TRADE AND GROWTH: RECONCILING THE MACROECONOMIC AND MICROECONOMIC EVIDENCE

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Abstract. Many empirical studies based on plant-level data have found that firms that enter the export markets are more productive than non-exporters and that this difference in productivity is achieved before firms become involved in exporting. These findings have challenged the traditional view that openness to trade increases productivity and economic growth. This article reconsiders the literature on trade, growth, and trade policies and argues that a careful examination of these new findings is consistent with the idea that exporting increases productivity and economic growth.

Keywords. Developing countries; Openness; Growth; Productivity; Trade policies

1. Introduction

Does openness to trade increase economic growth? Traditionally, economists have argued that more open economies grow more quickly. However, neither the existing theoretical models nor previous empirical analyses seem to have produced a definite and positive answer to this area of inquiry. The proliferation of plant-level data during the 1990s has renewed the interest on the subject and has focused attention on the specific channels by which trade may influence economic growth.

This new line of research has, however, uncovered new evidence that cannot be easily explained by previously existing theories. The main finding, and one that is common to all empirical studies in this area, is that exporters are more productive than non-exporters and that they coexist even in narrowly defined industries. Many scholars thought that this positive correlation was a clear proof that an outward orientation would improve economic growth. However, it has also been discovered that exporters usually self-select into the export markets. Firms that enter the export markets are already more productive than non-exporters before they ever actually begin to export. The existence of this self-selection process has led some scholars to conclude that exporting does not directly improve productivity and that the positive correlation between exports (or trade) and productivity (or growth) is explained by the fact that only the most productive firms can

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participate in the export markets. In other words, causality would go from productivity to exports.

This article re-examines the literature on trade, growth, and trade policies and reinterprets the findings of the new studies based on micro data. We argue that, at least in developing countries, the self-selection process may well be a conscious decision by which firms purposefully increase their productivity with the clear intention of becoming exporters. Therefore, the macroeconomic evidence showing that more open economies grow faster can be reconciled with the recent micro-economic findings.

The implications of a conscious self-selection process in terms of policy are important. If firms in developing countries increase their productivity with the international markets in mind, then any policy that may affect their decision to engage in exports may simultaneously influence firm-level productivity as well. Examples of trade policies that impact a firm's decision about whether or not to produce for external markets include export-promotion policies and non-tariff barriers of other countries. We argue that in order to help developing countries foster growth and development, advanced nations should reduce their trade barriers for the goods produced in poor countries. In this way, there would be an increase in the profitability of being an exporter that would induce many firms in these countries to adopt new and modern technologies that would, in turn, increase productivity. For developing countries, however, the policy implications are not as clear. Even though government support for exporting certainly increases the profitability of participating in export markets, they may also impose welfare costs if they target the "wrong" sectors or firms. In this article, we discuss the possibility of having externalities associated directly with exporting to justify the adoption of such policies. Nevertheless, the disparity in the effects and results of these policies in different countries (e.g. East Asia versus Latin America) imply that these policies should be approached or adopted with caution.

This article is organized according to the following structure. In the second section, we review the literature on trade and economic growth and distinguish between theoretical explanations and the main results which emerge from the various empirical studies that have already been conducted. In the third section, we describe and analyse the main findings of the new microeconomic studies on the relationship between exporting and productivity at the plant level. The fourth part discusses possible explanations of the results from the micro studies. This part is the basis for the analysis of policy that is carried out in the fifth section. Finally, section six provides concluding statements and proposes some possible directions for future research.

2. Openness to Trade and Economic Growth

2.1 *Theory*

In the traditional models of international trade, openness to trade from an autarkic situation increases the value of the total production in the economy.

Trade generates a static improvement in output, but it does not induce any additional economic growth. In other words, openness improves the allocative efficiency of the economy. In the Ricardian model, as trade becomes more open, the country specializes in the production of the good in which it has a comparative labour-productivity advantage; this product is exported. In the Heckscher–Ohlin model, the country exports the good which uses its abundant factor more intensively. As the economy opens, there is a shift in resources toward the sectors that draw upon the abundant factor, and the value of total production increases. An increase in total output, following a movement from autarky to free trade, can be also found in some models of economies of scale with monopolistic competition (e.g. Krugman, 1979), although in some other models, the output of each good may remain unchanged (e.g. Dixit and Norman, 1980; Krugman, 1980).

In models of economic growth, trade does not have a clear effect on the rate of growth. In the early growth models, such as the Harrod–Domar model (Harrod, 1939; Domar, 1946), where capital is the sole factor of production, a trade liberalization (moving the economy to free trade from autarky) has positive growth effects (Srinivasan, 1999). However, in neoclassical models of growth for closed economies, such as the Solow model (Solow, 1956) and the optimal-saving model, or Ramsey growth model (Cass, 1965), the steady-state rate of growth of output is completely exogenous, and it is equal to the rate of growth of the input that grows exogenously at the steady state (typically, labour) in addition to the equally exogenous rate of technological progress. Extensions of the Solow model (e.g. Baldwin, 1992) and the optimal-saving model (e.g. Srinivasan and Bhagwati, 1980) show that opening the economy to free trade from autarky has only temporary effects on the growth rate of output; as the economy converges to its free-trade steady state, the growth rate of output converges to its autarky steady-state value.[1] Trade, in this case, has a level effect as the value of output at the new steady state is higher than in autarky.

