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Time Series Analysis of Export Demand Equations: A Cross-Country Analysis

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Abstract

The paper estimates export demand elasticities for a large number of developing and developed countries, using time-series techniques that account for the nonstationarity in the data. The average long-run price and income elasticities are found to be approximately -1 and 1.5, respectively. Thus, exports do react to both the trade partners' income and to relative prices. Africa faces the lowest income elasticities for its exports, while Asia has both the highest income and price elasticities. The price and income elasticity estimates have good statistical properties.

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Contents

SUMMARY

The paper provides income and price elasticities of the export demand function for 53 industrial and developing countries, estimated within a consistent framework using time-series techniques that address the nonstationarity in the data.

The long-run price and income elasticities generally have the expected sign and, in most cases, are statistically significant. The average long-run price and income elasticities are approximately -1 and 1.5, respectively. Of the 53 countries, 22 have point estimates of long-run price elasticity greater than 1, and for 33 countries the unit-price elasticity cannot be rejected. Thirty-nine countries have point estimates of the long-run income elasticity that are greater than 1 and for 35 countries the unit-income elasticity cannot be rejected. Thus, exports do significantly react to both movements in the activity variable and relative prices. These elasticity estimates are shown to have good statistical properties; in particular, they have a very small bias (even in small samples).

While developing countries show, in general, lower price elasticities than developed countries, Asia has significantly higher price elasticities than both industrial and developing countries. Furthermore, Asia benefits from higher income elasticities than the rest of the developing countries, corroborating the view that trade has been a powerful engine of growth in the region. Africa has the lowest income elasticities, reflecting largely the type of products the region exports.

The recent literature is divided on the ability of a real devaluation in affecting imports and exports. Rose (1990, 1991) and Ostry and Rose (1992) find that a real devaluation has generally no significant impact on the trade balance, while Reinhart (1995) finds that a real devaluation does affect the trade balance. Using a much larger sample, the paper and its companion paper on import demand elasticities (Senhadji, 1998) provide strong support to the view that devaluations generally improve the trade balance.

I. Introduction

In many developing countries, with relatively limited access to international financial markets, exports play an important role in their growth process by generating the scarce foreign exchange necessary to finance their imports of energy and investment goods, both of which are crucial to their capital formation. In his Nobel prize lecture, Lewis (1980) pointed out that the secular slowdown in developed countries will inevitably reduce the development speed of developing countries unless the latter find an alternative engine of growth. That engine, he believed, was trade among developing countries. Riedel (1984) challenges Lewis's conclusions by arguing that most developing countries face a downward export demand function and therefore could expand their exports, despite the slowdown in developed countries, by engaging in price competition. However, Faini et. al. (1992) empirically show that Riedel's reasoning suffers from the fallacy of composition argument in the sense that a country alone can increase its market share through a real devaluation but all countries can not. A central element in this controversy is the size of the price and income elasticities of developing countries' export demand. Similarly, export and import demand elasticities are critical parameters in the assessment of real exchange rate fluctuations on the trade balance.

The higher the income elasticity of the export demand, the more powerful will exports be as an engine of growth.[2] The higher the price elasticity, the more competitive is the international market for exports of the particular country, and thus the more successful will a real devaluation be on promoting export revenues.

The recent literature is divided on the ability of a real devaluation in affecting imports and exports. Rose (1990, 1991) and Ostry and Rose (1992) find that a real devaluation has generally no significant impact on the trade balance, while Reinhart (1995) finds that a real devaluation does affect the trade balance. Using much larger samples, this paper and its companion paper on import demand elasticities (Senhadji, 1998) offer new evidence on this issue.

The high demand from policy makers for precise estimates of these elasticities generated an extensive empirical research into the issue during the last thirty years.[3] The traditional export demand function is a log-linear function of the real exchange rate and an activity variable, generally defined as the weighted (by the trade shares) average of the trade partners' GDP.

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[2] The trade linkage between growth in industrial countries and growth in developing countries is analyzed in detail in Goldstein and Khan (1982).

[3] See Houthakker and Magee (1969), Goldstein and Khan (1978), Bond (1985), Marquez and McNeilly (1988), Riedel (1984), and Faini et. al. (1992), among others. For a comprehensive survey, see Goldstein and Khan (1985).

Because of data constraints and the empirical success of this specification, it has dominated the empirical literature for more than a quarter century. A problem that has been largely ignored in the literature is that of nonstationarity, present in most macroeconomic variables, which invalidates classical statistical inference. Thus, if the variables that enter the export demand equation are found to contain a unit root, ignoring nonstationarity in these variables may lead to incorrect inferences.

This paper tackles this problem by deriving a tractable export demand equation that can be estimated, within the data constraints, for a large number of countries using recent time series techniques that address the nonstationarity of the data. The same methodology has been used to estimate the import demand elasticities, (see Senhadji, 1998). A related paper is Reinhart's (1995) which provides estimates of import and export demand elasticities for twelve developing countries, using Johansen's cointegration framework.

The derived aggregate export demand equation is log-linear in both relative prices and in the activity variable defined as the weighted (by the trade shares) average of GDP minus exports of the trade partners. An important insight from the explicit derivation of the aggregate export demand equation is that the definition of the activity variable depends on the aggregation level.[4] The model predicts a unique cointegrating vector between exports, the real exchange rate, and the activity variable. This prediction is not rejected by the data, and the cointegrating vector is estimated efficiently by the Phillips-Hansen's Fully-Modified (FM) estimator. The small sample properties of the price and income elasticities are also provided.

Section II derives the export demand function, Section III discusses the estimation strategy, Section IV presents the results. Concluding remarks are contained in Section V.

II. The model

Assume that the exporting country (the *home country*) has only one trading partner. The exporter's export demand will thus be the same as the import demand of the trade partner (the *foreign country*). Hereafter, we will refer to the exporting country as the *home* country and the importing country as the *foreign* country. Assume further that the import decision of the foreign country is made by an infinitely-lived representative agent who decides how much to

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[4]Because disaggregated export prices are not available for most developing countries, only aggregate export demand equations can be estimated.

consume from his domestic endowment (d_t^*) and of the imported good (m_t^*).[5] As noted above, the import demand of the foreign country (m_t^*) is identical to the export demand of the home country (x_t). The intertemporal decision of the representative agent from the *foreign country* can be formalized as:[6]

$$\underset{\{d_t^*, m_t^*\}_{t=0}^{\infty}}{Max} \quad E_0 \sum_{t=0}^{\infty} (1+\delta)^{-1} u(d_t^*, m_t^*) \tag{1}$$

subject to:

$$b_{t+1}^* = (1+r) b_t^* + (e_t^* - d_t^*) - p_t m_t^* \tag{2}$$

$$e_t^* = (1-\rho)\bar{e}^* + \rho e_{t-1}^* + \xi_t^*, \qquad \xi_t^* \sim (0,\sigma^2) \tag{3}$$

$$\lim_{T\to\infty} \frac{b_{T+1}^*}{\prod_{t=0}^{T} (1+r)^{-1}} = 0 \tag{4}$$

where: δ is the consumer's subjective discount rate; r is the world interest rate; b^*_{t+1} is the next period stock of home bonds held by the foreign country if positive and the next period stock of foreign bonds held by the home country if negative; e_t^* is the stochastic endowment which follows an AR(1) process with unconditional mean $\bar{e}^*$ and unconditional variance $\sigma^2/(1-\rho^2)$, where σ^2 is the variance of the *iid* innovation ξ_t^*, and ρ determines the degree of persistence of the endowment shock; and p_t is the price of the home good in terms of the foreign good. Equations (2–4) are (respectively) the current account equation, the stochastic process driving the endowment shocks, and the transversality condition that rules out Ponzi-schemes. The first order conditions of this problem are:

$$u_t^{d^*} = \lambda_t \tag{5}$$

$$u_t^{m^*} = \lambda_t p_t \tag{6}$$

$$\lambda_t = (1+\delta)^{-1} (1+r) E_t \lambda_{t+1} \tag{7}$$

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[5]The convention used for identifying the variables is that starred variables belong to the foreign (*importing*) country while nonstarred variables belong to the home (*exporting*) country.

[6]The strong assumptions in the model are necessary to derive an aggregate export demand equation that does not require more data than what is available. In particular, it is assumed that there is no production sector, which implies that the model does not distinguish between intermediate and final goods.

where λ_t is the Lagrange multiplier on the current account equation (2). From equation (5), λ_t is the foreign consumer's marginal utility for the domestic good. Following Ogaki (1992) and Clarida (1994), it is assumed that the instantaneous utility function u is addilog:

$$u(d_t^*, m_t^*) = A_t(d_t^*)^{1-\alpha}(1-\alpha)^{-1} + B_t(m_t^*)^{1-\beta}(1-\beta)^{-1} \qquad \alpha>0, \beta>0 \tag{8}$$

$$A_t = e^{a_0 + \epsilon_{A,t}} \tag{9}$$

$$B_t = e^{b_0 + \epsilon_{B,t}} \tag{10}$$

where A_t and B_t are exponential stationary random shocks to preferences, $\epsilon_{A,t}$ and $\epsilon_{B,t}$ are stationary shocks, and α and β are curvature parameters. Substituting equation (8) into equations (5) and (6) yields:

$$d_t^* = \lambda_t^{-\frac{1}{\alpha}} A_t^{\frac{1}{\alpha}} \tag{11}$$

$$m_t^* = \lambda_t^{-\frac{1}{\beta}} B_t^{\frac{1}{\beta}} p_t^{-\frac{1}{\beta}} \tag{12}$$

Substituting equations (9)–(11) into equation (12) and taking logs yields:

$$\log(m_t^*) = \log(x_t) = c_0 - \frac{1}{\beta}\log(p_t) + \frac{\alpha}{\beta}\log(d_t^*) + \epsilon_t \tag{13}$$

where: $c_0 = (1/\beta)(b_0 - a_0)$ and $\epsilon_t = (1/\beta)(\epsilon_{B,t} - \epsilon_{A,t})$. In this model, $x_t^* = e_t^* - d_t^* = GDP_t^* - d_t^*$, where x_t^* is exports of the foreign country. Consequently, $d_t^* = GDP_t^* - x_t^*$. Thus, the model yields an equation for the export demand for the home country ($\tilde{x}_t$) that is close to the standard export demand function except that the correct activity variable is $GDP_t^* - x_t^*$, i.e. GDP_t minus exports of the foreign country, rather than GDP_t^*. Equation (13) can be rewritten as:

$$\log(x_t) = c_0 - \frac{1}{\beta}\log(p_t) + \frac{\alpha}{\beta}\log(GDP_t^* - x_t^*) + \epsilon_t \tag{14}$$

