t^d\omega_t^g}{P_t^e}\right)K_t + b_{lg}\left(\frac{\omega_t^l\omega_t^g}{P_t^e}\right)K_t
\end{aligned}
$$

where: S_t = output supplied to domestic markets ;
X_t = output supplied to foreign markets;
L_t = real expenditure on labor;
G_t = real expenditure on intermediate goods;
ω_t^l = the cost of labor;
ω_t^g = the cost of intermediate goods;
P_t^d = the domestic price of domestically produced goods;
P_t^e = the foreign price of domestically produced goods;
K_t = the capital stock.
t = time.
The b's, α's, β's, and γ's are parameters to be estimated.

Π^t is linearly homogeneous in prices. A constant returns to scale profit function would be obtained by imposing the restrictions that $b_i=0$, $\alpha_i=0$, $\beta_i=0$, and $\gamma_i=0$, $\forall\ i = s,x,l$, and g.

As Diewert and Wales (1987) indicate, in order for the profit function to satisfy the theoretical curvature properties, namely, that the profit function be convex with respect to prices, the matrix of second derivatives of the restricted profit function with respect to prices must be positive semidefinite. This will be satisfied if and only if the matrix

[3] We also specified producer supply and input demand functions derived from the more restrictive Cobb-Douglas production function, but did not obtain reasonable results. For example, the effect of increases in export prices on exports was negative.

[4] See Diewert and Wales (1987).

$$B = \begin{bmatrix} b_{sx} & b_{sl} & b_{sg} \\ b_{sl} & b_{lx} & b_{lg} \\ b_{sg} & b_{lg} & b_{gx} \end{bmatrix}$$

is positive semidefinite. We did not impose positive semidefiniteness in the estimation, but did check whether the conditions were satisfied.

Partially differentiating the restricted profit function with respect to input and output prices yields: (1) a domestic supply function; (2) (minus) the labor demand function; (3) (minus) the intermediate input demand function; and (4) the export supply function. The resulting solutions are analogous to equations (8.5 - 8.9) in Diewert and Morrison (1988). As they suggest, we divide by K_t to make the assumption of homoskedasticity of the error terms more plausible.

$$\frac{X_t}{K_t} = b_{xx} + b_{xt}\, t + \alpha_x\, t\left(\frac{1}{K_t}\right) + b_x\left(\frac{1}{K_t}\right) + \beta_x\, K_t + \gamma_x t^2$$
$$- \tfrac{1}{2}\, b_{sx}\left(\frac{P_t^d}{P_t^e}\right)^2 - \tfrac{1}{2}\, b_{lx}\left(\frac{\omega_t^l}{P_t^e}\right)^2 - \tfrac{1}{2}\, b_{gx}\left(\frac{\omega_t^g}{P_t^e}\right)^2$$
$$- b_{sl}\frac{\left(P_t^d \omega_t^l\right)}{\left(P_t^e\right)^2} - b_{sg}\frac{\left(P_t^d \omega_t^g\right)}{\left(P_t^e\right)^2} - b_{lg}\frac{\left(\omega_t^l \omega_t^g\right)}{\left(P_t^e\right)^2} + \epsilon_x$$

$$\frac{L_t}{K_t} = b_{ll} + b_{lt}\, t + \alpha_l\, t\left(\frac{1}{K_t}\right) + b_l\left(\frac{1}{K_t}\right) + \beta_l\, K_t + \gamma_l t^2$$
$$+ b_{sl}\left(\frac{P_t^d}{P_t^e}\right) + b_{lx}\left(\frac{\omega_t^l}{P_t^e}\right) + b_{lg}\left(\frac{\omega_t^g}{P_t^e}\right) + \epsilon_l$$

$$\frac{G_t}{K_t} = b_{gg} + b_{gt}\, t + \alpha_g\, t\left(\frac{1}{K_t}\right) + b_g\left(\frac{1}{K_t}\right) + \beta_g\, K_t + \gamma_g t^2$$
$$+ b_{sg}\left(\frac{P_t^d}{P_t^e}\right) + b_{lg}\left(\frac{\omega_t^l}{P_t^e}\right) + b_{gx}\left(\frac{\omega_t^g}{P_t^e}\right) + \epsilon_g$$

$$\frac{S_t}{K_t} = b_{ss} + b_{st}\, t + \alpha_s\, t\left(\frac{1}{K_t}\right) + b_s\left(\frac{1}{K_t}\right) + \beta_s\, K_t + \gamma_s t^2$$
$$+ b_{sx}\left(\frac{P_t^d}{P_t^e}\right) + b_{sl}\left(\frac{\omega_t^l}{P_t^e}\right) + b_{sg}\left(\frac{\omega_t^g}{P_t^e}\right) + \epsilon_s$$

The exact forms of the output supply and input demand equations were determined by limitations of the available data. While we had information on production, domestic sales, exports, and input use of individual firms in the manufacturing sector, we did not have information on the output or export prices of the individual firms. Information on prices was available only in the form of sous-branche level price indices, corresponding to a three digit SITC classification.

In the absence of output prices of individual firms, we estimated the model at the sous-branche level to ensure a close correspondence between the price data and the output supply and input demand functions.[5] To arrive at sous-branche level values of domestic sales, exports, and expenditure on inputs we summed the values of individual firms in the sous-branche. We estimated our models for two different samples - one where the sous-branche level values were formed by summing the individual values over all firms in the sous-branche and the other formed by summing over only the firms that had exported in that year.

We considered two samples because it was not obvious what aggregation would lead to the closest connection between firm decisions and the relevant price data. The export price index, based on quantity weights of year t, does not capture changes in export prices of firms who happened not to export during year t. However, these unobserved price changes might be expected to affect the observed sous-branche changes in output and input demands from year t-1 to year t. Limiting the sample to exporting firms and correcting for the selectivity bias in forming that sample might present a closer connection between the export price and the output of the firms. However, limiting the sample to exporting firms weakens the connection between the domestic price index and output decisions since we do not have access to a domestic price index specific to exporting firms.

