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Outsourcing Globally During the Product Life Cycle: A Theory and Some Evidence

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Abstract

We develop a theoretical framework where products go through a standard life cycle and product quality is driven by cumulative production experience. Production experience influences the nature of cross-country outsourcing activity, and hence, the contents of trade. Multinational enterprises outsource the production of relatively mature, standardized products to low-cost producers with relatively little production experience, and those of more recently developed and non-standard products to producers with relatively more experience. Using panel data covering 110 countries and the period between 1970 and 1997, we find that production experience does help to account for the variation in export content. Developing countries with initially high cumulative production experience produced and exported younger products, whereas those with less experience dealt with more mature products. Our results suggest that intra-industry trade, openness, and foreign direct investment also help to generate exports that are in the earlier stages of their life cycle. Interestingly, once the effect of experience is accounted for, the impact of educational attainment on the average product life cycle stage of exports is not robust.

Keywords: learning-by-doing, human capital, intra-industry, trade.

JEL Classification Numbers: I20, J24, O11, O31, O40.

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1. Introduction

Economists have well established that learning-by-doing influences product proliferation, international trade, and economic growth.[1] They have also revealed that potential productivity gains from learning-by-doing decline as products or industries mature.[2] Together these findings suggest that embedding the learning-by-doing process into a product life cycle can be fruitful for better understanding the flows of foreign trade, in general, and the outsourcing activities of multinational enterprises, in particular. But, so far, theoretical and empirical work on how learning and the stages of the product life cycle jointly affect foreign trade and outsourcing has been lacking.

In this paper, we explore the relationship between learning and outsourcing during the product life cycle.[3] We develop a theoretical framework where products go through a standard life cycle and product quality is driven by cumulative production experience. Learning-by-doing influences the nature of cross-country outsourcing activity, and hence, the contents of trade. Multinational enterprises contract out the production of relatively mature, standardized products to low-cost producers with relatively little production experience, and those of more recently developed and non-standard products to producers with relatively more experience.

Using panel data covering 110 countries and the period between 1970 and 1997, we find that learning-by-doing does help to account for the variation in export content. Developing countries with initially high cumulative exporting experience produced and exported younger products, whereas those with less experience dealt with more mature products. In addition to demonstrating that learning-by-doing affects the nature of ex-

[1]See, for instance, Arrow (1962), Stokey (1991), Young (1991, 1993), Benarroch and Gaisford (2001), and Goh and Oliver (2002).

[2]The empirical evidence that suggests productivity gains are bounded from above, and thus, that they are inversely related to the product life cycle, is provided by Levhari and Sheshinki (1973). They show that the elasticity of output with respect to production experience is a concave (quadratic) function of the level of experience. Further, Epple, Argote, and Devadas (1991) find that the gains from learning is decreasing in the level of knowledge. For more details on this literature, see Young (1993).

[3]Products and services generally go through a three-stage product life cycle (hereafter, the PLC). In the first stage, products are relatively new and they undergo intense innovation. Markets for those products are not well-defined or standardized. In the second stage, a dominant design begins to emerge and sales increase. In the final stage, manufacturing starts to become standardized, product innovation is incremental rather than radical, and competition is based largely on price and cost minimization (see, Hobday, 1995).

ports, our empirical results suggest that formal schooling, intra-industry trade, openness, and foreign direct investment also influence whether economies export mainly standardized products or non-standardized, skill-intensive goods. Interestingly, however, we find that the effect of schooling on the average product life cycle stage of exports is not robust.

2. Related Literature

This paper sits at the crossroads of three strands in the economics literature. First, there exists a number of mostly empirical papers that identify the product life cycle (PLC) and explore its link with the patterns of international trade and outsourcing. Vernon was the first to articulate these potential links in the 1960s. According to Vernon (1966), multinational enterprises in developed countries would outsource predominantly the production of standardized products in less-developed countries. But in the late 1960s a change in the relationship Vernon had identified started to occur. As Vernon (1975) recognized, multinational enterprises had begun to establish subsidiaries (and to outsource production) in other developed countries, and "the interval of time between the introduction of a new product...and its first production at a foreign location [had] been rapidly shrinking." And over time, empirical evidence began to accumulate which suggested that, as developing country manufacturers became more and more experienced, their production and export activities involved products that were in earlier stages of their life cycles. [See, for instance, Hobday (1995), Lall (1998, 2000), Arpan and Kim (1973), Narayanan and Wah (2000).] By emphasizing the role of learning-by-doing and production experience in the MNEs' decisions to outsource, the work below provides an explanation for why and how the relationship between outsourcing and the product life cycle evolve over time.

Second, there are theoretical efforts to examine the nature of international outsourcing. Pack and Saggi (2001) explore the extent to which outsourcing activities generate technology transfers. They argue that the incentives of the MNEs to transfer their technologies to suppliers in less-developed economies are higher if there exists technological spillovers among less-developed firms and if such firms ability to penetrate the MNEs home market is limited. Grossman and Helpman (2002) construct a general equilibrium framework that helps to identify the determinants of international outsourcing. Their results indicate that, in deciding where to outsource, MNEs seek suppliers who have complementary expertise, who can custom-tailor products according to the MNEs needs, and who are willing to undertake relationship-specific investments.[4] Like the papers in this strand, our present effort aims to identify factors that influence international outsourcing activity.

Finally, there are theoretical papers that explore how role of learning-by-doing influences growth in open economies. Among the earliest is Young (1991) who shows how learning-by-doing, which generates spillovers into other goods and is–like it is in what follows–bounded from above, influences the gains from trade, technological progress, and economic growth. Benarroch and Gaisford (2001) follow up on Young's idea, and examine the impact of export promoting subsidies when learning-by-doing generates spillovers. They demonstrate that such subsidies in the South enhance learning and generates gains from trade for both the North and the South. Goh and Oliver (2002) present a model of trade and growth driven by learning-by-doing. By allowing capital goods to be traded internationally, they show that the existence of learning-by-doing in open economies helps to generate convergence of incomes per capita across countries. The work below highlights another novel channel through which learning-by-doing influences open economies.

The remainder of the paper is organized as follows: Section 3 describes the model, Section 4 discusses the data and our estimation strategy, Section 5 presents the results and some sensitivity analysis, and Section 6 concludes.

3. The Economy

Consider a static model where all economies are open.[5] There exists a numeraire good z

[4] More generally, these papers are related to the strand in the literature on the role of MNEs in foreign direct investment (FDI) flows. See, for example, Helpman (1984), Markusen (1984), Horstman and Markusen (1987, 1992), Brainard (1993), Markusen and Venables (1996, 1997, 1998).

[5] The model could be extended to encompass a dynamic infinite horizon. The qualitative nature of our main conclusions would not be altered under a dynamic, multi-period setup, although there could be potentially important long-run implications with respect to the cross-country world income distribution.

and n number of other goods produced by multinationals (MNEs). We assume that each good i, $i = 1, 2, ...n$, is produced by one MNE which possesses monopoly power in the production of that good. Hence, each good and MNE are associated with one industry.

