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What Can We Learn From Micro-Level Data?[*]

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Abstract

We review the micro-level evidence on the effects of trade and investment liberalization in the developing world. We focus, in particular, on the effects of the 1991 trade reform in India, since it provides an excellent controlled experiment in which the effects of a drastic trade regime change can be measured. The main findings can be summarized as follows. 1) There is evidence of trade-induced productivity gains (in this respect, however, India is something of an exception); 2) These gains mainly stem from the intra-industry reallocation of resources among firms with different productivity levels and: 3) they are larger in import competing sectors; 4) There is no evidence of significant scale efficiency gains. Indeed, unilateral trade liberalization is often associated with a reduced scale efficiency; 5) There is evidence of a pro-competitive effect of trade liberalization; 6) There is no evidence either of learning-by-exporting effects or

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of beneficial spillover effects from foreign owned to local firms; 7) There is evidence of skill upgrading induced either by technology imports, or by trade-induced reallocations of market shares in favor of plants with higher skill-intensity; 8) There is no evidence of trade-induced increases in labor demand elasticities. Direct evidence suggests, however, that trade exposure raises wage volatility; 9) There is no evidence of substantial employment contraction in import competing sectors.

JEL classification: F1

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1 Introduction

In the last decades, many developing countries (e.g., Chile in the late 1970s, Turkey in 1983, Mexico in 1985, Colombia in 1990-91, India in 1991) have undergone a deep economic transformation which has involved a process of dramatic trade liberalization. This paper reviews the main empirical studies using firm and plant-level panel data to investigate the effects of trade reforms on firm performance and labor market outcomes in developing countries. We discuss, in particular, the effects of the 1991 trade reform in India, since it provides an excellent controlled experiment in which the effects of a drastic trade regime change can be measured.

The allocative efficiency argument for free trade has been extensively debated by the traditional trade theory in the context of perfectly competitive markets. Since the late 1970s, however, the so-called *new trade theory* has shown that the gains from trade originating from specialization according to comparative advantage are only part of the story, since in the presence of imperfectly competitive markets trade liberalization can bring additional gains by reducing the deadweight losses created by domestic firms' market power. In particular, it has been argued that trade liberalization, by increasing competition, forces firms to lower price-marginal cost mark-ups and hence move down their average cost curves, thereby raising firm size and scale efficiency. Recently, it has also been shown that in the presence of within-industry firm heterogeneity, trade liberalization causes more productive firms to expand at the expense of less efficient firms (which either shrink or exit), thereby inducing additional efficiency gains. Moreover, trade and investment liberalization may foster technology advancement and productivity growth in developing countries through several channels, such as technology advancement embodied in imported capital goods and intermediate inputs, technology transfers accompanying foreign direct investment, learning-by-exporting effects, etc.

In the last decade, a number of empirical works have resorted to firm and plant-level panel data to see whether the predicted gains from trade liberalization have materialized in some recent episodes of drastic trade reform in the developing world. Most of these studies find that trade reform in developing countries was indeed accompanied by productivity growth, technology advancement, falling mark-ups and a reshuffling of resources toward the more efficient firms, although in some cases the evidence may fail to convince because of the hurdles involved in the methodology used in these studies. This is true, in particular, for India, where in some cases studies using slightly different methodologies find opposite results. However, aside from methodological issues, India seems an exception with respect to other trade liberalizing developing countries, since most studies find that the 1991 trade reform was in fact accompanied by a reduced productivity growth. One explanation for this result is that India is still a heavily regulated economy, and hence the expected benefits of industrial restructuring and of the trade-induced reallocation of resources are probably smaller and will take longer to materialize.

Although the efficiency argument for trade liberalization has generally been accepted, the main argument against trade reform in the developing countries that have opted for an import substitution industrialization strategy has often been that trade liberalization would exacerbate income inequality and hence deteriorate the conditions of the poor. In particular, concerns regarding higher unemployment among workers displaced by the contraction of import competing sectors, greater uncertainty and precariousness of job conditions, and the creation of new job opportunities only for the most qualified segments of the workforce have often been deemed inevitable consequences of trade liberalization.

In this respect, the traditional trade theory (which removes, by assumption, uncertainty and unemployment) should have been reassuring, since its most celebrated theorem (the Stolper-Samuelson theorem) predicts that a skill-poor developing country opening up to international competition will experience a reduction in wage income inequality. However, the empirical evidence contradicts this prediction, since it shows that the recent episodes of trade liberalization in developing countries are generally accompanied by a dramatic increase in wage inequality. The recent theoretical and empirical literature can explain this puzzling evidence, since it shows that in the presence of imperfectly competitive markets, increasing returns to scale and firm heterogeneity, trade liberalization can indeed exacerbate wage inequality even in a skill-poor developing country.

Plant-level evidence also shows that trade reforms in developing countries do not generally bring a sharp contraction of import competing skill-intensive sectors. Further, the evidence shows that trade exposure is associated with a greater wage volatility, but also with a greater investment in technology and human capital. This evidence, too, can generally be explained by trade models based on increasing returns to scale and imperfectly competitive markets.

A few recent papers address related issues from different perspectives. Harrison and Hanson (1999) focus on three empirical issues concerning the impact of trade reform. First, they address the question of the weak econometric link between trade policy and long-run growth, and argue that it may be due to the fact that, because of the lack of data, trade policy cannot yet be measured adequately. The second and third issues addressed by the authors are the small impact on employment and the large impact on wage inequality of trade reforms in developing countries. We will mention their results on these topics in the second part of the paper. Matusz and Tarr (1999), and Bacchetta and Jansen (2001) survey the evidence on the adjustment costs of trade liberalization. They show that the overwhelming majority of the studies find that adjustment costs are small in relation to the benefits of trade liberalization. Finally, Tybout (2001) reviews the plant-level evidence in the light of the new trade theory. Our work is complementary to his, since our review also extends to the effects of trade reforms on the labor markets and, most important, it provides a more extensive treatment of the theoretical foundations of empirical work.

The paper is organized as follows. Section 2 illustrates the theoretical predictions concerning the effects of trade liberalization on firm performance. Section 3 discusses the relevance of these effects for trade liberalizing developing countries in the light of the micro-level evidence. Section 4 reports the plant-level evidence on the impact of trade liberalization on learning and technology diffusion. Sections 5 and 6 examine the labor market outcomes of trade liberalization. Section 7 analyzes the effects of the 1991 trade liberalization in India. Section 8 concludes.

2 Trade Liberalization and Firm Performance

When markets are imperfectly competitive, trade liberalization may affect firm-level variables, such as mark-ups, size and productivity. This section illustrate these effects, while the next reviews the plant-level evidence on their empirical relevance.