An explanation for why the steady-state rate of growth in neoclassical models is not affected by policy changes can be traced to the assumption that the marginal product of capital (MPK) declines to zero as the capital-labour ratio increases indefinitely. However, it can be shown that if the MPK is bounded below by some positive number, then policy changes, such as trade liberalization, can have level as well as growth effects in the long run (Srinivasan, 1999). In such a case, the neoclassical model behaves like the Harrod–Domar model implying that openness to trade generates positive growth effects. The problem with this assumption is that it implies that labour becomes inessential as the capital-labour ratio increases without bound (Srinivasan, 2001).

Instead of assuming some arbitrary lower bound for the MPK, some researchers have postulated specific mechanisms that may prevent the MPK from going to zero. This simple idea forms the basis for the new growth models or endogenous growth models. The first mechanism assumes that capital means not only physical, but also human capital, and that there are

positive externalities associated with the accumulation of either kind of capital. In this context, the effect of an outward-orientated strategy as opposed to autarky over the rate of economic growth in steady state is not clear. Young (1991), for example, develops an endogenous growth model in which workers accumulate experience or human capital through learning-by-doing, which, although bounded in each good, exhibits spillovers across goods. He studies the case in which a developed country engages in free trade with a less-developed country and shows that the less-developed country grows less under free trade than in autarky, while the opposite occurs in the developed country. An intuitive interpretation could be described in the following manner: static comparative advantage implies that when countries become open to trade, the less-developed country specializes mostly in traditional goods, where learning has been exhausted, while the developed one specializes mostly in the goods that are still experiencing learning-by-doing.[2] The main problem with this type of models is that the assumption of externalities or spillovers seems implausible to many people. These models, for example, may not account for the extraordinary growth of some East Asian countries, unless such externalities are very strong (Pack, 1994).

The second way to avoid diminishing returns in models of growth is by introducing new intermediate goods or by improving the quality of the intermediate inputs (Pack, 1994).[3] A distinctive feature of these models is that research and development (R&D) are required when expanding the variety of goods or raising the quality of the products. Once again, the impact of international trade on growth is unclear. An example of this kind of model is presented in Grossman and Helpman (1991). The authors study a small economy that invents non-traded intermediate goods that are used to manufacture two final goods, which are internationally traded at exogenous world prices. In their framework, trade has direct as well as indirect effects. The direct effect is the transmission of knowledge from foreign sources. This effect enhances growth. The indirect effect refers to the influence of trade on domestic factor markets. If the economy imports human-capital-intensive goods, then international trade reduces the derived demand for human capital and, subsequently, also the cost of innovation. In this case, the indirect effect also encourages growth. But if the country exports human-capital-intensive goods, then trade ultimately impedes growth because the exportable sector draws human capital away from research activities. Another example is provided by Rivera-Batiz and Romer (1991). They use an endogenous growth model to analyse the effects of economic integration and growth and consider the case in which integration occurs between countries or regions that are similar. In their model, technological progress comes from the invention of new types of capital goods, which are created using R&D.[4] In this context, international integration has two effects. First, there is a scale effect due to the larger markets that increase world research activities and, secondly, the practice of international integration further generates cross-border technological spillovers that improve the productivity of research activities. Both effects promote economic growth.

2.2 *Evidence*

Many empirical studies have examined the role of openness on economic growth. They can be broadly classified in two groups (Edwards, 1993): (1) case studies of specific countries and (2) cross-country analyses. The first group includes two well-known and influential projects: the Bhagwati–Krueger project for the NBER, carried out during the 1970s;[5] and the Papageorgiou–Michaely–Choksi study conducted for the World Bank during the 1980s.[6] Both projects analysed particular cases of inward looking and outward looking countries. Although these studies differ in the way they measure openness or trade orientation, both reach the same conclusion: an import substitution strategy does not generate an increase in the long-term rate of growth of output; therefore, an outward-orientated strategy is more effective in achieving this goal. Although these two remarkable projects provided very detailed information about trade policies in developing countries, it is difficult to draw strong conclusions from them for at least three reasons: (1) they include only a handful of countries; (2) they differ in the economic techniques employed; and (3) researchers focused on different issues, specific to each of the respective countries (Edwards, 1993).

The cross-country literature, on the other hand, usually finds a positive relationship between measures of openness and growth. This positive association is then interpreted as evidence that openness to trade improves growth. Edwards (1993) reviews the most important studies published until the early 1990s and concludes that most of these cross-country studies suffer serious problems in terms of endogeneity and measurement errors. Moreover, he argues, the theoretical foundation of those studies is very simplistic, and they do not identify the exact mechanism by which trade affects growth. It is also not entirely clear how robust the results are. In fact, some scholars argue that almost all the results from previous studies are tenuous at best (e.g. Levine and Renelt, 1992).[7]

In Table 1, we summarize the most cited studies published during the 1990s (not covered by Edwards)[8] and some more recent studies.[9] As we can see in the table, researchers tend to find a positive and statistically significant correlation between some measure of openness and economic growth or productivity growth.

Some of the studies summarized in Table 1, however, cannot identify the direction of the causality between trade and growth, because the measures of openness they use, trade shares and trade policies, might be endogenous and therefore they cannot be used to identify the effect of trade on economic growth. One possible solution to this problem is to use instrumental variables. Frankel and Romer (1999) pursue this idea and construct measures of the geographical component of countries' trade (the idea is that geography is not affected by economic growth). Then they use these measures to obtain instrumental variables estimates of the effect of trade on income. The results show that trade has a large and robust positive impact on income, although only moderately significant.[10]

It is also possible that omitted variables may be creating a positive correlation between trade, or openness, and growth (Rodríguez and Rodrik, 2001; Hallak and Levinsohn, 2004). If one includes a geography measure, such as distance from the

Table 1. Empirical Evidence on Trade and Growth – Selected Studies.