3.1. The consumer

The representative (worldwide) consumer maximizes the following utility function:

$$U = \sum_{i=1}^{n} \frac{1}{\alpha}(q_i y_i)^{\alpha} + z; \qquad \alpha > 0, \tag{1}$$

subject to

$$\sum_{i=1}^{n} p_i y_i + z = I \tag{2}$$

where z denotes the consumption of the numeraire good, p_i, y_i, q_i respectively the price, the quantity, and the quality of good i, and I, $I > 0$, the income of the representative consumer.[6] This maximization problem yields the following inverse demand functions, $\forall\ i$,

$$p_i = \frac{q_i^{\alpha}}{y_i^{1-\alpha}} \tag{3}$$

Equation (3) suggests that demand for good i, y_i, is an increasing function of its quality q_i.

3.2. The Multinational Enterprise

The MNE has the capability to produce goods in its home country, but it can outsource part of the production process to a local supplier in another country. In either case, production technology is characterized by constant marginal costs. Let $C + M$ denote the total marginal cost of producing the good in the home country of the MNE. Part of the production process can be transferred abroad, which if done at home accounts for C units of the total marginal cost $C + M$. Thus, M denotes the marginal cost associated

[6] We elaborate on the determination of quality in Section 3.3.

with the non-transferable component of the production process.[7] Then MNE's profits if it produces in its home country, Π_h, are given by:[8]

$$\Pi_h = (p - C - M)y = q^{\alpha}y^{\alpha} - (C + M)y. \tag{4}$$

The MNE maximizes (4) by choosing the level of production y. The solution to this problem then yields:

$$y = \left(\frac{\alpha q^{\alpha}}{C + M}\right)^{\frac{1}{1-\alpha}} \quad , \tag{5}$$

which implies that the price for the good is given by a constant markup:

$$P = \frac{C + M}{\alpha} \tag{6}$$

According to (6), the price of the good is independent of its quality. Substituting the demand function given by (5) into the profit function of the MNE in (4), yields an expression of MNE's profits as a function of costs and quality. That is,

$$\Pi_h = (1 - \alpha)\left(\frac{\alpha q}{C + M}\right)^{\frac{\alpha}{1-\alpha}} . \tag{7}$$

3.3. Production Quality

The quality of the good, q, is given by the following:

$$q = A(H)e^{-1/(xY)}, \tag{8}$$

[7] The marginal costs C and M can be respectively asociated with the assembly of products and the production of the intermediate inputs. In general, the assembly stage is more labor intensive, and the production of intermediates is more knowledge based. Therefore, it is relatively easier to contract out the assembly of products to developing countries, which in general have more (less) abundant unskilled (skilled) labor. Alternatively, C and M can be respectively associated with the production of the entire product and marketing it globally, where the latter can be prohibitively expensive for local suppliers with limited global exposure. This is the interpretation put forward by Pack and Saggi (2001).

[8] Hereafter we drop product subscript i unless the discussion warrants its inclusion.

where H denotes the human capital of firm producing the good (which may or may not be the MNE), x, $x = 1, 2, ...X$, represents life cycle stage of the product, and Y denotes the cumulative production experience of the producer.[9] We assume that, $\forall\ H \geq 0$, A' > 0 and $A'' \leq 0$.

According to the specification in (8), product quality is bounded from above at $A(H)$.[10] The term $e^{-1/(xY)}$ in (8) captures the idea that cumulative production experience of the producer and the life cycle stage of the product *jointly* determine the effective quality of the product. In particular, the production quality of a relatively new good (i.e. one which has a low x) is higher the more experience the producer has (i.e. the higher is Y). And, the quality of a good produced by a relatively inexperienced supplier (i.e. which has a low Y) is higher the more mature and standardized the product is (i.e. a product for which x is closer to X).

Let the subscript j be such that $j = h$ for the MNE and $j = f$ for the local supplier. By assumption, the MNE has more cumulative production experience than any local supplier so that $Y_h > Y_f$. Then, given that $\forall\ H \geq 0$, $A' > 0$, the MNE can produce goods that are of higher quality than a local supplier as long as its human capital, H_h, is at least as high as that of a local producer, H_f. Thus, if $H_h \geq H_f$, $q_h = A(H_h)e^{-1/(xY_h)} > A(H_f)e^{-1/(xY_f)} = q_f$.

3.4. Outsourcing

We now turn to the MNE's decision regarding the location of production. As we stated above, the MNE can either produce goods in their home country or outsource to a local supplier in a foreign country. An MNE might find it profitable to outsource the production of its good to a supplier in a less-developed or developing country, presumably because such a supplier has lower production costs. However, due to the fact that the cumulative production experience of suppliers in such countries are generally lower

[9] As we note above, the production process entails a non-transferable stage which has to be undertaken by the MNE. We assume that either the quality variable q denotes the incremental quality associated with the potentially transferable, labor-intensive stage of production, or that quality is entirely determined in that labor-intensive stage, which may be undertaken by the MNE or the local suppliers.

[10] This is due to the fact that $\lim_{xY \to \infty} q = A(H)$.

than that of their counterparts in more advanced economies, MNE outsourcing might inherently entail a trade-off between quality and cost.

There are different mechanisms for an MNE to transfer the production of its good to the local supplier. These include host country-licencing, joint venture, subcontracting, and the establishment of a subsidiary. In most cases, the MNE and the local suppliers work together to maximize their joint profits. Thus, we assume that if the MNE outsources the production to a supplier in a foreign country, the MNE and the local producer maximize their joint surplus:

$$S = (z_h - v_h)^{\gamma}(z_f - v_f)^{(1-\gamma)} \ , \tag{9}$$

where γ, $0 < \gamma < 1$, parameterizes the Nash bargaining power of the MNE relative to the local supplier, and where $(z_h, z_f) \in \{G \ \cap \ [(z_h, z_f)| \ z_h \geq v_h \text{ and } z_f \geq v_f]\}$, with G denoting the set of feasible payoffs, and (v_h, v_f) respectively the disagreement payoffs of the MNE and the local producer.

Let P^* and y^* denote the price and quantity of the good produced such that

$$(P^*, \, y^*) \ = \ \arg\max \ (z_h - v_h)^{\gamma}(z_f - v_f)^{(1-\gamma)} \ . \tag{10}$$

Then the MNE's payoff is given by the following:

$$z_h = (P^* - M)y^* - T \tag{11}$$

where T represents the payment to the local producer and M is marginal cost of the non-transferable component of production. Note that the MNE's disagreement payoff, v_h, is given by (7).

The local producer uses the MNE's blueprints to add its value to good y, in exchange for which it gets the payment T. The marginal cost of producing the good for the local supplier is c, where $c < C$. The payoff of the local producer, z_f, is then given by

$$z_f = T - cy^* \ , \tag{12}$$

and its disagreement payoff, v_f, is equal to zero by assumption.