A second feature of the data was that because the base used in calculating the published price index changes every year, it was impossible to use a constant base-period weighted price indices in the analysis.[6] Because the value of the published price index in year t reflects the ***change*** in prices between year t-1 and t, maintaining a close connection between the theoretical model and the econometric specification implies that the estimating equations should relate ***changes*** in output supplies and input demands from year t-1 to t to the ***value*** of the price index in year t. Therefore, we estimated the

[5] All efforts to estimate models using individual firms as the unit of observation and replacing the unobserved firm prices by sous-branche level price indices were unsuccessful. We suspect that measurement error in the price data was responsible for the poor results.

model in differenced form.[7] This also has the advantage of eliminating any fixed unobserved sous-branche specific effects. The output supply and input demand equations that were estimated are given below:

$$\Delta\frac{X_t}{K_t} = b_{xt} + \alpha_x\left(\frac{t}{K_t} - \frac{t-1}{K_{t-1}}\right) + b_x\left(\frac{1}{K_t} - \frac{1}{K_{t-1}}\right) + \beta_x(K_t - K_{t-1}) + \gamma_x(2t-1)$$

$$- \frac{1}{2}\, b_{sx}\left(\frac{P^d_t/P^d_{t-1}}{P^e_t/P^e_{t-1}}\right)^2 - \frac{1}{2}\, b_{lx}\left(\frac{\omega^l_t/\omega^l_{t-1}}{P^e_t/P^e_{t-1}}\right)^2 - \frac{1}{2}\, b_{gx}\left(\frac{\omega^g_t/\omega^g_{t-1}}{P^e_t/P^e_{t-1}}\right)^2$$

$$- b_{sl}\frac{\left(P^d_t/P^d_{t-1}\right)\left(\omega^l_t/\omega^l_{t-1}\right)}{\left(P^e_t/P^e_{t-1}\right)^2} - b_{sg}\frac{\left(P^d_t/P^d_{t-1}\right)\left(\omega^g_t/\omega^g_{t-1}\right)}{\left(P^e_t/P^e_{t-1}\right)^2}$$

$$- b_{lg}\frac{\left(\omega^l_t/\omega^l_{t-1}\right)\left(\omega^g_t/\omega^g_{t-1}\right)}{\left(P^e_t/P^e_{t-1}\right)^2} + \epsilon_1$$

---

[6] An example of how domestic output price indices are calculated will illustrate this point. The Ministère du Plan et de l'Industrie makes available the following set of information on output at the three digit level: a) $P^d_t Q_t$ b) $P^d_{t-1}Q_{t-1}$ and c) $P^d_{t-1}Q_t$. From this information, the price index is calculated as:

$$\frac{P^d_t}{P^d_{t-1}} = \frac{P^d_t Q_t}{P^d_{t-1}Q_t}$$

Because Q_t is fixed, the ratio P^d_t/P^d_{t-1} will vary only with changes in prices from one year to the next.

However, this index can not be chained since

$$\frac{P^d_t}{P^d_{t-1}} \times \frac{P^d_{t-1}}{P^d_{t-2}} \neq \frac{P^d_t}{P^d_{t-2}}.$$

The price indices for exports and imports at the sous-branche level available from the Ministère du Plan et de l'Industrie are also calculated in this fashion.

[7] The only limitation (not a serious one in our estimation) is that we are forced to employ a price ratio in lieu of a price difference. For example, we must use

$$\frac{P^d_t/P^d_{t-1}}{P^e_t/P^e_{t-1}}$$

as a measure of how domestic prices have changed relative to export prices instead of

$$\frac{P^d_t}{P^e_t} - \frac{P^d_{t-1}}{P^e_{t-1}}.$$

$$\Delta\frac{L_t}{K_t} = b_{lt} + \alpha_l\left(\frac{t}{K_t} - \frac{t-1}{K_{t-1}}\right) + b_l\left(\frac{1}{K_t} - \frac{1}{K_{t-1}}\right) + \beta_l(K_t - K_{t-1}) + \gamma_l(2t-1)$$

$$+ b_{sl}\left(\frac{P_t^d/P_{t-1}^d}{P_t^e/P_{t-1}^e}\right) + b_{lx}\left(\frac{\omega_t^l/\omega_{t-1}^l}{P_t^e/P_{t-1}^e}\right) + b_{lg}\left(\frac{\omega_t^g/\omega_{t-1}^g}{P_t^e/P_{t-1}^e}\right) + \epsilon_2$$

$$\Delta\frac{G_t}{K_t} = b_{gt} + \alpha_g\left(\frac{t}{K_t} - \frac{t-1}{K_{t-1}}\right) + b_g\left(\frac{1}{K_t} - \frac{1}{K_{t-1}}\right) + \beta_g(K_t - K_{t-1}) + \gamma_g(2t-1)$$

$$+ b_{sg}\left(\frac{P_t^d/P_{t-1}^d}{P_t^e/P_{t-1}^e}\right) + b_{lg}\left(\frac{\omega_t^l/\omega_{t-1}^l}{P_t^e/P_{t-1}^e}\right) + b_{gx}\left(\frac{\omega_t^g/\omega_{t-1}^g}{P_t^e/P_{t-1}^e}\right) + \epsilon_3$$

$$\frac{S_t}{K_t} = \frac{S_{t-1}}{K_{t-1}} + b_{st} + \alpha_s\left(\frac{t}{K_t} - \frac{t-1}{K_{t-1}}\right) + b_s\left(\frac{1}{K_t} - \frac{1}{K_{t-1}}\right) + \beta_s(K_t - K_{t-1})$$

$$+ \gamma_s(2t-1) + b_{sx}\left(\frac{P_t^d/P_{t-1}^d}{P_t^e/P_{t-1}^e}\right) + b_{sl}\left(\frac{\omega_t^l/\omega_{t-1}^l}{P_t^e/P_{t-1}^e}\right) + b_{sg}\left(\frac{\omega_t^g/\omega_{t-1}^g}{P_t^e/P_{t-1}^e}\right) + \epsilon_4$$

where: $\Delta\frac{X_t}{K_t}$ is the real export supply relative to the real capital stock in time t minus the export supply relative to the stock of capital in time t-1.

$\Delta\frac{L_t}{K_t}$ is (minus) the real labor cost relative to the real stock of capital in time t minus the negative of the labor cost relative to the stock of capital in t-1.

$\Delta\frac{G_t}{K_t}$ is (minus) the real cost of intermediate goods inputs to the real stock of capital in time t minus the negative of the cost of intermediate goods inputs in time t-1.

$\frac{S_t}{K_t}$ is the real domestic sales relative to the real stock of capital in time t. Moving the lagged value over to the other side with a coefficient equal to minus one is an equivalent way of writing the differenced equation, but facilitates estimation in the model with the demand side equations.

2.B *THE DEMAND SIDE*

While maintaining the same specification of the supply side, we now add a simple model of the demand side. Domestic consumers may consume either domestically produced goods or imported goods, which are available at an exogenously determined world price. As was done on the supply side, we follow a dual approach and derive domestic consumers' demands for domestically produced goods and imported goods by partially differentiating their expenditure function with respect to domestic prices and imported prices respectively.

At a very high level of aggregation, one may posit only two goods - domestically produced goods and imported goods. However, as we are working with sous-branche level data, there are many more goods, each with its own price. In general, the expenditure function would be a function of the prices of all goods in the system. In order to simplify the model, we assume strong separability among goods in different sous-branches and across other non-manufacturing sectors. This implies that demand for domestically produced goods will be a function only of the prices of domestically produced goods and imports within that sous-branche. Our implicit assumption is that we are imposing a set of zero restrictions on parameters in the expenditure function. We do not test for these restrictions, but, in principle, they could be relaxed at the cost of reducing degrees of freedom. This is obviously an assumption one would want to relax at a later stage.