Study	Data	Main Result
Dollar (1992) [150]	95 developing countries	Positive
Edwards (1992) [84]	30 developing countries	Positive
Ben-David (1993) [57]	European Economic Community	Positive – convergence
Sachs and Warner (1995) [51]	122 countries	Positive
Harrison (1996) [54]	17–51 countries	Positive
Edwards (1998) [60]	93 countries	Positive (TFP)
Frankel and Romer (1999) [89]	98 countries	Positive – trade instrumented
Irwin and Terviö (2002) [8]	23–146 countries	Positive – trade instrumented no – if geography measure is also included.
Dollar and Kraay (2003) [4]	63–154 countries	Positive – trade instrumented no – if both trade and institutions are instrumented.
Alcalá and Ciccone (2004) [–]	138 countries	Positive (TFP) – both trade and institutions instrumented.
Noguer and Siscart (2005) [–]	98 countries	Positive – trade instrumented Robust to inclusion of geography and institutions.

TFP, total factor productivity.
"Positive" means there is a positive and significant correlation between openness and growth. "Positive – convergence" means that openness reduces income inequality across countries.
The number in [ ] indicates the number of citations as of June 2004 (*Social Sciences Citation Index*).

equator (e.g. Rodríguez and Rodrik, 2001; Irwin and Terviö, 2002) or a measure of quality of institutions (e.g. Rodrik *et al.,* 2002), the effect of openness on growth is reduced and sometimes becomes no significant. One could argue, however, that given that instrumented measures of trade and institutional quality are highly correlated, then regressions that include both variables do not permit to identify the partial effects of both trade and institutions on growth (Dollar and Kraay, 2003).

In light of the shortcomings and diverse results of econometric studies, one could ask whether case studies could provide a better understanding about the relationship between trade and growth. Some scholars (e.g. Edwards, 1993; Srinivasan and Bhagwati, 2001) argue that the best evidence about the effect of trade on growth has to be taken from case studies, such as those made by the NBER and World Bank. Their conclusion is that the virtues of openness established in these in-depth studies remain unrefuted. In spite of this last statement, some doubt still remains about the direction of the causality between trade and

growth. Positive correlations do not guarantee that trade is causing growth. Moreover, by using aggregate data in cross-country regressions, researchers are mixing countries and industries with very different characteristics. In addition, there is a significant heterogeneity at the firm level, even at narrowly defined industries (Berry, 1992; Tybout, 1996), that none of these models take into consideration. The proliferation of plant-level data during the last decade of the twentieth century has allowed researchers to study this relationship at a very disaggregate level and has provided important and new stylized facts.[11]

3. The New Micro Evidence

3.1 *Learning-by-Exporting or Self-Selection?*

During the 1990s, a series of empirical studies began to uncover the different characteristics of exporters and non-exporters. One of the most important findings of these works was that exporting firms are more productive than firms that focus on the domestic market (e.g. Aw and Hwang, 1995; Bernard and Jensen, 1995, 1999a, 2004; Bernard and Wagner, 1997; Aw and Batra, 1998; Aw *et al.*, 2000; Isgut, 2001; Mengistae and Pattillo, 2002; Alvarez and López, 2005).

Based on this new micro evidence, researchers started to investigate if the higher productivity of exporters could be explained by the existence of learning-by-exporting or just because only the more productive firms can export, i.e. firms self-select into the export markets.[12] The learning-by-exporting hypothesis says that firms that participate in foreign markets may acquire information from foreign customers and foreign contacts, who may suggest ways to improve the manufacturing process, new product designs, and increase the quality of the goods (Westphal *et al.*, 1984; Grossman and Helpman, 1991; World Bank, 1991; Keesing and Lall, 1992; World Bank, 1993).

Scholars have investigated the learning-by-exporting hypothesis using two different approaches. The first one is to focus on a small group of firms and ask them directly if they have received some type of assistance or valuable information from foreign contacts. This is the case-study approach and was mainly used before plant-level data became widely available. The second approach consists of using large panel data sets at the plant level or firm level to test if export participation improves productivity. If productivity increases with exporting, then there would be some support for the learning-by-exporting hypothesis and for the idea that trade increases growth. Note also that an increase in productivity with exporting may also be consistent with the existence of economies of scale. There is, however, little empirical support for this channel (e.g. Tybout and Westbrook, 1995).

3.1.1 *Case Studies*

Earlier evidence based on case studies suggests that information from foreign customers is an important source of knowledge for developing countries. In Table 2, we

Table 2. Learning-by-Exporting: Evidence from Case Studies

Study – country	Foreign customers provided
World Bank* – firms from Korea, Hong Kong, Thailand, Philippines, Taiwan, Argentina, Brazil, Colombia, Peru, and Uruguay	Information about products designs, materials, labeling, packaging, and shipping
Rhee and Pursell† – 112 Korean firms	Information about characteristics of the exported products. Assistance to reduce costs and increase efficiency. Programs to control and improve quality
Taiwan research institute‡ – 113 Taiwanese firms	New design ideas and product innovation
Wortzel and Wortzel§ – firms from Korea, Hong Kong, Taiwan, Thailand, and Philippines	Product design, including appearance and packaging; quality control
Hobday¶ – 55 firms from Korea, Taiwan, Hong Kong, and Singapore	Help with factory layout, assembly machinery, engineering back-up, and assistance to ensure quality
Pietrobelli** – 26 Chilean firms	Information about product design, technology design, and how to adapt the product to export markets

As reported in: *Kessing (1983) and Kessing and Lall (1992); †Westphal *et al.* (1979, 1984); ‡Aw and Batra (1998); §Wortzel and Wortzel (1981); ¶Hobday (1995); **Pietrobelli (1998).

summarize some case studies and the types of assistance that foreign buyers provided to exporters in some developing countries. It seems that foreign buyers provided valuable information on new technologies and product designs. They also seemed to have contributed to improve the quality of the exported goods. This evidence indicates that foreign contacts may have been a very important source of productivity growth in some developing countries.