The MNE and the local producer then bargain cooperatively over the payment T in order to allocate the joint surplus. The outcome is determined via a Nash bargaining. Plugging in (10)-(12) in (9), we get:

$$T \ = \ \arg\max \ (P^* y^* - My^* - T - v_h)^{\gamma}(T - cy^*)^{1-\gamma} \ . \tag{13}$$

The solution to this problem yields:

$$T = (1-\gamma)(P^* y^* - My^* - v_h) + \gamma c y^* \ . \tag{14}$$

Then, substituting in for T in the payoff function in (11) yields:

$$z_h = \gamma(P^* - M - c)y^* + (1-\gamma)v_h \tag{15}$$

Next, we denote the joint profits of the MNE and the local supplier (when the MNE is supplied by the local supplier) as $\tilde{\Pi}_h$, which is given by

$$\tilde{\Pi}_h = (P^* - M - c)y^* = (1-\alpha)\left(\frac{\alpha q_f}{c+M}\right)^{\frac{\alpha}{1-\alpha}} \ , \tag{16}$$

where q_f is given by equation (8). Using equations (11), (12) and (15), we then derive that $z_h = \Pi_h + \gamma(\tilde{\Pi}_h - \Pi_h)$ and that $z_f = (1-\gamma)(\tilde{\Pi}_h - \Pi_h)$. Note that the profits of both the MNE and the local supplier depend on their bargaining power.

It is clear that MNE outsources its production to the local supplier if $\tilde{\Pi}_h \geq \Pi_h$. Particularly, whether the profits of the MNE are higher with outsourcing depends on the quality that the local supplier can provide. After substituting for q_f and q_h from (8) into (7) and (16), we find that $\tilde{\Pi}_h \geq \Pi_h$ when

$$\frac{A(H_f)e^{-1/(xY_f)}}{c+M} \geq \frac{A(H_h)e^{-1/(xY_h)}}{C+M} \; . \tag{17}$$

Thus, the threshold product generation that enables outsourcing, $\tilde{x}$, satisfies the following:

$$\widetilde{x} = \frac{(Y_h - Y_f)}{Y_h Y_f} \frac{1}{\log[(C+M)A(H_f)/(c+M)A(H_h)]}. \tag{18}$$

Equation (18) suggests that the product life cycle, learning-by-doing, human capital, and the nature of outsourcing are inextricably linked. Specifically, it suggests that an MNE is more willing to outsource a product that is in the early stages of its product life cycle (i.e. a product for which x is relatively small) only if the quality reduction due to outsourcing is not too large. The marginal loss associated with lower quality is related to the term $Y_h - Y_f$. Note that this term is smaller the more cumulative learning experience a local supplier has. Only when this is the case, does the MNE transfer the production of a relatively new good to a foreign supplier. In contrast, since the quality loss associated with the outsourcing of relatively mature and more standardized products (i.e. a product for which x is relatively large) is relatively small for a given cumulative experience gap, $Y_h - Y_f$, an MNE is more willing to transfer the production of such products to relatively inexperienced local suppliers.

As (18) implies, the human capital of the MNE relative to that of the local supplier, H_h/H_f, as well as its relative costs, $(C+M)/(c+M)$, also impact what type of product is outsourced by the MNE. In particular, the higher is the MNE's human capital relative to that of the local supplier, the bigger is the potential quality gap and the MNE outsources relatively more mature and standardized products. In contrast, the higher is the MNE's marginal production costs relative to the local supplier, the more willing it is to transfer to the local supplier the production of goods in the earlier stages of their PLCs.

Figures 1 and 2 depict the role of learning-by-doing in the MNE's decision to outsource. In both figures, the MNE's profits when it produces the good in its home country, Π_h, and that when it contracts out production to the local supplier, $\tilde{\Pi}_h$, are shown. For a given cumulative experience gap, $Y_h - Y_f$, and levels of human capital such that $H_h > H_f$, Figure 1 illustrates the PLC phase at which it becomes more profitable for the MNE to outsource production. Figure 2 then depicts how a narrowing of the cumulative experience gap, $Y_h - Y_f$, affects this critical phase.

[Figures 1 and 2 about here.]

While our model, strictly interpreted, applies to outsourcing behavior of the MNEs, there exists both theoretical and empirical justifications why it is more broadly relevant for international trade and exports: First, outsourcing activity has grown considerably in the last two decades and it now accounts for a significant share of the global flows of international trade. Recent data for 37 trading partners of the United States show for example that, between 1986 and 1997, the exports of U.S. affiliates *alone* account for about 10 percent of those countries' total manufacturing exports. Similarly, data for 19 countries show that the share of U. S. imports that are related to production-sharing arrangements tripled between 1970 and 1990 to account for 12 percent of total U. S. imports.[11] Moreover, the simple mechanism outlined above, where the cumulative production experience of local producers influences the kinds of products they produce for the MNEs to market abroad, is applicable even when the local producers do not enter the above-specified type of contractual relationships with MNEs: It is important even when local firms sell their products to importers in advanced economies or export directly by themselves.

[11] The data for the U. S. affiliates' exports are from the BEA (http://www.bea.doc.gov), and that for imports related to production-sharing are from the U. S. International Trade Comission (http://www.ftc.gov).

4. Estimation Strategy and Data

The framework outlined above illustrates the links among the product life cycle, learning-by-doing, outsourcing, and exports. In this section we find empirical evidence of the above-mentioned effects. We demonstrate that countries with higher initial levels of human capital stock and cumulative learning experience tend to produce and export products that are during the earlier stages of their life cycle. But economies with lower levels of initial human capital stock and learning experience specialize in the export of products that are relatively standardized and mature.

Equation (18) specifies the implications for the empirical relationship between the product life cycle, learning-by-doing, human capital, and the nature of exports. Implementing a convincing empirical test of its prediction, however, raises several issues. The most important involve the choice of a proxy for cumulative learning experience and the construction of the product life cycle (PLC) index. In the estimations below, we chose to employ cumulative per-capita exports of manufactured goods to developed countries as a proxy for foreign trade experience. To some degree, our choice reflects the limitations imposed upon us by the available data. But given the specification in (18), per capita cumulative export experience is highly relevant in the context of cross-border contracting and outsourcing: Countries that have relatively more export experience per capita should be more capable of meeting the quality requirements of their foreign contractors.[12]

The cross-country average of per-capita cumulative exports exhibits a strong growth trend. In addition, (18) suggests that the relevant measure of experience is not the absolute level of each countries' cumulative experience but that relative to the cumulative experience of the MNE. For these reasons, we focus on the ratio of each country's per-capita cumulative exports to the highest per-capita cumulative exports in our data. We observe this variable in an initial sub-period, keep a running total of it over the subsequent periods, and examine how it impacts the average product life cycle of a country's exports.

