IMPORTED MACHINERY

FOR

EXPORT COMPETITIVENESS

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Abstract

We analyse the relationship between export competitiveness and investment in machinery, allowing for imperfect substitution between domestically produced and imported machinery. A translog export price function is estimated for developed, export-oriented developing, and import-substituting developing countries in a panel data setting. Between 1967 and 1990, imported machinery helped lower export prices for export-oriented developing countries. Throughout, imported machinery was not a substitute for domestic machinery. Import-substituting developing countries were unable to harness imported machinery to reduce costs in the early years, though from about the early 1980s, with an opening up of their trade regimes, they were also able to benefit from the cost-reducing effect. Our results also imply that innovative effort based on imported technologies can be a precursor to the development of domestic innovation capabilities, which may ultimately become the main nexus of a country's innovation efforts.

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1. Introduction

This paper builds on two recent lines of research: investment in equipment as a source of economic growth and imported goods as conduits for the international diffusion of technology. We combine these two themes to assess the effectiveness of imported machinery in increasing export competitiveness and hence in stimulating growth.[1]

Underlining the importance of machinery in the development process, De Long and Summers (1991, 1992a, 1992b, 1993) find strong empirical support for a causal relationship between equipment investment and growth in a cross-section of developing and developed countries. In particular, they find that a one-percentage point increase in the share of equipment investment in gross domestic product (GDP) raises the GDP growth rate by 0.34 percentage points.[2] They infer that the domestic R&D and learning activities associated with the production and installation of equipment create generalized benefits for that economy.

The De Long/Summers results are also consistent with the possibility that the foreign knowledge embodied in imported equipment may be of significant value to the economy buying the equipment. Studying the spillovers of knowledge across national boundaries, Coe and Helpman (1995) and Engelbrecht (1997) find that international spillovers are mediated through imported goods: the greater the imports, the higher is benefit of the stock of foreign knowledge. Engelbrecht notes that these papers do not distinguish between different types of imports; such a distinction is likely to be important since consumer goods, intermediate inputs, and equipment are likely to convey spillovers to differing degrees. Coe, Helpman, and Hoffmaister (1997) extend these earlier studies and find specifically that imported capital goods are critical conduits of international knowledge.

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[1] Several studies suggest that more extensive trade is associated with higher productivity growth (e.g., Pack and Page 1994 and Srinivasan 1995 and 1999). However, Rodriguez and Rodrik (1999) and Rodrik (1999) are sceptical of such results where they are based on cross-sectional growth regressions. Srinivasan and Bhagwati (1999) express general concern about cross-sectional growth analyses and conclude that "nuanced and in-depth studies" of individual countries, over a period of time, provide the clearest evidence in favor of the beneficial effects of greater trade-orientation.

[2] In the traditional neoclassical model, an increase in the investment rate raises output but has no long-run effect on growth rates. The endogenous growth literature identifies conditions under which increased investment has external effects and hence raises growth rates. De Long and Summers go further and find evidence that the external effects are strongest when the investment is in machinery rather than in buildings and structures.

In this paper, we examine empirically the differential efficiency of domestically produced and imported machinery. With information freely accessible to all, there would be no difference in the efficiency of domestic and imported machines. However, in practice, information is not freely available. Even in the absence of formal intellectual property protection, domestic producers can be at a handicap relative to international producers because knowledge is tacit (see, for example, Mody 1989 for a review of the economic and management literature on tacitness). As a consequence, domestic and imported machinery trigger different forms of learning in the domestic economy. Domestic machinery production and installation may, in some instances, be associated with considerable innovative activity within a developing country. More often, however, the domestic production of machines is associated with adaptive R&D, i.e., tailoring of foreign machinery to local requirements and upgrading earlier vintages of domestic equipment.

In contrast, imported machinery is bundled with “knowledge” in various forms: blueprints, installation support, quality control software, and services of trained engineers and supervisors. Such knowledge absorption is less glamorous than the development, or even the adaptation, of machines. However, because it forms a more comprehensive package, it can lead potentially to greater short-run efficiency and stronger absorptive capacity in the long-run. Imported machinery will also be more efficient because it is typically of newer vintage than domestically produced machinery.[3]

We use the country’s trade regime to proxy the incentives to deploy knowledge (see chart 1). Not all economies (and firms within them) are able to take advantage of the bundled software and training and of the greater efficiency built into the new vintages of imported machinery. To stay competitive, firms in countries with high export orientation are likely to have strong incentives to exploit the knowledge flows associated with imported machinery. In principle, import substitution was also based on the premise that, with temporary protection, domestic producers would also have the incentive to tap into and internalize internationally available knowledge. The extent to which this process actually occurred, however, is an empirical question. Incentives in more protected “import-substituting” economies were likely to be weaker on account of the relatively small size of domestic markets and the less demanding

[3] We are aware that other mechanisms for knowledge transmission can be important, including through foreign buyers of exported goods who provide technical and marketing support in the context of long-term relationships (Westphal, Rhee, and Purcell 1981, Egan and Mody 1992, Mody and Yilmaz 1997).

domestic users of that machinery (see Srinivasan and Bhagwati 1999 for a review of how incentives are blunted in an import-substituting regime). Thus, while alternative explanations are possible, the results of this study are consistent with the proposition that import-substituting regimes create weaker incentives to invest in technological improvements that can help increase their greater presence as exporters in international markets.

Chart 1: Trade regimes and the effects of imported and domestic machinery

	Trade regime	
	Export-oriented	**Import-substituting**
Imported machinery	Creates access to pool of international knowledge with incentives to exploit it.	Can access international knowledge pool but small domestic markets may blunt incentives.
Domestic machinery	With strong incentives, the limits of domestic knowledge pool can be overcome over time as domestic capacity improves.	Both the knowledge pool and incentives may be limited.

In Figure 1, we plot the change in the volume of exports against the change in the capital stock in the previous year. In export-oriented countries, an increase in exports is strongly associated with an increased stock of imported machinery. A positive relationship also exists between increases in exports and the domestic machinery stock. A similar set of relationships is found for developed countries. In contrast, for import-substituting developing countries, imported equipment and export growth are negatively related.

Our empirical analysis focuses on the price of exports rather than on export volume. This formulation specifies a link from imported machinery to reduced costs and prices, which, in turn, lead to greater exports. The relationship between machinery investment and export competitiveness is analysed using a model of imperfect competition in international markets, and allows for imperfect substitutability between domestically produced and imported machinery. An export price function is specified based on the demand for exports and the costs of producing the exported goods. A short-run cost function with variable labor and materials costs and fixed stocks of imported and domestically produced machinery is used. Higher levels of capital stock are expected to lower short-run production costs and hence export prices. Higher productivity of imported machinery would be reflected in greater cost reduction than can be achieved through the use of domestic machinery.

The export price equation is estimated for developed countries (DCs) and for less-developed countries (LDCs), and within the latter for export-oriented and import-substituting economies. For each country group, the fixed-effects procedure on panel data is used. But first, the t-bar test recently developed by Im, Pesaran and Shin (1996) is used to identify, in a panel data context, the presence of stochastic trends in export price and explanatory variables. We find that the variables do have stochastic trends (unit roots). Thus, because of the potential collinearity in the movement of variables of interest, the export price function is estimated in first differences.

In the empirical application, to allow for lagged effects, we distinguish between the effects due to the past year's new investment and the stock of capital at the start of the previous year. For the entire sample period, the flow of new imported investment in the previous year is seen to be associated with a decline in export prices in developed and export-oriented developing countries, but not in import-substituting developing countries. Throughout, we find that domestic machinery is not a substitute for imported machinery.

The results also show that the relationship between imported machinery and equipment and export prices has evolved over time. We estimate the export price function for several "windows." For developed countries, the beneficial effect of imported equipment declined rapidly and had disappeared by the early 1970s; but from the late-1970s, the stock of *domestic* equipment was associated with a cost reducing effect. In export-oriented countries, the cost-reducing effect of imported machinery rose in the 1970s but, while remaining statistically significant, declined in quantitative significance after that. Once again, the importance of a domestic machinery stock increased in the 1980s. These experiences suggest that innovative effort based on imported technologies can be a precursor to the development of domestic innovation capabilities, which may ultimately become the main nexus of a country's innovation efforts. Finally, for import-substituting countries, imported machinery generated the cost reducing benefits only from the 1970s, following the opening up by some of them to a more open trade regime, especially for the import of capital goods. But the transition to domestic capabilities, embodied in domestic capital goods, has not yet occurred in this group of countries.