III. Estimation strategy

Because each of the three variables in the export demand equation (13) can be either Trend-Stationary (TS) or Difference-Stationary (DS), four cases need to be considered. These are given in Table 1. In Section IV, results from unit root tests show that case 1 is the most common among countries, with some countries falling into the second case. Of prime interest is estimates of the standard price and income elasticities for the export demand defined, respectively, as the coefficients on the log of the real exchange rate ($-1/\beta$) and on the log of the activity variable (α/β). Note that $\tilde{x}_t$ and $\tilde{p}_t$ are in general endogenously determined by the export demand and export supply (not modeled here). Therefore $\tilde{p}_t$ is likely to be correlated with the error term ϵ_t in equation (14) and OLS would yield biased estimates of the price and income elasticities. Phillips-Hansen's FM estimator corrects for this potential simultaneity bias, as well as for autocorrelation in the cointegration framework. The four cases are as follows:

(*1*) *All three variables are Difference-Stationary (DS)*

In the model, the following three assumptions are necessary to achieve DS for all three variables:

(*I*) For $\tilde{d}_t^*$ to be DS, we need to assume $r=\delta$. Then the Euler equation (7) becomes:

$$\lambda_t = E_t \lambda_{t+1} \tag{15}$$

In other words, λ_t follows a martingale process. Therefore, λ_t can be written as: $\lambda_t=\lambda_{t+1}+e_t$, where e_t is such that $E_t e_t=0$. In other words, λ_t has a unit root; therefore, $\tilde{d}_t^*$ will also inherit a unit root since $\tilde{A}_t$ is stationary. If $\tilde{d}_t^*$ has a unit root then, from equation (13), $\tilde{x}_t$ will also have a unit root.

(*ii*) The log of the real exchange rate will be assumed to be DS (it will be seen that this assumption cannot be rejected statistically for most countries).[7]

(*iii*) $\tilde{p}_t$ and $\tilde{d}_t^*$ are not cointegrated with cointegrating vector $(1\ -\alpha)$.

Under assumptions (*I*)–(*iii*), equation (13) implies that $\tilde{x}_t$, $\tilde{d}_t^*$ and $\tilde{p}_t$ are cointegrated with cointegrating vector $(1\ 1/\beta\ -\alpha/\beta)$. Furthermore, this cointegrating vector is unique (up to a scale factor), since the export demand equation (13) has three I(1) variables and two common stochastic trends.[8] If a cointegration relation between these three variables does not exist, estimation of the export demand equation (13) will result in a spurious regression. Hence, to detect this potential spuriousness, a residual-based cointegration test will be performed on equation (13).

(*2*) *One among the three variables is Trend-Stationary (TS)*

We have three cases depending on which variable is TS:

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[7]The variable $\tilde{p}_t$ is either exogenously given under the small country assumption or is endogenously determined by the interaction of the demand and supply for exports. The supply of exports is not explicitly modeled here.

[8]See Stock and Watson (1988).

(*1*) $\tilde{x}_t$ is TS. The model will yield this case if $\tilde{p}_t$ is DS and if assumption (*I*) in case (*1*) is satisfied. For this case, the model predicts that $\tilde{p}_t$ and $\tilde{d}_t^*$ are cointegrated with cointegrating vector $(1\ -\alpha)$.

(*ii*) $\tilde{p}_t$ is TS. The model implies that $\tilde{x}_t$ and $\tilde{d}_t^*$ are cointegrated with cointegrating vector $(1\ -1/\beta)$.

(*iii*) $\tilde{d}_t^*$ is TS. From equation (7) and (11), $\tilde{d}_t^*$ will be TS if $\delta > r$. In this case, the model predicts that $\tilde{x}_t$ and $\tilde{p}_t$ are cointegrated with cointegrating vector $(1\ -\alpha/\beta)$.

In all three cases, if a cointegration relation between these pairs of variables does not exist, attempts to estimate the export demand equation (13) will result in a spurious regression. Hence, to detect this potential spuriousness, two residual-based cointegration test will be performed on equation (13).

(*3*) Two of the three variables are TS. This case can be viewed as a rejection of the model, since there is no linear combination of the three variables that yields a stationary process.

(*4*) All three variables are TS. This is the only case in which classical inference is valid. The export demand equation (13) becomes a classical regression equation with population coefficients $(1\ 1/\beta\ -\alpha/\beta)$.

Equation (14) was estimated in a dynamic form (that is, with the lagged dependent variable included as an explanatory variable) to keep the specification as close as possible to the literature where this autoregressive distributed lag (ARDL) specification has been widely used.[9] This dynamic form also proved to be more successful in the estimation stage:

$$\log(x_t) = \gamma_0 + \gamma_1 \log(x_{t-1}) + \gamma_2 \log(p_t) + \gamma_3 \log(GDP_t^* - x_t^*) + \epsilon_t. \qquad (16)$$

While the lagged dependent variable enriches the dynamics of the export demand equation, its introduction into the cointegration framework outlined above is not innocuous. Indeed, equation (16) resembles but is not the error correction form of equation (14) since the dependent variable and the two explanatory variables are in levels and not in first differences. Pesaran and Shin (1997) show that this ARDL specification is well specified and retains the usual interpretation under stationarity even if the variables are I(1). The authors also show that the FM estimator yields efficient estimates of the short- and long-run elasticities. In particular, the FM estimates of the short-run elasticities are $\sqrt{T}$-consistent, and the covariance matrix of these estimators has a well-defined limit that is asymptotically singular, such that the estimators of γ_2 and γ_3 are perfectly collinear with the estimator of γ_1. These results have

[9]A specification analysis by Thursby and Thursby (1984) shows that this type of dynamic specification outperforms the static ones. The lagged dependent variable can be introduced in the model by assuming some type of adjustment costs, see Goldstein and Khan (1985).

the interesting implication that the FM estimators of the long-run price and income elasticities, defined respectively as $E_p=\gamma_2/(1-\gamma_1)$ and $E_y=\gamma_3/(1-\gamma_1)$, converge to their true value faster than the estimators of the short-run elasticities, that is γ_2 and γ_3. Indeed, the estimates of E_p and E_y are *T*-consistent. Despite the singularity of the covariance structure of the FM estimators of the short-run elasticities, valid inferences on the short- and long-run elasticities can be made using standard normal asymptotic theory. Indeed, Pesaran and Shin (1997) show that the short and long-run elasticities follow a *mixture normal* distribution. However, the asymptotic theory may be only a crude approximation for small samples. This issue will be examined by computing the small sample distribution of the elasticities using Monte Carlo simulation methods.

IV. Estimation results

The national account data come from the World Bank national accounts database. The data for the trade shares used to compute the activity variable were taken from UNSO COMTRADE, a United Nations disaggregated trade flow database . The sample includes 70 countries for which the required data are available for a reasonable time span. The list of countries is given in Table 1. In general the data are available from 1960 to 1993, with some exceptions.[10] The usual problem is choosing the corresponding proxies for the variables in the model, since the latter is a crude simplification of reality. The variables in equation (16) will be proxied by the following: x_t will be measured by total exports of goods and services in real terms. The activity variable ($gdpx_t^*$) is computed as the weighted average of the trade partners GDP minus their exports. The weights are given by the share of the home country exports to each of its partners:

$$gdpx_t^* = \sum_{i=1}^{N} \omega_t^i GDP_t^i, \text{ and } \omega_t^i = x_t^i / \sum_{i=1}^{N} x_t^i \qquad (17)$$

where GDP_t^i is real *GDP* of trade partner *i* of the home country in year *t*, x_t^i refers to nominal exports of the home country to its trade partner *i* in year *t*.

The choice of a proxy for p_t is not straightforward. In the model, since the only competing market to the home country 's exports is the domestic market of the foreign trade partner, p_t is simply the ratio of the export price of the home country to the domestic price of the (unique) trade partner. In reality, the home country has many trading partners as well as non-trading partners competing for the same export markets. Ideally, a relative price should be included for all potential competitors of the home country exports, namely the export price of the home country relative to the domestic price of each importing country, as well as the export price of the home country relative to the export price of each potential competitor.

[10]The following countries have a shorter data range: Cameroon 1965–1993, Ecuador 1965–1993,Tunisia 1961–1993 and Yugoslavia 1960–1990.

Obviously, this strategy cannot be implemented econometrically as the equation will contain many highly correlated relative prices leading to the usual multicollinearity problem. Instead, researchers have constructed one relative price that extracts most of the information contained in all the relative prices mentioned above.[11] One possibility is to use the weighting scheme for the activity variable, described in equation (17), also for the construction of a composite price index that captures closely the potential competitive pressures facing the home country's exports. However, the home country's exports compete not only with the domestic market of each trading partner but also with other potential suppliers to these markets. The world export unit value, used in this paper, implies that the threat imposed by each country in the world to the home country's exports is measured by each country's share in world exports. The export unit value index has been retained not because it is necessarily the most appropriate one from a theoretical point of view, but because it is readily available.

1. Unit root test

To determine in which of the four categories (discussed in section III) each country falls, the three variables in the export demand equation must be tested for the presence of a unit root. The three variables in the export demand equation (16) are as follows: real exports of goods and services of the home country (*x*), the real exchange rate (*p*), and the activity variable computed as the weighted average of the trade partners' *GDP* minus exports ($gdpx^*$). The unit-root hypothesis is tested using the Augmented-Dickey-Fuller (*ADF*) test which amounts to running the following set of regressions for each variable:

$$x_t = \mu + \gamma t + \phi_0 x_{t-1} + \sum_{i=1}^{k-1} \phi_i \Delta y_{t-i} + \xi_t, \qquad k = 1,\ldots,5 \tag{18}$$

Note that for k=1, there are no Δy_{t-I} terms on the right-hand side of equation (18). The lag length (*k*) in the *ADF* regression is selected using the Schwarz Criterion (*SIC*). The results are reported in Table 1. For x_t, only 6 out of the 70 countries reject the unit root at 5 percent or less (Algeria, Burundi, Mauritania, Rwanda, and Senegal at 1 percent, Dominican Republic at 5 percent). Similarly, the null of a unit root in p_t is rejected only for 1 country (Ecuador at 5 percent). Finally, as for $gdpx^*_t$, the unit root is rejected for 10 countries (Brazil, Cote d'Ivoire, Paraguay, and Zaire at 1 percent; Bolivia, Gambia, Greece, Malawi, New Zealand, and Pakistan at 5 percent). These results show that for a large number of countries, the unit root hypothesis cannot be rejected at conventional significance levels. This may simply reflect the low power of the *ADF* test, especially considering the small sample size.