The construction of the PLC index is more straightforward: The National Science Foundation (NSF) collects data on intra-industry R&D spending as a share of gross

[12]The results we present here are robust to using cumulative per capita output instead of cumulative per capita exports.

sales revenue.[13] Based on the notion that R&D spending declines as the industry (or product) matures, we use this variable to proxy for the average life cycle stage of each industry. Then, using industry-wide exports as weights, we aggregate to determine the average life cycle stage of a country's exports. As an alternative but admittedly more subjective measure, we also use the United States Bureau of Economic Analysis (BEA) manufacturing industries code, and assign an index that ranges from 0 to 3 to each product code group. For product classes or industries where there is little or no manufacturing, we assign zero. For products with more manufacturing content, we assign 1 to older and highly standardized products, 3 to relatively new products, and of course, 2 to all those somewhere in between. Although in all results we show below we utilize the NSF R&D data as a proxy for the PLC index, the qualitative nature of what we present is robust to using the alternative PLC index we generated with the BEA code.

Another related issue arises due to the fact that country-specific features that could be correlated with export product characteristics may be driven by historical trade experience. For example, the existence of policies aimed at promoting or restricting foreign trade or of historical trade linkages may not only impact the total volume of trade but also the characteristics of products that are traded externally. In addition, there can be time-specific effects that influence the relationship between production experience and export characteristics. To help alleviate these concerns, we estimate a two-way, fixed-effects model utilizing panel data where we control for country- and time-specific effects.[14]

A third issue that needs to be addressed involves reverse causality and problems associated with endogeneity. It is quite plausible that the average PLC index influences the subsequent volume of exports. We attempt to address this issue in three ways. First, to focus attention on the link from learning-by-doing to product export contents, we use a lagged value of cumulative export shares, exploring the relationship between initial cumulative export shares and the PLC index. Second, we include the lagged-value of the PLC index as an additional explanatory variable. And third, we explore the importance of reverse causality by examining the relationship between the initial PLC

[13] This data is acccessible at http://caspar.nsf.gov/nsf/srs/indrd.

[14] Despite the fact that the Hausman test rejects a random-effects specification with our sample, we verified that we get similar results using a random-effect model.

and subsequent cumulative per capita export shares.

Our empirical estimates of the effect of cumulative learning experience on export content, measured by the average PLC index of exports, are obtained by estimating the following equation with panel data:

$$PLCI_{i,t} = \mu_i \ + \ \lambda_t \ + \ \beta_1 CUMEXP_{i,t-1} \ + \ \beta_2 SCHOOL_{i,t} \ + \ \beta_3 X_{i,t} \ + \ \upsilon_{i,t} \quad (19)$$

where $PLCI_{i,t}$ is an export-weighted PLC index of a country i at time t, μ_i is a country-specific effect, λ_t is a time specific effect, $CUMEXP_{i,t-1}$ is a measure of relative cumulative exports in the preceding period (constructed as defined above), and $SCHOOL_{i,t}$ is the gross secondary enrollment rates. $X_{i,t}$ are additional control variables that may help to explain the PLC index and $\upsilon_{i,t}$ is the variability in the index not explained by the regressors. We assume that $\upsilon_{i,t}$ is uncorrelated with the regressors and is distributed normally with a mean of zero and a variance of $\sigma^2_{i,t}$.[15]

The control variables in $X_{i,t}$ include the average level and growth rate of real GDP, $GDPCAP_{i,t}$, $GROWTH_{i,t}$, the openness to foreign trade, $OPEN_{i,t}$, (as measured by the ratio of exports plus imports to GDP), the gross foreign direct investment, $FDI_{i,t}$, and a measure of the extent to which foreign trade flows are driven by intra-industry trade, $IIT_{i,t}$.[16] We include $GDPCAP_{i,t}$ and $GROWTH_{i,t}$ because whether a country exports mostly standardized, mature products or non-standard newer ones might depend on its level of economic development and growth. We control for $OPEN_{i,t}$ and $FDI_{i,t}$ based on similar reasons. And we include $IIT_{i,t}$ to help account for the extent to which a country's exports might mainly involve the assembly and not the production of non-standard, high value-added, newer products.

When determining our data selection strategy, we need to consider the fact that the PLC index we construct changes very slowly. It is important to allow sufficient time

[15]In addition to adopting this assumption on the distribution of errors because of its intuitive appeal for cross-country data, we also confirmed it with a Cook-Weisberg test for heteroscedasticity.

[16]The intra-industry trade index, $IIT_{i,t}$, is computed as $\sum_j w_j * A_j$, where j denotes the industry, $w_j \equiv (Exp_j + \operatorname{Im} p_j) \ / \ \sum_j \ (Exp_j + \operatorname{Im} p_j)$, and $A_j \equiv [1 - |Exp_j \ - \ \operatorname{Im} p_j| / (Exp_j + \operatorname{Im} p_j)]$.

between observations of both the PLC index, $PLCI$, and cumulative per capita exports, $CUMEXP$, so that we can observe significant changes in both our explanatory variable and dependent variable. Thus, we face a trade-off in constructing our data set: A larger number of years between observations allows us to examine more meaningful changes in the PLC index and the explanatory variables, but at the same time, it also reduces the number of time periods we include in our regression, lowering the efficiency of our fixed effects estimation. With these trade-offs in mind, we initially examine a fixed effects model with five-year sub-periods. Later, we also consider three other models with longer and shorter sub-periods, all of which yield similar empirical results.

Our panel spans the years 1970 to 1997, and we divide it into six sub-periods: 1970-75, 1975-79, 1980-84, 1985-89, 1990-94, and 1995-97. We use the first period covering 1970 to 1975 to derive initial values for the lagged explanatory variable, cumulative per capita exports, $CUMEXP$. For each of the countries in our panel, we update cumulative per capita exports in all the subsequent sub-periods, 1975-79, 1980-84, 1985-89, 1990-94, and 1995-97. Then, we observe how the cumulative per capita export shares ($CUMEXP$) in any given period affects the average life cycle stage of exports ($PLCI$) over the subsequent sub-period.

Using this methodology, we are able to include 110 countries in our panel. Of those, 88 countries are developing countries and the remainder are industrialized countries.[17] The framework we present above makes the model more relevant for exporters in developing countries, since according to our model, cost differentials between developed and developing countries drive outsourcing activity. That noted, country income classifications are based on somewhat ad-hoc criteria. Moreover, there can exist considerable cost advantages to–and motives for–outsourcing to suppliers located in relatively high-income countries. Thus, we estimate equation (19) for both developing countries and for the whole sample of countries.

The data we use to estimate (19) come from a variety of sources. Those for the PLC index, $PLCI$, and cumulative exports per capita, $CUMEXP$, are constructed from Feenstra, Lipsey, Bowen (1997). Control variables like real GDP per capita, $GDPCAP$,

[17] The industrialized countries in our full sample are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, The Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.

real GDP growth, $GROWTH$, gross foreign direct investment, FDI, and gross secondary school enrollment rates, $SCHOOL$, are from the *World Development Indicators* (2001). Data on openness, $OPEN$, are from the Summers and Heston, Penn World Tables.