Although these studies have provided important information about the role of exporting in increasing productivity, they suffer several problems. First, they only focus on small groups of firms; hence, it is not clear how general these results are. Second, the firms selected are usually some of the most successful exporters in their respective countries; thus, these studies are susceptible of some selection bias. Finally, these studies do not quantify the effects of exporting on productivity. In spite of these problems, case studies can be very useful to explain some of the apparently contradictory findings of the empirical analyses based on plant-level data.

3.1.2 *Studies Based On Plant-Level Data*

Several researchers have tried to verify the existence of learning-by-exporting by using plant-level data and diverse econometric techniques. The results tend to give only moderate support for this hypothesis and strongly support to the idea that only the best firms can export (self-selection). In Table 3, we summarize

the empirical evidence, based on plant- or firm-level data, concerning learning-by-exporting. As the table indicates, all the studies have found that firms self-select into the export markets.[13] This result is very robust, and it does not depend on characteristics of the specific country under study. Empirical support for learning-by-exporting is not as strong. Some studies find simultaneous evidence of self-selection and learning-by-exporting. This occurs in some African countries, Turkey, and Canada. The other studies either do not find empirical support for learning-by-exporting or, when they find some, it seems to be limited to some industries, young exporters, and firms with a very high involvement in exporting. Also, when learning is present, the effect seems to last only 1 or 2 years after entry to export markets.

It is possible that the lack of evidence of learning-by-exporting in developing countries could be explained by a continuous diffusion of newly acquired technology from exporters to non-exporters, in a way that both groups follow similar

Table 3. Microeconomic Evidence on Self-Selection and Learning-by-Exporting

Study	Country	Results
Clerides *et al.* (1998)	Colombia, Mexico, and Morocco	SS; LE in some Moroccan industries
Bernard and Jensen (1999a)	USA	SS
Kraay (1999)	China	LE in established exporters (does not test self-selection)
Aw *et al.* (2000)	Korea, Taiwan	SS; LE in some Taiwanese industries
Bigsten *et al.* (2000)	Cameroon, Ghana, Kenya, and Zimbabwe	SS; LE
Isgut (2001)	Colombia	SS
Delgado *et al.* (2002)	Spain	SS; LE in young exporters
Castellani (2002)	Italy	SS; LE in plants with high export orientation
Wagner (2002)	Germany	Absence of LE (does not test self-selection)
Girma *et al.* (2002)	UK	SS; LE in first 2 years of exporting
Baldwin and Gu (2003)	Canada	SS; LE
Van Biesebroeck (2003)	Nine Sub-Saharan African countries	SS; LE
Yasar and Nelson (2003)	Turkey	SS; LE
Alvarez and López (2004)	Chile	SS; LE in entrants
Hahn (2004)	Korea	SS; LE in first years of exporting
Arnold and Hussinger (2004)	Germany	SS

SS means evidence consistent with self-selection, and LE means evidence consistent with learning-by-exporting.

productivity trajectories. Westphal (2002, p. 307) explains that " (. . .) it may be that continuing export activity is required – as an input, as it were – simply to maintain an exporting firm's productivity edge". Another possibility is that the contact between a firm and a foreign client may occur well before any flow of export is revealed in the data (Tybout, 2003).

4. Possible Explanations for Self-Selection

4.1 *Sunk Costs*

One possible explanation for the self-selection of firms into the export markets is the existence of sunk entry costs in the international markets. These costs may arise because firms trying to enter the export markets may need to make contacts with potential foreign customers, establish distribution channels, and modify their products to foreign tastes or to country-specific regulations. In the presence of these entry costs, only the more productive firms can enter the export markets, and this may explain why exporters are more productive than non-exporters. This idea may also explain why there is high persistence in the export status.[14] If sunk entry costs are present, then firms may continue in the export markets when there is a negative shock, in order to avoid paying the entry costs again. In the same way, a positive shock may not necessarily induce entry of firms in the export markets, if the increase in current profits cannot cover the entry costs. Some studies have found that previous export experience increases the probability of exporting (e.g. Roberts and Tybout, 1997; Bernard and Jensen, 2004), which has been interpreted as evidence that entry costs are important.

Under this hypothesis, productivity does not increase with exporting. In fact, it is usually assumed that productivity is exogenous with respect to the export decision. Sometimes, it is even assumed that productivity is a random variable not controlled by the firms. All other things constant, entry and exit from the export markets are driven by productivity shocks at the firm level. Thus, firms that receive good productivity shocks may become exporters.[15]

4.2 *Conscious Self-Selection*

It is possible that the self-selection of firms into the export markets could be explained by firms making conscious decisions to increase productivity with the international markets in mind. This may occur if, for example, the goods that are produced for the export markets in developing countries are of a higher quality than the analogous goods made for the domestic market (see evidence in Keesing, 1983; Kessing and Lall, 1992);[16] therefore, firms that want to produce for the more demanding international markets have to introduce new technologies, usually developed in industrial countries, to produce high-quality good. The introduction of these new technologies raises firm-level productivity by raising the value of the output.[17] Under this hypothesis, firms make investments to

produce higher quality export goods with the purpose of capturing the potentially higher returns available in the international markets.