We adopt the same functional form for the expenditure function as we did for the restricted profit function, namely the generalized McFadden form. The expenditure function is defined as:

$$E(P_t^d, P_t^m, Y_t) = \frac{1}{2} d_{dm} \frac{\left(P_t^d\right)^2}{P_t^m} Y_t + b_{dd} P_t^d Y_t + b_{mm} P_t^m Y_t + b_d P_t^d + b_m P_t^m$$

$$+ b_d P_t^d t\, Y_t + b_m P_t^m t\, Y_t + \alpha_d P_t^d t + \alpha_m P_t^m t + \beta_d P_t^d Y_t^2$$

$$+ \beta_m P_t^m Y_t^2 + \gamma_d P_t^d t^2 Y_t + \gamma_m P_t^m t^2 Y_t$$

Partially differentiating the expenditure function with respect to the domestic price of domestically produced goods and imported goods yields the domestic demand

for domestically produced goods and the demand for imports. Again, given the nature of the price indices, we estimate the model using differences in demands. Since the equilibrium condition is that the domestic supply equal the domestic demand of domestically produced goods, the measures of supply and demand must be in the same units. Because domestic supply S_t is deflated by real capital, we also deflate domestic demand D_t by real capital. Thus, the demand side of the model is given by[8]:

$$\frac{D_t}{K_t} = \frac{D_{t-1}}{K_t} \cdot \frac{Y_t}{Y_{t-1}} + b_{dm}\left(\frac{P_t^d/P_{t-1}^d}{P_t^m/P_{t-1}^m}\right)\frac{Y_t}{K_t} + b_d \frac{1}{K_t}\left(1 - \frac{Y_t}{Y_{t-1}}\right)$$
$$+ b_{dt}\frac{Y_t}{K_t} + \alpha_d \frac{t}{K_t}\left(1 - \frac{Y_t}{Y_{t-1}}\right) + \alpha_d \frac{1}{K_t} \cdot \frac{Y_t}{Y_{t-1}}$$
$$+ \beta_d \frac{Y_t}{K_t}(Y_t - Y_{t-1}) + \gamma_d \frac{Y_t}{K_t}(2t-1) + u_d$$

$$\frac{M_t}{K_t} = \frac{M_{t-1}}{K_t} \cdot \frac{Y_t}{Y_{t-1}} - \frac{1}{2} b_{dm}\left(\frac{P_t^d/P_{t-1}^d}{P_t^m/P_{t-1}^m}\right)^2 \frac{Y_t}{K_t} + b_m \frac{1}{K_t}\left(1 - \frac{Y_t}{Y_{t-1}}\right)$$
$$+ b_{mt}\frac{Y_t}{K_t} + \alpha_m \frac{t}{K_t}\left(1 - \frac{Y_t}{Y_{t-1}}\right) + \alpha_m \frac{1}{K_t} \cdot \frac{Y_t}{Y_{t-1}}$$
$$+ \beta_m \frac{Y_t}{K_t}(Y_t - Y_{t-1}) + \gamma_m \frac{Y_t}{K_t}(2t-1) + u_m$$

where: D_t = the domestic demand for domestically produced goods;
M_t = the demand for imported goods;
Y_t = real GDP;
P_t^m = the price of imported goods;
the b's, α's, β's, and γ's are parameters to be estimated;
and all other variables are defined as before.

3. *THE DATA*

The data used in the estimation are drawn from two sources. The export,

[8] The steps in going from the expenditure function to the specific functional form for the demand for domestically produced goods were as follows. First, partially differentiate the expenditure function with respect to the domestic price P_t^d and divide by Y_t. Express in difference form $(D_t/Y_t) - (D_{t-1}/Y_{t-1})$. Take (D_{t-1}/Y_{t-1}) over to the right hand side with a coefficient equal to one. Finally, multiply both left and right hand sides by (Y_t/K_t). A similar procedure was followed for the derivation of the demand for imports.

output, and import price indices were obtained from the Ministère du Plan et de l'Industrie. These series were only available from 1980. The intermediate goods index was calculated by applying the output price indices to the input-output matrix for production in Côte d'Ivoire. It was available only at the two digit level. To ensure conformability with the other indices, we calculate a labor cost index as the median nominal wage of all firms in the sous-branche in year t relative to the median nominal wage in year t-1. The median was chosen to reduce the effect of outliers. Additional details on the price indices are contained in the data appendix.

Data on the value of imports within the sous-branche classification are also obtained from the the Ministère du Plan et de l'Industrie. The imports refer to imports of final goods within this classification, not the imported inputs used by domestic firms within the sous-branche.

All other data on domestic sales, exports, expenditure on labor, and expenditure on intermediate inputs was calculated from information provided to the Banque des Données Financières by individual firms in the manufacturing sectors. The value of domestic sales was measured by the value of gross sales minus the value of exports. Capital was measured as net cumulated investment, deflated by an aggregate capital goods price index. All differences are real differences, expressed in prices prevailing at time t - 1 and deflated by the appropriate price index.

This information was available going back to 1976, but we could not consider a longer sample period owing to the limitation on the price data. Details on the construction of the data and a brief description of the data set is contained in the data appendix.

4. *ESTIMATION AND RESULTS*

We estimated models with and without the demand side equations and with and without the restrictions of a constant returns to scale technology for two different samples[9]. The models with only the output supply and input demand equations were estimated using iterative seemingly unrelated regression. The models with the demand side were estimated using iterative three-stage least squares. The results are presented for the sample obtained from an aggregation over all firms in the sous-branche in Table

[9] All models were estimated using SAS's PROC SYSNLIN.

Table I. All Firms

	Supply Side Only		Joint Supply and Demand	
Parameter	CRTS	Non-CRTS	CRTS	Non-CRTS
b_{sx}	4.38*	3.26*	39.87*	39.85*
	(1.35)	(1.30)	(1.48)	(1.97)
b_{sl}	-0.60*	-0.47*	-3.62*	-3.12*
	(0.17)	(0.15)	(0.20)	(0.23)
b_{sg}	-2.92*	-2.28*	-27.37*	-30.04*
	(0.97)	(0.95)	(1.08)	(1.54)
b_{lx}	0.42*	0.44*	0.67*	0.64*
	(0.04)	(0.04)	(0.05)	(0.04)
b_{lg}	0.17	0.07	2.20*	2.08*
	(0.12)	(0.10)	(0.18)	(0.21)
b_{gx}	2.52*	2.19*	19.01*	23.22*
	(0.74)	(0.73)	(0.98)	(1.41)
b_{xt}	0.60*	0.64*	1.75*	1.15*
	(0.12)	(0.15)	(0.22)	(0.25)
b_x		-1.04		-27.3
		(11.6)		(19.8)
α_x		2.77		23.7*
		(5.19)		(9.4)
β_x		1.15E-5		5.96E-5
		(9.98E-5)		(1.43E-4)
γ_x		-0.03		0.01
		(0.02)		(0.03)
b_{lt}	-0.01	-0.07	0.91*	0.49*
	(0.06)	(0.05)	(0.09)	(0.10)
b_l		-2.23		13.2**
		(1.84)		(7.3)
α_l		-2.56*		-13.7*
		(0.83)		(7.3)
β_l		1.59E-5		4.4E-5
		(1.57E-5)		(5.12E-5)
γ_l		0.0078		0.01
		(0.0034)		(0.01)
b_{gt}	0.13	0.06	7.28*	5.90*
	(0.33)	(0.33)	(0.64)	(0.87)
b_g		-16.3		1.38E+2*
		(12.3)		(64.1)
α_g		-2.79		-1.10E+2*
		(5.50)		(30.4)
β_g		8.69E-6		2.71E-4
		(1.06E-4)		(4.6E-4)
γ_g		-0.03		0.04
		(0.02)		(0.10)

Table I. All Firms (Cont.)