The plan of the paper is as follows. The underlying model and the empirical specification of the price function are presented in the next section. In Section 3 the data and the econometric implementation are discussed. Results are presented in Section 4. Section 5 concludes and outlines possibilities for future research. Data sources, the definition of variables, descriptive statistics, and the unit root test results are presented in the Appendix.

2. A Model of Imperfect Competition in Export Markets

In setting up the model, we are guided by the following intuition. The significance attached to machinery investment by some countries, especially the Newly Industrializing Countries of East Asia (NICs), was not accidental but was dictated by the adoption of an export-oriented strategy and the resulting discipline of international competition. To maintain market presence, exporters had to continually reduce production costs and/or enter into the production of higher quality products. Both strategies required substantial investment in new vintages of machinery and equipment. Initially, domestic machinery had lower productivity and, consequently, the scope for substitution of domestic for imported machinery was small. Over time the more advanced countries developed the technological capability to produce machinery that could compete with imports from developed countries.

This intuition can be tested by estimating a *cost* function that includes machinery stock as an explanatory variable. However, data on production costs are difficult to obtain. For this reason, we estimate an export *price* function, which is based on both demand and cost function parameters. In a model of imperfect competition, manufacturers arrive at their export price, given demand and cost conditions. While demand depends on competitors' prices and on incomes in target markets, production costs depend on input prices, output levels, and other variables that shift the cost function, such as the stocks of imported and domestic machinery.

We assume that production for domestic and export markets are two independent decisions and focus on exports.[4] Firms produce export goods through an homothetic production function, using two variable inputs, labor and materials (including raw materials, fuel and electricity), and a quasi-fixed input, the capital stock. Firms are assumed to be price takers in input markets. Consequently, the short-run cost function is separable in variable input prices, on the one hand, and the quasi-fixed input and output, on the other.

We assume that each firm exports a differentiated product and chooses its export price to maximize its profits at a point in time, given the demand curve for its product and the cost of production.[5] When the second-order condition for profit maximization is satisfied, it is possible to solve for the profit-maximizing price, by inverting the first-order condition. The profit-maximizing price is a function of all variables that enter the cost function (wage rate, w, price of materials, p_m, and the capital stock, K) plus variables that shift the demand function (namely the competitors' average price, p_c, and the world income, Y). Export price may also be a function of the exchange rate (e), as discussed below.

$$p = p(p_c, Y, w, p_m, e, K) \qquad \textbf{(1)}$$

The elasticities of export price with respect to variable input prices, prices of competing products, and the capital stock depend on the parameters cost and demand functions. When the second-order condition for profit maximization is satisfied, a positive elasticity of marginal cost with respect to input prices is sufficient to generate a positive elasticity of the export price with respect to input prices. In other words, the exporter will increase its price following an increase in input prices.

Again, with the second-order condition satisfied, decreasing marginal costs with increasing machinery stock is both a necessary and a sufficient condition for the price function to be a decreasing function of machinery stock. Consequently, if the estimated price elasticity

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[4] For a similar assumption and empirical implementation, see Feenstra (1989). If marginal costs of production for the domestic market and export markets are not flat, influences in one market will influence the other. Essentially, an omitted variable bias would arise, where the omitted variables refer to demand influences in the domestic economy. If domestic demand were to shift exogenously, then the marginal costs of production would change, leading to a change in prices charged in both the domestic and international markets. We believe that these exogenous shifts would be reflected in the domestic input prices (of wages and materials). However, it is possible that a bias still remains. The direction of this bias is not clear, though. If increased domestic activity leads to more investment but also higher marginal costs, a larger stock of private capital would be associated with higher export prices—the opposite of the relationship that we are hypothesizing.

[5] Since the analysis is restricted to the cost reducing effect of the technology embodied in existing machinery, the model is a static one and does not incorporate investment demand for domestic and imported machinery. Analytically, it is not difficult to incorporate the demand for machinery through a dynamic model. However, due to lack of data on cost of production and the rental price of capital stock, it is not possible to estimate factor demand functions of the long-run model.

with respect to machinery stock is negative, then it follows that technology embodied in new machinery has a cost reducing effect.

For the purpose of empirical estimation and following Mann (1986 and 1989), we simplify the demand function by substituting "world price," p_w, for competitors' price, p_c, and world income, Y. The "world price" variable reflects the influence of pricing decisions of all competitors and of changes in the world income. Thus, using the reduced form price equation, we analyze the elasticity of export price with respect to "world" price (which combines the influences of competitors' prices and "world income"), two input prices, and the two kinds of machinery stock.[6]

In the empirical analysis, we assume that the export price decision is best summarized by the translog price function:

$$\log p = l + \sum_i b_i \log X_i + 0.5 \sum_i y_i (\log X_i)^2 + \sum_i \sum_{j>i} y_{i,j} (\log X_i \log X_j) \qquad \textbf{(2)}$$

where $X_i = p_w, w, p_m, e, I^m_{-1}, I^d_{-1}, K^m_{-2}, K^d_{-2}$. I^d and I^m are the investment flows using domestic and imported capital goods respectively and K^d and K^m are the corresponding stocks. A variable with subscript "-1" is lagged one period and "-2" subscript implies a two period lag. By considering the past year's investment and the stock prior to that, we are able to obtain some sense of the lags with which the effects operate.[7]

Finally, previous studies analyzing export price behavior under imperfect competition have noted that exchange rates often exercise an independent influence on the price of traded goods. In other words, even if all variables on both sides of the equation are measured in the same currency, exchange rate movements seem to have a significant impact on the price of exports (see Feenstra 1989, Ohno 1989, and Mann 1986). By representing the input prices in local currency terms and including the exchange rate as a separate variable, we allow for the possibility that exchange rate changes are not perfectly passed through to export prices. The

[6] Local currency wages and price of material inputs were obtained by dividing the corresponding variables denominated in US dollars by the annual average exchange rate.

[7] Note, of course, that we are not decomposing the stock of capital in a strict sense this year's stock of capital is the sum of the new investment plus the prior stock; that simple identity does not carry forward when we take logs.

main results of this paper remain unchanged if instead we measure the input prices in dollars and drop the exchange rate variable.

3. Empirical Specification and the Data

The export price equation is estimated for a cross-section of 14 developed countries (DCs) and 25 less-developed countries (LDCs). The definitions of variables and data sources are presented in table A.1 in the appendix and the descriptive statistics are in table A.2.

Since the model is derived based on profit-maximizing assumptions for an individual firm, it would be best to use firm- or industry-level data to estimate the price function in equation 2. However, it is not possible to take that route because of data constraints. While data on export prices, input prices and investment can be found for some manufacturing sub-sectors in some countries, it is not possible to obtain data on domestic and imported components of investment undertaken by each industry. We are forced, therefore, to aggregate all manufactured exports from a country.

Aggregation can be justified by assuming either a representative firm (as in Feenstra 1989 and Ohno 1989) or a translog aggregate production technology for manufacturing exporters (Pindyck and Rotemberg 1983). Aggregation, however, presents its own problems. The higher the level of aggregation the more difficult it becomes to obtain price indices that reflect firm-level pricing decisions. An aggregate price measure incorporates changes in the composition of the commodity basket, as well as the market price of each commodity in the basket. Is this a problem for our proposed empirical analysis? Note that our focus is on cost reduction. To the extent that changes in the composition of exports from one year to the next are important, the cost reduction impact will be blurred. Indeed, if products were moving up the quality ladder, we would expect to find no cost reduction effect. Hence a finding of cost reduction despite that possibility provides somewhat greater confidence in our results.

Since our LDC sample includes countries with substantially different development strategies, we divide LDCs into two groups, export-oriented and import-substituting, based on the classification used by the World Bank (World Bank 1986; see also Balasubramanyam *et al.* 1996.) As can be seen in table A.3, between the 1967-73 and 1973-85 no major shift occurred in the outward-orientation of the countries included in our sample. However, while countries remained differentiated in terms of broad policy stance, trade policy regimes did not remain fixed during this period. The process of reduction in trade barriers has continued apace and several of the "import-substituting" countries adopted more export-oriented policies during the 1980s and, in this sense, the differences in policy regimes narrowed.