Tables 1.a and 1.b present summary statistics from our developing country sample and full sample. Both tables show that there exist, relatively strong, positive correlations between the product life cycle index, $PLCI$, and cumulative export experience, $CUMEXP$, income per capita, $GDPCAP$, average educational attainment, $SCHOOL$, and the intra-industry trade index, IIT. An interesting observation from both tables is that the unconditional correlation both between the product life cycle index, $PLCI$, and cumulative export experience, $CUMEXP$, are very similar for both developing countries and the full sample.

[Tables 1.a and 1.b about here.]

5. Results

5.1. Initial Estimates

Since our theory focuses on the link between the MNEs in advanced economies and local suppliers in developing countries, we first estimate equation (19) using the developing-country sample. The results appear in Table 2.a.

The first three columns present results from OLS estimations, the next three those with robust errors, and the last three columns show results generated with robust regression techniques. These results are consistent with the idea that the trade-weighted, average product life cycle index, $PLCI$, is associated positively with the initial level of cumulative export experience, $CUMEXP$. This association is robust to alternative econometric specifications and the inclusion of various control variables related to macroeconomic performance and foreign trade activity. While $PLCI$ is also positively related to the initial value of our human capital variable, $SCHOOL$, this association is not as robust as the one between $PLCI$ and $CUMEXP$. With respect to the association between $PLCI$ and the control variables that we include, the strongest–and most robust–is that between the $PLCI$ and the intra-industry trade index, IIT. This suggests that an important share of high technology, young product exports involve assembly only. Put differently, assembly and re-exports are more prevalent for products that are in the earlier stages of their PLCs.

[Table 2.a about here.]

As stated earlier, our theory primarily focuses on MNEs' outsourcing production activity to low-cost suppliers in developing countries. However, there is no ex-ante reason to believe that the theory should be confined to developing countries only since there can exist considerable advantages or motivations for MNEs to shift their production to suppliers located in relatively high-income countries. Thus, Table 2.b gives results from repeating the preceding exercise using all countries in our sample. These results are roughly consistent with those presented in Table 2.a. The product life cycle index, $PLCI$, is associated positively and significantly with the initial level of cumulative export experience, $CUMEXP$. This association is robust to alternative specifications and the inclusion of the control variables. Interestingly, though, the positive association between the $PLCI$ and our human capital variable, $SCHOOL$, is significant in only two of the nine specifications in Table 2.a and in four out of nine specifications in Table 2.b. This suggests that, controlling for cumulative export experience and other factors related to exports, the education of the work force is more important in determining advanced countries' export mix but that it is less of a factor for less developed economies. [We elaborate more on this below.]

[Table 2.b about here.]

5.2. Sensitivity Analysis

In this section we describe several exercises that further explore the strength of the relationship between the initial level of production experience and the average product life cycle index of exports.[18]

First, we employ robust regression techniques (that eliminates outliers–observations

[18] All of the results described in this section but not reported in detail are available from the authors upon request.

for which Cook's D > 1–and iteratively selects weights for the remaining observations to reduce the absolute value of the residuals) to help deal with concerns that results might be heavily influenced by an individual country in our data set. As shown in columns (7)-(9) of Tables 2.a and 2.b, outliers do not heavily influence our main results. Even when outliers are eliminated or given lower weights in regressions, a relatively high degree of initial cumulative production experience leads to exports of younger products.

Our initial estimations rely on cumulative exports per capita at the beginning of a time period and a measure of subsequent product life cycle index. However, the years we use to calculate the initial cumulative exports per capita immediately precede those years which we use to calculate subsequent PLC index of average exports. In order to determine if our results are sensitive to the time period in which we measure the initial cumulative level of per capita exports, in Tables 3.a and 3.b we repeat the estimations presented in Tables 2.a and 2.b, but this time we measure cumulative per capita level of exports with a five-year lag between the last year we use in the $CUMEXP$ measure and the first year we use in the $PLCI$ measure (i.e., cumulative exports per capita, $CUMEXP$, is measured over the periods 1970-75, 1970-80, 1970-1985, 1970-1990, and 1970-95, and the product life cycle index of exports, $PLCI$, is measured over the periods 1980-84, 1985-89, 1990-94, and 1995-97). These results confirm our initial findings: The trade-weighted, average, product life cycle index, $PLCI$, is associated positively and significantly with the initial level of cumulative export experience, $CUMEXP$. This association is robust to alternative econometric specifications and the inclusion of various control variables. The $PLCI$ is also positively related to the initial value of our human capital variable, $SCHOOL$, but this association is not as robust as the one between $PLCI$ and $CUMEXP$. With respect to the association between $PLCI$ and the control variables that we include, the strongest–and most robust–is again that between the $PLCI$ and the intra-industry trade index, IIT.

[Tables 3.a and 3.b about here.]

By construction, the variation over time in our dependent variable, the export-weighted average product life cycle index, $PLCI$, is small. Hence, it is important to check the degree to which lagged values of the $PLCI$ can explain the cross-country variations in $PLCI$ over time. To this end, Tables 4.a and 4.b include the lagged values of the $PLCI$ as an additional explanatory variable. As shown, while the lagged-$PLCI$ explains a great deal of the variation in subsequent $PLCI$, the effect of the initial level of cumulative export experience, $CUMEXP$, on the product life cycle index still remains significant and positive.

[Tables 4.a and 4.b about here.]

We also attempted to determine how robust our results were to different sample selection strategies. As mentioned above, a larger number of years between observations reduces the number of time periods we include in our regression, reducing the efficiency of our fixed effects estimation. But it also allows us to examine more meaningful changes in the PLC index and the explanatory variables. Keeping this tradeoff in mind, we generated another data set by increasing the time period between the measurement of cumulative per capita exports and that of the product life cycle index. Now there are three sub-periods between the years 1970 and 1997. They cover 1970-79, 1980-89, and 1990-97. As before, we use the first period covering 1970 to 1979 to derive initial values for the lagged explanatory variables, cumulative per capita exports, $CUMEXP$. For each of the countries in our panel, we update cumulative per capita exports in the two subsequent sub-periods, 1980-89 and 1990-97. While we do not report the results here, our findings are similar to the ones shown in Tables 2.a and 2.b. We also repeated the estimations presented in Tables 2 and 3 by measuring $CUMEXP$ annually and with a three-year moving average window. These results, too, confirm our initial findings which suggest that higher values of lagged cumulative learning lead to exports that are, on average, in earlier stages of their product life cycle.

It is quite plausible that countries that produce goods and services that are newly invented and in the earlier stages of their PLCs tend to export more. To test whether our results are plagued by reverse causality, we also explored the relationship between the initial PLC index and subsequent cumulative per capita exports. Our results are shown in Tables 5.a and 5.b. As can be seen, the effect of the initial PLC on the subsequent volume of cumulative per capita exports is not robust. In some cases, the coefficient on lagged-$PLCI$ is even negative and significant.

[Tables 5.a and 5.b about here.]