To see how trade liberalization can affect firm performance, first consider a simple setting with representative firms.[1] Next we will show that more can be learned by allowing for firm heterogeneity. Consider then n identical firms competing *à la* Cournot in a sector producing a homogeneous good. The aggregate demand has a constant elasticity σ. The technology features plant-level scale economies and is summarized by the following total cost function:

$$TC = f + \frac{1}{\varphi}q \tag{1}$$

where q is firm output, f is a fixed overhead cost and $1/\varphi$ is a constant marginal cost. Both f and $1/\varphi$ are in terms of labor, the only production factor, chosen as the numeraire. Profit maximization

[1] This example draws on Markusen (1981). Similar results under different assumptions about market structure can be found in Krugman (1979) and Helpman and Krugman (1985).

by individual firms (taking the output of rivals as given) implies the following mark-up pricing rule:

$$p = \frac{\sigma n}{\sigma n - 1} \frac{1}{\varphi} \tag{2}$$

Equation (2) is crucial for understanding the pro-competitive effect of trade liberalization. It shows that a firm's price-marginal cost mark-up, $\frac{\sigma n}{\sigma n-1}$, depends negatively on the perceived product demand elasticity, σn. Thus, when firms face a fiercer competition due to a rise in the number (n) of rivals, they perceive a higher demand elasticity and consequently lower their mark-up.

With unrestricted entry, profits (π) are zero in equilibrium:

$$\pi = (p - 1/\varphi)q - f = 0 \quad \Rightarrow \quad q = f\varphi(\sigma n - 1) \tag{3}$$

Finally, full employment of labor (L) requires:

$$L = nl = n(f + q/\varphi) \tag{4}$$

where $l = f + q/\varphi$ represents labor employed by each firm. Solving equations (3) and (4) for n and q gives:

$$n = \left(\frac{L}{\sigma f}\right)^{\frac{1}{2}}, \quad q = f\varphi\left[\left(\frac{\sigma L}{f}\right)^{\frac{1}{2}} - 1\right] \tag{5}$$

It can be shown that trade integration among countries with similar tastes and technology is formally equivalent to an increase in the size of the economy, as captured by an increase in L. The effects on firm performance are straightforward:

1) Equation (5) shows that trade integration (i.e., a rise in L) raises the number of firms n. From (2), this implies that firms perceive a higher demand elasticity and hence lower their price and mark-up. This is the *pro-competitive* effect of trade integration.

2) Trade integration raises firm size q (see equation (5)).

3) The trade-induced increase in firm size raises firm productivity (given by q/l) due to a better

exploitation of scale economies. This is the *scale efficiency gain* from trade integration.

2.1 Introducing firm heterogeneity

The above results have been derived from a setting with representative firms. Several reasons suggests, however, to extend the general equilibrium trade models to allow for firm heterogeneity. In particular:

1) Recent work *inter alia* by Roberts and Tybout (1996), Olley and Pakes (1996), Aw, Chen and Roberts (1997) reports evidence of a significant degree of within-industry plant-level heterogeneity. Hence, allowing for firm heterogeneity may add an important element of realism to the framework of analysis.

2) Micro-level empirical evidence shows that exporting firms have different characteristics with respect to non-exporting firms. In particular, the former are larger, more efficient, more skill-intensive and pay higher wages (Bernard and Jensen, 1997, 1999; Clerides et al., 1998).

3) Most plant-level empirical studies show that trade-induced productivity gains stemming from the reshuffling of resources between plants with different productivity levels are more relevant than the scale efficiency gains due to a better exploitation of plant-level scale economies (Tybout, 2001; Tybout and Westbrook, 1995; Pavcnik, 2002). Therefore, trade models based on representative firms may miss an important mechanism through which trade reform affects the allocation of resources, aggregate productivity and income inequality.

One of the most rigorous attempts to embed firm heterogeneity into a general equilibrium trade model is provided by Melitz (2002), who generalizes Krugman (1980) by dropping the assumption of symmetric firms[2]. This model provides new insights on the impact of trade liberalization on the intra-industry reallocation of resources and can help explain the stylized facts mentioned above.

On the demand side, the model features love for variety, captured by a standard CES util-

[2]Although Krugman (1980) is a cornerstone of the new trade theory, it is uninteresting (in the absence of firm heterogeneity) from the standpoint of the effects of trade liberalization on firm performance. The reason is that, since in this model firms face a constant demand elasticity, trade integration has no effects on firms' mark-ups, and on their size and productivity.

ity function, as in Krugman (1980). The production side of the economy is characterized by a continuum of firms, each producing a different variety. The technology features plant-level scale economies and is summarized by a total cost function as in equation (1), $TC(\varphi) = f + q/\varphi$. The only difference is that now firms have different productivity levels, indexed by φ. Hence, φ captures firm heterogeneity in this model. Firms face a demand curve with a constant elasticity $\sigma > 1$. Profit maximization implies the familiar mark-up pricing rule, $p(\varphi) = \frac{\sigma}{\sigma-1}\frac{1}{\varphi}$. Firms' profits are then $\pi(\varphi) = r(\varphi)/\sigma - f$, where $r(\varphi)$ is revenue. It can be shown that the ratios of any two firms' outputs and revenues only depend on the ratio of their productivity levels:

$$\frac{q(\varphi_1)}{q(\varphi_2)} = \left(\frac{\varphi_1}{\varphi_2}\right)^{\sigma}, \quad \frac{r(\varphi_1)}{r(\varphi_2)} = \left(\frac{\varphi_1}{\varphi_2}\right)^{\sigma-1} \tag{6}$$

Equation (6) and the expressions for $p(\varphi)$ and $\pi(\varphi)$ show that *more productive firms* (i.e., firms with a higher φ) *are bigger, charge a lower price and earn higher profits than less productive firms.*

The equilibrium aggregate price index P is a generalization of the standard price index associated with a CES utility function:

$$P = \left[\int_0^{\infty} p(\varphi)^{1-\sigma} n\mu(\varphi) d\varphi\right]^{\frac{1}{1-\sigma}} \tag{7}$$

where $\mu(\varphi)$ is the equilibrium distribution of productivity levels and n is the equilibrium number of firms. Using the expression for $p(\varphi)$, the price index can be written as:

$$P = n^{\frac{1}{1-\sigma}} p(\widetilde{\varphi}) = n^{\frac{1}{1-\sigma}} \frac{\sigma}{\sigma-1} \frac{1}{\widetilde{\varphi}} \tag{8}$$

where $\widetilde{\varphi}$ is the weighted average of firms' productivity levels. Note that the inverse of the price index equals real per capita income W (i.e., $W = P^{-1}$). Hence, as in Krugman (1980), both an increase in the number of available varieties n and in the average productivity $\widetilde{\varphi}$ raise real per capita income and welfare. However, while in Krugman (1980) the average productivity is exogenously given and trade reform can only exert its effects through an increase in n, in this model $\widetilde{\varphi}$ is endogenous and hence it can be influenced by trade integration.