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[11] The reduction of the number of prices included in the equation can be justified from a theoretical point of view by assuming that consumer's preferences are *separable* leading to multi-stage budgeting. See the discussion in Goldstein and Khan (1985), pp 1061–63.

2. Export demand equations

The results in Table 1 underscore the presence of nonstationarity in the data and the adverse consequences of neglecting it. Most countries (53 of the 70) fall into case 1 (for which the unit-root hypothesis cannot be rejected for all three variables in the export demand equation) and the remaining 17 countries fall into case 2 (for which the unit-root hypothesis can be rejected for only one of the three variables). No country belongs to case 3, which can been viewed as a rejection of the model, since the export demand equation becomes ill-specified in the sense that its estimation inevitably leads to a spurious regression. No country belongs to case 4 either (case 4 is the only case where all three variables are TS, and therefore classical inference would have been valid).

As shown in Section III, the model predicts a cointegrating relationship between the three I(1) variables in the first case and between the two I(1) variables in the second case. The export equation (16) has been estimated for the 70 countries in the sample (all falling into the first and second cases) using both the OLS and FM estimators.

Table 2 reports the results for the 53 countries that show the correct sign for both the income and price elasticities. Columns labeled x_{-1}, p and $gdpx^*$ give, respectively, the coefficient estimates of the lagged dependent variable (log of exports of goods and nonfactor services in real terms), the short term price elasticity γ_1 (i.e., the coefficient of the log of the relative price) and the short term income elasticity γ_2 (i.e., the coefficient of the log of $gdpx^*$). The long-run price and income elasticities are defined as the short term price and income elasticities divided by one minus the coefficient estimate of the lagged dependent variable. These are given by E_p and E_y for the FM estimates. Their variance, and hence their *t-statistics*, are computed using the *delta method.*[12] The column labeled *ser* reports the standard error of the regression. Finally, column *AC* gives Durbin's autocorrelation test. It amounts to estimating an AR(1) process on the estimated residuals of the export equation. Durbin's test is simply a significance test of the AR(1) coefficient using the usual *t-test.* For the OLS regressions, AR(1) autocorrelation is detected (at 10 percent or less) for 6 of the 53 countries. Another potential problem with the OLS estimates is the possible endogeneity of p_t. The FM estimator corrects for both autocorrelation and simultaneity biases.

Even though Table 2 reports both the OLS and FM estimates of the export demand equation, that is, the cointegrating equation (16), the discussion will focus only on the FM estimates,

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[12] The delta method consists of taking the Taylor approximation of var(E_p) and var(E_y):

$$var(E_p) = (\frac{1}{1-\gamma_1})^2 var(\gamma_2) + [\frac{\gamma_2}{(1-\gamma_1)^2}]^2 var(\gamma_1) + 2(\frac{1}{1-\gamma_1})[\frac{\gamma_2}{(1-\gamma_1)^2}]cov(\gamma_1,\gamma_2),$$

where γ_1 is the coefficient of the lagged dependent variable and γ_2 is the short-run price elasticity; var(E_y) is obtained by substituting γ_2 by γ_3 in var(E_p), where γ_3 is the short-run income elasticity.

since both estimation methods yield relatively similar results. The short-run price elasticities vary from -0.0 (Peru) to -0.96 (Paraguay) with a sample average (over the first 53 countries) of -0.21, a median of -0.17, and a standard deviation of 0.19. The long-run price elasticities vary from -0.02 (Peru) to -4.72 (Turkey). The sample average is -1.00, the median is -0.76, and the standard deviation is 0.97. Exports are much more responsive to relative prices in the long-run than in the short-run. The short-run income elasticities vary from 0.02 (Ecuador) to 1.15 (Finland). The sample average is 0.41, the median is 0.33, and the standard deviation is 0.31. Thus, the average short-run income elasticity is significantly less than 1. The long-run income elasticities vary from 0.17 (Ecuador) to 4.34 (Korea). The sample average is 1.48, the median is 1.30, and the standard deviation is 0.85. Thus, exports respond significantly more to both relative prices and income in the long-run than in the short-run.

The columns E_p^c and E_y^c give the long-run bias-corrected price and income elasticities. The correction is generally small. As will be discussed in the Appendix, the bias is negligible when the relative price and the activity variable are either exogenous or weakly endogenous, as is the case for most countries. Since unit-price and unit-income elasticities are widely used as benchmark values, a formal test for long-run unit-price and unit-income elasticities is provided in columns labeled E_p=-1 and E_y=1, respectively. This test uses exact critical values of the t-statistic given in Table 5. Twenty of the 53 countries reject a long-run unit-price elasticity and 18 countries reject a long-run unit-income elasticity at 10 percent or less. The fit as measured by $\bar{R}^2$ is good.

The discussion in Section III shows that in cases 1 and 2 (which together cover the 53 countries in Table 2), estimates of price and income elasticities are meaningful only if the I(1) variables are cointegrated. Table 2 shows the results of the Phillips-Ouliaris (P-O) residual test for cointegration. Even with a relatively small sample size (thus low power) the null of non-cointegration is rejected for 51 (at 1 percent in most cases) of the first 53 countries.

Do these elasticities differ significantly across geographical regions? To answer this question, the 53 countries in the sample were classified in five regions — Africa (*af*), Asia (*as*), Latin America (*la*), and Middle East and North Africa (*me*) — and OLS regressions were run on regional dummies:[13]

$$\underset{(3.56)}{|E_p| = 0.79} \; \underset{(-0.05)}{- \; 0.02\,d_{af}} \; \underset{(2.38)}{+ \; 1.39\,d_{as}} \; \underset{(1.05)}{- \; 0.37\,d_{la}} \; \underset{(1.51)}{- \; 0.67\,d_{me}}, \quad \bar{R}^2 = .07, \quad N{=}53 \tag{19}$$

$$\underset{(9.00)}{E_y = 1.74} \; \underset{(-1.73)}{- \; 0.51\,d_{af}} \; \underset{(0.98)}{+ \; 0.50\,d_{as}} \; \underset{(-2.12)}{- \; 0.65\,d_{la}} \; \underset{(-0.57)}{- \; 0.22\,d_{me}}, \quad \bar{R}^2 = .07, \quad N{=}53 \tag{20}$$

[13] *t-statistics* are given in parentheses.

$$|E_p| = \underset{(3.44)}{0.79} - \underset{(1.26)}{0.35}\, d_{ldc}, \quad \bar{R}^2 = .01, \quad N=53 \tag{21}$$

$$E_y = \underset{(8.81)}{1.74} - \underset{(-1.73)}{0.42}\, d_{ldc}, \quad \bar{R}^2 = .04, \quad N=53 \tag{22}$$

where E_p and E_y are the long-run price and income elasticities; and d_i, I=*af*, *as*, *la*, and *me* are the regional dummies. Interestingly, Asia has significantly higher price elasticities than both industrial and developing countries, and also has higher income elasticities than the rest of the developing countries. It is worth mentioning that developing countries, except Asia, have significantly lower income elasticities than industrial countries. Developing countries also show lower price elasticities than developed countries. Finally, the lower income elasticities for developing countries in general and for Africa in particular are even more forcefully demonstrated by the following weighted least squares regressions:[14]

$$E_y = \underset{(25.77)}{1.83} - \underset{(-6.99)}{1.04}\, d_{af} - \underset{(-1.14)}{0.40}\, d_{as} - \underset{(-2.28)}{0.54}\, d_{la} - \underset{(-3.89)}{0.62}\, d_{me}, \quad \bar{R}^2 = .90, \quad N=53 \tag{23}$$

$$E_y = \underset{(24.71)}{1.83} - \underset{(-6.69)}{0.78}\, d_{ldc}, \quad \bar{R}^2 = .89, \quad N=53 \tag{24}$$

While developing countries' income elasticities are lower, they remain larger than one. Consequently, growth in their partner countries will translate into growth at least of the same magnitude of their exports. Thus trade remains an important engine of growth for all developing countries.

[14] All the variables in the equations have been weighted by the inverse of the standard error of the corresponding elasticity.

V. Conclusion

The paper provides income and price elasticities of the export demand function for 53 industrial and developing countries, estimated within a consistent framework and taking the possible nonstationarity in the data into account.

The long-run price and income elasticities generally have the expected sign and, in most cases, are statistically significant despite the constraints imposed by data availability. Indeed, data availability dictated both the level of aggregation as well as the simplicity of the model.

The average price elasticity is close to zero in the short-run but reaches about one in the long-run. Twenty two of the fifty three countries in the sample have point estimates of long-run price elasticity larger than one and for thirty three countries the unit-price elasticity cannot be rejected. It takes six years for the average price elasticity to achieve 90 percent of its long-run level. A similar pattern holds for income elasticities in the sense that exports react relatively slowly to changes in trade partners' income. The short-run income elasticities are on average less then 0.5 while the long-run income elasticities are on average close to 1.5. Thirty nine countries have point estimates of long-run income elasticity that are larger than one and for thirty five countries the unit-income elasticity cannot be rejected. Thus, exports do significantly react to both movements in the activity variable and the relative price, though slowly.

A comparison with Reinhart (1995), who uses a similar methodology, shows that her estimates of the price elasticities are significantly lower. Her mean estimate (over the ten developing countries showing the right sign, is -0.44) while it is -1.14 in this paper (where the mean is over the 37 developing countries in the sample). Conversely, her average income elasticity is 1.99 compared to 1.32 in this paper. These differences may simply reflect the difference in the periods of analysis and sample sizes.

While developing countries show, in general, lower price elasticities than developed countries, Asian has significantly higher price elasticities than both industrial and developing countries. Furthermore, Asian countries benefit from higher income elasticities than the rest of the developing world, corroborating the general view that trade has been a powerful engine of growth in the region. Africa, in contrast, faces the lowest income elasticities.

Finally, the elasticity estimates of the export demand function are shown to have good statistical properties. In particular the bias is in general very small. It is also shown that inference about the elasticities conducted on the basis of the usual asymptotic t- or F-distributions may be very misleading because these distributions provide only a very crude approximation to the small sample distributions.