	Supply Side Only		Joint Supply and Demand	
Parameter	CRTS	Non-CRTS	CRTS	Non-CRTS
b_{st}	1.95*	2.25*	-10.59*	-8.39*
	(0.47)	(0.53)	(0.97)	(1.23)
b_s		-74.6		-2.12E+2*
		(30.5)		(93.8)
α_s		54.74		1.75E+2*
		(13.64)		(45.2)
β_s		3.62E-4		-4.91E-4
		(2.65E-4)		(6.3E-4)
γ_s		-0.06		-0.08
		(0.06)		(0.14)
b_{dm}			0.00016	-3.75E-4**
			(0.0002)	(0.0002)
b_{dt}			0.0016	0.0021*
			(0.0010)	(0.0009)
b_d			-2.92E+3	-2.29E+4*
			(1.44E+4)	(1.17E+4)
α_d			-2.57E+2*	-2.21E+2*
			(99.91)	(84.8)
β_d			-6.01E-8	-4.4E-7*
			(2.76E-7)	(2.24E-7)
γ_d			0.0012	0.0010*
			(0.0004)	(0.0004)
b_{mt}			-0.11*	-0.24*
			(0.06)	(0.06)
b_m			2.56E+6*	1.62E+6
			(1.08E+6)	(1.13E+6)
α_m			1.19E+4*	2.92E+4*
			(6.20E+3)	(6.89E+3)
β_m			4.93E-5*	3.12E-5
			(2.06E-5)	(2.16E-5)
γ_m			-0.05*	-0.14*
			(0.03)	(0.03)
Objective*N	546.00	530.00	239.34	211.95
N	139	139	139	139

Standard errors are in parentheses.
* Significant at the 5 percent level.
** Significant at the 10 percent level.

Table II. Exporting Firms Only

	Supply Side Only		Joint Supply and Demand	
Parameter	CRTS	Non-CRTS	CRTS	Non-CRTS
b_{ex}	7.32*	6.64*	54.29*	35.41*
	(1.93)	(1.98)	(1.68)	(1.72)
b_{el}	-1.75*	-1.40*	-2.39*	-3.41*
	(0.35)	(0.36)	(0.47)	(0.25)
b_{eg}	-3.90*	-3.72*	-40.49*	-25.93*
	(1.42)	(1.43)	(1.26)	(1.33)
b_{lx}	1.04*	0.84*	0.97*	0.66*
	(0.13)	(0.13)	(0.11)	(0.04)
b_{lg}	0.16	0.08	0.63	2.20*
	(0.26)	(0.13)	(0.41)	(0.21)
b_{gx}	3.23*	3.27*	31.81*	19.35*
	(1.13)	(1.14)	(1.34)	(1.20)
b_{xt}	0.65*	0.73*	2.16*	1.10*
	(0.16)	(0.19)	(0.27)	(0.23)
b_x		14.81*		42.44
		(5.56)		(46.55)
α_x		-2.07**		16.13
		(1.17)		(10.16)
β_x		-2.14E-6		5.80E-5
		(8.68E-5)		(1.31E-4)
γ_x		-0.01		-0.014
		(0.02)		(0.029)
b_{lt}	0.56*	0.44*	0.85*	0.65*
	(0.14)	(0.15)	(0.15)	(0.11)
b_l		-8.80*		15.95
		(2.91)		(18.74)
α_l		0.68		-1.11E+1*
		(0.61)		(4.10)
β_l		1.70E-5		3.70E-5
		(4.54E-5)		(5.20E-5)
γ_l		0.01		0.013
		(0.01)		(0.012)
b_{gt}	0.40	0.31	9.04*	5.39*
	(0.48)	(0.50)	(0.93)	(0.75)
b_g		-7.99		1.76E+2
		(8.30)		(1.39E+2)
α_g		0.77		-9.94E+1*
		(1.74)		(30.12)
β_g		3.06E-5		2.30E-4
		(1.30E-4)		(3.9E-4)
γ_g		-0.01		0.036
		(0.04)		(0.088)

Table II. Exporting Firms (Cont.)

	Supply Side Only		Joint Supply and Demand	
Parameter	CRTS	Non-CRTS	CRTS	Non-CRTS
b_{st}	1.66*	2.13*	-12.86*	-7.73*
	(0.47)	(0.82)	(1.30)	(1.06)
b_s		-0.86		-2.33E+2
		(20.9)		(2.00E+2)
α_s		5.65		1.57E+2*
		(4.39)		(80.29)
β_s		2.62E-4		-9.80E-7
		(3.27E-4)		(3.81E-7)
γ_s		-0.09		0.0014
		(0.09)		(0.00036)
b_{dm}			-0.0012*	-4.5E-4*
			(0.0003)	(0.0002)
b_{dt}			0.00185	0.0030*
			(0.0015)	(0.0008)
b_d			-6.83E+4	-5.12E+4*
			(4.36E+4)	(1.98E+4)
α_d			-5.50E+1	-3.02E+2*
			(1.38E+2)	(80.29)
β_d			-1.31E-6	-9.80E-7*
			(8.42E-7)	(3.81E-7)
γ_d			0.00014	0.0014*
			(0.00062)	(0.00036)
b_{mt}			-0.22*	-0.80*
			(0.04)	(0.046)
b_m			7.58E+6*	3.23E+6*
			(2.71E+6)	(1.49E+6)
α_m			1.68E+4*	6.61E+3
			(4.07E+3)	(5.04E+3)
β_m			1.46E-4*	6.17E-5*
			(5.23E-5)	(2.86E-5)
γ_m			-0.063*	-0.027
			(0.019)	(0.022)
Objective*N	530.00	510.00	276.42	202.60
N	134	134	134	134

Standard errors are in parentheses.
* Significant at the 5 percent level.
** Significant at the 10 percent level.