Before estimating the export price function we test for non-stationarity of the variables using the t-bar statistic proposed by Im, Pesaran and Shin (1996) for heterogeneous panels. This is a well-known crucial first step in time series models. When a time series equation contains a non-stationary variable, then the results based on this estimation will be spurious. Im, Pesaran, and Shin (1996) have recently extended the stationarity tests to cross section, time series model. The test procedure is simple. It is an extension of the widely used Augmented Dickey-Fuller (ADF) test to panel data framework and allows for heterogeneity across groups included in the panel. First, the average ADF unit root test statistics for the panel is obtained as the mean of individual ADF unit root statistics. Next, the expected value and the standard error of the average ADF test statistic under the null hypothesis of a unit root are obtained through Monte Carlo simulation. The t-bar statistic is calculated as the average ADF minus its expected value divided by its standard error. Im, Pesaran, and Shin (1996) show that under the null hypothesis of a unit root, t-bar statistic has a standard normal distribution for sufficiently large number of countries, N, and number of time periods, T, while $\sqrt{N}/T$ goes to zero. Using Monte Carlo method they show that t-bar test has more power than ADF tests applied to each individual in the panel separately.

The results of the Im-Pesaran-Shin test are presented in table A.4 in the Appendix. We cannot reject the null hypothesis of a unit root for all variables of the price function for all country groups. Consequently, estimating the export price function in levels (equation 2) would generate spurious results. Next, we test for unit roots in the first-differenced variables and reject non-stationarity. This allows us to estimate the equation in first differences.

4. Empirical Results

The first-differenced export price equation is estimated using the fixed-effects procedure, which amounts to assuming that countries do differ in terms of the trend coefficient, which could be interpreted as disembodied technical change.[8]

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[8] Alternatively, one could assume that individual effects occur on a random basis rather than being fixed. This implies that, instead of the constant term, the individual effect is part of the random disturbance. However, this is not justified in our case because we did not sample countries on a random basis.

For all country groups in our analysis, the translog parameters are estimated using the data for 1967-1990 period. The parameter estimates of the translog price equation are presented in table 1. The adjusted-R^2, sum of squared residuals, Durbin-Watson statistic, as well as Wald tests for hypotheses of interest are also reported. The specification test for functional form indicates that the translog function provides a better approximation of the export price decision than the Cobb-Douglas function.

However, the parameters of the translog function cannot be interpreted directly. Instead, one needs to derive the elasticity estimates of the export price function with respect to input prices, exchange rate, and the imported and domestic machinery using the underlying parameters of the translog function. These elasticities take the following form:

$$E_i = \boldsymbol{b}_i + y_i \overline{\log X_i} + \sum_{j \neq i} y_{i,j} \overline{\log X_j} \tag{3}$$

where $X_i = p_w, w, p_m, e, I_{-1}^m, I_{-1}^d, K_{-2}^m, K_{-2}^d$ and a bar over a variable denotes its average value for the country group throughout the sample period.

The standard error of each elasticity is estimated using the δ-method (for a more detailed treatment see Rao 1973, pp. 388-390). One can write the elasticities in the following matrix notation: $\boldsymbol{E} = \mathbf{Z}\,\mathbf{Y}$, where $\mathbf{Y}$ is the *44x1* vector of translog function parameters and $\mathbf{Z}$ is a *8x44* matrix of zeros, ones and the means of log variables, as given in equation 3. Using this matrix notation we obtain the variance-covariance matrix of the elasticity matrix ***E***, $\mathrm{S}_{\boldsymbol{E}} = \boldsymbol{Z}\,\mathrm{S}_{\mathbf{y}}\,\boldsymbol{Z}'$, where $\mathbf{S}_{\mathbf{y}}$ is the variance-covariance matrix of the parameter estimates, excluding the intercept.

In the rest of the paper, the results focus on the elasticities and are presented in two parts. First, based on table 2, the full sample period, 1967-90, is discussed; this is the period for which we have complete data for the variables of interest.[9] Next, in order to undertake a more detailed analysis of the data, we repeat the estimations of the translog function for sub-sample windows, where each time we drop one observation from the beginning of the sample. We present the sub-sample elasticity estimates for different country groups in tables 3 through 5.

4.1 Full Sample Period: 1967-1990

We briefly note the results with respect to some of the conditioning parameters. World price elasticity is high when own-price elasticity of demand is high and/or there are significant diseconomies of scale in production. Indeed, world price elasticity approaches one as own-price elasticity approaches infinity, i.e., the demand curve for the country's products is infinitely elastic. As expected, the world price elasticity estimate is the lowest for developed countries (0.35), which face the least elastic demand curve and where diseconomies of scale are likely to be the weakest. The test result supports the hypothesis that world price elasticity is significantly different from one for developed countries. World price elasticity for LDCs, on the other hand, is 0.94, which is quite close to one. Taken separately, world price elasticity is about the same for export-oriented LDCs and for imported-substituting LDCs and, in both cases, is not statistically different from one.

Lower wage and material price elasticities for LDCs are consistent with their price-taking role in the world market. A price-taking firm cannot increase its prices to fully reflect increases in unit costs. In contrast, for a firm with market power, which can influence the export price of its products, the wage and material price elasticity would be significantly different from zero. Wage elasticity is the highest, 0.24, for developed countries. Wage elasticity for LDCs is 0.02 and statistically not different from zero. The result for LDCs is driven mainly by import-substituting LDCs. While their wage elasticity is –0.07 and not significantly different from zero, the wage elasticity for the export-promoting countries is 0.11 and statistically significant. The materials price elasticity is significantly different from zero for all groups. It is the highest for the developed country group (0.19), and approximately 0.06 for LDC groups.

What is the evidence for the cost-reducing role of machinery and equipment stock? Elasticity estimates for the entire period show that imported machinery has a cost reducing impact for developed countries and export-oriented LDCs. But this effect is significant for the imports of equipment in the past year and not for the stock of imported equipment at the start of the previous year. Thus, the evidence suggests that the technology embodied in new imported equipment helps the competitive position and, moreover, is relatively quick acting. For export-oriented developing countries, the coefficient on the lagged capital *stock* term is also negative though statistically insignificant. Thus, the implication is that the gains achieved from new investments in imported capital goods are not reversed. For developed countries, the coefficient

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[9] The binding data constraint is imposed by the use of machinery investment data from the Penn World

on the lagged capital stock term is positive but never statistically different from zero, implying also some persistence in the cost reducing effects.

Do domestic and imported machinery substitute for each other? The nonnested Davidson & McKinnon (1981) J-test is used to test whether imported and domestically produced machinery are perfect or imperfect substitutes in terms of their cost reduction effect (see also Greene 1997 for a description of the test). If they are imperfect substitutes, then we need to consider their cost reduction effects separately and the price equation with both imported and domestic machinery as separate right-hand-side variables, as in equation (2) above, is appropriate. However, if they are perfect substitutes, then we need to include their sum, the total machinery stock, as a right-hand-side variable. The usual nested test does not apply in this situation because an alternative to the null hypotheses cannot be constructed based on restricting the parameters implied by the null. Because of this property of the model, imperfect and perfect substitution are nonnested hypotheses.

The J-test is used in such situations but because it is a two-way test its use may lead to inconclusive results. In the first stage (which we call hypothesis test H2) imperfect substitution is the null hypothesis and perfect substitution is the alternative hypothesis.[10] The procedure works as follows. First the predicted export price is obtained under the assumption of perfect substitution (domestic and imported machinery are added to form one capital stock variable). Then this predicted export price is included as an additional variable in the export price estimation under the imperfect substitution assumption. If the coefficient on the predicted export price variable is significantly different from zero, then imperfect substitution hypothesis is rejected. The J-test amounts to testing whether the estimate of the dependent variable obtained under the alternative

perfect substitution specification has any explanatory power in the null imperfect substitution specification of the export price function. If it does, then we reject the imperfect substitution hypothesis. The p-values reported in tables 2 through 5 refer to the statistical significance of the coefficient on the predicted price estimated from the alternative hypothesis.