Small-Sample Properties of the Elasticity Estimates

Empirical researchers are generally interested in two statistical properties of their estimates of export elasticities. First, there is the magnitude of these elasticities. A relevant question, then, is how close the estimates are to their true value in small samples. The systematic deviation of the estimates from their true value is measured by the bias of the estimates. Second, there is interest in inference, that is hypotheses testing, about these estimates. For example, are the price and income elasticities significantly different from one? Testing such hypotheses requires knowing the distribution of the *t*-statistic (defined as the coefficient estimate divided by its standard deviation).[1] The asymptotic distribution of this statistic is unknown for the long-run elasticities as these elasticities are nonlinear transformations of the import demand coefficients. In addition, the definition of the long-run elasticities includes the lagged dependent variable for which the *t-statistic* follows a nonstandard distribution in the nonstationary case. In light of this, using the critical values of the asymptotic *t*-distribution for hypothesis testing may be misleading.

This section provides the exact bias as well as the exact distribution of the *t*-statistic, which is crucial for inference as discussed above, for the short- and long-run elasticities using Monte Carlo simulation methods.

1. Small-sample bias of the short- and long-run elasticities

Table 3 provides the bias (in percent) for the OLS and the FM estimates of the short- and long-run price and income elasticities (the computational details are given in the table). The first panel of Table 3 reports the bias for the lagged dependent variable (α_1), the short-run price elasticity (α_2), and the short-run income elasticity (α_3). The bias varies significantly with the degree of endogeneity of the explanatory variables, that is, with the correlation between the innovations in the export demand equation and in the real exchange rate (R_{12}), and the correlation between the innovations in the export demand equation and in the activity variable (R_{13}). The bias is reported for 5 different values of R_{12} and R_{13}, yielding 25 bias distributions for each coefficient estimate.[2] The FM bias is *minimum* when $R_{12} = R_{13} = 0$ and equals -0.89 percent, 0.78 percent and -1.01 percent for the dependent variable, and the short-run price and income elasticities, respectively. This implies that both the short-run price and income elasticities are underestimated, the former by 0.78 percent and the latter by 1.01

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[1]The ratio of the coefficient estimate to its standard error will be subsequently referred to as the *t-statistic* even if its small sample distribution is different from the t-distribution.

[2]The five values are -0.6, -0.3, 0, 0.3 and 0.6. These values cover all correlation values in the data.

percent.[3] The corresponding OLS figures are -4.97 percent and 4.94 percent. The OLS bias is generally significantly higher than the corresponding FM bias. Note that for this benchmark case (where R_{12}=R_{13}=0), OLS differs from FM both in magnitude and in the direction of the bias. Negative values of R_{12} tend to bias both the price and the income elasticities downward, while positive values induce an upward bias. Negative values of R_{13} tend to bias both the price and the income elasticities upward, while positive values induce a downward bias. The bias becomes substantial for high values of R_{12} and/or R_{13}.

The second panel of Table 3 shows the corresponding bias for the long-run price and income elasticities (E_p and E_y). Since long-run elasticities depend not only on the short-run elasticities (α_1 and α_2) but also on the adjustment speed as measured by the coefficient on the lagged dependent variable (α_1), the bias in the short-run elasticities do not translate one for one to long-run elasticities. As was the case for the short-run elasticities, the OLS bias is generally significantly higher than the corresponding FM bias. When R_{12}=R_{13}=0, the FM bias for E_p and E_y (-1.02 percent for E_p and 0.68 percent for E_y) are close to their minimum value. The corresponding OLS figures are 3.44 percent and -3.23 percent. This implies that both the long-run price and income elasticities are underestimated. Negative values of R_{12} tend to bias both long-run elasticities upward, while positive values have the opposite effect. Negative values of R_{13} induce an upward bias to the long-run price elasticity and a downward bias to the long-run income elasticity. The reverse holds for positive values of R_{13}. Interestingly, the bias on the long-run elasticities is generally lower than the bias on the short-run elasticities.

2. Small-sample distribution of the t-statistic

Tables 4 shows the small sample distribution of the t-statistic for the OLS estimates of the export demand coefficients. The table reports critical values at 1 percent, 5 percent, 10 percent, 90 percent, 95 percent and 99 percent. These critical values are reported for five different values of R_{12} and R_{13}, yielding 25 small-sample distributions of the t-statistic with the associated critical values.[4] For the benchmark case where both explanatory variables are assumed to be exogenous ($R_{12}=R_{13}=0$), the small sample t-distribution for the real exchange rate (p) and the activity variable (y^*) are symmetric but are wider than the asymptotic t-distribution. For reference, the asymptotic critical values of the t-distribution at 1 percent, 5 percent and 10 percent are -2.33, -1.65 and -1.28, respectively. The corresponding small-sample critical values are -2.56, -1.77 and -1.38 for p, and -3.02, -2.04, and -1.62 for y^*. The t-distribution of the lagged dependent variable (x_{-1}) is skewed to the left as expected, since x_t has a unit root. When p is allowed to be endogenous (i.e., $R_{12}\neq 0$), the distribution of its t-statistic becomes skewed while the t-statistic distribution of y^* becomes flatter. Similarly,

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[3]Because the price elasticity is negative while the income elasticity is positive, the elasticities are underestimated if the price elasticity bias is positive and the income elasticity bias is negative.

[4]The computational details are given in the note to the table.

when y^* is allowed to be endogenous (i.e., $R_{13}\neq0$), the distribution of its t-statistic becomes skewed while the t-statistic distribution of p becomes flatter. The stronger the endogeneity of p and/or y^* — that is, the larger (in absolute value) R_{12} and/or R_{13} — the larger is the departure from the asymptotic t-distribution.

Similarly, Table 5 provides the small-sample t-distribution for the FM estimates of the long-run elasticities. For the benchmark case $R_{12}=R_{13}=0$, the t-distribution of E_p and E_y are symmetric but flatter than the asymptotic t-distribution. The 1 percent, 5 percent and 10 percent critical values are -2.83, -1.85, and -1.39 for E_p, and -3.65, -2.22, and -1.65 for E_y. As for the t-statistic distribution of the short-run elasticities, when p is allowed to be endogenous, the t-statistic distribution of E_p becomes skewed while the t-statistic distribution of E_y becomes flatter. Similarly, when y^* is allowed to be endogenous, the t-statistic distribution of E_y becomes skewed while the t-statistic distribution of E_p becomes flatter. The stronger the endogeneity, the larger is the deviation from the asymptotic t-distribution.

Table 1. Augmented -Dickey Fuller Test for Variables Entering the Export Demand Equation

Country	x	k	p	k	gdpx*	k	nobs	Country	x		p	k	gdpx*	k	nobs
1 ALGERIA	-5.44 **	1	-2.04	1	-1.31	1	34	26 GREECE	-1.63	1	-1.69	1	-4.21 *	1	34
2 ARGENTINA	-3.16	1	-2.09	1	-2.54	1	34	27 GUATEMALA	-2.55	1	-2.59	1	-3.11	1	34
3 AUSTRALIA	-1.96	1	-2.15	1	-2.99	1	34	28 HAITI	-2.29	1	-2.64	1	-3.00	1	34
4 AUSTRIA	-0.82	1	-1.77	1	-1.33	1	34	29 ICELAND	-1.67	1	-2.26	1	-1.75	1	34
5 BELGIUM-LUXEMBOURG	-1.62	1	-1.89	1	-1.45	1	34	30 INDIA	-0.74	1	-2.35	1	-2.66	1	34
6 BENIN	-2.18	1	-2.50	1	-2.44	1	34	31 ISRAEL	-1.57	1	-2.47	1	-0.88	1	34
7 BOLIVIA	-1.79	1	-2.52	1	-3.34 *	1	34	32 ITALY	-2.23	1	-2.17	1	-1.31	1	34
8 BRAZIL	-3.08	1	-2.42	2	-5.40 **	1	34	33 JAMAICA	-2.61	2	-2.57	1	-3.32	1	34
9 BURUNDI	-5.33 **	1	-2.24	1	-3.26	1	34	34 JAPAN	-1.26	1	-2.65	1	-1.65	1	34
10 CAMEROON	-1.28	1	-1.59	1	-2.34	1	29	35 KENYA	-1.18	1	-2.17	1	-0.97	1	34
11 CANADA	-2.62	1	-2.64	2	-2.86	1	34	36 KOREA	-0.71	1	-2.37	1	-2.66	1	34
12 CENTRAL AFRICAN	-2.21	1	-1.25	1	-2.63	1	34	37 MALAWI	-2.73	1	-2.23	1	-3.60 *	1	34
13 CHILE	-1.89	1	-2.17	1	-2.24	1	34	38 MALAYSIA	-1.27	1	-2.30	1	-2.97	1	34
14 CHINA	-1.56	1	-2.16	1	-2.24	1	34	39 MALTA	-1.55	1	-1.37	1	-0.91	1	34
15 COLOMBIA	-1.63	1	-2.56	1	-2.59	1	34	40 MAURITANIA	-5.41 *	1	-1.84	1	-2.14	1	34
16 COSTA RICA	-1.46	1	-2.60	1	-3.31	1	34	41 MAURITIUS	-2.05	1	-2.66	1	-2.52	2	34
17 COTE D'IVOIRE	-1.49	1	-1.99	2	-3.75 **	1	34	42 MEXICO	-1.80	1	-2.62	1	-2.28	1	34
18 DENMARK	-3.06	1	-1.97	1	-1.74	1	34	43 MOROCCO	-3.45	1	-1.78	1	-2.96	1	34
19 DOMINICAN REP.	-3.99 *	1	-2.63	1	-2.56	1	34	44 NETHERLANDS	-1.49	1	-1.87	1	-2.13	1	34
20 ECUADOR	-1.75	1	-4.08 *	1	-2.32	2	29	45 NEW ZEALAND	-3.37	1	-2.24	2	-4.17 *	1	34
21 EGYPT	-2.94	2	-1.88	1	-2.22	1	34	46 NIGER	-2.62	1	-1.77	1	-2.69	1	34
22 FINLAND	-1.75	1	-2.13	2	-2.94	1	34	47 NIGERIA	-2.07	1	-2.60	1	-0.90	1	34
23 FRANCE	-0.95	1	-1.97	1	-1.46	1	34	48 NORWAY	-2.42	1	-2.14	1	-1.63	1	34
24 GAMBIA	-2.83	1	-1.95	2	-3.95 *	1	34	49 PAKISTAN	-1.49	1	-2.24	1	-3.82 *	1	34
25 GERMANY	-2.08	1	-1.97	1	-1.45	1	34	50 PANAMA	-2.31	1	-2.59	1	-2.21	1	34