I and for the sample aggregated only over the exporting firms in Table II. We also estimated the model with only exporting firms using a two-stage correction for possible selectivity bias, but found little difference in the results with the more complicated selectivity bias correction.[10] The main points to make with respect to these estimates are that: (a) the parameters are all of the expected signs; (b) on the whole, the parameters on the price variables are estimated quite precisely; (c) the results with exporting firms only are similar to those with all firms, but with a somewhat greater sensitivity to price variation; (d) the restrictions implied by a constant returns to scale production process are rejected in at the one percent level in all cases; and (e) the theoretical curvature conditions, that the profit function be convex with respect to prices, are satisfied in all but one of the models estimated. For all cases except for the estimation of all firms with the demand side and a constant returns to scale technology, all the eigenvalues of the matrix of price coefficients were positive, indicating a positive semidefinite matrix.

Because of the nonlinearities present in all the models, it is difficult to draw inferences from tables of the estimated coefficients of the structural model. Model simulations based on the estimated coefficients provide a clearer picture of the effect of price changes on output and exports.[11] The simulations were performed as follows:

1) Given the estimated covariance matrix of the coefficients, take 100 random draws of the coefficients.
2) Solve the model for each draw to yield 100 base values of the endogenous variables for each sous-branche and each year. Recall that the model solves for ΔX. As an example, let the k^{th} value of the change in exports for sous-branche i in time period t equal ΔX^0_{itk}, where $k = 1,\ldots,100$.
3) Change an exogenous variable by a given percent, say z.
4) Repeat steps (1) and (2). Denote the new k^{th} value of the change in exports for sous-branche i in time period t as ΔX^1_{itk}, again with $k = 1,\ldots,100$.
5) For each sous-branche and each year, calculate the mean difference as,

[10] In the first stage we predicted the probability that each firm in the sous-branche would export, constructed a Mills ratio for each exporting firm, and estimated the models using sous-branche level data with the sum of all individual firms' Mills ratios. This has the implicit assumption that the covariance matrix of the errors in the export probability equations and the second stage model equations is the same for all firms.

[11] All simulations were done using SAS's PROC SIMNLIN.

$$\left(\overline{\Delta X^1_{it} - \Delta X^0_{it}}\right) = \frac{1}{100}\sum_{k=1}^{100}\left(\Delta X^1_{itk} - \Delta X^0_{itk}\right)$$

6) Take the average of the mean difference over all sous-branches and all years.
7) Divide by the average value of exports in year t-1 over all sous-branches and years to calculate the percentage change in the mean difference.
8) Finally, divide by the percentage change in the exogenous variable z to yield the arc elasticity.

By simulating the model one hundred times, one can calculate not only the mean elasticity but also a standard error of the simulation. For over 90 percent of the sous-branches and years, one can not reject the hypothesis that the distribution of the one hundred solutions of the endogenous variables is normal. Thus, these standard errors can be used to form confidence intervals for the simulated elasticities.

Table III presents arc elasticities based on simulations of the model with supply equations only and non-constant returns to scale for the sample aggregated over all firms. The reported elasticities capture the partial effects of a change in one exogenous variable, holding all other exogenous variables constant. In particular, it is important to note that the elasticities with respect to changes in export prices, labor costs, and intermediate goods costs were obtained holding domestic prices constant. These elasticities pertain to the short run, keeping capital fixed. Standard errors of the simulations are presented in parentheses. There is very little dispersion around the mean effect. The low standard errors reflect the fact that the price variables that are changed in the simulations were precisely estimated in Tables I and II.

Table III indicates a positive export supply response to increases in export prices. Given the estimated elasticity of 0.34, a 40 percent increase in export prices (of the order of magnitude contemplated in the subsidy cum tariff program) would be expected to lead to a 12 percent increase in exports. This is very close to the value of the short-run own price export supply elasticity obtained by Diewert and Morrison (1988) using aggregate U.S. data. Using a very different methodology and aggregate quarterly data for Greece, Balassa et al (1986) find a short-run elasticity of around 0.6. Their estimated long run elasticities are considerably higher.

The low output supply elasticity (0.03) and the negative domestic supply elasticity (-0 11) with respect to an increase in export prices, suggests that the increase in exports comes about primarily from a decrease in sales to the domestic market.

Table III. Arc Elasticities Based on Estimates of Supply Side Model
(With Non-constant Returns to Scale, Sample of All Firms)

	Change in Price				
	Export (+10%)[a]	Export (+40%)	Domestic (+10%)	Labor (+10%)	Int. Goods (+10%)
Change in Real Quantity					
Exports	0.51	0.34	-0.48	-0.06	-0.17
	(0.01)[b]	(0.01)	(0.04)	(0.01)	(0.03)
Domestic Sales	-0.14	-0.11	1.12	-0.16	-0.80
	(0.01)	(0.01)	(0.04)	(0.01)	(0.03)
Total Output	0.06	0.03	0.62	-0.13	-0.60
	(0.01)	(0.01)	(0.03)	(0.01)	(0.02)
Labor	0.08	0.07	0.87	-0.84	-0.11
	(0.01)	(0.01)	(0.03)	(0.01)	(0.02)
Int. Goods	0.04	0.03	1.09	-0.03	-1.07
	(0.01)	(0.01)	(0.04)	(0.01)	(0.03)

[a] The percentage changes in the prices that were used in calculating the arc elasticities are presented at the top of each column. Because the model is nonlinear, the point estimates of the elasticities calculated on the basis of a 10 percent change in price are different from those calculated on the basis of a 40 percent change.

[b] Standard errors of the simulations are presented in parentheses.

Holding domestic prices constant, the increase in the relative profitability of exporting due to a 40 percent increase in export prices is estimated to lead to roughly a 4 percent decrease in domestic sales. Since the output effect is small, the effect of the increase in export prices on input demands for labor and intermediate goods is also estimated to be small.

Increases in input prices have the expected effects. An increase in labor costs reduces labor use, export supply, supply to the domestic market, and output. The own price elasticity for both labor and intermediate goods is close to minus one. Output appears to respond more in the short run to changes in the cost of intermediate goods than to changes in the cost of labor.

The third column is included to allow for a comparison of our results with other approaches that assume that domestic prices are exogenous and do not respond to changes in export or import prices. The simulations suggest that both the supply curve for domestic sales and for exports are responsive to changes in domestic prices. The own price elasticity is 1.12 for domestic sales and 0.51 for exports, based on a similar 10 percent increase in prices.

The supply curve for domestic sales is clearly more responsive to price that that of exports. In other words, it takes a higher increment in price to induce an equal increase in output for export goods than for domestic goods. Given our framework, we can only speculate why this is the case. The differences may reflect higher costs of transportation, higher costs of achieving a standard quality for export markets, higher transaction costs, or increased risk.

Consistent with the notion of a fairly flat supply curve for domestic sales, the simulations suggest relatively high elasticities of output, use of labor, and use of intermediate goods with respect to the domestic price. As output would have to increase substantially before domestic prices would rise, higher domestic prices would be associated with a large reduction in exports. We do not want to place undue emphasis on the results of a change in domestic prices, since we do not believe that they should be considered exogenous.