Melitz shows that in the absence of any trade costs, a move from autarky to free trade has no effect on the distribution of productivity levels and average productivity. In this case, the effects of trade integration are identical to those predicted by Krugman (1980), i.e., a welfare increasing expansion in the product variety, and firm heterogeneity has no impact on average industry productivity.

In order to give firm heterogeneity an important role to play, two routes can be taken. One is to relax the assumption of an exogenously fixed demand elasticity (σ) for each variety. The other is to assume the existence of sunk entry costs into foreign markets.

As far as the former is concerned, (in a separate appendix) Melitz shows that, even in the absence of any trade costs, firm heterogeneity is crucial for the impact of trade when firms' demand elasticity endogenously increases with product variety, as in Krugman (1979). In this case, trade integration among two identical countries expands the variety of products and hence increases the elasticity of substitution among them. In turn, an increased elasticity of substitution induces a reallocation of market shares towards more efficient firms and thus generates an aggregate productivity gain. The intuition for this result is that a higher elasticity of substitution generates a premium in terms of market shares in favor of firms charging a lower price, i.e., the more efficient ones.

The second setting carefully explored by Melitz builds on the assumption of sunk entry costs into foreign markets. Melitz refers to the results of empirical studies confirming that *firms face significant fixed costs associated with the entry into foreign markets*: "These costs are related to the fact that a firm must find and inform foreign buyers about its product and learn about the foreign market. Further, it must adapt its product to foreign standards and set up new distribution channels in the foreign country".

The assumption that exporting firms face a fixed cost of exporting has striking implications.[3] In the presence of firm heterogeneity, only the more efficient ones can afford to pay the fixed cost of exporting. Hence, these costs generate a partition of firms into exporting and non-exporting firms. The former sell to both the domestic and the foreign markets, whereas the latter only sell to the domestic market. Hence, this partition of firms implies that exporting firms are larger and more productive than non-exporting firms, and this is consistent with the plant-level empirical evidence.

This setting based on firm heterogeneity and fixed costs of exporting can help explain the effects of trade liberalization on intra-industry reallocation of resources and aggregate productivity. In particular, it allows to explain the empirical finding that output share reallocations among firms with different productivity levels are the main source of trade-induced productivity gains. The intuition is the following. In the trade regime, all domestic firms face foreign competition in their domestic market, which induces a loss of revenue and market share. For non-exporting firms this translates into a loss of profits. Among these non-exporting firms, the less efficient incur negative profits and exit, whereas the other non-exporting firms survive with a lower market share than in autarky. Conversely, exporting firms expand their market share and profits because their access to foreign markets more than compensate the loss of revenue in the domestic market. Hence, *trade induces both the exit of less efficient firms and the reallocation of market shares towards the more efficient exporting firms. Both effects contribute to an increase in average productivity.*

[3] In section 5 we will see that, as shown by Manasse and Turrini (2001), the interaction of fixed costs of exporting and firm heterogeneity has also striking implications with regard to the effects of trade liberalization on wage inequality.

3 Evidence on the Effects of Trade Liberalization on Firm Performance[4]

3.1 Evidence on the pro-competitive effect of trade liberalization

The pro-competitive effect of trade liberalization has traditionally been investigated by using industry-level data. This literature examines the correlation between trade exposure and price-cost margins at the industry level, using import penetration rates as a measure of trade exposure. Empirical studies for industrial countries (see, for instance, Schmalensee, 1989) show a negative correlation between price-costs margins and import competition, especially when domestic concentration is high. This result is consistent with the argument that import competition reduces profits in industries which enjoy above normal returns.

As for the developing world, the country studies reported in Roberts and Tybout (1996), relative to Chile, Colombia, Mexico, Morocco and Turkey, add to the standard industry-level analysis a study of the correlation between trade exposure and price cost-margins at the plant-level, to see whether the observed effects at the industry-level are common to all producers in an industry or are concentrated in a subset of producers.[5]

3.1.1 Industry-level evidence

As far as the industry-level analysis is concerned, the country studies use the industry-level price-cost margin to measure industry-level performance. It is immediate to show that, if we assume that unit expenditures on labor and materials are constant with respect to output, then the price-cost margin is a monotonic transformation of the price-marginal cost mark-up. The price-cost margin in industry j at time t, PCM_{jt}, is measured as the value of output $(P_{jt}Q_{jt})$ minus expenditures on labor and materials over the value of output. It equals profits (Π_{jt}) plus payments to capital

[4] **See also Tybout (2001) on the topics covered in this section.**

[5] The authors of the country studies reported in Roberts and Tybout (1996) are: J. Tybout for Chile (ch.9), M. Roberts for Colombia (ch.10), J.-M. Grether for Mexico (ch.11), M. Haddad, J. de Melo and B. Horton for Morocco (ch.12) and F. Foroutan for Turkey (ch.13).

as a proportion of the industry's value of output:

$$PCM_{jt} = (\Pi_{jt} + (r_t + \delta)K_{jt})/P_{jt}Q_{jt} \quad (9)$$

where K_{jt} is capital stock, r_t is the competitive gross return on capital and δ is the depreciation rate. Equation (9) shows that sectoral $PCMs$ are influenced by both the rate of profit and the capital intensity. The country studies use the following basic model:

$$PCM_{jt} = f(H_{jt}, IMP_{jt}, H_{jt} \cdot IMP_{jt}, K_{jt}/Q_{jt}, I_j, T_t) \quad (10)$$

Here, H_{jt} is the Herfindahl index, an index of industry structure which is inversely correlated with the degree of competition among domestic producers. IMP_{jt} is the import penetration ratio; the pro-competitive effect of trade liberalization should show up as a negative correlation between the price-cost margin and import penetration. The interaction term $H_{jt} \cdot IMP_{jt}$ tests the hypothesis that, if highly concentrated industries enjoy above normal profits because of market power, then they should be more sensitive to foreign competition. K_{jt}/Q_{jt} is the capital-output ratio, which controls for sectoral differences in capital-intensity (see equation (9)). Finally, I_j and T_t are industry and time dummies, respectively.