Table 1. Augmented -Dickey Fuller Test for Variables Entering the Export Demand Equation (concluded)

Country	x	k	p	k	gdpx*	k	nobs
51 PARAGUAY	-3.00	1	-0.88	1	-5.08 **	1	34
52 PERU	-2.55	1	-2.30	3	-2.68	1	34
53 PHILIPPINES	-2.31	1	-2.42	1	-2.20	1	34
54 PORTUGAL	-2.25	1	-1.97	1	-1.03	1	34
55 RWANDA	-6.12 *	1	-2.18	1	-1.87	1	34
56 SENEGAL	-4.40 *	1	-1.49	2	-2.55	1	34
57 SOMALIA	-2.33	1	-1.99	1	-2.77	1	30
58 S. AFRICA	-2.92	2	-2.13	1	-1.53	1	34
59 SPAIN	-1.73	1	-1.83	1	-1.72	1	34
60 SWEDEN	-1.99	1	-2.16	1	-1.75	1	34
61 SWITZERLAND	-1.02	3	-2.01	1	-2.06	1	34
62 TOOGO	-1.19	1	-1.10	1	-3.53	1	34
63 TRINIDAD &	-1.88	1	-2.65	1	-0.83	1	34
64 TUNISIA	-1.82	1	-1.31	2	-2.96	1	33
65 TURKEY	-1.87	1	-2.06	1	-2.00	1	34
66 UNITED KINGDOM	-1.35	1	-2.20	1	-1.44	1	34
67 UNITED STATES	-2.69	2	-1.51	2	-2.81	1	34
68 URUGUAY	-2.40	1	-1.82	1	-2.72	1	34
69 YUGOSLAVIA	-1.74	1	-2.28	1	-2.08	1	31
70 ZAIRE	-2.56	1	-2.73	1	-6.80 **	1	31

Note to table:
Variables are as follows: real exports of goods and nonfactor services (*x*), a weighted (by the share of exports) average of the trade partners' GDP minus exports (*gdpx**) and the real exchange rate (*p*) computed as the ratio of the exports deflator to the world export unit values index. These three variables are tested for the existence of a unit root using the Augmented-Dickey-Fuller (ADF) test. The optimal lag selected by the Schwarz criterion in the ADF regression is given by *k*. Critical values are a linear interpolation between the critical values for T=25 and T=50 given in table B.6, case 4, in Hamilton (where T is the sample size). Significance levels at 1 percent and 5 percent are indicated by ** and *, respectively.

Table 2. Export Demand Equations

Country	OLS estimates x_{-1}	p	$gdpx^*$	AC	ser	R^2	Fully-Modified estimates x_{-1}	p	$gdpx^*$	E_p	E_y	E_p^c	E_y^c	ser	R^2	$P\text{-}O$	E_p=-1	E_y=1	nobs
1 ALGERIA	0.13	-0.07	0.99	-0.24	0.08	0.93	0.27	-0.07	0.83	-0.09	1.15	-0.09	1.14	0.04	0.93	-6.62 a	30.42 a	2.83 c	34
	0.96	-2.02	6.52	-1.42			2.91	-3.26	7.60	-3.08 b	22.32 a								
2 ARGENTINA	0.33	-0.14	0.94	0.12	0.10	0.95	0.56	-0.11	0.56	-0.24	1.28	-0.24	1.28	0.08	0.95	-5.11 a	6.45 a	1.75	34
	2.15	-2.06	3.90	0.63			4.33	-1.94	2.73	-2.04 c	7.90 a								
3 AUSTRALIA	0.82	-0.20	0.19	-0.13	0.05	0.99	0.90	-0.17	0.08	-1.73	0.80	-2.24	0.79	0.04	0.99	-4.93 a	-0.52	-0.36	34
	6.57	-1.93	1.20	-0.70			9.58	-2.13	0.64	-1.22 c	1.45								
4 AUSTRIA	0.67	-0.08	0.88	0.10	0.03	1.00	0.75	-0.04	0.65	-0.15	2.59	-0.15	2.49	0.03	1.00	-5.25 a	4.41 a	12.99 a	34
	9.96	-1.41	4.58	0.55			11.44	-0.70	3.37	-0.75	21.16 a								
5 BENIN	0.73	-0.29	0.49	0.43	0.19	0.93	0.80	-0.26	0.31	-1.32	1.55	-1.24	1.55	0.11	0.93	-4.13 c	-0.50	1.07	34
	5.55	-1.04	1.56	2.76			10.14	-1.58	1.59	-2.07 b	3.00 b								
6 BURUNDI	0.04	-0.22	0.98	-0.09	0.16	0.79	0.28	-0.19	0.74	-0.26	1.03	-0.25	1.02	0.15	0.77	-6.61 a	5.81 a	0.13	34
	0.26	-2.21	4.07	-0.46			1.71	-2.01	3.08	-2.00 c	5.07 a								
7 CAMEROON	0.71	-0.08	0.94	0.09	0.14	0.96	0.84	-0.04	0.36	-0.24	2.29	-0.17	2.26	0.11	0.96	-3.84 c	1.10	0.82	29
	4.96	-0.50	2.05	0.37			7.48	-0.30	0.91	-0.34	1.46 b								
8 CHILE	0.81	-0.21	0.28	-0.04	0.08	0.99	0.85	-0.17	0.20	-1.08	1.31	-1.39	1.29	0.06	0.99	-5.47 a	-0.21	0.73	34
	10.07	-2.39	2.04	-0.21			14.60	-2.61	1.87	-2.99 a	3.14 b								
9 CHINA	0.69	-0.78	0.46	0.42	0.11	0.99	0.80	-0.63	0.24	-3.13	1.20	-3.55	1.15	0.12	0.99	-13.3 a	-2.77 a	0.38	34
	10.44	-4.30	4.34	2.46			10.29	-3.08	1.71	-4.08 a	2.24 b								
10 COLOMBIA	0.72	-0.25	0.48	0.11	0.07	0.98	0.86	-0.21	0.19	-1.52	1.39	-1.73	1.39	0.06	0.98	-4.61 b	-0.63	0.88	34
	6.07	-1.72	2.74	0.55			7.76	-1.70	1.12	-1.86 b	3.13 b								
11 COTE D'IVOIRE	0.64	-0.16	0.54	0.09	0.11	0.96	0.84	-0.03	0.25	-0.16	1.52	-0.16	1.46	0.09	0.96	-5.64 a	1.89	0.89	34
	4.91	-1.80	2.01	0.50			7.58	-0.32	1.10	-0.35	2.62 b								
12 DENMARK	0.78	-0.05	0.37	0.22	0.03	1.00	0.85	-0.06	0.23	-0.36	1.51	-0.41	1.51	0.02	1.00	-4.44 b	2.05	2.43	34
	10.21	-0.85	2.56	1.16			11.77	-1.13	1.70	-1.14	7.22 a								
13 DOMINICAN REPUBLIC	0.40	-0.47	0.86	0.09	0.14	0.94	0.56	-0.36	0.59	-0.81	1.34	-0.85	1.29	0.12	0.93	-5.73 a	0.93	1.36	34
	3.07	-3.75	4.06	0.48			4.91	-3.41	2.97	-3.96 a	5.38 a								
14 ECUADOR	0.77	-0.57	0.24	0.31	0.14	0.96	0.87	-0.43	0.02	-3.21	0.17	-2.51	0.16	0.14	0.95	-4.34 b	-0.86	-0.33	29
	8.34	-4.11	0.73	1.54			8.95	-2.98	0.06	-1.25	0.07								

Table 2. Export Demand Equations (continued)