Finally, it is possible that the impact of learning on export content is influenced by the industry-wide concentration of production experience. To examine whether that is the case, we constructed the Herfindahl industry concentration index for our sample, and reestimated (19) with the index as an additional control variable in X_t. The Herfindahl index was not statistically significant in any of the empirical estimations similar to those in Tables 2 and 3. Hence, we do not report them here.

6. Conclusion

Learning-by-doing and cumulative production experience influence wide ranging economic phenomena such as product proliferation, foreign trade and economic growth. Yet their potential to generate productivity improvements are bounded from above because the extent to which additional learning takes place and cumulative production experience leads to further improvements declines as industries or products mature. These findings suggest to us that, understanding the determinants of foreign trade flows, in general, and outsourcing activity of the MNEs, in particular, requires embedding learning-by-doing into the broader context of the product life cycle.

To achieve this end, we develop a theoretical framework where products go through a standard life cycle and product quality is driven by cumulative production experience. Learning-by-doing influences the nature of cross-country outsourcing activity, and hence, the contents of trade. Multinational enterprises contract out the production of relatively mature, standardized products to low-cost producers with relatively little production experience, and those of more recently developed and non-standard products to producers with relatively more experience.

Using panel data covering 110 countries and the period between 1970 and 1997, we find that learning-by-doing helps to account for the variation in export content. Developing countries with initially high cumulative production experience produced and exported younger, products, whereas those with less experience dealt with more mature products. In addition to demonstrating that learning-by-doing affects the nature of exports, our empirical results suggest that formal schooling, the extent of intra-industry trade, and the openness of economies also influence whether economies export mainly standardized products or non-standardized more skill-intensive goods.

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Figure 1. The decision to outsource when Y_h - Y_f is large.

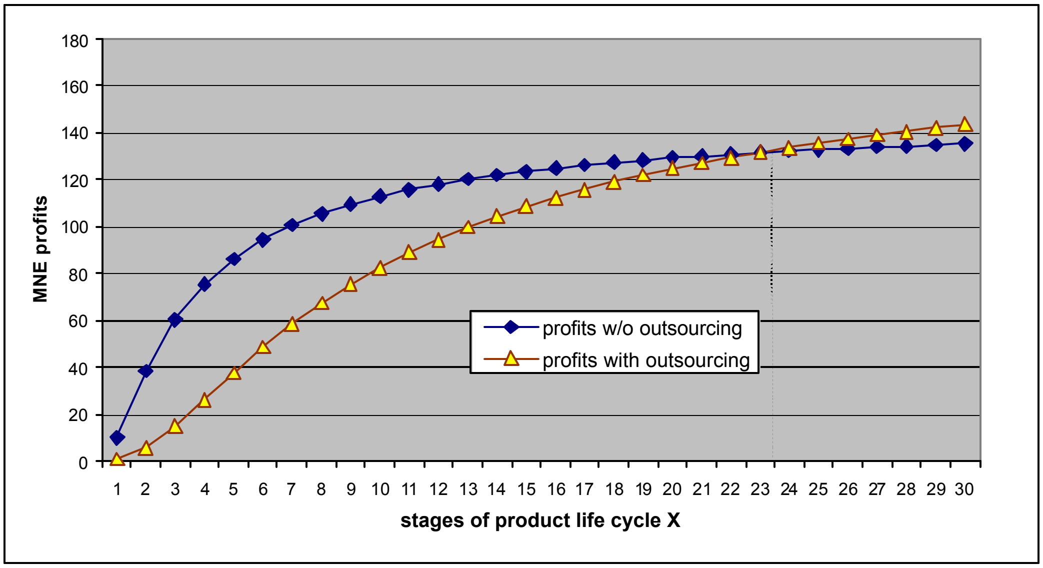

Figure 2. The decision to outsource when Y_h - Y_f is small.

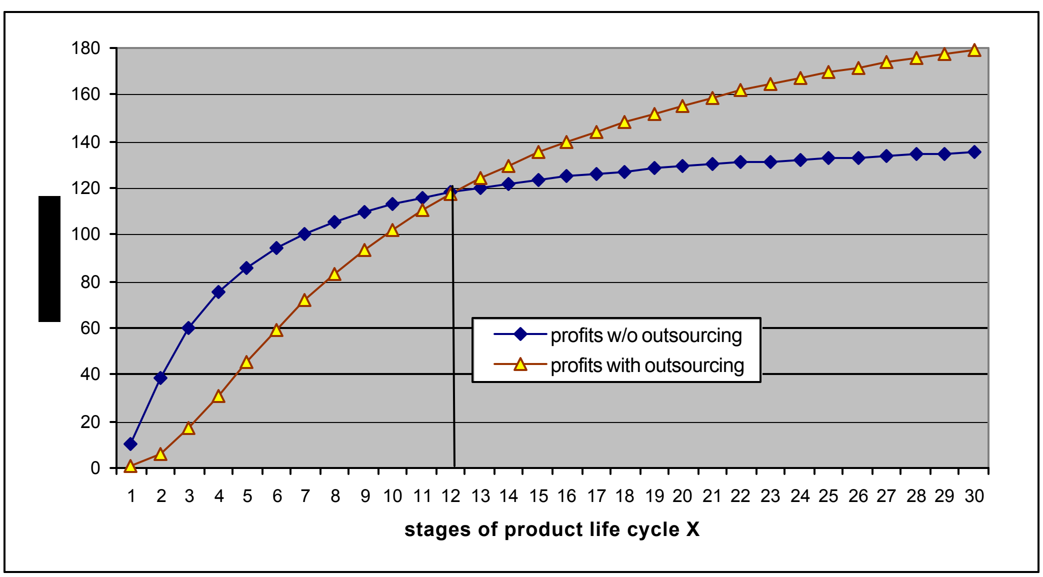

Table 1.a. Descriptive Statistics for Developing Countries

			The Correlation Matrix							
	Mean	*S. D.*	*PLCI*	*CUMEXP*	*SCHOOL*	*IIT*	*OPEN*	*FDI*	*GDPCAP*	*GDPGR*
PLCI	.996	.688	1.00	...	...	...	...	...	...	...
CUMEXP	.020	.060	.577	1.00	...	...	...	...	...	...
SCHOOL	38.73	25.47	.389	.316	1.00	...	...	...	...	...
IIT	30.11	18.44	.496	.447	.511	1.00	...	...	...	...
OPEN	64.65	44.69	.462	.741	.290	.324	1.00	...	...	...
FDI	3.81E+7	1.39E+8	.478	.632	.266	.379	.328	1.00	...	...
GDPCAP	1.94	2.72	.544	.824	.578	.538	.521	.597	1.00	...
GDPGR	3.79	3.58	.099	.181	.103	.125	.179	.216	.176	1.00