Tables, which ends in 1990.

[10] We thank an anonymous referee for suggesting the use of nonnested hypothesis tests.

Next, we take perfect substitution as the null hypothesis and imperfect substitution as the alternative and again conduct the J-test (H3). If the test fails to reject the null perfect substitution hypothesis, then we conclude that the two types of machinery are perfect substitutes. If, instead, the test rejects the null hypothesis of perfect substitution, then we need to look at the result of the test where the null hypothesis is imperfect substitution (H2). If the null hypothesis of imperfect substitution can not be rejected then we can conclude that the two types of machinery are imperfect substitutes.

Though potentially ambiguous, the J test, in this instance, is quite clear. The null hypothesis of perfect substitution is rejected but the null of imperfect substitution cannot be rejected even at very high significance levels.

4.2 Sub-sample Windows

Considerable changes occurred in the extent of market power and the technology absorption capacity of different countries over the period 1967-1990. Sub-sample windows regressions help us study the evolution of elasticity estimates. We start with the full 1967-90 sample. Then, we drop the observation for 1967 and estimate the model for the 1968-90 sub-sample. Next, we drop the observation for 1968 and estimate the model for 1969-90 and so on up to the 1979-90 sub-sample window. In this fashion, we obtain 13 different estimates of elasticity. In the remainder of this section, we analyze and discuss these results in detail. As we move from the first (1967-90) to the last (1979-90) window, we obtain a better fit for the regressions (the adjusted-R^2 increases) for DCs and for import-substituting LDCs, while the quality of the fit in this sense remains relatively unchanged for export-oriented LDCs.

Note first that the Davidson and McKinnon J-test continues to strongly reject the null of perfect substitution (between imported and domestic machinery) but not the null hypothesis of imperfect substitution.

For developed countries, we find that the cost reducing effect of investment in new machinery declined quite rapidly and, though the sign continued to be negative in all except one period, by the early 1970s the effect had become statistically insignificant. Soon, thereafter, i.e., by the mid-1970s, domestic machinery stock is seen to have a cost reducing effect. One could interpret this shift as implying that domestic capabilities matured by the early 1970s in developed countries and hence the leading edge of the innovation process shifted from a reliance on external sources to a locus of domestic research and adaptation activities. The implication is not necessarily that domestic machinery embodied more sophisticated technologies than imported machinery but rather that domestic machinery came to occupy a more central role in a broader process of technical innovation, one that had persistent effects.

For export-oriented developing countries, we find a similar pattern of evolution. In the case of these countries, the cost-reducing effect of new investment in imported machinery remains statistically significant throughout the period, though there is some suggestion that the magnitude of the effect declined in the 1980s. In the 1980s also, with the development of domestic capabilities (not always in advanced research but typically in rapid reverse engineering and adaptation of technologies), the domestic investment process came to occupy a more central role in technological advance.

Finally, for import substituting economies, the effect of imported equipment had been negligible till the late-1970s. The inevitable process of opening markets began to occur also in these countries in the early 1980s. This was accompanied also by domestic deregulation and, hence, greater competition both from domestic and foreign competitors. During this period, we see that investment in imported goods came to acquire greater importance in terms of its cost-reducing role. However, the results also suggest that the period of technological advance based on imported goods has not yet been followed by a shift to domestic sources of innovation.

5. Conclusions

In this paper, we have provided empirical evidence on the relationship between export competitiveness and the flows and stock of machinery, allowing for the possibility of imperfect substitution between domestically produced and imported machinery. Our results show that imported machinery has had an important cost reducing effect in developed and export-oriented developing countries. This effect acted quickly and typically was not reversed. For developed countries, the cost-reducing effect of imported capital goods faded by the early 1970s, presumably as locus of innovation centered increasingly on domestic sources of innovation. For export-oriented developing countries, imports of capital goods continued to have an effect throughout the period, though the benefits from domestic innovative activities also became tangible from the early 1980s.

In contrast, in countries where import-substitution had been the dominant trade strategy, exporters were not able to or did not have the incentive to use imported machinery to improve their competitiveness till the late 1970s. Thereafter, as some of these economies became more open to international trade and less regulated domestically, imported capital goods came to be more closely aligned to innovation decisions and hence to a cost-reducing effect. Domestically produced machinery does not appear to have provided sustained aid to international competitiveness in such countries.

An interpretation of the De Long and Summers papers is that since additions to the stock of machinery spur growth, government policies should support the rapid increase of equipment stock. However, the authors themselves were cautious in this regard and were more inclined to favor a liberal import regime, which while rewarding entrepreneurial behavior, would facilitate the inflow of imported equipment and hence foster growth.

This paper certainly supports that view. But this paper also suggests the possibility of sequencing in innovative activities. Early innovation is most quickly achieved through imports of technology. However, in parallel, domestic innovation capability can be built and ultimately become the locus of the principal investment in innovation. In the wake of increasing labor costs, countries adopting an export-oriented strategy, and especially the East Asian NICs, relied heavily on machinery imports to acquire modern technology. Governments and private businesses supported the absorption and adaptation of imported technology through local R&D and engineering efforts. Over time, the domestic efforts have come to occupy a more prominent position.

Further work along these lines would benefit from disaggregated time series data on manufacturing subsectors. Data on sectoral machinery investment as well as machinery prices would enable endogenizing the use of machinery. Further, our results point to the importance of trade as a vehicle for transfer of knowledge, identifying capital goods as the conduit. However, recently, Keller (2000) and Branstetter (2001) have argued that while international knowledge transfer through trade may occur, knowledge spillovers within a country are quantitatively more important. Our results suggest that the relative importance of internal and external knowledge spillovers may change over time as the international environment changes and also as the domestic incentives and absorptive capacity evolve. A further exploration of the determinants of internal and external knowledge spillovers is also likely to be a fruitful avenue of research.

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Figure 1. Change in Manufactured Exports on Change in Total, Imported and Domestic Machinery Stock