Table IV presents quantity responses based on simulations of the model with joint estimation of supply and demand, with non-constant returns to scale and for the sample aggregated over all firms. Again, the simulations pertain to the short run, with capital fixed. In these simulations, domestic prices are permitted to respond to

Table IV. Arc "Elasticities" Based on Joint Estimation of Supply and Demand (With Non-constant Returns to Scale, Sample of All Firms)

	Change in Price						
	Export (+10%)[a]	Export (+40%)	Import (+10%)	Import (+40%)	Export & Import (+40%)	Labor (+10%)	Int. Goods (+10%)
Change in Real Quantity							
Exports	0.15 (0.02)[b]	0.10 (0.01)	-0.07 (0.01)	-0.06 (0.01)	0.05 (0.01)	-0.03 (0.01)	-0.05 (0.02)
Domestic Sales	-0.03 (0.002)	-0.03 (0.01)	0.20 (0.01)	0.16 (0.01)	0.13 (0.01)	-0.02 (0.002)	-0.16 (0.01)
Total Output	0.03 (0.01)	0.01 (0.004)	0.12 (0.004)	0.09 (0.004)	0.11 (0.01)	-0.02 (0.005)	-0.12 (0.01)
Imports	0.01 (0.001)	0.01 (0.001)	-0.04 (0.002)	-0.03 (0.002)	-0.03 (0.002)	0.01 (0.003)	0.04 (0.002)
Domestic Price	0.19 (0.002)	0.19 (0.002)	0.02 (0.001)	0.01 (0.001)	0.21 (0.002)	0.10 (0.004)	0.72 (0.002)
Labor	0.04 (0.008)	0.03 (0.006)	0.10 (0.006)	0.08 (0.005)	0.12 (0.007)	-0.64 (0.008)	0.48 (0.01)
Int. Goods	0.01 (0.01)	0.003 (0.01)	0.20 (0.01)	0.16 (0.01)	0.17 (0.01)	0.12 (0.002)	-0.34 (0.01)

[a] The percentage changes in the prices that were used in calculating the arc elasticities are presented at the top of each column. Because the model is nonlinear, the point estimates of the elasticities calculated on the basis of a 10 percent change in price are different from those calculated on the basis of a 40 percent change.

[b] Standard errors of the simulations are presented in parentheses.

changes in one of the exogenous prices. In the previous simulations presented in Table III, the increase in exports due to an increase in export prices resulted from a movement along the export supply curve. As the domestic prices were kept constant, no shift in the supply curve for exports took place. Thus, the previous simulations provide evidence of elasticities of the supply curve. In contrast, the simulations presented in Table IV do not yield elasticities of supply and for that reason the term elasticities is in quotes. The simulations do present percentage changes in quantities with respect to percentage changes in prices, but the changes are calculated by comparing two different equilibrium points after allowing domestic prices to adjust. As a change in domestic price shifts the export supply curve, the two equilibrium points correspond to two different short-run export supply curves (cf. points A and B in Figure 1 of Section 2).

Table IV indicates that domestic prices, in fact, do respond to changes in exogenous prices. Domestic prices are responsive to changes in export prices, labor costs, and costs of intermediate goods - all changes that would shift the domestic supply curve. With an elasticity of approximately 0.2, a 40 percent increase in export prices would be expected to increase the domestic price by 8 percent. Domestic prices are not very responsive to changes in import prices, which would shift the domestic demand curve. These results are consistent with the fairly flat domestic supply curve, suggested from the simulations of the previous model, and with a fairly inelastic domestic demand curve.

Allowing domestic prices to respond reduces the estimated supply responses as theory would predict and as discussed previously. An increase in export prices would lead to a movement along the firms' export supply function. This increase in relative profitability of exports shifts back the domestic supply function and because the domestic demand is downward sloping leads to an increase in the domestic price. With a 40 percent increase in export prices, domestic prices are estimated to increase by roughly 8 percent. This increase in domestic prices reduces the incentive for firms to substitute away from domestic sales and towards exports. While the sign pattern is the same as with the supply side only, the estimated change in exports and domestic output are one third of their previous values in Table III. The same 40 percent increase in export prices leads to a 4 percent increase in exports, compared to the 12 percent increase in the previous case when domestic prices were not allowed to vary.

The fact that the export and output responses in this simulation are smaller is not an indication of a lack of responsiveness to price change in the manufacturing

sector. As the export supply and domestic supply functions have exactly the same form in the two models, one can directly compare the partial derivatives of the supply functions with respect to the output price. The results indicate that the estimated slopes of the supply function are actually larger in the model where demand and supply are estimated jointly. Moreover, the evidence has indicated that domestic prices do respond to changes in export prices and that firms react in a theoretically consistent manner.

As before, the net effects on output and the use of labor and intermediate goods are small. One would expect the estimated output response to be greater when both export and domestic prices increase than when only export prices are allowed to increase. However, it appears that the net output response is too small to measure this effect.

Accounting for a downward sloping domestic demand curve also leads to a much smaller drop in output and input use with an increase in input prices. However, the same pattern prevails of output being more responsive to changes in prices of intermediate goods than to changes in labor costs. In Table IV, labor and intermediate goods are estimated to be substitutes. In Table III, the cross-price elasticities were negative, but imprecisely estimated.

Using the model with demand equations as the basis for the simulations allows us to consider the effects of an increase in import prices, alone, or in combination with an increase in export prices (as would occur under a tariff cum subsidy program). Given the apparently relatively flat domestic supply curve, increases in import prices that would shift out the domestic demand curve have a sizable effect on domestic sales and output. Holding all other prices constant, an increase in import prices of 40 percent is estimated to decrease imports by 1.2 percent and increase domestic sales by 5.4 percent. As the increase in domestic demand holding export prices constant makes sales to the domestic market relatively more attractive, exports would fall. The 40 percent increase in import prices is estimated to lead to a 2.4 percent drop in exports. The net effect on output is to raise total output by 3.6 percent.

As there is a significant effect on output with the increase in import prices, the use of labor and intermediate goods must go up to generate the additional production. Expenditure on labor is estimated to go up by 3.2 percent and expenditure on intermediate goods by 6.4 percent with the 40 percent increase in import prices.

The simulated effect of the tariff cum subsidy program (a simultaneous 40 percent increase in import and export prices) was estimated to increase output by 4 percent. The percentage increase in domestic sales is more than double that of exports (5.2 to 2 percent). Thus, more of the increased output comes about from an increase in domestic sales rather than exports. All firms benefit from the increase in the import price of their competing products. Exporting firms benefit directly from an increase in export prices, while nonexporting firms benefit only to the extent that higher export prices increase domestic prices.

In drawing inferences about a subsidy program from these results, it is important to note a critical distinction between an export subsidy and a nominal devaluation. A nominal devaluation will always lead to an increase in export prices, while export subsidies will lead to higher export prices ***only*** if firms choose to participate and take advantage of the subsidy program. If, due to lack of credibility of the program or high transaction costs, firms do not participate, their export prices will not rise. Only if enough firms participate in the subsidy program to affect the domestic price level, will firms that do not export benefit from the export subsidy program.