Since most of variation in the panel data used in these country studies is across industries, it is not surprising that the estimation results crucially depend on whether or not industry dummies are included in the regression equation. When industry dummies are excluded, four out of five countries studies (i.e., those for Chile, Colombia, Mexico and Morocco) find that the coefficients of both IMP_{jt} and $H_{jt} \cdot IMP_{jt}$ are negative and highly significant. This suggests that import competition is negatively correlated with sectoral profitability and that the effect is larger for highly concentrated industries.

These results are substantially weakened, however, when industry dummies are included in the regression equation. Note that in this case estimated coefficients only reflect temporal variation in the data, and hence they are better suited to isolate the pro-competitive effect of increased foreign competition. The country studies show that, when industry dummies are included, evidence of a significant pro-competitive effect of trade liberalization is found only in Colombia and Mexico.

3.1.2 Plant-level evidence

The country studies also examine the pro-competitive effect of foreign competition by looking at plant-level evidence on price-costs margins. They use the following basic model:

$$PCM_{ijt} = f(S_{ijt}, S_{ijt}^2, IMP_{jt}, S_{ijt} \cdot IMP_{jt}, K_{jt}/Q_{jt}, I_j, T_t) \tag{11}$$

where PCM_{ijt} is the price-cost margin of plant i in industry j and time t, S_{ijt} is the share of plant i's output in sector j's total domestic production, and the other variables in (11) have the same interpretation as in equation (10). The interaction term $S_{ijt} \cdot IMP_{jt}$ tests the hypothesis that the pro-competitive effect of foreign competition is stronger among firms with a higher domestic market share.

The coefficient of the linear term S_{ijt} is generally positive and significant, whereas that of the quadratic term S_{ijt}^2 is generally negative. This suggests that price-costs margins rise at a decreasing rate with market shares. More interestingly, in every country studied the coefficients on IMP_{jt} and $S_{ijt} \cdot IMP_{jt}$ are negative and highly significant, whereas industry dummies do not generally have any explanatory power. Thus, exposure to foreign competition is associated with lower price-cost margins, and the effect is concentrated among the large plants. This result suggests that looking at plant-level evidence highlights a powerful and systematic pro-competitive role of foreign competition.

3.2 Plant-level evidence on trade-induced productivity gains

The literature which uses plant-level data to investigate the productivity gains from trade liberalization shows mixed results. Tybout, de Melo and Corbo (1991) find little evidence of productivity growth in manufacturing after trade reform in Chile. Conversely, Harrison (1994) finds a significant productivity increase after trade liberalization in Cote d'Ivoire. In section 7, we show that empirical works using a similar methodology find opposite results with regard to the effects of the 1991 trade liberalization in India. In this section, we briefly review two recent studies which will help us clarify the methodological hurdles involved in estimating the effect of trade reform on productivity.

Tybout and Westbrook (1995) use plant-level panel data to study the efficiency gains induced by the Mexico trade liberalization. Prior to 1985, Mexico was an inward-looking economy due to heavy policies of trade protection.[6] In 1985, the Mexican government announced its decision to join the GATT and undertook major reforms leading to a reduction in tariffs by 45% and import licenses by more than 75% within three years. Hence, the Mexican experience provides an interesting setting to study the empirical relevance of trade-induced productivity gains in developing countries.

The methodology employed by Tybout and Westbrook allows them to disentangle three potential sources of productivity gains. The first derives from exploitation of scale economies. As shown in Section 2, trade integration, by increasing the perceived product demand elasticity, causes firms to loose market power and forces them down their average cost curves, thereby inducing scale efficiency gains. The second source of productivity gains derives from market share reallocations among plants with different levels of efficiency. As shown in Section 2, in the presence of substantial firm heterogeneity, market share reallocations can be a relevant source of trade-induced productivity gains. Finally, the authors include a catch-all residual term which captures changes in productivity not accounted for by scale effects or share reallocations, such as technical change, learning-by-doing, externalities, capacity utilization, elimination of waste, managerial effort, and so on. The main findings of Tybout and Westbrook are the following.

a) *Scale efficiency effects.* Most manufacturing sectors show increasing returns to scale, and for the smallest plants in these industries returns to scale are often relevant (as high as 1.2). However,

[6]The data used by the authors are from Mexico's Annual Industrial Survey and cover the period 1984 through 1990. The sample plants represent 80% of total output.

the largest plants in these industries generally appear to have reached a minimum efficient scale. Thus, given that large plants account for a disproportionate share of sectoral output, industrial expansion does not induce large gains in scale efficiency. More precisely, the mean output growth was more than 50% in the period 1984-1990. But despite this substantial output growth, the exploitation of scale economies accounts for only the 0.55% rise in average productivity. These results suggest that the focus of trade models with imperfect competition and representative firms on the gains from scale economies exploitation may be somewhat misplaced, since these gains appear modest in magnitude.

b) *Output share reallocations.* This effect accounts for more than 1% rise in average productivity. Although this figure is quite modest, it suggests that output share reallocations among firms with different productivity levels might be empirically more relevant than scale efficiency effects, and hence that firm heterogeneity can be a key determinant of the efficiency gains from trade liberalization.

c) *Residual effect.* Most of the average increase in productivity comes from the catch-all residual effect, which accounts for 9.6% rise in average productivity. This implies that most of the estimated overall efficiency gains (11.16%) are indeed left unexplained.

The above results must be interpreted with caution, because of the hurdles involved in the methodology used by Tybout and Westbrook, which are common, however, to most analyses of the efficiency gains from trade liberalization. The main methodological problems involved in estimating the productivity gains from trade reform can be summarized as follows (see Pavcnik, 2002).

1) *Identification of the trade effects.* In most studies, the identification of trade effects relies on the comparison of plant productivity before and after a trade policy change. As a consequence, this approach attributes productivity changes originating from other sources to trade policy. To see how serious this problem can be, note that most studies use data covering only a short time period after trade reform, which implies that the estimates of productivity growth can be heavily

affected by the cyclical behavior of the economy in the aftermath of the reform. Note, further, that in some episodes of trade liberalization, a deep economic downturn is often the trigger of these reforms, and hence productivity gains from liberalization can be underestimated if a prolonged recession leads to reduced capacity utilization.