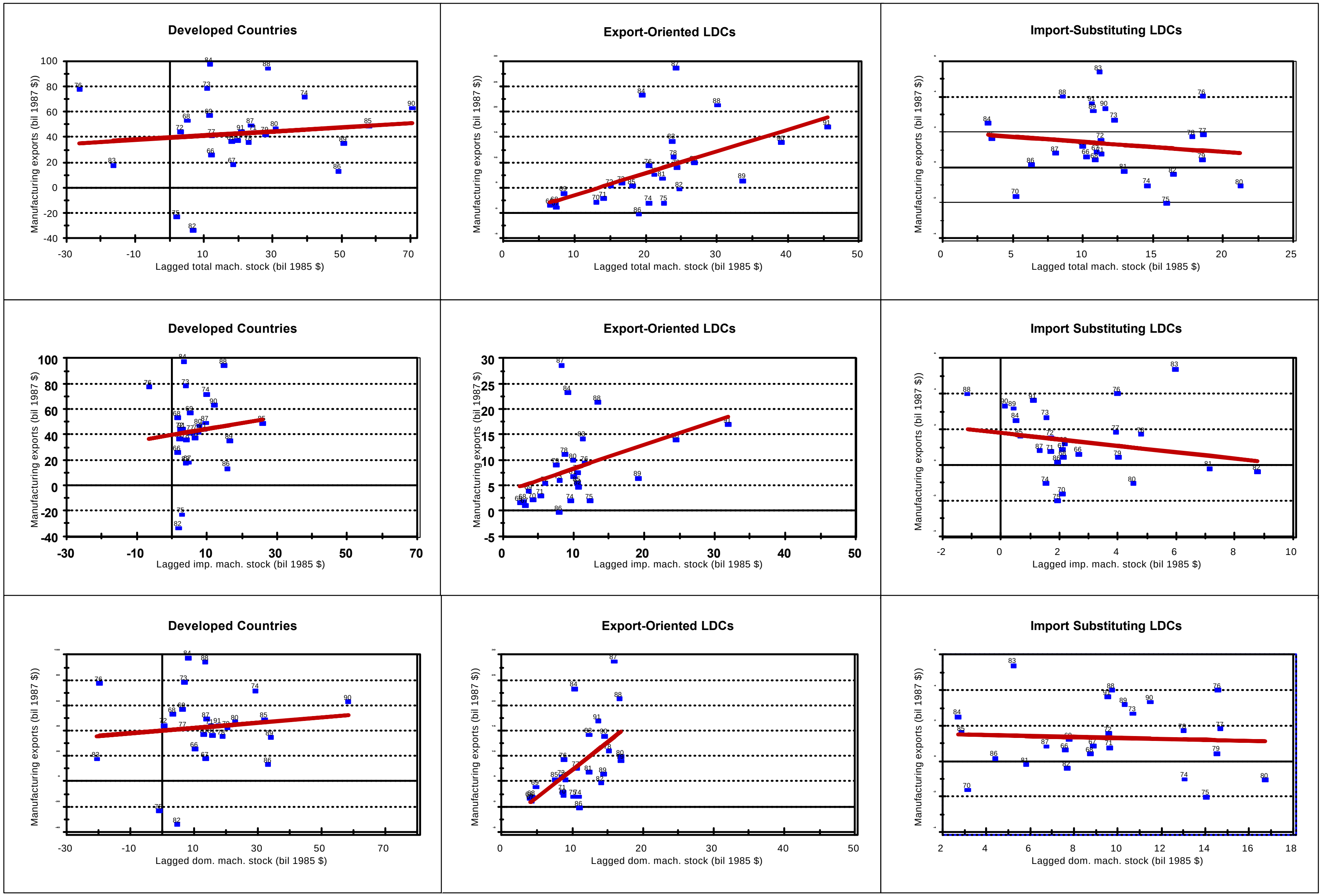

Table 1. Export price equation – TransLog estimates (1967-1990)

Parameter	Developed Countries		Less-Developed Countries		Export-Oriented LDCs		Import-Substituting LDCs	
b_{Pw}	2.418	(1.62)	-2.595	(1.39) #	-1.951	(2.31)	-4.187	(2.02) *
b_{w}	-0.517	(0.89)	-0.003	(0.52)	-1.536	(1.23)	0.286	(0.78)
b_{Pm}	1.608	(1.15)	1.878	(0.35) **	2.451	(0.59) **	1.798	(0.56) **
b_{e}	-0.340	(1.71)	-2.140	(0.64) **	-1.221	(1.52)	-2.170	(0.97) *
b_{Im}	-1.699	(0.73) *	1.156	(0.35) **	0.990	(0.78)	1.936	(0.49) **
b_{Id}	-0.124	(0.46)	0.474	(0.32)	0.676	(0.45)	0.414	(0.48)
b_{Km}	2.782	(1.33) *	-1.446	(0.79) #	-2.389	(1.47)	-3.146	(1.43) *
b_{Kd}	0.428	(0.68)	-0.652	(0.98)	0.696	(1.53)	0.554	(1.57)
y_{Pw}	-0.217	(0.27)	0.319	(0.31)	0.352	(0.46)	0.589	(0.47)
y_{w}	-0.138	(0.14)	-0.116	(0.05) *	-0.255	(0.13) *	-0.098	(0.08)
y_{Pm}	0.226	(0.18)	0.175	(0.04)	0.259	(0.05) **	0.161	(0.07) *
y_{e}	0.392	(0.31)	0.135	(0.07) #	-0.039	(0.20)	0.203	(0.11) *
y_{Im}	0.072	(0.08)	0.026	(0.05)	-0.059	(0.06)	0.201	(0.09) *
y_{Id}	-0.010	(0.02)	0.011	(0.01)	0.004	(0.02)	0.010	(0.02)
y_{Km}	-0.176	(0.18)	0.099	(0.12)	0.037	(0.20)	0.593	(0.25) *
y_{Kd}	-0.060	(0.07)	0.076	(0.08)	-0.060	(0.12)	0.234	(0.13) #
$y_{Pw,w}$	-0.027	(0.17)	0.037	(0.10)	0.161	(0.17)	0.032	(0.16)
$y_{Pw,Pm}$	-0.222	(0.18)	-0.393	(0.08) **	-0.502	(0.12) **	-0.405	(0.14) **
$y_{Pw,e}$	0.094	(0.26)	0.423	(0.14) **	0.418	(0.24) #	0.424	(0.21) *
$y_{Pw,Im}$	0.163	(0.10) #	-0.172	(0.07) *	-0.167	(0.11)	-0.306	(0.10) **
$y_{Pw,Id}$	0.118	(0.07) #	-0.044	(0.06)	0.018	(0.07)	-0.011	(0.10)
$y_{Pw,Km}$	-0.012	(0.16)	0.295	(0.11) **	0.170	(0.19)	0.515	(0.16) **
$y_{Pw,Kd}$	-0.259	(0.08) **	0.077	(0.08)	0.061	(0.17)	-0.009	(0.12)
$y_{w,Pm}$	0.199	(0.09) *	0.033	(0.03)	-0.011	(0.06)	0.071	(0.04) #
$y_{w,e}$	-0.138	(0.13)	0.084	(0.05) #	0.284	(0.15) *	0.024	(0.08)
$y_{w,Im}$	-0.066	(0.06)	0.085	(0.03) **	0.118	(0.06) *	0.049	(0.06)
$y_{w,Id}$	-0.058	(0.05)	-0.028	(0.03)	-0.031	(0.05)	0.000	(0.05)
$y_{w,Km}$	0.095	(0.11)	-0.088	(0.04) *	-0.097	(0.10)	-0.037	(0.10)
$y_{w,Kd}$	0.117	(0.08)	0.026	(0.04)	0.113	(0.13)	-0.052	(0.09)
$y_{Pm,e}$	-0.302	(0.23)	-0.216	(0.05) **	-0.255	(0.08) **	-0.231	(0.08) **
$y_{Pm,Im}$	-0.053	(0.09)	0.009	(0.03)	0.036	(0.03)	0.018	(0.04)
$y_{Pm,Id}$	-0.062	(0.07)	0.049	(0.02) *	0.052	(0.03) #	0.032	(0.03)
$y_{Pm,Km}$	-0.109	(0.11)	0.005	(0.03)	-0.064	(0.05)	0.018	(0.05)
$y_{Pm,Kd}$	0.111	(0.08)	-0.056	(0.02) *	-0.026	(0.04)	-0.050	(0.03)
$y_{e,Im}$	0.249	(0.11) *	-0.100	(0.03) **	-0.164	(0.06) **	-0.059	(0.06)
$y_{e,Id}$	0.083	(0.07)	-0.030	(0.03)	-0.033	(0.05)	-0.043	(0.06)
$y_{e,Km}$	-0.209	(0.15)	0.069	(0.05)	0.172	(0.11)	0.010	(0.09)
$y_{e,Kd}$	-0.122	(0.09)	0.055	(0.04)	-0.085	(0.13)	0.098	(0.08)
$y_{Im,Id}$	0.013	(0.04)	0.012	(0.02)	-0.012	(0.03)	0.003	(0.04)

$y_{Im,Km}$	-0.009	(0.09)	-0.049	(0.06)	0.109	(0.09)	-0.184	(0.09)

Table 1 (cont'd). Export price equation – TransLog estimates (1967-1990)

Parameter	Developed Countries	Less-Developed Countries	Export-Oriented LDCs	Import-Substituting LDCs
$y_{Im,Kd}$	-0.027 (0.05)	-0.027 (0.03)	-0.081 (0.06)	-0.041 (0.06)
$y_{Id,Km}$	-0.056 (0.05)	-0.013 (0.02)	-0.011 (0.04)	-0.032 (0.04)
$y_{Id,Kd}$	0.029 (0.03)	-0.037 (0.02) #	-0.065 (0.04)	-0.021 (0.03)
$y_{Km,Kd}$	0.074 (0.09)	-0.021 (0.08)	0.058 (0.12)	-0.287 (0.17) #
Adj-R^2	0.87	0.35	0.49	0.22
DW Stat.	1.95	2.21	2.22	2.21
RSS	0.332	5.044	1.365	3.397
No of DOF	268	502	218	240
H1	87.9 [<0.001]	2.13 [0.15]	0.65 [0.42]	0.29 [0.59]
H2	2.81 [0.20]	0.03 [0.87]	1.30 [0.26]	-0.15 [0.70]
H3	34.9 [<0.001]	18.4 [<0.001]	15.5 [<0.001]	12.9 [<0.001]
H4	43.1 [<0.001]	11.9 [0.98]	6.4 [0.85]	8.4 [0.76]
H5	154.7 [<0.001]	96.2 [<0.001]	101.7 [<0.001]	69.2 [0.001]

Notes: Figures in parentheses are heteroskedasticity consistent (White 1980) standard errors.
Figures in square brackets are the marginal significance levels for the corresponding hypothesis.
**, * and # denote significance at the 1, 5 and 10 percent level, respectively.