Previous evaluations of export subsidies have appraised their performance on the basis of the extent to which they lead to an increase in exports. They paid less attention to net effects on output and employment. Our simulation results suggest that in the short run a greater increase in exports (4 percent as opposed to 2 percent), would occur if the export subsidy was ***not*** accompanied by an import tariff. Indeed, we ran an additional simulation (not reported in Table IV) that suggested that a still larger increase in exports (8 percent) would be obtained if a 40 percent increase in export prices was accompanied by an equal decrease in import prices. This is consistent with the finding of Nogues (1990) that export subsidies failed (in the sense that they did not lead to increased exports) in Argentina where there was high import protection, but succeeded in Brazil when they were accompanied by import liberalization. However, at least in the short run in Côte d'Ivoire, increases in exports do not compensate for the decreases in domestic sales that occur when domestic producers confront lower prices for competing imports.

5. *THE PROGRAM AND ITS STYLIZED FACTS*

The behavioral relationship estimated and reported in this paper could be used

to predict output and export supply under the set of export and import prices that prevailed with the Ivorian export subsidy cum import tariff program. These predictions should then be compared to, and evaluated against the actual changes of exports, imports, and output. An estimate of the *net* effect of the program could be obtained by comparing the predicted supply under the actual export and import prices with the predicted supply under the export and import prices that would have prevailed in the absence of the program. Unfortunately, neither complete price nor output information is available to us at the moment. We therefore do not attempt to evaluate the effectivness of the program. Instead, we only sketch the main elements of the subsidy-tarrif program, present what is known about its implementation, and attempt to draw a picture of the main changes during its first two years. We also analyse the likely causes of the observed pattern, relating it to the elasticities and simulations reported above.

5.A. *The Export Subsidy cum Import Tax Scheme*

The tariff cum subsidy program was announced at the end of 1985, with the first disbursements taking place in the middle of 1986. Initially, an export subsidy at a rate equal to the tariff rate on a similar product was instituted for three sectors - wood products, textiles, and agro-processing. The program was implemented selectively primarily because of the concern over its budgetary impacts. The gross subsidy rate varied from 10 to 40 percent even within the same subsector. In January, 1988 the export subsidy was expanded to the chemical and rubber industries. Other industries such as machinery, electronics, etc. were still excluded. The payments were to be made within three months, but, in practice, have been paid out with a longer lag which reduces the value of the subsidy. At the beginning of the program, import tariffs were adjusted and increased with the objective of achieving enough revenue to finance the export subsidy.

From 1986 to August 1988, 52 firms took advantage of the new export incentives. We have identified most of these firms in the sample , but only 42 had continuous data for the years since their creation. Most of these firms are "veteran" exporters. They are much larger than other exporters: in 1987 their mean size (1,020 workers) was more than twice the average size of all exporters (438). Their export level (in nominal CFA) is again almost twice that of other exporting firms, reflecting not only the size differential but also a much higher propensity to export. The premium receiving firms

exported on average in 1987 almost 60 percent of their total output compared to only 28 percent for non premium receiving firms.

No thorough analysis of the impact, or even the potential impact of this scheme, has yet been conducted. (The study by Noel and Gilles (1984) studied the impact of uniform export subsidy and import tariff within a general equilibrium SAM model.) Preliminary evidence, in the form of firm surveys conducted by the Government, indicates that to date the scheme has not had its desired effect. Firms currently exporting state that the subsidy has helped them to maintain their market share, but has not affected their plans for investment. Producers of import substitutes assert that the scheme has had very little effect on the prices of imports and, therefore, has not enhanced their competitiveness.

In the next sub-section we present the evidence regarding the performance of the exporting sector and of the premium-receiving firms after the implementation of the program. Since the firm data from the Banque des Donnéces Financières is incomplete for 1987 and 1988, we base the inference of changes only on firms for which data is available for pairs of adjacent years (t and t-1). The annual files are matched and merged for every two preceding years, allowing a comparison using identical firms in both t and t+1. Using information on the date of creation, surviving firms are distinguished from "true" entry and also from "true" exiting firms. This distinction is required in order to detect any response of entry into more rewarded sectors, and exit from less rewarded sectors as a response to the change in the trade regime. All the relevant nominal values were deflated by the appropriate price deflators.

5.B. *The Experience with the Program: 1986-1987*

During 1986-1987 the nominal (CFA) value of exports declined by 11 percent in 1986 and by 1.0 percent in 1987. However when exports are deflated by export prices the results are just the opposite: the volume of exports increased sharply both in 1986 and 1987 (15 and 22 percent respectively). To verify this result, we compared it with the volume of exports data obtained from the customs figures. This alternative source provides an independent series on the quantity of exports and its confirms our earlier results, suggesting also a significant increase in the quantities exported. This growth took place while export prices (in domestic currency) in most sectors declined, mainly as a result of the large appreciation of the CFA versus the U.S. dollar. Thus the total

volume and the dollar value of exports increased, though exports values in terms of CFA or French francs have decreased.

The output and export behaviour of the premium firms resemble closely that of the export sector. During the period 1981-1985, the export performance of the two groups of firms was similar, averaging a volume growth of 13 percent annually. During 1986, however, the premium firms experienced a lower growth of exports compared to other firms (6 versus 15 percent). In 1987 the export growth rate was almost equal to that of the non premuim firms (23 percent).

The output and export performance (expansion) in 1986-87 could be based on three possible effects. First, the export subsidy could have contributed to this growth by offsetting to some extent the decline in export prices. Second, the appreciated CFA would have led to lower imported input prices leading to a shift to the right of the supply curve. Thirdly, the decline in domestic demand as well as the shift to the right of the supply curve, could explain the export performance in 1986 and 1987. The model and the simulations presented in the previous section suggest that, in the past, all three of these effects have contributed to growth in real exports. The elasticities reported in tables III and IV suggest a large sensitivity of exports to domestic prices and a more modest export response to export and input price changes. However, in order to evaluate the exact relative importance of the three factors more information is needed about the actual changes of export and input prices as well aggregate demand.

6. *CONCLUSIONS*

From a methodological standpoint, two results emerged from this paper. First, the exercise of estimating firms' output supply and input demand functions using flexible functional forms was successful. The estimates satisfied theoretical curvature properties and the price effects were precisely estimated. Second, joint estimation of supply and demand leads to considerably different estimates of export and output supply responses than estimates based on supply relations alone. Simply instrumenting for endogenous domestic prices may take care of simultaneous equations bias, but is not an adequate substitute for modeling of the demand side. Without modeling the demand side, it is not possible to obtain estimates of the net effect of changes in export prices on exports and output. Although our specification of the demand side was relatively simple, the results were consistent with theoretical expectations. Further work using

less restrictive specifications of the demand side would be useful, as would estimations based on alternative flexible functional forms.