2) *Simultaneity bias.* Assume that plant i's technology is described by the following Cobb-Douglas production function:

$$y_{it} = \beta_0 + \sum_{j=1}^{J} \beta_j x_{it}^j + e_{it}; \quad e_{it} = \omega_{it} + \epsilon_{it} \tag{12}$$

where all variables are in logarithms, y_{it} is output and x_{it}^j is the jth input. The error term e_{it} is composed of a stochastic disturbance ϵ_{it} plus an unobserved plant-specific efficiency term ω_{it}. Note that, since more productive plants are willing to hire more inputs, the error term e_{it} is positively correlated with factor inputs. This implies that OLS estimates (or between estimates, as in Tybout and Westbrook, 1995) of the production function coefficients are biased upward, thus involving biased estimates of ω_{it}.[7]

In some cases (e.g., in Harrison, 1994) this problem has been tackled by assuming that the plant-specific efficiency term is time-invariant, which allows to estimate equation (12) using a fixed effects estimator. This approach only removes the bias originating from the time-invariant component of plant-specific efficiency, so it does not solve the problem completely. What is more worrisome, however, is that this approach, by treating plant-specific efficiency as time-invariant, also removes the possibility to measure how it evolves after trade reform.

Hence, in general, the simultaneity problem is either neglected or tackled improperly in the literature.

3) *Self-selection bias.* The literature generally neglects the self-selection bias induced by plant closing. Pavcnik (2002) shows that, under certain conditions, a negative correlation is to be

[7]Estimates of ω_{it} are in fact based on the difference between actual output and output predicted from estimates of the production function coefficients.

expected between the efficiency term ω_{it} and capital stock, conditional on surviving plants. This implies that the estimated coefficient of capital stock in production function (12) is generally biased downward.

Pavcnik (2002) proposes an alternative methodology which addresses most of these issues. In particular, the problem of identification of the trade effects is addressed by comparing plants' productivity growth in the export oriented and import competing sectors with that of firms in the non-traded sector. The simultaneity and self-selection biases are addressed by using a semiparametric procedure in which the plant-specific efficiency term is modeled as a time-varying function of capital and investment.

Pavcnik implements her methodology using data on Chilean manufacturing plants for the period 1979 to 1986, i.e., in the aftermath of a drastic trade liberalization. Plants are partitioned into three groups. Plants belonging to a 4-digit ISIC industry exporting more than 15% of its total output are characterized as export oriented. Plants belonging to an industry whose ratio of imports to total output exceed 15% are instead characterized as import competing. The rest of the plants belong to the non-traded sector.

Pavcnik uses the mentioned procedure to obtain consistent estimates of plants' productivity growth in each of these groups. The results are striking. In the period 1979-1986, the productivity of export oriented plants grew, on average, by 25.4%, that of import competing plants grew by even more (31.9%), while that of plants in the non-traded sector grew by only 6.2%. These results suggest a dramatic productivity growth differential in favor of plants exposed to international competition with respect to inward-oriented plants. They also suggest that, in the case of a unilateral trade liberalization (such as the one experienced by Chile), trade-induced productivity gains can be higher for import competing plants relative to export oriented plants.

Pavcnik also uses a procedure similar to that used by Tybout and Westbrook (1995) to disentangle the contribution of output share reallocations among firms with different productivity levels to productivity growth. She finds that in the export oriented sector, average productivity growth due to output share reallocations equals 16.6%, while the rest (8.7%) is due to within plants productivity growth. The figures for the import competing sector and the non-traded sector are, respectively, 21.3% and 10.7%, and 2.4% and 3.8%. These results strongly suggest that the reshuffling of resources in favor of more productive firms is a critical determinant of productivity growth and that, consistent with Melitz (2002)'s model, this effect can be largely due to trade liberalization.

3.3 More on trade policy and scale efficiency

Tybout and Westbrook (1995) also look at patterns of sectoral change in measures of foreign competition to see whether they are correlated with estimated productivity changes. Correlations are generally insignificant. The only robust finding is that heightened import competition reduces scale efficiency. This result seems to contradict one of the main predictions of the simplest models of the new trade theory (such as the one illustrated in Section 2), i.e., that in the presence of imperfect competition the trade-induced increase in firm size can be an important source of efficiency gains. Indeed, most general equilibrium models based on imperfect competition (see, for instance, Cox and Harris, 1985) predict that trade liberalization will generate welfare gains primarily through the mechanism of increased scale.

The empirical evidence on the effects of trade liberalization on firm size is mixed. Roberts and Tybout (1991) find that higher import penetration is associated with lower employment per plant in Chile and Colombia. Conversely, other works on developed countries find that the removal of tariff protection increases output.[8]

The theoretical literature emphasizes that the effects of trade policy in the presence of imperfect competition are generally sensitive to the specific assumptions concerning market structure and industry characteristics. Following Head and Ries (1999), now we argue that a slight modification of the simple model illustrated in Section 2 can help explain the finding of Tybout and Westbrook

[8] See, for instance, Baldwin and Gorecki (1986) and Caves (1984) for an analysis of average plant scale in Canada and Australia, respectively.

(1995) that increased import competition may reduce firm size and scale efficiency.

Consider n domestic firms and n^* foreign firms competing *à la* Cournot in an industry producing a homogeneous good. Domestic and foreign firms employ the same production technology, featuring a fixed cost f and a constant marginal cost $1/\phi$. Markets are segmented, as in Brander (1981). Let τ_h and τ_f denote the ad valorem tariffs charged by the domestic and foreign country, respectively. The profits of domestic and foreign firms (π and π^*, respectively) are given by:

$$\begin{aligned} \pi &= (p_h - 1/\phi)q_h + (p_f/(1+\tau_f) - 1/\phi)q_f - f \\ \pi^* &= (p_h/(1+\tau_h) - 1/\phi)q_h^* + (p_f - 1/\phi)q_f^* - f \end{aligned} \tag{13}$$

Here, q_h and q_h^* denote, respectively, domestic and foreign firms' sales to the domestic market, whereas q_f and q_f^* are domestic and foreign firms' sales to the foreign market, respectively. p_h and p_f are the final consumer prices in the domestic and foreign market, respectively.

Since the two markets are segmented (and marginal costs are constant), a firm's choice of output in one market is independent of its choice of output in the other market. Hence we can concentrate on the domestic market to study the impact of τ_h on q_h and q_h^*, noting that the impact of τ_f on q_f is analogous to that of τ_h on q_h^*. The first order conditions for profit maximization in the domestic market are given by:

$$\begin{aligned} \frac{\partial \pi}{\partial q_h} &= p_h' q_h + p_h - 1/\phi = 0 \\ \frac{\partial \pi^*}{\partial q_h^*} &= p_h' q_h^* + p_h - (1+\tau_h)/\phi = 0 \end{aligned} \tag{14}$$

Totally differentiating equations (14) with respect to q_h, q_h^* and τ_h, using Cramer's rule and assuming that firms' outputs are strategic substitutes, it is possible to show that:

$$\frac{\partial q}{\partial \tau_h} > 0, \ \ \frac{\partial q^*}{\partial \tau_h} < 0 \tag{15}$$

Inequalities in (15) show that a home tariff raises output per firm in the domestic country and lowers output per firm in the foreign country. Similarly, a foreign tariff raises output per firm in the foreign country and lowers output per firm in the domestic country. The intuition is that a home tariff raises the marginal cost of foreign exporting firms, forcing them to lower output to raise marginal revenue and restore the equality between marginal cost and marginal revenue. In turn, foreign firms' contraction allows domestic firms to expand.