Hypothesis Tests:

H1: World price elasticity is equal to one. (joint test for market power and economies of scale)
H2: Davidson & McKinnon J-test: Imported and domestic M&E are imperfect substitutes.
H3: Davidson & McKinnon J-test: Imported and domestic M&E are perfect substitutes.
H4: Country fixed effects are not different from each other.
H5: Cobb-Douglas and Translog functional forms are not different.

Table 2. Export price equation – Elasticity estimates (1967-1990)

	Developed Countries	Less-Developed Countries	Export-Oriented LDCs	Import-Substituting LDCs
E_{Pw}	0.355^{**} (0.069)	0.942^{**} (0.079)	0.923^{**} (0.095)	0.925^{**} (0.139)
E_{w}	0.240^{**} (0.054)	0.020 (0.03)	0.112^{**} (0.041)	-0.070 (0.066)
E_{Pm}	0.187^{**} (0.032)	0.062^{**} (0.013)	0.062^{**} (0.016)	0.056^{*} (0.022)
E_{e}	-0.712^{**} (0.050)	-0.092^{**} (0.032)	-0.213^{**} (0.052)	-0.022 (0.056)
E_{I}^{m}	-0.052^{**} (0.019)	-0.024 (0.022)	-0.072^{*} (0.033)	0.001 (0.010)
E_{I}^{d}	-0.016 (0.998)	-0.041 (0.48)	-0.042 (0.86)	-0.058 (0.76)
E_{K}^{m}	-0.097 (0.115)	-0.017 (0.084)	-0.029 (0.13)	0.068 (0.185)
E_{K}^{d}	-0.078 (0.089)	-0.170 (0.12)	-0.171 (0.15)	-0.188 (0.22)

See Notes for Table 1.

Table 3: Elasticity estimates for developed countries (sub-sample windows)

Sub-sample Window	Elasticity Estimates								Adj. R^2	Degrees of Freedom	Hypothesis Tests (marginal significance levels)		
	p_w	w	p_m **	e **	I^m_{-1}	I^d_{-1}	K^m_{-2}	K^d_{-2}			H1	H2	H3
1967-1990	0.355**	0.24**	0.187	-0.712	-0.052**	-0.016	0.097	-0.078	0.87	268	[<.001]	0.094	[<.001]
1968-1990	0.333**	0.258**	0.20	-0.724	-0.051**	-0.017	0.061	-0.067	0.87	255	[<.001]	0.10	[<.001]
1969-1990	0.28**	0.269**	0.223	-0.766	-0.053**	-0.019	-0.015	-0.108	0.88	242	[<.001]	0.965	[<.001]
1970-1990	0.277**	0.254**	0.218	-0.761	-0.039*	-0.015	0.054	-0.115	0.88	229	[<.001]	0.932	[<.001]
1971-1990	0.254**	0.263**	0.222	-0.774	-0.035#	-0.017	0.128	-0.113	0.89	216	[<.001]	0.194	[<.001]
1972-1990	0.214**	0.288**	0.238	-0.795	-0.019	-0.023	0.142	-0.124	0.89	202	[<.001]	0.035	[<.001]
1973-1990	0.18*	0.244**	0.239	-0.812	-0.017	-0.017	0.129	-0.136	0.90	188	[<.001]	0.103	[<.001]
1974-1990	0.147*	0.187**	0.25	-0.831	-0.009	-0.018	0.216	-0.112	0.90	174	[<.001]	0.475	[<.001]
1975-1990	0.125#	0.134**	0.212	-0.83	-0.02	-0.017	0.10	-0.231*	0.90	160	[<.001]	0.482	[<.001]
1976-1990	0.194*	0.079	0.185	-0.77	0.004	-0.027	0.283	-0.201*	0.92	146	[<.001]	0.234	[<.001]
1977-1990	0.162#	0.084	0.184	-0.786	-0.012	-0.033	0.171	-0.347**	0.92	132	[<.001]	0.647	[<.001]
1978-1990	0.154#	0.10	0.204	-0.8	-0.018	-0.035	0.193	-0.346**	0.93	118	[<.001]	0.124	[<.001]
1979-1990	0.147	0.079	0.157	-0.806	-0.02	-0.023	0.147	-0.233*	0.93	104	[<.001]	0.031	[<.001]

Explanatory Notes:

Parameters: **p_w**: world price, **w**: wage rate, **p_m**: price of raw materials, **e**: exchange rate, I^m_{-1} and I^d_{-1}: investment in imported and domestic machinery in t-1, K^m_{-2} and K^d_{-2}: stock of imported and domestic machinery at the end of t-2.

Hypothesis Tests:

H1: World price elasticity is equal to one. (joint test for market power and economies of scale)

H2: Davidson & McKinnon J-test: Imported and domestic M&E are imperfect substitutes.

H3: Davidson & McKinnon J-test: Imported and domestic M&E are perfect substitutes.

Significance Levels:

**, * and # denote significance at the 1, 5 and 10 percent level, respectively. (When a symbol appears at the top of the column it applies apply to all parameters in that column).

Table 4: Elasticity estimates for export-oriented LDCs (sub-sample windows)

Sub-sample Window	Elasticity Estimates								Adj. R^2	Degrees of Freedom	Hypothesis Tests (marginal significance levels)		
	p_w^{**}	w^{**}	p_m^{**}	e	I^m_{-1}	I^d_{-1}	K^m_{-2}	K^d_{-2}			H1	H2	H3
1967-1990	0.923	0.112	0.062	-0.213^{**}	-0.072^{*}	-0.042	-0.029	-0.171	0.49	218	0.42	0.26	[<.001]
1968-1990	0.882	0.108	0.068	-0.22^{**}	-0.082^{*}	-0.044	-0.093	-0.177	0.50	209	0.20	0.60	[<.001]
1969-1990	0.925	0.102	0.066	-0.201^{**}	-0.071^{*}	-0.038	-0.006	-0.154	0.52	199	0.42	0.68	[<.001]
1970-1990	0.854	0.114	0.070	-0.221^{**}	-0.074^{*}	-0.037	-0.045	-0.209	0.52	188	0.11	0.71	[<.001]
1971-1990	0.844	0.109	0.072	-0.207^{**}	-0.079^{*}	-0.042	-0.072	-0.188	0.52	177	0.09	0.59	[<.001]
1972-1990	0.857	0.108	0.068	-0.191^{**}	-0.094^{**}	-0.025	-0.081	-0.159	0.55	165	0.10	0.43	[<.001]
1973-1990	0.829	0.099	0.065	-0.192^{**}	-0.11^{**}	-0.003	$-0.243^{\#}$	-0.149	0.58	153	0.05	0.91	[<.001]
1974-1990	0.80	0.085	0.081	-0.163^{**}	-0.102^{**}	-0.002	-0.116	-0.189	0.56	141	0.02	0.92	[<.001]
1975-1990	0.811	0.087	0.058	-0.138^{**}	-0.099^{**}	0.001	-0.138	-0.16	0.39	129	0.03	0.73	[<.001]
1976-1990	0.862	$0.064^{\#}$	0.088	-0.134^{**}	-0.055^{*}	-0.023	-0.095	-0.376^{**}	0.51	117	0.10	0.74	[<.001]
1977-1990	0.875	0.088	0.083	-0.093^{*}	-0.067^{*}	-0.018	-0.189	-0.44^{**}	0.52	105	0.21	0.87	[<.001]
1978-1990	0.915	$0.067^{\#}$	0.061	-0.05	-0.063^{*}	-0.006	-0.267	-0.261^{*}	0.52	93	0.43	0.86	[<.001]
1979-1990	0.909	$0.072^{\#}$	0.056	-0.072	$-0.033^{\#}$	-0.002	-0.179	$-0.207^{\#}$	0.55	81	0.46	0.19	[<.001]

See the explanatory notes of Table 3.