Contrary to prior expectations, our results suggest that firms in Côte d'Ivoire do sell more to the foreign market when it is more profitable to do so. Exports respond positively to increases in export prices and negatively to increases in import prices. However, the fact that exports would be lower if an export subsidy were combined with an import tariff is not an argument for introducing an export subsidy alone. Firms producing in the tradable goods sector suffer from an overvalued exchange rate not only because they would receive a lower price for their exports, but also because they must compete against lower priced imports. Our estimates indicate that the introduction of an export subsidy alone would be insufficient to increase output of the tradable goods sector. The combination of an export subsidy with an import tariff, which comes closer to mimicking the effects of a devaluation, would serve to counteract some of the short-run adverse output effects of an overvalued exchange rate. We cannot speak to the longer run effects of such a program, to the budgetary implications, or to implementation issues.

The results presented in this paper do not in any way constitute an evaluation of the actual tariff cum subsidy program that was adopted in Côte d'Ivoire in 1986. The subsidy program has not resulted in the type of uniform increase in export prices within a sous-branche that was analyzed in this paper. As of August 1988, only 52 firms had taken advantage of the new export incentives. These firms comprise a third of all eligible exporters, but a lower proportion of all manufacturing firms within the sous-branches eligible for the subsidy. Most of the firms which applied for the subsidy are large, veteran exporters, employing on average more than 1000 workers and exporting more than 60 percent of their output (see Lavy, Newman, and Salomon, 1989 for more details).

The program had started with long delays in subsidy payments, which may have discouraged firms from applying for the subsidy. Even though tariff rates on imports were raised, no increases in tariff revenues could be detected. By the fall of 1988, the program's budgetary burden led the government to stop all payments and the program was de facto abandoned. However, this program remains a policy option under discussion.

DATA APPENDIX

I. THE FIRM DATA.

All firms in the manufacturing sector that follow the French accounting system known as the *plan comptable* are required to file their balance sheets with the Banque des Données Financières (BDF). The BDF has collected records from more than 900 industrial companies between 1974 and 1987. These records include more than 500 variables on each firm for each year. This data includes such information as:

- Chiffre d'affaires (Gross Sales)
- Exports
- Variation de Stocks (Product Inventory Variation)
- Achats (Purchases)
- Imports
- Effectif Total (Total Number of Employees)
- Masse Salariale Totale (Total Wages)
- Investissement Net Cumule (Cumulated Net Investment)

Other variables include short-term and long-term debts, Gross Fixed Capital Formation, Subsidies, Taxes, and Gross Values Added. For an extensive discussion of this data see Ministère de l'Industrie (1988).

Coverage of the manufacturing sector is extensive, but not complete. Small or medium size firms apparently can elect to pay their income tax "by default" and have the government estimate their profits in lieu of reported profits. This diminishes their incentive to file reports. Moreover, the sanctions for not reporting do not appear to be extremely strong and some modern firms apparently chose not to report all their information to the BDF. It is much more likely that selective information will be missing than that the firms do not report at all.

In a study based on the same data, Lorch (1989) concludes that "It seems fair to say that the BDF covers the sector of large manufacturing enterprises well, with few enterprises missing; among medium-size manufacturers the majority is covered by the BDF; and of small yet 'modern' enterprises the BDF contains only a sample which might not be representative".

One of the problems in working with the data was that zeros and missing values

were both denoted with a period. If important variables such as sales, value added, number of employees, and cumulated investment that should not be zero were missing for at least two consecutive years, it was assumed that the firm went out of business and was dropped from the sample for the years when the values were missing. This was later checked with independent information on firms that went out of business and our decision rule was observed to be very accurate. We assumed that firms with a period for exports did not export.

As calculated sous-branche level data from the summation of individual firm data, we were careful to aggregate only firms with complete records on all variables used in the analysis. Thus, if data on the number of employees was missing, we did not add that firm's domestic sales to the total domestic sales in the sous-branche. Even with this rule, the sous-branche level data that we constructed proved to be very close to the sous-branche level data published by the Banque des Donnees Financieres. For example, for 12 out of 30 sous-branches we had exactly the same value of domestic sales. For only three sectors, did our selection rule result in less than 80 percent of the value of domestic sales.

II. *THE PRICE DATA.*

We used 6 price indices, for:

- Export Prices
- Import Prices
- Output Prices
- Intermediate Good Prices
- Cost of Capital
- Cost of Labor

All prices, except for labor costs, were provided by the Direction de la Statistique of the Ministère du Plan et de l'Industrie. The labor costs were calculated with firm data from the BDF. Exports, Imports, Output Price and Labor Costs are available at the sub-sector (3 digits) level. The Intermediate Good Price Index is available only at the branch level (2 digits) and the Capital Price Index is common to the whole economy.

For some years and some sectors the export price index, as reported by the Direction de la Statistique, increases or decreases dramatically by up to 100 % from one

year to the next. We strongly suspected coding errors or measurement errors as the strange numbers at the three digit level could always be traced to strange numbers at the four digit level. When this occurred, we deleted the subsector at the four digit level and recalculated three digit level price indices based on the remaining four digit subsectors. An adjustment was made in this fashion in 1981 for sub-sectors 80, 120, and 212; in 1982 and 1983 for sub-sectors 100, 155, and 212; and in 1984 for sub-sectors 155 and 212. Sous-branche 19 was dropped completely from the analysis as there were no subsectors that could be used to modify the price data.

The import price index presented the same kind of problems. The import prices suspected of measurement error were dropped. This was done in 1981 and 1982 for sub-sectors 131, 161, and 163; and in 1984 and 1985 for sub-sector 132.

Finally, there were some sub-sectors of the BDF data for which there was no corresponding subsector in the price data from the Ministère du Plan et de l'Industrie. These subsectors were dropped from the analysis. After all the modifications, we were left with 139 (sub-sector , year) observations in the analysis. The sub-sectors were as follows:

61 : Decorticage du cafe
63 : Biscuiteries
74 : Conserves de poissons
76 : Produit Derives du Cafe et du Cacao
80 : Fabrication de Boissons et Glaces Alimentaires
90 : Industries des Corps Gras Alimentaires
100: Autres industries alimentaires
111: Egrenage du Coton
113: Filature, Tissage
116: Sacherie, Ficelerie
117: Fabrication d'articles d'habillement
119: Fabrication d'autres articles textiles
120: Industrie du cuir et autres articles chaussants
131: Premiere Transformation du Bois
132: Menuiserie
133: Fabrication de meubles
152: Fabrication d'engrais, pesticides, insecticides
155: Fabrication de peintures, vernis, laques, cosmetiques, parfums

156: Fabrication d'articles en plastique
161: Production de caoutchouc naturel
163: Fabrication d'articles en caoutchouc
174: Cimenteries
175: Fabrication de briques et agglomeres et autre produits en ciment
201: Fabrication d'ouvrages simples en metal
202: Construction de machines
203: Construction de machines, appareils et fournitures electriques
204: Mecanique de precision
211: Fabrication d'articles en papier ou carton
212: Imprimeries, editions
213: Fabrication de bijoux et orfevrerie.

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