To sum up, competition *à la* Cournot in the context of segmented markets implies that unilateral trade liberalization by the domestic country reduces firm size and scale efficiency in the domestic country and raises scale efficiency in the foreign country.[9] This result may help explain why empirical studies often find that increased import competition due to unilateral trade liberalization reduces firm size in developing countries.

Head and Ries (1999) test the implications of this model using a panel of 230 Canadian 4-digit SIC industries for the period 1987-1994. The focus of their empirical analysis is on the effects on firm size of the 1988 Canada-U.S. Free Trade Agreement, which led to a gradual bilateral tariff removal between the two countries. Their basic regression equation is:

$$\ln q_{it} = \alpha_i + \beta_t + \gamma^{CA}\tau_{it}^{CA} + \gamma^{US}\tau_{it}^{US} + \epsilon_{it} \tag{16}$$

where q_{it} is average output per plant in the ith industry at time t, α_i and β_t are industry and time fixed effects, respectively, τ_{it}^{CA} and τ_{it}^{US} are the industry tariff rates charged by the Canadian and U.S. governments, respectively, and ϵ_{it} is an error term. Regression results show that Canadian tariff reductions lowered plant scale in Canada, while U.S. tariff reductions had the opposite effect. Both effects are highly significant and quite large in magnitude. For instance, estimated coefficients imply that the average reduction of Canadian tariffs by of 5.4% caused a 6.1% scale reduction in Canada, while the average reduction of U.S. tariffs by 2.8% caused a 4.6% scale increase in Canada.

An other interesting result is that tariff effects are smaller in industries characterized by high

[9]Head and Ries (1999) show that this result holds also under the assumption of free entry of firms.

turnover rates (measured as the sum of entry and exit divided by the number of establishments). This suggests that plant entry and exit dampen scale adjustments, and hence that industries characterized by free entry and exit are not much affected by tariff reductions. This result is in line with results reported by Roberts and Tybout (1991) for Chile and Colombia, showing that the effect of import penetration on employees per plant decreases with industry turnover.

Head and Ries also look at plant size heterogeneity to examine whether plants belonging to different size groups show a different response to trade policy changes. Their main result is that only the scale of large plants is responsive to tariff reductions. Conversely, small plants are *de facto* insulated from the effects of trade liberalization.

To sum up, the plant-level evidence illustrated in this section suggests that trade-induced scale efficiency gains are generally small in magnitude, because: 1) a disproportionate share of industry output is produced by large firms, which appear to have reached minimum efficient scale; 2) small plants' output does not respond much to tariff reductions; 3) entry and exit of firms in response to changing profit opportunities lower the quantity adjustment by incumbent firms in sectors with high turnover rates. The evidence also shows that unilateral trade liberalization generally reduces firm size and scale efficiency in import competing sectors. This is not a worrisome result, however, since the evidence also shows that, notwithstanding this negative effect, overall trade-induced productivity gains are higher in import competing sectors.

4 Trade and Technology Advancement

In addition to the static effects illustrated in Section 2, trade liberalization has also been argued to have other static and dynamic effects, most of which are related to knowledge diffusion and technology advancement. Here we briefly review some of these effects.

Imports of differentiated intermediate inputs and capital goods

As first shown by Ethier (1982), in the presence of firm-level scale economies, free trade in differentiated intermediate inputs is formally equivalent to technical progress. The reason is that imports of intermediates allow a finer division of labor which increases firms' efficiency. A similar reasoning applies to imports of differentiated capital goods. Further, through imports of intermediates and capital goods, domestic firms can benefit from foreign innovations incorporated in these goods. This argument is particularly relevant for developing countries. In a dynamic extension of Ethier (1982)'s model, Rivera-Batiz and Romer (1991) have also shown that, under certain conditions (indeed quite restrictive), trade in differentiated intermediates can permanently increase the rate of innovation and growth. Finally, as shown by Lee (1993), if capital goods are capital-intensive, then trade liberalization reduces the price of capital goods in capital-poor developing countries, thereby increasing the return to investment and the growth rate of capital stock in these countries; similarly, trade liberalization reduces the price of imported technology in developing countries, thereby stimulating technology advancement.

Foreign direct investment

Foreign investment can generate several benefits for the host country. For instance, it can finance the expansion of industries in which the domestic country enjoys a comparative advantage. Further, it can lead to the transfer of knowledge from foreign to local firms. Finally, it can provide local firms with the critical know-how to break into foreign markets.

If foreign entrants possess a better technology, they can foster productivity improvements in the domestic industry either directly, by raising the productivity of the resources used in production, either indirectly through knowledge spillovers to local firms. As far as the latter effect is concerned, local firms can learn from foreign firms either by simply observing them, or through turnover of labor, as employees move from foreign to local firms.

Learning by exporting

It is often argued, mainly on the basis of anecdotal evidence, that there are several channels through which domestic exporters can benefit from the technical expertise of foreign buyers.[10] In particular, breaking into foreign markets allows firms to acquire knowledge of international best

[10] See, *inter alia*, World Bank (1993).

practice. Further, foreign buyers often provide their suppliers with technical assistance and product design in order to improve the quality of imported goods. It has also been noted that in some cases foreign buyers transmit to their suppliers located in low-wage countries the tacit knowledge acquired from their other suppliers located in technologically advanced countries. Hence, exporting may foster learning and productivity growth.

Aside from these beneficial effects, trade liberalization has also been argued to have potentially negative dynamic effects for developing countries. These negative effects can be thought of as the dynamic counterpart to the static gains from specialization based on comparative advantage. For instance, as shown by Lucas (1988) and Young (1991), in the presence of sectoral asymmetries in the relevance of learning-by-doing, a developing country which in the free trade regime switches its production mix toward technologically stagnant sectors may suffer a permanent reduction in its rate of productivity growth. Similarly, Grossman and Helpman (1991) have shown that trade liberalization can adversely affect the rate of innovation and growth in a human capital-poor developing country by diverting its resources away from R&D. Further, Rodrik (1988) argues that, if firms invest in superior technology to reduce their costs, then their incentive to invest depends positively on output. It follows that trade liberalization may reduce the incentive to invest in new technology for firms belonging to the import competing sectors, since these sectors should contract after trade liberalization.