Anecdotal evidence and some recent econometric studies give support to this hypothesis. In terms of anecdotal evidence, we can mention the case of the wine industry in Chile. This country is today one of the top-five exporters of wine in the world. However, 20 years ago, the Chilean exports of wine were barely 10 million dollars, mainly because the wine produced in this country at that time was not to the taste of consumers in developed countries. A major change in technology was needed to enable domestic firms to produce high-quality wine at a large scale in the foreign markets.[18] Around 1981, a Spanish firm came to Chile with a new technology and began to produce high-quality wine. As a result of this, domestic firms adopted the same technology and began producing a better quality wine. Since then, the exports of wine have increased dramatically, reaching more than 670 million dollars in 2003.[19] An important, and we think rather general, feature about this example is that the wine that is consumed in the domestic market has remained very homogenous and of low quality. This means that the introduction of the new technology was done with the explicit purpose of exporting a high-quality product. Other evidence is presented in a study of manufacturing firms in Sub-Saharan Africa (Wangwe, 1995). The study interviewed 55 exporting firms and finds that entry into export markets has often been preceded by investments in upgrading technology to meet higher quality requirements.

In terms of econometric evidence, López (2003) uses plant-level data from the Chilean manufacturing sector and finds that plants that are about to enter the export markets not only increase their productivity before entry but also their investment levels, without affecting their market shares in the domestic economy. In other words, it seems that plants that are transitioning from the domestic to the foreign markets are investing in new machinery and technologies with the explicit purpose of becoming exporters.

The introduction of new technologies does not, however, guarantee that productivity increases instantaneously. Most likely, a long process of learning and mastery may be required to reach high levels of productivity. Moreover, this mastery and learning might typically require a stream of investments over time (Evenson and Westphal, 1995). This process can be thought as technological effort,[20] which is necessary to assimilate and master technology. Note that this process is not costless as it is assumed in most traditional neoclassical models. Pack and Westphal (1986, p. 105), for example, argue that even though most of the technology used by developing countries has been transferred from industrial countries, there is in fact technological change in these countries, "in the sense of gaining mastery over products and processes that are new to the local economy". Moreover, each firm does not know with certainty all the things that a technology can accomplish, and it cannot articulate explicitly how it accomplishes everything that it does (Nelson, 1987). In other words, firms have to learn the tacit elements of technology and gain mastery of them. Pack (1992b, p. 22), notes that in less-developed countries, "(r)ather than simply purchasing foreign equipment and using it according to prevailing norms, an indigenous effort was undertaken,

particularly in large firms, that changed the method of production".[21] In addition, while knowledge has characteristics of public good, its transmission requires conscious and costly investments by the recipients of technologies (Pack and Saggi, 1997; Nelson and Pack, 1999a).

4.2.1 *Imported Technology*

There is not much econometric evidence about the direct role of exporting in relation to the decision to introduce imported technology. Braga and Willmore (1991) use Brazilian establishment data to study the effects of selected variables on the probability that a firm purchases imported technology. They find that the coefficient of an export dummy is positive and highly significant. They interpret this result as evidence that involvement in the more competitive international markets demands greater access to imported technology.[22] A more recent study, Pamukcu (2003), uses plant-level data from Turkey to study the determinants of innovation decisions of manufacturing plants. The results show that exporters use more imported capital goods and are more likely to innovate than non-exporters. There is also a positive correlation between the propensity to export (exports/sales) and innovation, which can be explained by the fact that firms introducing innovations are more likely to become exporters.

There is also some empirical evidence about the contribution of imported machinery on productivity using aggregate data, and it seems that this is a very important channel of technology diffusion for developing countries (see Table 4).

4.2.2 *Increase in R&D*

If exporters try to improve the quality of goods and reduce production costs, they may also increase their expenditures on R&D. There is some evidence consistent with this idea. Alvarez (2001) uses a survey of technological innovation for Chilean manufacturing firms and finds that about 60% of the firms that were exporting invested in R&D, while only a 20% of the non-exporters invested in R&D. He also finds that, controlling initial size, foreign ownership, and other firm characteristics, exporters are more likely to invest in R&D than non-exporters. However, he also finds causality in the other direction: firms that invest in

Table 4. Imports of Machinery and Productivity – Selected Studies

Study	Data	Results
Coe *et al.* (1997)	77 developing countries	Positive
Dessus (1999)	Taiwan	Positive
Keller (2000)	Eight OECD countries	Positive – effect may be larger in developing countries.

"Positive" means there is a positive and significant effect of imports of machinery on productivity.

R&D are more likely to export. This positive correlation is also observed in developed countries. Bleaney and Wakelin (1999), for example, find that, for a sample of British manufacturing firms, export shares are higher in sectors with higher R&D expenditures as a proportion of output. More work is needed to study the effects of the export decision on R&D expenditures.

4.3 *Initial Export Orientation and Productivity*

Another interpretation of the new evidence has been provided by Hallward-Driemeier *et al*. (2002). The authors argue that the initial orientation of the firm, whether it decides to be an exporter or a domestic-oriented firm, is exogenous to the productivity level of the firm. If firms that were established as exporters are more productive than firms that became exporters, then it means that firms that target export markets make different decisions regarding investments and technology in ways which raise productivity. In other words, the higher returns available in the world markets are an incentive to make the investments necessary to increase productivity.

Hallward-Driemeier *et al*. (2002) use a rich and new manufacturing plant-level data set for five Asian countries and find that domestic firms that began to export in the year of establishment are systematically more productive than domestic firms which became exporters. Again, this evidence seems to go in the direction that openness enhances productivity.