Country	x_{-1}	p	$gdpx^*$	AC	ser	R^2	x_{-1}	p	$gdpx^*$	E_p	E_y	E_p^c	E_y^c	ser	R^2	$P\text{-}O$	$E_p=-1$	$E_y=1$	$nobs$
15 EGYPT	0.78	-0.26	0.33	0.26	0.09	0.97	0.84	-0.24	0.18	-1.44	1.12	-1.43	1.12	0.07	0.97	-9.80 a	-0.67	0.29	34
	8.84	-2.41	2.20	1.34			11.33	-2.68	1.37	-2.19 b	2.63 b								
16 FINLAND	0.38	-0.64	1.30	0.18	0.04	0.99	0.45	-0.58	1.15	-1.05	2.09	-1.20	2.09	0.03	0.99	-4.58 a	-0.34	21.22 a	34
	3.76	-5.05	6.08	1.00			5.36	-5.55	6.26	-6.61 a	40.64 a								
17 FRANCE	0.76	-0.01	0.57	0.37	0.03	1.00	0.79	0.00	0.49	-0.02	2.28	-0.02	2.18	0.03	1.00	-3.82	2.85 b	9.17 a	34
	9.97	-0.05	3.09	2.17			11.42	-0.05	2.90	-0.05	16.31 a								
18 GAMBIA	0.38	-0.51	0.53	0.25	0.15	0.89	0.49	-0.40	0.43	-0.79	0.84	-0.74	0.84	0.11	0.89	-4.26 b	0.81	-1.72	34
	2.32	-2.42	3.31	1.36			4.02	-2.59	3.56	-3.08 b	8.96 a								
19 GREECE	0.55	-0.31	1.32	0.18	0.07	0.99	0.66	-0.24	0.95	-0.70	2.81	-0.80	2.81	0.05	0.99	-4.77 a	0.61	4.45 b	34
	4.44	-1.40	3.46	0.94			7.08	-1.27	3.11	-1.43 c	6.91 a								
20 GUATEMALA	0.85	-0.12	0.05	0.02	0.09	0.94	0.90	-0.09	0.03	-0.87	0.31	-0.92	0.29	0.05	0.94	-4.69 a	0.11	-1.10	34
	11.46	-0.62	0.40	0.11			20.55	-0.76	0.43	-0.77	0.48								
21 HAITI	0.72	-0.02	0.37	0.01	0.18	0.84	0.80	-0.07	0.29	-0.37	1.41	-0.44	1.44	0.10	0.83	-5.91 a	1.55	0.76	34
	5.69	-0.13	1.53	0.06			10.49	-0.93	1.82	-0.89	2.63 c								
22 ICELAND	0.61	-0.27	0.57	0.12	0.07	0.98	0.70	-0.28	0.41	-0.93	1.37	-1.11	1.39	0.04	0.98	-4.75 a	0.29	3.16	34
	4.61	-2.02	2.60	0.67			9.71	-3.81	3.39	-3.76 a	11.78 a								
23 ITALY	0.58	-0.07	0.95	0.18	0.04	1.00	0.65	-0.05	0.80	-0.14	2.26	-0.13	2.25	0.03	1.00	-4.83 a	4.75 a	13.74 a	34
	4.95	-0.87	3.25	0.93			6.55	-0.69	3.27	-0.76	24.63 a								
24 JAPAN	0.82	-0.25	0.46	0.05	0.06	1.00	0.87	-0.17	0.27	-1.27	2.11	-1.33	2.02	0.03	1.00	-9.74 a	-0.48	2.21 c	34
	10.00	-1.56	1.65	0.27			19.70	-1.94	1.81	-2.30 b	4.21 a								
25 KENYA	0.62	-0.34	0.27	-0.29	0.07	0.94	0.84	-0.33	0.03	-2.07	0.17	-2.36	0.17	0.05	0.94	-7.49 a	-0.81	-1.22	34
	4.17	-3.64	1.57	-1.43			7.66	-4.71	0.21	-1.56 c	0.25								
26 KOREA	0.72	-0.61	1.21	0.27	0.10	1.00	0.76	-0.52	1.04	-2.17	4.34	-2.15	4.31	0.08	1.00	-4.95 a	-1.51	7.58 a	34
	8.03	-2.05	2.59	1.51			10.52	-2.15	2.73	-2.80 b	9.85 a								
27 MALAWI	0.34	-0.18	0.79	0.19	0.11	0.93	0.50	-0.05	0.63	-0.10	1.25	-0.11	1.20	0.06	0.93	-10.7 a	5.01 a	1.70	34
	2.03	-1.22	3.38	1.16			4.91	-0.55	4.16	-0.57	8.43 a								
28 MALTA	0.78	-0.12	0.64	0.27	0.08	0.99	0.84	-0.04	0.46	-0.22	2.80	-0.21	2.79	0.06	0.98	-3.88 c	1.18	4.43 a	34
	10.80	-0.86	3.19	1.57			13.39	-0.33	2.52	-0.34	6.89 a								
29 MAURITIUS	0.78	-0.25	0.45	-0.05	0.15	0.90	0.89	-0.21	0.34	-1.92	3.17	-1.67	3.24	0.10	0.94	-6.02 a	-0.46	1.56	34
	5.96	-1.45	1.66	-0.37			10.24	-1.82	1.91	-0.96	2.28 c								
30 MOROCCO	0.63	-0.38	0.43	0.01	0.07	0.97	0.81	-0.28	0.22	-1.47	1.12	-1.45	1.11	0.06	0.97	-6.42 a	-0.45	0.42	34
	6.17	-2.59	3.21	0.06			8.06	-2.19	1.52	-1.41	3.95 b								

Table 2. Export Demand Equations (continued)

Country	x_{-1}	p	$gdpx*$	AC	ser	R^2	x_{-1}	p	$gdpx*$	E_p	E_y	E_p^c	E_y^c	ser	R^2	$P\text{-}O$	$E_p=-1$	$E_y=1$	$nobs$
31 NEW ZEALAND	0.78	-0.17	0.21	-0.24	0.04	0.99	0.90	-0.13	0.08	-1.25	0.78	-1.62	0.80	0.03	0.99	-9.50 a	-0.19	-0.41	34
	5.53	-2.16	1.20	-1.29			9.33	-2.42	0.64	-0.94	1.49								
32 NIGER	0.65	-0.32	0.15	-0.15	0.19	0.50	0.84	-0.28	0.06	-1.74	0.38	-1.83	0.36	0.13	0.46	-7.41 a	-0.49	-0.82	34
	4.79	-1.42	0.79	-0.80			8.60	-1.80	0.47	-1.16	0.50								
33 NIGERIA	0.78	-0.04	0.25	0.09	0.17	0.85	0.91	-0.04	0.15	-0.50	1.69	-0.43	1.72	0.12	0.85	-5.14 a	0.44	0.47	34
	6.04	-0.45	1.25	0.46			9.31	-0.65	1.03	-0.43	1.15								
34 NORWAY	0.82	-0.17	0.36	0.22	0.03	1.00	0.90	-0.15	0.17	-1.51	1.65	-1.73	1.65	0.03	1.00	-9.43 a	-0.46	1.44	34
	7.91	-2.10	1.66	1.14			10.40	-2.32	0.91	-1.36 c	3.67 b								
35 PANAMA	0.78	-0.23	0.16	-0.22	0.06	0.99	0.85	-0.17	0.07	-1.14	0.47	-1.07	0.47	0.04	0.99	-7.33 a	-0.20	-0.56	34
	7.20	-2.64	0.62	-1.17			12.21	-2.75	0.41	-1.68 c	0.50								
36 PARAGUAY	0.57	-0.88	1.21	0.01	0.14	0.96	0.64	-0.96	1.11	-2.67	3.08	-2.80	2.96	0.12	0.96	-4.75 a	-2.62 b	7.20 a	34
	6.24	-4.39	5.42	0.09			7.93	-5.70	5.42	-4.19 c	10.66 a								
37 PERU	0.62	-0.06	0.13	-0.06	0.09	0.72	0.78	0.00	0.12	-0.02	0.53	-0.02	0.54	0.06	0.71	-6.30 a	3.34 c	-2.08 c	34
	4.19	-0.60	1.19	-0.32			8.17	-0.05	1.64	-0.05	2.30								
38 PHILIPPINES	0.52	-0.62	0.59	0.03	0.07	0.98	0.59	-0.51	0.49	-1.24	1.20	-1.22	1.19	0.05	0.98	-4.59 b	-1.32	1.57	34
	6.01	-6.33	4.09	0.15			8.64	-6.60	4.20	-6.92 a	9.52 a								
39 PORTUGAL	0.88	-0.25	0.24	0.22	0.11	0.96	0.93	-0.20	0.09	-2.92	1.30	-2.89	1.29	0.08	0.96	-4.93 a	-0.33	0.17	34
	7.01	-1.15	0.80	1.19			9.84	-1.21	0.38	-0.50	0.75								
40 SENEGAL	0.26	-0.42	0.42	0.00	0.11	0.84	0.45	-0.28	0.32	-0.50	0.58	-0.47	0.58	0.08	0.84	-6.64 a	2.54 b	-2.85	34
	1.71	-2.58	3.15	0.01			3.64	-2.27	2.79	-2.59 b	3.93 a								
41 SOUTH AFRICA	0.59	-0.20	0.26	0.21	0.03	0.97	0.65	-0.18	0.23	-0.51	0.66	-0.50	0.65	0.02	0.97	-9.12 a	4.02 a	-5.35 a	34
	6.59	-4.47	4.56	1.11			8.91	-5.45	5.24	-4.15 a	10.33 a								
42 SPAIN	0.60	-0.06	1.18	0.12	0.05	1.00	0.67	-0.06	0.94	-0.18	2.86	-0.19	2.75	0.04	1.00	-12.0 a	3.80 b	11.71 a	34
	4.39	-0.58	2.72	0.62			6.05	-0.74	2.64	-0.82	18.01 a								
43 SWEDEN	0.55	-0.13	0.76	0.33	0.03	1.00	0.68	-0.09	0.53	-0.29	1.65	-0.30	1.59	0.03	1.00	-4.13 b	3.20 b	5.62 a	34
	5.01	-1.88	3.68	1.84			6.26	-1.37	2.58	-1.29 c	14.22 a								
44 SWITZERLAND	0.31	-0.12	1.18	0.34	0.02	1.00	0.42	-0.10	0.98	-0.17	1.69	-0.18	1.62	0.02	1.00	-9.30 a	12.07 a	15.92 a	34
	2.91	-2.42	6.24	2.04			4.36	-2.34	5.65	-2.52 b	39.10 a								
45 TOGO	0.57	-0.21	0.58	0.13	0.22	0.90	0.84	-0.05	0.21	-0.33	1.27	-0.34	1.22	0.17	0.89	-6.74 a	0.79	0.16	34
	3.20	-1.21	1.22	0.69			5.82	-0.36	0.53	-0.38	0.74								
46 TRINIDAD AND TOBAGO	0.24	-0.29	0.91	0.17	0.10	0.96	0.37	-0.25	0.78	-0.39	1.24	-0.31	1.22	0.09	0.96	-5.40 a	9.49 a	1.81 c	34
	1.58	-4.63	4.28	0.91			2.80	-4.58	4.20	-6.13 a	9.41 a								

Table 2. Export Demand Equations (concluded)

Country	x_{-1}	p	$gdpx^*$	AC	ser	R^2	x_{-1}	p	$gdpx^*$	E_p	E_y	E_p^c	E_y^c	ser	R^2	$P\text{-}O$	E_p=-1	E_y=1	$nobs$
47 TUNISIA	0.59	-0.17	1.15	-0.09	0.07	0.99	0.78	-0.17	0.54	-0.78	2.43	-0.77	2.42	0.05	0.99	-6.00 a	0.36	4.50 b	33
	5.62	-1.26	3.67	-0.47			8.60	-1.68	1.93	-1.29	7.64 a								
48 TURKEY	0.82	-0.69	0.31	0.09	0.14	0.98	0.88	-0.58	0.06	-4.72	0.51	-5.38	0.51	0.10	0.98	-4.72 a	-1.83 c	-0.32	34
	10.59	-2.50	1.15	0.45			15.84	-2.96	0.30	-2.32 b	0.33								
49 UNITED KINGDOM	0.58	-0.16	0.61	0.03	0.03	1.00	0.66	-0.12	0.48	-0.35	1.43	-0.33	1.42	0.02	1.00	-5.41 a	4.71 a	6.86 a	34
	7.19	-2.59	4.84	0.17			9.38	-2.45	4.29	-2.54 b	22.81 a								
50 UNITED STATES	0.79	-0.19	0.26	0.48	0.05	0.99	0.96	-0.03	0.05	-0.73	1.04	-0.69	1.04	0.05	0.99	-3.53	0.10	0.04	34
	8.41	-1.42	2.20	2.86			9.52	-0.23	0.34	-0.27	0.93								
51 URUGUAY	0.66	-0.48	0.21	-0.14	0.09	0.97	0.75	-0.39	0.15	-1.55	0.59	-1.77	0.59	0.06	0.97	-5.92 a	-1.05	-0.87	34
	5.70	-2.67	1.12	-0.78			9.35	-3.05	1.02	-2.94 a	1.24								
52 YUGOSLAVIA	0.47	-0.23	0.67	-0.10	0.07	0.97	0.55	-0.19	0.52	-0.42	1.17	-0.41	1.16	0.05	0.97	-6.03 a	7.24 a	1.23	31
	3.45	-3.33	2.92	-0.54			5.84	-3.80	3.30	-5.13 a	8.55 a								
53 ZAIRE	0.50	-0.15	0.58	0.15	0.14	0.91	0.58	-0.15	0.39	-0.37	0.93	-0.37	0.92	0.10	0.90	-4.57 b	5.08 a	-0.19	31
	3.84	-2.27	2.69	0.72			6.28	-2.91	2.00	-2.98 b	2.48 b								
Mean	0.61	-0.27	0.59				0.72	-0.21	0.41	-1.02	1.47	-1.07	1.45						
Median	0.64	-0.21	0.53				0.79	-0.17	0.32	-0.78	1.30	-0.77	1.29						
Stdev	0.19	0.20	0.35				0.17	0.19	0.31	0.97	0.85	1.04	0.84						
Min	0.04	-0.88	0.05				0.27	-0.96	0.02	-4.72	0.17	-5.38	0.16						
Max	0.88	-0.01	1.32				0.96	0.00	1.15	-0.02	4.34	-0.02	4.31						