In the previous section, we have already shown that there is evidence of trade-induced productivity gains in the developing world, and that these gains are larger for import competing firms. Hence, the available micro-level evidence suggests that the potentially negative effects of trade reforms are actually offset by their positive effects. In section 7, we will report more micro-level evidence on the effects of trade reform in India. In the rest of this section, we discuss the empirical relevance of some of the mentioned channels of international technology diffusion.

4.1 The import channel of technology diffusion[11]

In the absence of plant-level studies on the link between imports and productivity growth, here we briefly discuss the evidence based on more aggregated data. Coe and Helpman (1995) is one of the first attempts to perform a rigorous test of the relevance of imports as a vehicle for the international transmission of technology. Using a sample of OECD countries, these authors ask how much of a country's total factor productivity can be explained by domestic and foreign R&D activities, where the latter is crucially defined as the import share-weighted average of partner countries' R&D activities. Coe and Helpman find that both domestic and foreign R&D have a positive and significant effect on domestic TFP. Further, for small countries (only), the TFP elasticity to foreign R&D is significantly larger than that to domestic R&D. Similarly, using patent data, Eaton and Kortum (1996) find that innovations that originate abroad explain more than 90% of productivity growth of small OECD countries, and that more than half of these innovations originate from only three countries, i.e., the U.S., Japan and Germany.

Coe, Helpman and Hoffmaister (1997) extend their analysis to a large sample of developing countries. One important difference is that import shares are computed by considering imports of machinery and equipment only, since these goods are more likely to embody new knowledge. Their results strongly suggest that intermediate goods imports raise total factor productivity also in developing countries. Meyer (2001) restricts even further the definition of imports used to compute import shares by considering machinery only and finds that in this case the TFP elasticity to foreign R&D in developing countries is twice as large as in the case in which all imports are used to compute foreign R&D.

A recent paper by Barba Navaretti and Soloaga (2002) looks at the role of imported machines in transferring embodied technological progress. They use data on unit values of machines exported by the EU to a sample of neighboring developing and transition countries in Central-Eastern Europe and in the Southern Mediterranean. Here, unit values proxy for the technological complexity

[11] **See also Barba Navaretti and Tarr (2000) and Keller (2001a) for two recent surveys of international trade and technology diffusion.**

of machines. The authors find that imported machines have a positive impact on total factor productivity, and that the impact is larger the higher the technological complexity of imported machines.

The above studies examine the link between TFP, R&D and imports at the aggregate level. However, as noted by Keller (2001b), R&D spending is highly concentrated by industry. For instance, about 80% of total manufacturing R&D is conducted in only four 3-digit ISIC industries in OECD countries (chemical products, electrical and non-electrical machinery and transport equipment). Therefore, Keller performs separate regressions for the sample of low-R&D industries and finds that TFP elasticities are significantly smaller in these industries.

To sum up, preliminary evidence using aggregate data suggests that imports are a highly relevant channel of international technology diffusion, and that the domestic productivity effect of knowledge originating abroad is greater the smaller the size and the lower the level of development of the domestic country, and the greater both the technology intensity of industries and the complexity of imported machines.

4.2 Foreign direct investment

Haddad and Harrison (1993), Aitken and Harrison (1994) and Harrison (1996) are among the first to use plant-level panel data to analyze the impact of joint ventures and foreign subsidiaries on local firms' productivity in developing countries. These studies ask two related questions, namely, whether foreign firms exhibit higher productivity levels than local firms, and whether knowledge spillovers from foreign to local firms raise the latter's productivity level. Data come from three developing countries, Cote d'Ivoire (1975-87), Morocco (1985-89) and Venezuela (1983-88). Foreign firms are defined as all firms with foreign equity that exceed 5% of assets.

As far as the performance of foreign relative to local firms is concerned, these studies find that, consistent with other evidence, foreign firms generally exhibit higher total factor productivity, pay higher wages and have much higher import and export propensities.[12]

A more interesting question is whether local firms benefit from spillovers generated by their foreign counterparts. Aitken and Harrison (1994) test this hypothesis by assuming that, if knowledge is transmitted from foreign to local firms, then the productivity of the latter should be higher in sectors with a larger foreign presence. They use a panel of Venezuelan firms to estimate the following Cobb-Douglas production function:

$$\log Y_{ijt} = \log A_{ijt} + a_1 \log SL_{ijt} + a_2 \log UL_{ijt} + a_3 \log M_{ijt} + a_4 \log K_{ijt} \tag{17}$$

Here, Y_{ijt} is output of firm i in sector j at time t, A is total factor productivity, SL is skilled labor, UL is unskilled labor, M is raw materials, and K is capital stock. In order to capture the effect of foreign presence on local firms' TFP, A is modeled as follows:

$$\log A_{ijt} = b_1 + b_2 FDI_{jt} + b_3 D_j + b_4 D_t + e_{it} \tag{18}$$

where FDI_{jt} is the share of foreign firms (as measured by the share of foreign assets in total sector assets) in sector j at time t, D_j and D_t are sector and time dummies, respectively, and e_{it} is an error term. A positive effect of foreign presence on local firms' TFP should show up as a positive and significant coefficient b_2.

Estimation results critically depend on whether or not sectoral dummies D_j are included in the regression. When sectoral dummies are excluded, the coefficient b_2 is positive and significant. This suggests a positive correlation between foreign presence and local firms' efficiency. The correlation may be spurious, however, since foreign firms may be attracted to sectors in which local firms make higher profits. In fact, when controlling for unobserved fixed industry characteristics through sectoral dummies, b_2 turns negative and highly significant. Notice that in this case only temporal

[12] The evidence on total factor productivity growth is mixed. In particular, only in the case of Venezuela TFP growth is higher for foreign firms. The converse is true for Mexico, and the difference is insignificant for Cote d'Ivoire.

variation in the FDI variable is exploited to estimate b_2, which suggests that increased foreign presence has a negative short-run impact on local firms' productivity. One possible explanation for this result is that foreign firms reduce the market share of local firms, thereby reducing their capacity utilization. Another possibility is that foreign firms, by paying higher wages, attract the best workers, thereby reducing the productivity of local firms.