Table 1.b. Descriptive Statistics for All Countries

			The Correlation Matrix							
	Mean	*S. D.*	*PLCI*	*CUMEXP*	*SCHOOL*	*IIT*	*OPEN*	*FDI*	*GDPC.*	*GDPGR*
PLCI	1.181	.799	1.00	...	...	...	...	...	...	...
CUMEXP	.083	.171	.549	1.00	...	...	...	...	...	...
SCHOOL	52.13	32.78	.532	.597	1.00	...	...	...	...	...
IIT	36.03	22.11	.603	.562	.665	1.00	...	...	...	...
OPEN	65.04	42.65	.335	.389	.153	.208	1.00	...	...	...
FDI	3.68E+8	1.54E+9	.406	.246	.362	.369	-.088	1.00	...	...
GDPCAP	5.72	8.93	.552	.842	.751	.600	.078	.499	1.00	...
GDPGR	3.32	3.29	.052	.011	.006	.027	.186	-.024	-.042	1.00

Table 2.a. Fixed Effects Estimation– Developing Countries (Lag One)

Dependent Variable: PLC index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	OLS			Robust Errors			Robust Regressions		
$EXPRATIO_{t-1}$	9.267* (.800)	6.731* (1.011)	3.344* (1.425)	9.267* (1.573)	6.731* (1.390)	3.344* (1.550)	7.568* (.274)	7.053* (.405)	4.916* (.574)
$SCHOOL_t$	.006* (.003)	.003 (.003)	.002 (.003)	.006* (.003)	.003 (.002)	.002 (.002)	.001 (.001)	.0001 (.001)	.0001 (.001)
IIT_t	...	.013* (.002)	.012* (.002)	...	.013* (.003)	.012* (.002)	...	.006* (.001)	.005* (.001)
$OPEN_t$	...	.003* (.001)	.003* (.001)	...	.003 (.002)	.003 (.002)	...	-.00004 (.0005)	-.000004 (.0005)
FDI_t	...	.474* (.204)	.355** (.204)	...	.474* (.221)	.355** (.204)	...	.129 (.082)	.103 (.082)
$GDPCAP_t$	...	...	.102* (.031)	...	...	.102* (.031)	...	...	.062* (.012)
$GDPGR_t$	...	...	-.006 (.005)	...	...	-.006 (.005)	...	...	.001 (.002)
$R-squared$	.84	.88	.89	.88	.92	.92	...	...	...
$No.\ of\ obs.$	384	369	369	384	369	369	384	369	369

Note: Country-specific and time-specific fixed effects estimate. Heteroskedasticity-corrected standard errors are in parenthesis. *, ** respectively denote significance at the 5 percent and 10 percent levels.

Table 2.b. Fixed Effects Estimation–All Countries (LagOne)

Dependent Variable: PLC index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	OLS			Robust Errors			Robust Regressions		
$EXPRATIO_{t-1}$	5.793*	5.366*	4.695*	5.793*	5.366*	4.695*	4.382*	4.348*	3.540*
	(.489)	(.430)	(.479)	(.857)	(.800)	(.790)	(.187)	(.185)	(.208)
$SCHOOL_t$	.004*	.003	.001	.004*	.003	.001	.004*	.002*	.001
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.001)	(.001)	(.001)
IIT_t	...	.013*	.013*	...	.013*	.013*	...	.005*	.005*
		(.002)	(.002)		(.003)	(.002)		(.001)	(.001)
$OPEN_t$	...	.002**	.003*	...	.002	.003	...	-.00002	-.00004
		(.001)	(.001)		(.002)	(.002)		(.0005)	(.0005)
FDI_t	...	.059*	.030	...	.059*	.030**	...	.055*	.035*
		(.017)	(.019)		(.018)	(.017)		(.007)	(.008)
$GDPCAP_t$	...	...	.035*	...	...	.035*	...	...	.031*
			(.011)			(.012)			(.005)
$GDPGR_t$	...	...	-.005	...	...	-.005	...	...	.001
			(.005)			(.005)			(.002)
$R-squared$	.88	.91	.91	.91	.93	.94	...	...	...
$No.\ of\ obs.$	485	463	463	485	463	463	485	463	463

Note: Country-specific and time-specific fixed effects estimate. Heteroskedasticity-corrected standard errors are in parenthesis. *, ** respectively denote significance at the 5 percent and 10 percent levels.

Table 3.a. Fixed Effects Estimation–Developing Countries (Lag Two)

Dependent Variable: PLC index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	OLS			Robust Errors			Robust Regressions		
$EXPRATIO_{t-2}$	10.987*	9.348*	5.700*	10.987*	9.348*	5.700*	9.740*	8.712*	3.714*
	(1.120)	(1.408)	(1.940)	(1.859)	(1.432)	(1.779)	(.375)	(.525)	(.737)
$SCHOOL_t$	.008*	.003	.002	.008*	.003	.002*	.002	.001	.001
	(.004)	(.003)	(.003)	(.004)	(.004)	(.003)	(.001)	(.001)	(.001)
IIT_t	...	.014*	.013*	...	.014*	.013*	...	.004*	.004*
		(.003)	(.003)		(.003)	(.003)		(.001)	(.001)
$OPEN_t$	...	.005*	.006*	...	.005**	.006*	...	.0003	.0006
		(.001)	(.001)		(.003)	(.003)		(.0005)	(.0005)
FDI_t	...	.376**	.279	...	.376**	.279	...	.942*	.853*
		(.207)	(.210)		(.215)	(.215)		(.077)	(.080)
$GDPCAP_t$	...	...	.097*	...	...	.097*	...	...	.050*
			(.037)			(.040)			(.014)
$GDPGR_t$	...	...	-.009	...	...	-.009	...	...	-.0001
			(.007)			(.006)			(.003)
$R-squared$	.87	.91	.91	.91	.94	.94	...	...	...
No. of obs.	296	289	289	296	289	289	292	284	285

Note: Country-specific and time-specific fixed effects estimate. Heteroskedasticity-corrected standard errors are in parenthesis. *, ** respectively denote significance at the 5 percent and 10 percent levels.

Table 3.b. Fixed Effects Estimation–All Countries (Lag Two)

Dependent Variable: PLC index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	OLS			Robust Errors			Robust Regressions		
$EXPRATIO_{t-2}$	6.540* (.616)	6.675* (.547)	6.240* (.669)	6.540* (.815)	6.675* (.543)	6.240* (.539)	5.794* (.254)	5.755* (.279)	5.472* (.339)
$SCHOOL_t$	.004** (.002)	.001 (.002)	.0007 (.002)	.004** (.002)	.001 (.002)	.0007 (.002)	.003* (.001)	.0004 (.001)	.0005 (.001)
IIT_t	...	.015* (.002)	.014* (.002)	...	.015* (.003)	.014* (.003)	...	.005* (.001)	.005* (.001)
$OPEN_t$	...	.005* (.001)	.005* (.001)	...	.005* (.002)	.005* (.002)	...	.0002 (.001)	.0004 (.001)
FDI_t	...	.025 (.019)	.012 (.022)	...	.025* (.013)	.012 (.015)	...	.028* (.010)	.020** (.011)
$GDPCAP_t$	...	...	.018 (.015)	...	...	.018 (.013)	...	...	.013** (.008)
$GDPGR_t$	...	...	-.006 (.006)	...	...	-.006 (.006)	...	...	.0003 (.003)
$R-squared$	.91	.94	.94	.94	.96	.96	...	...	...
No. of obs.	377	367	367	377	367	367	374	361	361

Note: Country-specific and time-specific fixed effects estimate. Heteroskedasticity-corrected standard errors are in parenthesis. *, ** respectively denote significance at the 5 percent and 10 percent levels.