Table 5: Elasticity estimates for import-substituting LDCs (sub-sample windows)

Sub-sample Window	**Elasticity Estimates**								**Adj. R^2**	**Degrees of Freedom**	**Hypothesis Tests (marginal significance levels)**		
	p_w **	w	p_m **	e	I^m_{-1}	I^d_{-1}	K^m_{-2}	K^d_{-2}			**H1**	**H2**	**H3**
1967-1990	0.925	-0.07	0.056	-0.022	0	-0.058	0.068	-0.188	0.22	240	0.589	0.702	[<.001]
1968-1990	0.853	-0.058	0.067	-0.03	0.013	-0.073	-0.028	-0.246	0.26	228	0.259	0.543	[<.001]
1969-1990	0.952	-0.012	0.061	-0.044	-0.016	-0.052	0.118	0.018	0.38	216	0.675	0.376	[<.001]
1970-1990	0.946	-0.006	0.056	-0.046	-0.023	-0.044	0.207	0.016	0.4	203	0.621	0.643	[<.001]
1971-1990	0.956	0.002	0.055	-0.029	-0.018	-0.038	0.371#	-0.076	0.44	191	0.675	0.425	[<.001]
1972-1990	0.867	-0.02	0.052	-0.045	-0.028	-0.029	0.276	-0.033	0.44	179	0.168	0.587	[<.001]
1973-1990	0.85	-0.041	0.049	-0.014	-0.02	-0.039	0.276	-0.125	0.45	166	0.107	0.653	[<.001]
1974-1990	0.818	0.08	0.049	-0.063#	-0.02	-0.007	0.367#	0.003	0.46	153	0.031	0.824	[<.001]
1975-1990	0.781	0.079	0.034	-0.063#	-0.026	-0.015	0.308	0.012	0.28	140	0.013	0.899	[<.001]
1976-1990	0.885	0.031	0.047	-0.07*	-0.018	-0.035	0.276	-0.086	0.37	127	0.168	0.818	[<.001]
1977-1990	0.832	0.052	0.047	-0.084*	-0.055*	-0.013	0.105	0.15	0.45	114	0.045	0.354	[<.001]
1978-1990	0.904	0.042	0.029	-0.059#	-0.056*	-0.044	0.139	0.196	0.53	101	0.253	0.463	[<.001]
1979-1990	0.918	0.001	0.036	-0.028	-0.078*	-0.016	-0.138	0.33	0.58	88	0.388	0.596	[<.001]

See the explanatory notes of Table 3.

APPENDIX

DATA SOURCES, DESCRIPTIVE STATISTICS AND UNIT ROOT TESTS

Table A.1 Definition of Variables and Data Sources

Developed and Less Developed Countries	
p_w	Unit value index for manufacturing exports from the rest of the world, 1987=100. Calculated from the export prices of all other countries weighted by their world market shares. *Source: IECTRADE database, The World Bank.*
w	Annual wage per employee in manufacturing industry, 1000 US$, (= Total Wage Bill/No of Employees), *Source: UNIDO Sectoral Database*). The $ value was converted to local currency using the exchange rate, e.
e	Exchange rate, local currency per US$, annual average. *Source: International Financial Statistics, IMF.*
K^T	Stock of total machinery, in 1985 constant US$. Calculated from machinery investment data, by perpetual inventory method assuming a depreciation rate of 12%. *Source: Penn World Tables, Version 5.6.*
K^m	Stock of imported machinery, constant 1985 US$. Obtained from imports of Non-electrical machinery (= 711,712,714, 715, 717,718,719) and electrical machinery (= 722, 723, 72491, 726, 7295, 7296, 7297, 7299), SITC, Rev. 1, using the perpetual inventory method with a 12% depreciation rate. *Source: COMTRADE Database, United Nations, Geneva* Note: To obtain imports in constant prices, import data in current US$ was deflated by the dollar price of investment goods from Penn World Tables, 5.6.
K^d	Stock of domestically produced machinery (= K^T - K^m)
Developed Countries only	
p	Price index for manufacturing exports of country *j*, US$, 1987=100. *Source: OECD*
p_m	Price index for imported raw materials, local currency, 1987=100. *Source: OECD*
Less Developed Countries only	
p	Price index for manufacturing exports, US$, 1987=100. *Source: IECTRADE database, The World Bank*
p_m	Price index for crude petroleum imports, US$, 1987=100. *Source: IECTRADE database, The World Bank.* The $ value was converted to local currency using the exchange rate, e.

Table A.2 Descriptive Statistics

	Period Average (standard deviation)				Capital Stock (1990)		
	p (1987=100)	w ($1000)	p_m (1987=100)	e (LC/US$)	K^T (billion 1985 $)	K^d	K^m
Developed Countries							
Australia	82.60	10.88	78.50	1.00	95.8	56.3	39.5
	(23.9)	(5.3)	(27.8)	(0.2)			
Austria	63.41	9.84	53.85	18.32	42.2	14.3	27.9
	(26.5)	(6.5)	(32.2)	(4.9)			
Belgium-	65.80	10.61	66.95	42.29	52.4	6.5	45.9
Luxembourg	(29.0)	(6.0)	(34.8)	(8.5)			
Germany	61.92	13.51	61.91	2.61	390.7	248.5	142.2
	(27.4)	(8.1)	(32.7)	(0.8)			
Denmark	62.70	14.09	51.84	7.12	31.3	11.6	19.7
	(27.1)	(7.9)	(34.2)	(1.4)			
Finland	61.61	10.30	65.26	4.33	36.2	17.2	19.0
	(31.9)	(7.2)	(31.4)	(0.7)			
France	63.37	9.91	60.86	5.65	339.2	213.2	125.9
	(27.3)	(5.8)	(32.5)	(1.3)			
Britain	66.35	8.99	65.59	0.52	335.9	196.2	139.7
	(30.2)	(5.8)	(32.2)	(0.1)			
Italy	62.43	8.52	66.98	1007.2	307.0	230.8	76.2
	(29.6)	(5.5)	(26.0)	(407.5)			
Japan	65.39	11.07	51.01	253.5	860.7	805.3	55.4
	(27.7)	(8.4)	(33.5)	(74.8)			
Netherlands	67.02	12.73	57.13	2.73	76.2	12.6	63.7
	(26.7)	(7.1)	(36.9)	(0.6)			
New Zealand	70.14	8.79	54.99	1.19	17.1	8.9	8.2
	(32.0)	(4.5)	(29.5)	(0.4)			
Sweden	66.25	11.85	79.24	5.55	54.69	13.84	40.84
	(29.1)	(5.5)	(26.1)	(1.3)			
USA	69.76	15.64	66.62	1.00	1603.1	1203.8	399.3
	(28.9)	(6.9)	(30.9)	(0.0)			
Export-Oriented LDCs							
Israel	93.18	11.48	150.26	0.60	23.09	12.79	10.29
	(16.0)	(5.5)	(65.0)	(0.8)			
S. Korea	91.93	3.58	149.81	653.56	84.84	38.35	46.49
	(17.9)	(2.4)	(66.5)	(156.0)			
Portugal	80.95	3.48	161.04	92.08	16.87	3.43	13.44
	(18.4)	(1.1)	(66.8)	(54.3)			
Thailand	86.64	1.44	152.06	22.94	39.09	18.96	20.14
	(19.3)	(0.6)	(62.5)	(2.5)			
Turkey	91.13	3.67	153.31	545.07	64.02	48.14	15.88
	(28.3)	(1.2)	(66.1)	(789.5)			

Table A.2 Descriptive Statistics (continued)