Note to table:

The dependent variable is real export of goods and nonfactor services (x). The explanatory variables are the lagged dependent variable (x_{-1}), the real exchange rate (p) computed as the ratio of exports deflator to the world export unit value index and the weighted (by export shares) average of trade partners' GDP minus exports ($gdpx^*$). The export demand equation is estimated using both OLS and the Phillips-Hansen's Fully Modified estimator. The long-run price and income elasticities are given by E_p and E_y, respectively. E_p^c and E_y^c give the long run price and income elasticities corrected for bias (see Table 4). For each country, the estimated coefficients and their *t-stat* (below the coefficient estimates) are provided. The following statistics are also provided: Durbin's test for autocorrelation (AC), R^2, standard error of the regression (ser), and the number of observations for each country ($nobs$). Cointegration between the three variables in the export demand equation is tested using the Phillips-Ouliaris residual test given in column $P\text{-}O$. Finally, the columns labeled $E_p=-1$ and $E_y=1$ report the two-tailed test for unit-price and unit-income elasticities, respectively. The asymptotic critical values for the Phillips-Ouliaris test at 10 percent, 5 percent and 1 percent are, respectively, -3.84, -4.16 and -4.64. The letters a, b, c indicate significance at 1 percent, 5 percent and 10 percent. Exact critical values (from Table 8) are used to compute the significance level of E_p, E_y, $E_p=-1$ and $E_y=1$.

Table 3. Bias for Short- and Long Run Elasticities for Both OLS and the Fully-Modified Estimator (in percent)

Short Run Price and Income Elasticities

		OLS					FM				
		R_{13}=-.7	R_{13}=-.3	R_{13}=-.0	R_{13}=.3	R_{13}=.7	R_{13}=-.7	R_{13}=-.3	R_{13}=-0	R_{13}=.3	R_{13}=.7
R_{12}=-.7	α_1	4.37	0.40	-6.55	-14.58	-20.38	3.60	1.25	-3.93	-10.41	-15.95
	α_2	-53.11	-53.01	-82.99	-84.94	-109.72	-15.43	-19.13	-42.64	-54.79	-79.19
	α_3	-21.44	-9.95	10.05	33.99	52.66	-17.64	-9.88	6.97	28.12	47.29
R_{12}=-.3	α_1	5.50	1.16	-4.64	-11.19	-17.72	4.71	2.02	-2.14	-7.36	-13.22
	α_2	-22.97	-29.34	-43.01	-50.99	-65.70	0.35	-6.85	-19.27	-31.42	-49.18
	α_3	-22.65	-9.93	7.27	27.01	47.66	-20.62	-11.59	2.21	19.52	39.71
R_{12}= 0	α_1	6.67	2.19	-3.11	-8.96	-15.73	5.62	2.83	-0.89	-5.50	-11.37
	α_2	7.83	1.84	-4.97	-12.12	-22.43	15.20	8.42	0.78	-8.84	-22.98
	α_3	-23.89	-10.65	4.94	22.61	43.79	-23.00	-13.46	-1.01	14.32	34.65
R_{12}=.3	α_1	7.76	3.64	-1.98	-8.31	-14.66	6.20	3.74	-0.16	-5.03	-10.57
	α_2	37.50	32.50	31.73	22.15	16.68	28.67	23.11	18.62	8.02	-1.93
	α_3	-25.52	-13.24	3.15	22.37	42.15	-24.65	-15.85	-2.68	13.82	33.02
R_{12}=.7	α_1	8.72	5.31	-1.25	-9.06	-14.73	6.53	4.61	0.05	-5.81	-10.95
	α_2	64.46	54.79	66.68	45.88	51.79	40.00	33.85	34.03	18.41	15.77
	α_3	-26.82	-16.54	2.02	24.90	42.43	-25.18	-18.27	-2.68	16.78	34.65

Long Run Price and Income Elasticities

	OLS					FM				
R_{12}=-.7	-98.62	-62.43	-48.95	-19.68	-17.61	-36.16	-28.36	-25.30	-11.52	-10.74
	5.54	-2.39	-9.17	-12.95	-14.25	-0.42	-1.04	-4.36	-6.95	-8.51
R_{12}=-.3	-67.02	-41.78	-23.83	-6.97	1.17	-26.55	-22.00	-13.07	-3.97	0.19
	7.55	-0.46	-6.21	-9.76	-11.92	1.37	1.51	-2.03	-3.90	-6.32
R_{12}= .0	-29.79	-12.77	3.44	14.69	22.86	-15.02	-5.90	-1.02	7.22	12.78
	9.40	2.62	-3.23	-7.08	-9.84	4.65	0.39	0.68	-2.86	-5.16
R_{12}= .3	0.20	15.92	32.37	38.66	45.57	1.77	5.12	14.04	19.40	25.55
	16.00	5.98	-1.19	-5.09	-8.07	4.69	3.93	-0.01	-1.95	-4.13
R_{12}= .7	36.12	-226.13	63.08	57.04	67.48	14.50	13.47	29.04	29.64	38.29
	19.62	116.60	1.44	-4.49	-7.32	4.39	4.25	1.32	-2.05	-4.07

Note to table: Table 3 provides the bias for both the short- and long-run elasticities. The bias is generated by simulating the export demand model: $x_t=\alpha_1 x_{t-1}+\alpha_2 p_t+\alpha_3 gdpx_t^*+\varepsilon_{1t}$, $p_t=p_{t-1}+\varepsilon_{2t}$ and $gdpx_t^*=gdpx_{t-1}^*+\varepsilon_{3t}$; $(\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}) \sim N(0,\Sigma)$ and $corr(\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}) = R_{ij}$, $i, j=1,2,3$; x_t denotes exports, p_t is the real exchange rate and and $gdpx_t^*$ is the activity variable, i.e. GDP-exports of the trade partner. All variables are logs. The coefficients α_1,α_2 and α_3 are set to .80, -1.00 and 1.00, respectively. The long run elasticities are defined as $E_p= \alpha_2/(1-\alpha_1)$ and $E_y= \alpha_3/(1-\alpha_1)$. The empirical distribution of the elasticities is generated from 5000 drawings of 34 observations each (the sample size in the data) from the restricted model. For each drawing, the export demand model is estimated. This yields 5000 estimates of the short- and long-run elasticities. For each drawing, the bias is simply the difference between the elasticity estimate and its true value. Table 3 reports the mean of these biases expressed in percentage of the true elasticities. The bias is computed for 5 different values of R_{12} (the correlation between ε_{1t} and ε_{2t}) and R_{13} (the correlation between ε_{1t} and ε_{3t}). This yields 25 bias estimates for each elasticity.

Table 4. Fully-Modified t-statistic Critical Values for the Export Demand Equation Parameters