5. Self-Selection and Trade Policy

If productivity is exogenous with respect to the export decision, then trade policies may not have any impact on firm-level productivity, although they might affect aggregate productivity through a reallocation of resources from low-productivity firms to high-productivity firms, which produce a larger share of the output (Bernard *et al.,* 2003; Melitz, 2003). The potential reallocation of resources across firms might be considerable. Bernard and Jensen (1999b), for example, find that more than 40% of total factor productivity (TFP) growth in the US manufacturing sector, during the period 1984–1992, resulted from changing output shares across plants. On the other hand, if firms make conscious efforts to increase their productivity with the purpose of becoming exporters, then we can say that productivity depends on the decision of whether or not to target the international market. Therefore, any change in the variables that affect the profitability of being an exporter may potentially affect firm-level productivity through this channel. In this section, we discuss the potential effects of two particular policies: non-tariff barriers of developed economies and export promotion of developing countries.

5.1 *Trade Barriers of Developed Countries*

One of the variables that may affect the profitability of participating in external markets is the set of trade barriers imposed by other countries. For developing

countries, trade restrictions of more developed countries are extremely important, because these markets are the ones which potentially allow increases in the quality of the products, and consequently in productivity, from developing countries. Tariffs are relatively low in industrial countries; thus, the main barriers that manufactured goods from developing countries face in these markets are non-tariff barriers.[23] Therefore, a reduction in non-tariff barriers of developed countries in manufactured sectors would probably induce many firms in developing countries to introduce new technologies and increase the quality of the goods they produce. This practice, in turn, would increase productivity, and if spillovers are present, it may generate a considerable improvement in the productivity of the economy as a whole.

5.2 *Export Promotion Policies of Developing Countries*

5.2.1 *Some Country Evidence*

Export promotion policies have been used widely around the world, although some of them are now prohibited by the World Trade Organization. The most known, and perhaps successful, episodes of export promotion in developing countries are the cases of Korea and Taiwan. In both countries, governments intervened actively in the economy, especially in the promotion of manufactured exports, which raises the question of whether the governments of these countries are to some extent responsible for the spectacular economic growth.[24] One common feature that Taiwan and Korea share is that the high rates of economic growth were accompanied by rapid human and physical capital accumulation and also by an impressive increase in the volume of exports, mainly manufactures. This observation has generated two possible explanations or views for the success of these countries: the assimilation view and the accumulation view (Nelson and Pack, 1999b).

The assimilation view stresses the role of learning and mastery of foreign technologies in explaining the industrialization process and rapid economic growth of some East Asian countries (Pack and Westphal, 1986; Pack, 1992b). According to this view, industrial exports constitute the principal engine of growth, as they are the main source of knowledge, technology, and learning. Physical and human capital accumulation is necessary but not sufficient for the assimilation process. In this perspective, manufactured exports have allowed a rapid growth of TFP which would explain the unusually rapid economic growth of these countries.

Some evidence supports the idea that a high TFP growth rate was an important source of growth in East Asia. Dollar and Sokoloff (1990) and Pack (2000) have found that TFP growth in Korean manufacturing has been extraordinarily high compared with other countries. In addition, the high productivity growth seems to be explained by a rapid growth in manufactured exports. Pack and Page (1994) use cross-country regressions to show that the rapid productivity change in

East Asia was partly the result of the notable performance of manufactured exports.

The accumulation view, on the other hand, emphasizes the role of physical and human capital accumulation in explaining economic growth (Krugman, 1994; Young, 1994, 1995; Rodrik, 1995). According to this view, the massive investment in physical and human capital made by the East Asian countries is a sufficient explanation of their economic growth. In this case, a rapid export growth is the result and not the cause of economic growth. In this context, TFP growth is not the main source of economic growth. Contrary to the evidence of Dollar and Sokoloff, Young (1994) estimates that TFP growth in East Asia either in the aggregate or in manufactures has not been spectacular. Young argues that the main source of economic growth in East Asia has been capital accumulation (see also Kim and Lau, 1994). Young also documents the fundamental role of factor accumulation in explaining the extraordinary growth of Hong Kong, Singapore, Taiwan, and Korea (see Young, 1995). He shows that TFP growth in these countries closely approximates the historical performance of the OECD and Latin American economies. Similar results are found by Collins and Bosworth (1995) who use simple growth accounting to decompose the growth in output per capita into the contributions from physical and human capital accumulation and of a residual measure of the change in TFP. By applying this methodology to seven East Asian economies, as well as other countries from other regions (other developing countries and industrial economies), they find that TFP played a small role in East Asia's rapid economic growth. Consistent with Young (1995), they find that the investment and saving rates of these countries have been impressive.

Rodrik (1995) argues that it is difficult to see how export orientation could have played a significant causal role in the growth of these countries. He notices that the profitability of exports during the beginning of industrialization in Korea and Taiwan was too low to explain the export boom of these countries. In addition, exports were initially too small to have an important effect on economic growth. Rodrik suggests that a more plausible explanation is provided by the rapid capital accumulation that occurred in both countries. The governments of these countries subsidized and coordinated investment decisions. He argues that factor accumulation and not TFP growth explain economic growth.

In a later article, Rodrik (1997) develops a model which shows that the exports of East Asia may have been driven by an increase in the profitability of investment. His idea is that an increase in the profitability of investment in developing countries induces higher imports, because most of the capital goods in these countries are imported. If the economy cannot borrow freely from abroad, then an increase in exports is needed to pay for the imports. In this case, the increase in exports does not come from an increase in the relative price of exportables.

Rodrik's claim that the profitability of exports was not significant in Asia becomes problematic, because he only considers direct subsidies on exports to compute exporting profitability. But Amsden (1993) has shown that when one includes not just direct but also indirect subsidies (such as preferential credit for

long-term investment, support for R&D, etc.), then the government support to exports in Korea has been much greater than direct subsidies alone suggest.