	Period Average (standard deviation)				Capital Stock (1990)		
	p *(1987=100)*	w *($1000)*	p_m *(1987=100)*	e *(LC/US$)*	K^T	K^d *(billion 1985 $)*	K^m
	Export-Oriented LDCs						
Brazil	88.02	3.36	151.46	0.00	101.16	80.25	20.91
	(18.5)	(1.0)	(58.9)	(0.0)			
Indonesia	90.98	0.75	151.46	936.2	75.68	53.72	21.95
	(20.9)	(0.2)	(58.9)	(526.3)			
Malaysia	83.69	2.27	151.46	2.44	27.57	8.59	18.98
	(22.7)	(0.7)	(58.9)	(0.2)			
Singapore	80.03	5.54	151.46	2.18	37.55	8.48	29.08
	(21.0)	(2.6)	(58.9)	(0.2)			
Uruguay	77.69	3.27	151.46	0.16	5.56	4.52	1.05
	(23.6)	(1.2)	(58.9)	(0.3)			
Greece	93.49	5.90	146.69	85.36	20.11	10.23	9.88
	(18.3)	(2.1)	(68.0)	(51.2)			
Hong Kong	83.11	1.63	151.46	6.34	23.48	6.65	16.84
	(18.2)	(0.7)	(58.9)	(1.4)			
	Import-Substituting LDCs						
Argentina	76.22	5.47	160.46	0.03	11.95	3.65	8.30
	(25.4)	(2.3)	(56.8)	(0.1)			
Colombia	76.07	2.32	156.76	136.40	12.54	5.57	6.97
	(23.3)	(0.6)	(75.4)	(141.8)			
Guatemala	82.23	2.04	155.41	1.55	3.40	2.06	1.34
	(16.9)	(0.6)	(54.8)	(1.0)			
Honduras	83.09	2.65	155.41	2.12	2.43	1.63	0.80
	(18.3)	(0.9)	(54.8)	(0.5)			
India	90.98	1.00	162.94	10.80	165.90	150.51	15.39
	(20.9)	(0.3)	(53.3)	(3.0)			
Kenya	96.19	0.10	151.46	12.46	3.15	1.04	2.11
	(14.6)	(0.0)	(58.9)	(5.2)			
Sri Lanka	88.33	1.78	153.44	21.19	2.32	0.91	1.41
	(16.6)	(0.3)	(56.5)	(10.2)			
Mexico	80.97	4.32	130.70	0.61	98.60	68.55	30.05
	(22.1)	(1.1)	(50.8)	(1.0)			
Panama	89.69	4.54	173.38	1.00	1.40	0.53	0.87
	(17.1)	(1.1)	(62.9)	(0.0)			
Peru	90.96	2.89	155.76	0.01	10.11	6.26	3.85
	(15.3)	(1.0)	(72.7)	(0.0)			
Philippines	81.86	1.26	148.53	13.06	21.45	14.17	7.28
	(15.4)	(0.4)	(63.4)	(6.6)			
Venezuela	93.83	7.62	151.46	10.36	28.86	11.53	17.33
	(26.0)	(2.9)	(58.9)	(12.1)			
Pakistan	89.69	1.10	151.46	13.44	68.62	62.15	6.47
	(17.1)	(0.4)	(58.9)	(4.1)			

Table A.3 Trade Regimes of Developing Countries (World Bank classification)*

1967-73				1973-85			
Outward-oriented		Inward-oriented		Outward-oriented		Inward-oriented	
Strongly	*Moderately*	*Strongly*	*Moderately*	*Strongly*	*Moderately*	*Strongly*	*Moderately*
Singapore	**Brazil**	Mexico	**Turkey**	**Singapore**	**Malaysia**	**Indonesia**	India
S. Korea	**Israel**	Kenya	Argentina	**Hong Kong**	**Thailand**	Sri Lanka	Peru
Hong Kong	**Thailand**	Philippines	Pakistan	**S. Korea**	**Brazil**	Pakistan	Argentina
	Indonesia	Honduras	Sri Lanka		**Turkey**	Colombia	
	Malaysia		Peru		**Israel**	Mexico	
	Colombia		**Uruguay**		**Uruguay**	Philippines	
	Guatemala		India			Kenya	
						Honduras	
						Guatemala	

*Countries not included in the classification: **Greece, Portugal** and Panama, Venezuela. Countries with names in bold face are treated as export-oriented and the others as import-substituting.
Source: The World Bank, World Development Report, 1986.

Definitions:

Strongly outward-oriented: Trade controls are either non-existent or very low in the sense that any disincentives to export resulting from import barriers are more or less counterbalanced by export incentives. There is little or no use of direct controls and licensing arrangements, and the effective exchange rates for imports and exports are roughly equal.

Moderately outward-oriented: Incentives favor production for domestic rather than export markets. But the average rate of effective protection for the home market is relatively low and the range of effective protection rates relatively narrow. The use of direct controls and licensing arrangements is limited. The effective exchange rate is higher for imports, but only slightly.

Moderately inward-oriented: Incentives clearly favor production for the domestic market. The average rate of effective protection for home markets is fairly high and the range of effective protection rates relatively wide. Direct import controls are extensive. The exchange rate is somewhat overvalued.

Strongly inward-oriented: Incentives strongly favor production for the domestic market. The average rate of effective protection for home markets is high and the range of effective protection rates wide. Direct controls and licensing disincentives to the traditional export sector are pervasive, positive incentives to nontraditional exports are few or nonexisting, and the exchange rate is substantially overvalued.

Table A.4: Im-Pesaran-Shin Unit Root Test Results

	Average ADF	Expected Value [a]	Standard Error	Standardized Average ADF
Developed Countries				
Variables in First Differences				
$\boldsymbol{Dp}$	-2.5276	-1.4290	0.1688	-6.5060 **
$\boldsymbol{Dw}$	-2.5814	-1.4492	0.1663	-6.8068 **
$\boldsymbol{Dp_m}$	-2.5718	-1.4810	0.1694	-6.4389 **
$\boldsymbol{De}$	-2.3588	-1.4401	0.1675	-5.4833 **
$\boldsymbol{DK^T}$	-2.2518	-1.6831	0.1724	-3.2990 *
$\boldsymbol{DK^m}$	-2.3732	-1.5619	0.1683	-4.8201 **
$\boldsymbol{DK^d}$	-2.6671	-1.6402	0.1680	-6.1125 **
Variables in Levels				
$\boldsymbol{p}$	-1.8951	-1.4752	0.1645	-2.5530
$\boldsymbol{w}$	-1.6833	-1.5182	0.1660	-0.9947
$\boldsymbol{p_m}$	-1.4419	-1.6494	0.1711	1.2127
$\boldsymbol{e}$	-1.2044	-1.5305	0.1658	1.9671
$\boldsymbol{K^T}$	-1.9335	-1.5804	0.1671	-2.1130
$\boldsymbol{K^m}$	-1.4902	-1.7306	0.1730	1.3891
$\boldsymbol{K^d}$	-1.4609	-1.7087	0.1697	1.4599
Less-Developed Countries				
Variables in First Differences				
$\boldsymbol{Dp}$	-2.5336	-1.5538	0.1860	-5.2669 **
$\boldsymbol{Dw}$	-2.1085	-1.4809	0.1805	-3.4769 *
$\boldsymbol{Dp_m}$	-2.9571	-1.5463	0.1811	-7.7875 **
$\boldsymbol{De}$	-2.1858	-1.5420	0.1893	-3.3992 *
$\boldsymbol{DK^T}$	-2.3027	-1.5194	0.1749	-4.4792 *
$\boldsymbol{DK^m}$	-2.1896	-1.5907	0.1783	-3.3589 *
$\boldsymbol{DK^d}$	-2.2340	-1.4719	0.1707	-4.4646 **
Variables in Levels				
$\boldsymbol{P}$	-1.1557	-1.6773	0.1928	2.7043
$\boldsymbol{w}$	-1.1079	-1.5930	0.1836	2.6425
$\boldsymbol{p_m}$	-1.5940	-1.5661	0.1773	-0.1572
$\boldsymbol{e}$	-0.9703	-1.8957	0.1844	5.0184
$\boldsymbol{K^T}$	-1.7476	-1.3673	0.1850	2.0562
$\boldsymbol{K^m}$	-1.0986	-1.6987	0.1844	3.2539
$\boldsymbol{K^d}$	-1.2850	-1.6709	0.1795	2.1480

[a] Expected value and standard error of the average ADF are computed via stochastic simulations with 10,000 replications. * and ** indicate that the null hypothesis of a unit root in each country's variable is rejected at the 5 and 1 % significance levels, respectively.