			R_{13}=-.7			R_{13}=-.3						R_{13}=.3				
		m_{-1}	p	y		p	y	m_{-1}	p	y	m_{-}	p	y	m_{-}	p	y
R_{12}=-.7	1%	-1.17	-3.63	-7.88	-2.19	-3.67	-5.49	-4.40	-4.20	-4.31	-6.34	-4.46	-2.94	-9.36	-5.63	-1.97
	5%	-0.14	-2.58	-5.78	-1.26	-2.63	-3.98	-3.11	-2.95	-2.91	-4.89	-3.19	-1.79	-7.66	-3.88	-0.91
	10%	0.49	-2.06	-4.76	-0.67	-2.12	-3.11	-2.51	-2.40	-2.22	-4.30	-2.55	-1.17	-6.90	-3.10	-0.35
	90%	5.14	0.79	0.38	3.23	0.97	1.23	1.19	0.96	2.19	-0.57	1.11	3.17	-2.72	0.93	4.85
	95%	5.79	1.18	1.02	3.82	1.39	1.79	1.72	1.39	2.86	-0.09	1.62	4.00	-2.21	1.48	5.91
	99%	7.01	1.98	2.21	4.88	2.20	3.04	2.64	2.26	4.19	0.74	2.74	5.70	-1.30	2.52	8.17
R_{12}=-.3	1%	-0.39	-3.23	-6.12	-1.70	-3.49	-4.74	-3.51	-3.69	-3.63	-5.12	-3.83	-2.94	-7.40	-4.40	-2.29
	5%	0.60	-2.29	-4.33	-0.84	-2.40	-3.23	-2.30	-2.47	-2.47	-3.80	-2.72	-1.84	-5.92	-3.00	-1.30
	10%	1.16	-1.77	-3.47	-0.31	-1.92	-2.53	-1.74	-1.94	-1.91	-3.20	-2.08	-1.31	-5.27	-2.41	-0.80
	90%	5.18	1.13	0.77	3.32	1.24	1.29	1.71	1.32	1.91	0.28	1.43	2.57	-1.44	1.46	3.53
	95%	5.79	1.54	1.29	3.85	1.71	1.80	2.21	1.82	2.55	0.70	1.93	3.29	-0.98	2.03	4.48
	99%	6.98	2.33	2.39	4.76	2.45	2.94	3.04	2.76	3.61	1.57	3.13	4.76	-0.18	3.11	6.26
R_{12}=0	1%	0.21	-2.85	-5.20	-1.30	-3.08	-4.24	-2.94	-3.15	-3.34	-4.52	-3.36	-2.81	-6.63	-3.61	-2.30
	5%	1.17	-1.96	-3.68	-0.44	-2.05	-2.83	-1.82	-2.07	-2.30	-3.21	-2.24	-1.82	-5.24	-2.47	-1.43
	10%	1.70	-1.52	-3.02	0.10	-1.59	-2.25	-1.30	-1.63	-1.76	-2.65	-1.72	-1.29	-4.55	-1.88	-0.92
	90%	5.56	1.40	0.87	3.61	1.52	1.32	2.09	1.64	1.79	0.74	1.75	2.24	-0.89	1.93	2.96
	95%	6.13	1.85	1.35	4.12	1.99	1.81	2.58	2.14	2.29	1.17	2.32	2.87	-0.43	2.50	3.79
	99%	7.20	2.75	2.32	4.98	2.86	2.76	3.46	3.15	3.29	2.05	3.43	4.10	0.41	3.80	5.54
R_{12}=.3	1%	0.64	-2.48	-5.23	-0.96	-2.63	-3.98	-2.57	-2.81	-3.37	-4.50	-2.91	-2.72	-6.57	-3.20	-2.35
	5%	1.72	-1.69	-3.48	0.01	-1.78	-2.71	-1.60	-1.74	-2.24	-3.19	-1.90	-1.78	-5.24	-1.94	-1.41
	10%	2.23	-1.23	-2.80	0.53	-1.28	-2.15	-1.06	-1.30	-1.67	-2.60	-1.39	-1.27	-4.55	-1.35	-0.95
	90%	6.26	1.69	0.93	4.17	1.79	1.29	2.41	1.99	1.68	0.88	2.15	2.12	-0.81	2.40	2.82
	95%	6.90	2.21	1.42	4.71	2.29	1.76	2.88	2.50	2.18	1.33	2.74	2.74	-0.32	3.09	3.52
	99%	7.94	3.09	2.35	5.71	3.24	2.72	3.87	3.48	3.20	2.25	3.91	3.96	0.59	4.31	5.16
R_{12}=.7	1%	0.92	-2.07	-5.45	-0.58	-2.22	-4.15	-2.69	-2.33	-3.39	-4.94	-2.76	-2.71	-7.42	-2.72	-2.40
	5%	2.19	-1.28	-3.70	0.48	-1.46	-2.73	-1.64	-1.37	-2.23	-3.59	-1.54	-1.71	-5.90	-1.39	-1.43
	10%	2.82	-0.89	-2.90	1.04	-1.01	-2.17	-1.07	-0.94	-1.62	-2.95	-1.00	-1.26	-5.23	-0.79	-0.94
	90%	7.40	2.06	0.91	5.03	2.02	1.22	2.72	2.42	1.63	0.75	2.62	2.14	-1.09	3.18	2.85
	95%	8.12	2.57	1.40	5.61	2.62	1.74	3.27	2.98	2.19	1.27	3.26	2.76	-0.56	3.83	3.60
	99%	9.28	3.64	2.26	6.71	3.70	2.61	4.47	4.23	3.28	2.30	4.59	3.94	0.55	5.32	5.32

Note to table: Table 4 provides exact critical values of the Fully-Modified *t-statistic* at 1%, 5%, 10%, 90%, 95% and 99% significance levels. These critical values are generated by simulating the export demand model: $x_t=\alpha_1 x_{t-1}+\alpha_2 p_t+\alpha_3 y_t^*+\varepsilon_{1t}$, $p_t=p_{t-1}+\varepsilon_{2t}$ and $y_t^*=y_{t-1}^*+\varepsilon_{3t}$; $(\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}) \sim N(0,\Sigma)$ and $corr(\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t})=R_{ij}$, i, j=1,2,3; x_t denotes exports, p_t is the real exchange rate and y_t is the activity variable, i.e. GDP-exports of the trade partner. All variables are in logs. The coefficients α_1, α_2 and α_3 are set to .80, -1.00 and 1.00, respectively. For each of the coefficients α_1, α_2 and α_3, the critical values are computed by (i) Setting the coefficient for which the critical values are computed to zero (restricted model). (ii) Drawing 5000 samples of 34 observations each (the sample size in the data) from the restricted model. (iii) Computing the usual t-statistic for each drawing. (iv) Finally, using the resulting vector of 5000 t-statistic values to generate an empirical distribution from which the critical values can be computed. For each coefficient, the empirical t-distribution is computed for 5 different values of R_{12} (the correlation between ε_{1t} and ε_{2t}).

Table 5. Fully-Modified t-statistic Critical Values for Long Run Export Price and Income Elasticities

		R_{13}=-.7		R_{13}=-.3		R_{13}=0		R_{13}=.3		R_{13}=.7	
		E_p	E_y	E_p	E_y	E_p	E_y	E_p	E_y	E_p	E_y
R_{13}=-.7	1%	-4.28	-10.37	-4.45	-7.05	-5.06	-4.89	-5.37	-3.08	-6.92	-1.95
	5%	-2.58	-7.09	-2.69	-4.61	-3.22	-3.01	-3.50	-1.73	-4.40	-0.88
	10%	-2.01	-5.73	-2.08	-3.46	-2.50	-2.24	-2.74	-1.13	-3.39	-0.35
	90%	0.77	0.37	0.95	1.21	0.93	2.22	1.10	3.48	0.95	5.65
	95%	1.12	0.97	1.35	1.76	1.39	2.96	1.66	4.55	1.55	7.29
	99%	1.80	2.05	2.25	3.06	2.21	4.84	3.03	7.17	2.80	11.04
R_{13}=-.3	1%	-3.52	-8.33	-3.85	-5.87	-4.26	-4.18	-4.41	-3.13	-5.24	-2.23
	5%	-2.21	-5.42	-2.42	-3.73	-2.61	-2.67	-2.82	-1.79	-3.23	-1.20
	10%	-1.70	-4.20	-1.82	-2.81	-1.98	-1.92	-2.19	-1.22	-2. 58	-0.76
	90%	1.06	0.74	1.20	1.24	1.30	1.93	1.43	2.83	1.50	4.24
	95%	1.44	1.20	1.64	1.79	1.80	2.68	2.00	3.74	2.12	5.46
	99%	2.20	2.34	2.53	3.00	2.94	4.32	3.52	6.13	3.51	9.03
R_{13}=0	1%	-2.89	-7.67	-3.26	-5.38	-3.59	-3.91	-3.58	-3.08	-4.09	-2.23
	5%	-1.86	-4.74	-2.00	-3.29	-2.14	-2.45	-2.35	-1.75	-2.67	-1.32
	10%	-1.43	-3.61	-1.51	-2.47	-1.60	-1.75	-1.73	-1.21	-1.94	-0.85
	90%	1.34	0.78	1.48	1.24	1.65	1.78	1.79	2.45	2.01	3.61
	95%	1.70	1.23	1.93	1.76	2.23	2.47	2.39	3.24	2.73	4.79
	99%	2.70	2.39	3.09	3.06	3.43	4.16	3.86	5.30	4.29	7.77
R_{13}=.3	1%	-2.38	-7.50	-2.70	-5.50	-2.92	-4.24	-3.21	-3.01	-3.74	-2.42
	5%	-1.53	-4.66	-1.65	-3.21	-1.72	-2.42	-1.95	-1.71	-2.02	-1.29
	10%	-1.15	-3.44	-1.23	-2.39	-1.25	-1.65	-1.36	-1.17	-1.38	-0.85
	90%	1.66	0.83	1.75	1.20	2.01	1.73	2.24	2.31	2.54	3.37
	95%	2.13	1.30	2.26	1.72	2.60	2.43	2.97	3.21	3.45	4.48
	99%	3.37	2.40	3.61	3.25	3.90	4.26	4.59	5.51	5.06	7.41
R_{13}=.7	1%	-1.86	-8.87	-2.17	-5.77	-2.35	-4.57	-2.93	-3.04	-2.96	-2.64
	5%	-1.23	-4.95	-1.39	-3.43	-1.32	-2.47	-1.58	-1.70	-1.46	-1.35
	10%	-0.84	-3.60	-0.99	-2.43	-0.92	-1.65	-0.99	-1.18	-0.79	-0.87
	90%	2.01	0.83	2.05	1.15	2.50	1.69	2.85	2.32	3.47	3.50
	95%	2.54	1.32	2.62	1.68	3.21	2.46	3.63	3.27	4.35	4.95
	99%	4.09	2.57	4.10	3.08	4.94	4.59	5.43	5.83	6.42	8.34

Note to table: Table 5 provides exact critical values of the Fully-Modified *t-statistic* at 1%, 5%, 10%, 90%, 95% and 99% significance levels for long run export price and income elasticities (E_p and E_y, respectively). These critical values are generated by simulating the export demand model: $x_t=\alpha_1 x_{t-1}+\alpha_2 p_t+\alpha_3 gdpx_t^*+\varepsilon_{1t}$, $p_t=p_{t-1}+\varepsilon_{2t}$ and $gdpx_t^*=gdpx_t^*+\varepsilon_{3t}$; $(\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}) \sim N(0,\Sigma)$ and $corr(\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}) = R_{ij}$, i, j=1,2,3; x_t denotes exports, p_t is the real exchange rate and $gdpx_t^*$ is the activity variable, i.e. GDP-exports of the trade partner. The coefficients α_1, α_2 and α_3 are set to .80, -1.00 and 1.00, respectively. The long-run elasticities are defined as $E_p=\alpha_2/(1-\alpha_1)$ and $E_y=\alpha_3/(1-\alpha_1)$. Their respective t-statistic critical values are computed by (i) Setting, respectively, α_2 and α_3 equal to zero (restricted model). (ii) Drawing 5000 samples of 34 observations each (the sample size in the data) from the restricted model. (iii) Computing the usual t-statistic for E_p and E_y using the Taylor approximation formula for each drawing. (iv) Finally, using the resulting vector of 5000 t-statistic values to generate an empirical distribution from which the critical values can be computed. For both E_p and E_y, the empirical t-distribution is computed for 5 different values of R_{12} (the correlation between ε_{1t} and ε_{2t}) and R_{13} (the correlation between ε_{1t} and ε_{3t}). This yields 25 empirical t-distributions for both long-run elasticities.

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