Table 4.a. Fixed Effects Estimation–Dev. Countries (Controlling For Lagged PLC)

Dependent Variable: PLC index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	OLS			Robust Errors			Robust Regressions		
$EXPRATIO_{t-1}$	4.306* (.746)	3.551* (.900)	1.928 (1.219)	4.306* (1.188)	3.551* (1.037)	1.928** (1.098)	3.632* (.302)	3.654* (.417)	.097 (.513)
PLC_{t-1}	.646* (.050)	.531* (.050)	.514* (.050)	.646* (.110)	.531* (.098)	.514* (.095)	.605* (.020)	.348* (.023)	.344* (.021)
$SCHOOL_t$	.004* (.002)	.003 (.002)	.002 (.002)	.004* (.002)	.003 (.002)	.002 (.002)	.001 (.001)	.001 (.001)	.0004 (.001)
IIT_t	...	.009* (.002)	.008* (.002)	...	.009* (.002)	.008* (.002)	...	.006* (.001)	.005* (.001)
$OPEN_t$	...	.003* (.001)	.004* (.001)	...	.003* (.001)	.004* (.001)	...	.001* (.0005)	.001* (.0004)
FDI_t	...	.340* (.172)	.290** (.174)	...	.340** (.178)	.290** (.168)	...	.410* (.080)	.639* (.073)
$GDPCAP_t$	...	...	.052* (.027)	...	...	.052* (.023)	...	...	.031* (.011)
$GDPGR_t$	...	...	-.007 (.004)	...	...	-.007 (.004)	...	...	-.0001 (.002)
$R-squared$	.90	.92	.92	.92	.94	.94	...	...	...
$No.\ of\ obs.$	384	369	369	384	369	369	384	369	369

Table 4.b. Fixed Effects Estimation–All Countries (Controlling For Lagged PLC)

Dependent Variable: PLC index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	OLS			Robust Errors			Robust Regressions		
$EXPRATIO_{t-1}$	2.308* (.426)	2.608* (.395)	2.427* (.420)	2.308* (.578)	2.608* (.592)	2.427* (.573)	2.139* (.190)	2.306* (.191)	2.279* (.206)
PLC_{t-1}	.692* (.042)	.592* (.042)	.582* (.043)	.692* (.091)	.592* (.086)	.582* (.085)	.669* (.019)	.633* (.020)	.633* (.021)
$SCHOOL_t$	.003* (.001)	.002 (.001)	.002 (.001)	.003* (.001)	.002** (.001)	.002 (.001)	.002* (.001)	.001* (.001)	.0014** (.0007)
IIT_t	...	.009* (.002)	.008* (.002)	...	.009* (.002)	.008* (.002)	...	.003* (.001)	.003* (.001)
$OPEN_t$	...	.003* (.001)	.003* (.001)	...	.003* (.001)	.003* (.001)	...	.0005 (.0004)	.0005 (.0005)
FDI_t	...	.026** (.014)	.015 (.015)	...	.026* (.013)	.015 (.012)	...	.017* (.007)	.017* (.007)
$GDPCAP_t$	...	...	.013 (.009)	...	...	.013 (.008)	...	...	.001 (.004)
$GDPGR_t$	...	...	-.006 (.004)	...	...	-.006 (.004)	...	...	.0003 (.002)
$R-squared$	.93	.94	.94	.95	.96	.96	...	...	...
$No. of obs.$	485	463	463	485	463	463	485	463	463

Table 5.a. Reverse Causality–Developing Countries

Dependent Variable: Cumulative Per Capita Exports

	(1)	(2)	(3)	(4)	(5)	(6)
PLC_{t-1}	.001	.001	.0002	-.003*	-.003**	-.0001
	(.003)	(.002)	(.0002)	(.001)	(.002)	(.0001)
$EXPRATIO_{t-1}$	...	...	...	.917*	.917*	.827*
				(.033)	(.074)	(.003)
$SCHOOL_t$	-.221*	-.221*	-.012	.067	.067	.009**
	(.110)	(.105)	(.009)	(.057)	(.043)	(.006)
IIT_t	-.170	-.170**	.021*	.061	.061	.014*
	(.105)	(.091)	(.009)	(.054)	(.040)	(.005)
$OPEN_t$	.076	.076	.011*	.057*	.057	.018*
	(.053)	(.078)	(.005)	(.027)	(.041)	(.002)
FDI_t	.039*	.039*	-.002*	-.006	-.006	-.0005
	(.009)	(.018)	(.001)	(.005)	(.010)	(.0004)
$GDPCAP_t$	.013*	.013*	.005*	-.0006	-.0006	-.001*
	(.001)	(.004)	(.0001)	(.0007)	(.0007)	(.0001)
$GDPGR_t$	-.087	-.087	-.035**	-.086	-.086	.003
	(.231)	(.160)	(.020)	(.117)	(.078)	(.010)
$R-squared$	.97	.98	...	.99	.99	...
No. of obs.	373	373	373	369	369	369

Note: Country-specific and time-specific fixed effects estimate. *, ** respectively denote significance at the 5 percent and 10 percent levels.

Table 5.b. Reverse Causality–All Countries

Dependent Variable: Cumulative Per Capita Exports

	(1)	(2)	(3)	(4)	(5)	(6)
PLC_{t-1}	.033* (.005)	.033* (.011)	.002* (.0004)	-.0002 (.003)	-.0002 (.003)	.0001 (.0003)
$EXPRATIO_{t-1}$	...	...	...	.858* (.026)	.858* (.048)	.894* (.003)
$SCHOOL_t$	-.342** (.185)	-.342** (.187)	-.014 (.014)	-.019 (.091)	-.019 (.081)	.029* (.010)
IIT_t	.079 (.229)	.079 (.140)	.095* (.018)	.113 (.112)	.113** (.059)	.011 (.012)
$OPEN_t$	.117 (.117)	.117 (.193)	.023* (.009)	.165* (.057)	.165* (.062)	.032* (.006)
FDI_t	-.007* (.002)	-.007* (.003)	-.002* (.0001)	.0001 (.001)	.0001 (.001)	.0002* (.0001)
$GDPCAP_t$	.002* (.001)	.002 (.003)	-.001* (.0001)	-.004* (.0006)	-.004* (.001)	-.004* (.0001)
$GDPGR_t$	.375 (.517)	.375 (.299)	-.073** (.040)	.066 (.252)	.066 (.157)	-.006 (.027)
$R-squared$	.98	.99	...	.99	.99	...
$No.\ of\ obs.$	467	467	467	463	463	463

Note: Country-specific and time-specific fixed effects estimate. *, ** respectively denote significance at the 5 percent and 10 percent levels.