5.2.2 *Externalities and Spillovers from Exporting*

Standard economic theory demonstrates that export subsidies are distortionary unless they are used to correct a pre-existing distortion directly related to export activities. It has been argued that, at least in the case of developing countries, exporting firms can generate knowledge about technologies and foreign markets that could be used by other exporters and non-exporters. For example, when an entrant exporter invests to master a new technology, it generates a cost reduction to subsequent nearby entrants (Westphal, 1990). In addition, exporters tend to adopt efficient and competitive management styles and training of a higher quality of labour which may benefit other sectors (Keesing, 1967; Feder, 1982; Edwards, 1993). In other words, exports may cause positive externalities and technological spillovers within the exporting sector and on non-exporter sectors.

The evidence for it is not entirely conclusive. Aitken *et al.* (1997), for example, find that general export activity (domestic exporters and multinational exporters) has no effect on the probability of exporting for domestic plants (such as in the case of Mexico); however, the exports from multinationals increase the probability of exporting for other firms.[25] Clerides *et al.* (1998) analyse the existence of spillovers by regressing export participation on regional and industry export intensity. They find that, for Colombia, the presence of many exporters increases a firm's chances of being an exporter itself. Moreover, production costs become lower in those regions of Colombia where export activity increases. One interpretation, they say, is that exporters become more productive by participating in external markets, but non-exporters are able to share in cost reductions. This might be evidence of externalities. Nicita and Olarreaga (2000) estimate the effect of information spillovers across markets of four developing countries (Egypt, Korea, Malaysia, and Tunisia) using three-digit bilateral trade data and data on information flows. Taking the USA as a reference, they estimate that an extra dollar increase in the exports from Korea to the USA generates on average an increase in Korean exports to the rest of the world of 14 cents. For Malaysia this figure is 10 cents, whereas for Egypt and Tunisia is about 2 cents. A more recent article, by Aw (2002), finds strong evidence of spillovers from export activities. Using firm-level data for the Taiwanese electronics industry, the results show that a firm's expected future productivity is positively affected by being located in a sector and a county with high export activity.

However, contradictory evidence was discovered by Bernard and Jensen (2004), when they focus on a developed country. They use a panel of US manufacturing plants to test the role in export decision of spillovers from neighbouring exporters. They find almost no role for geographical spillovers and no evidence for the importance of export activity by other firms in the same industry. This result may be due to the fact that they use a sample of firms which are substantially larger

than the manufacturers generally, and it is not representative of the population of manufacturing firms in the USA.

5.2.3 *Other Benefits from Exporting*

Other arguments to encourage exports have been mentioned in the literature, although none of them seems to constitute a real externality associated to exporting. Thus, intervention, in these cases, becomes a more controversial issue.

Technology Licensing
Exporting may induce technology licensing from developed countries. Technology developers usually prefer exporting firms, because this would be a good indicator about the abilities of the potential partner (World Bank, 1993). Licensing existing technological knowledge about production processes offers significant opportunities to developing countries for improving the level of productivity (Pack and Page, 1994).

However, inflows of foreign technology may substitute for domestic efforts in R&D. In other words, there may not be a one-for-one increase in the stock of domestic knowledge (Pack and Saggi, 1997). Basant and Fikkert (1996) provide evidence on this possibility. Using a panel data of Indian firms from 1974–1975 to 1981–1982, they find that expenditures on technology through licensing agreements and domestic R&D are substitutes for one another in the production of knowledge.

Returning Nationals
Exports may induce an increase in the real wages which may attract nationals educated or trained abroad.[26] This return of nationals may provide important transfers of knowledge (World Bank, 1993). It seems that returning nationals who were educated in Japan and the USA and then worked for a foreign firm helped to transfer technology and the best practice methods in some Asian countries. Pack (2001), for example, mentions that, by the mid-1980s, all the postgraduates employed in the industry of Taiwan are foreign-educated nationals. Pack suggests that the productivity of foreign education was very high: the income of those in manufacturing with graduate education was 35% higher than the income of those with a bachelor's degree and 140% above the average wage in the sector.

6. Conclusions and Future Research

This article has argued that the recent findings of new empirical analyses based on plant-level data can be consistent with the view that openness to trade increases productivity and growth in developing countries. We argued that a careful examination of the apparently contradictory results of these studies reveals that the causal link between trade and growth seems to run from the former to the latter.

This interpretation is, on the one hand, consistent with the findings of many studies based on aggregate data and with a large amount of anecdotal evidence.

On the other hand, it would permit to derive policy implications that might help developing countries to experience faster productivity growth. The bad news for these countries is that it appears that the main policy changes should come from the receptors of their exports, i.e. industrial countries. We argued that a reduction in the many restrictions which advanced countries impose on the goods produced in less-developed economies could potentially increase the profitability of becoming an exporter in these countries and might induce the adoption of more advance technologies that improve productivity at the firm level.

In terms of future research, we believe it is necessary to study more explicitly the role of policies on productivity of developing countries. Until now, researchers have focused on the effects of trade liberalizations in developing economies, but no attempts have been made to quantify the direct effect of export-promotion policies on productivity at the firm level. We also need to make progress toward explaining the contradictory evidence on learning-by-exporting that comes from the many case studies and some of the econometric analyses. This might require the use of data sets with more detailed information, not usually available in the manufacturing surveys. It seems also appropriate to focus more attention on the role of externalities. If it is found that exporting activities generate real cost reductions to other firms, then there might be some room for a discussion of policy implications in terms of government export support. Finally, it would be important to advance the empirical literature on trade and growth toward identifying the exact mechanisms through which trade affects growth and not just compute correlations.

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Notes

1. In the Solow model, trade may not generate any growth if the consumption good is imported and the capital good is exported (this idea is from Mazumdar, 1996; see Lewer and Van den Berg, 2003a for empirical support to this hypothesis).
2. There is, however, a special case when the initial gap between a less-developed country and a developed country is small under free trade. Then, the less-developed country can overtake the developed one if it has a greater work force.
3. Here capital represents the variety or quality of inputs.
4. Thus, the model is more relevant to analyze economic integration between industrial countries.
5. In 1978, the NBER published the results in 11 volumes under the name *Foreign Trade Regimes and Economic Development*. Two of the volumes were written by Bhagwati and Krueger. The others were devoted to each of the nine countries under study: Turkey, Ghana, Israel, Egypt, Philippines, India, Korea, Chile, and Colombia.
6. The World Bank project included 19 countries, and it was published in seven volumes in 1991 under the title *Liberalizing Foreign Trade*.

7. Levine and Renelt (1992) use a variant of Leamer's extreme-bound analysis (see Leamer 1983, 1985) to examine whether the conclusions from previous studies are relevant to small changes in the conditioning information set. They find that none of the measures of openness they use is correlated with growth (although some of them are correlated with investment). The conclusions of Levine and Renelt (1992) should be regarded cautiously. Sala-i-Martin (1997) argues that the extreme-bound tests are too strong for any variable to pass them. Instead of labeling variables as "robust" versus "non-robust," he assigns levels of confidence to each variable. He shows that different measures of openness are positively correlated with growth and statistically significant.
8. The number of citations was obtained from the *Social Sciences Citation Index*.
9. For a comprehensive survey of the empirical literature on trade, in particular exports, and growth see Giles and Williams (2000).
10. Their estimates for the impact of trade on income are very large: an increase of one percentage point in the ratio trade to GDP increases income per person between one-half and two percent. As a reference, we can mention that Lewer and Van den Berg (2003b) find, after examining the empirical literature on trade and growth, that a one percentage point increase in exports growth is associated with one fifth percentage point increase in economic growth.
11. It is important to point out that there are many articles which have studied the relationship between trade and productivity using aggregate data, or industry level data, for a single country or a small group of countries. Examples using aggregate data include Hsiao (1987), Kunst and Marin (1989), Marin (1992), Bodman (1996), Frankel *et al*. (1996), Agosin (1999) and Lawrence and Weinstein (1999). Examples using industry-level data include studies by Jenkins (1995), Choudhri and Hakura (2000), Kim (2000), Ferreira and Rossi (2003) and Singh (2003). The results are usually mixed: some find that trade or exports cause economic or productivity growth, others that productivity causes exports, and yet others find no relation or clear causality.
12. Some scholars have also used plant-level data to study the effects of trade liberalization on productivity. Most of them find that liberalization increases productivity. See, for example, Tybout *et al*. (1991), Harrison (1994), Krishna and Mitra (1998), Sjöholm (1999), Alam and Morrison (2000), Fernandes (2002) and Pavcnik (2002). For a discussion about the channels through trade liberalizations may affect productivity in developing countries see Rodrik (1992), Dijkstra (2000) and Tybout (2000).
13. Kraay (1999) and Wagner (2002) do not test the self-selection hypothesis.
14. Roberts and Tybout (1997) show, for the Colombian manufacturing sector, that between 84 and 91% of the number of exporters in a given year remained as exporters in the following year.
15. The idea that productivity shocks drive firms in and out of the export markets is found in the literature on industrial evolution which studies firms' entry and exit decisions. Classic papers of this literature are Jovanovic (1982) and Hopenhayn (1992).
16. A possible explanation for this phenomenon is that consumers in developed countries are wealthier than consumers in developing countries; hence, they demand higher quality goods. Brooks (2001), for example, develops a model in which wealthier consumers (from developed countries) demand higher-quality goods, to explain why firms in developing countries sell only a small fraction of their total sales in the international markets.
17. Westphal (1982) argues that export activities appear to accelerate the acquisition of technologies and generates productivity improvements and efficiency gains. Pack (1992a, p. 229) explains that the source of economic growth in some Asian countries

"was their ability to extract relevant technological knowledge from industrial economies and utilize it productively within the domestic economy".

18. Agosin (1999, p. 96) explains that this technological change "included the introduction of stainless steel vats, the use of small casks made of new wood instead of the large old barrels previously used for ageing the wine, and investments in new refrigeration plant and equipment for grinding and pressing the grapes".
19. Source: *http://www.vinasdechile.com*.
20. Dahlman and Westphal (1982) define technological effort as the use of technological knowledge together with other resources to assimilate or adapt existing technologies and/or to create new technology.
21. This effort pursued to adapt the foreign technologies to local conditions.
22. This result, however, does not necessarily establish the direction of the causality.
23. As an example, we can mention that a report of the Ministry of Economy of Chile (see www.economia.cl) shows that, in 2001, the Chilean exports were affected by 180 non-tariff barriers and that a significant number of them were imposed by industrial countries.
24. Between 1960 and 1994, the annual percentage rate of growth was 8.5% in Korea and 8.7% in Taiwan. Source: Collins and Bosworth (1996).
25. For a discussion of the ways by which exports from multinationals may affect domestic firms see Blomström and Kokko (1998).
26. According to Pack and Page (1994), Koreans and Taiwanese returning to their countries receive salaries roughly commensurate with their opportunity cost in the USA.

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