4.3 Learning by exporting?

The micro-level evidence shows a positive robust correlation between exporting and productivity. There are two plausible non incompatible explanations for this stylized fact. One is that, as shown by Melitz (2002) and discussed in Section 2, more efficient firms self-select into export markets. The other is the learning-by-exporting argument, according to which exporting causes efficiency gains. Two recent papers address the question of the direction of causality. Bernard and Jensen (1999) use data relative to U.S. manufacturing plants for the period 1984-1992. They find that size, wages, productivity and capital intensity are all higher for exporters relative to non-exporters. They also find clear evidence that good firms become exporters, since performance is higher ex-ante for exporters. However, they do not find evidence that exporting improves performance, since productivity and wage growth are not higher ex-post for exporters relative non-exporters.

Clerides, Lach and Tybout (1998) address the same question and reach similar results. They use plant-level manufacturing data for Colombia (1981-1991), Mexico (1986-1990) and Morocco (1984-1991). Their approach is based on the idea that, if exporting fosters productivity growth, then the productivity trajectory of exporting firms should change after they break into foreign markets. To test this hypothesis, they estimate econometrically the reduced form of a theoretical model derived from the hysteresis literature (Baldwin, 1989; Dixit, 1989) which explicitly considers two possible explanations for the correlation between exporting and productivity, namely, self-selection and learning-by-exporting.

In particular, they estimate, industry by industry, by full information maximum likelihood

(FIML), the following two-equations system:

$$\begin{aligned} y_{it} &= 1 \;\; if \;\; \boldsymbol{\beta}_x \mathbf{X}_{it} + \beta_e e_t + \sum_{j=1}^{J} \beta_j^c \ln(AVC_{it-j}) + \sum_{j=1}^{J} \delta_j y_{it-j} + & (19) \\ +\eta_{it} &\leq 0; \; and \;\; y_{it} = 0 \;\; otherwise \\ \ln(AVC_{it}) &= \gamma_0 + \gamma_e \ln(e_t) + \sum_{j=1}^{J_c} \gamma_j^k \ln(K_{it-j}) + \sum_{j=1}^{J_c} \gamma_j^c \ln(AVC_{it-j}) + \sum_{j=1}^{J_y} \gamma_j^y y_{it-j} + v_{it} & (20) \end{aligned}$$

Equation (19) represents the export market participation decision by plant i at time t. It is a dynamic discrete choice equation in which y_{it} takes a value of one if the firm decides to export and a value of zero otherwise. Here, $\mathbf{X}_{it}$ is a vector of exogenous plant characteristics, e_t is the real exchange rate (which proxies for changes in relative prices that are common to all plants), the summation of the terms AVC_{it-j} is a distributed lag in the average variable cost (which proxies for marginal cost), the summation of the terms y_{it-j} is a distributed lag in the participation variable, and η_{it} is a disturbance.[13] This equation allows to test whether, after controlling for plant-specific characteristics, for movements in industry relative prices and for past export participation decisions, past realizations of marginal costs are negatively correlated with the decision to break into foreign markets. If this is the case, we can conclude that, ceteris paribus, firms experiencing a productivity increase (as proxied by a fall in marginal costs) are more likely to be exporters.

For all countries and for most industries, FIML estimation results show that the sum of coefficients of the distributed lag in marginal costs is negative. Individual coefficients are never significant, however, (maybe because of the high collinearity among them) and some of them are positive. In sum, these results provide weak evidence in favor of the hypothesis that firms improving their relative performance self-select into foreign markets.[14]

Equation (20) allows to test the learning-by-exporting hypothesis: if firms experience cost reductions after entering foreign markets, then, after controlling for firm-specific differences in

[13] In both equations, the disturbances are composed of unobserved plant random effects plus transitory noise.

[14] FIML estimation results also show that, in all countries and all industries, firms with large capital stocks are more likely to become exporters. Further, firms with past export experience are more likely to be exporters. This latter result is consistent with the literature on hysteresis.

capital stock (K_{it-j}) and in past realization of marginal costs, we should observe a negative correlation between export experience and marginal costs. FIML estimation results show, however, that the coefficients γ_j^y on lagged export experience are generally insignificant. In some cases they are significant, but with the wrong (positive) sign. Only in a few cases these coefficients are negative and significant, e.g., in the Moroccan apparel and leather industries.[15]

In short, these results do not support the learning-by-exporting hypothesis. There are several reasons, however, to be cautious in interpreting the results. In particular, since the time span covered by the data is very short, the econometric analysis can only pick up gains in efficiency which materialize in the short-run (within three years). Further, even if these gains materialize immediately (which is quite unlikely, given that learning is a gradual process), in the short-run they can be offset by the sunk entry costs associated with becoming an exporter. Indeed, sunk entry costs may contribute to explain the positive and significant correlation between exporting and marginal costs found by the authors in some cases. Hence, this evidence simply suggests that becoming an exporter does not generate short-run efficiency gains.[16]

5 Trade, Technology and Wage Inequality in Developing Countries

According to the traditional trade theory, trade liberalization should pose no serious distributional issues in developing countries. The reason is that, since developing countries are high-skilled labor scarce relative to industrial countries, their trade-induced specialization in low-skilled intensive activities should increase the relative demand for low-skilled labor, thereby reducing wage inequality in these countries. This prediction has often been used to argue in favor of trade liberalization in developing countries, since it would both increase efficiency and lower wage dispersion in these

[15]FIML estimation results of equation (20) also show that firms with a larger capital stock have lower marginal costs, and that marginal costs tend to follow a second order autoregressive process.

[16]Also, as correctly noted by the authors, their approach does not allow to detect efficiency gains accruing to workers in the form of higher wages, but that leave average variable costs unchanged.

countries.

The empirical evidence on wage inequality in developing countries seems to contradict this optimistic prediction.[17] As shown, *inter alia*, by Robbins (1996) and Harrison and Hanson (1999), many developing countries experiencing drastic trade liberalizations in the recent past, such as Chile, Mexico, Costa Rica and Uruguay, have seen a concomitant increase in wage inequality and a generalized increase in the relative demand for skilled labor (i.e., skill upgrading).

This puzzling evidence has stimulated an impressive body of research by way of new explanations of the link between trade and labor markets. Here we briefly review the main explanations, focusing on their implications for labor market outcomes in developing countries.

Outsourcing

Feenstra and Hanson (1996) formulate a model with capital mobility and a continuum of production activities with different skill-intensities. They show that trade and investment liberalization bring about North-South outsourcing of production activities which are at the same time unskill-intensive relative to other activities performed in the North, and skill-intensive relative to activities performed in the South. The main implication is that, contrary to the standard two-sector Heckscher-Ohlin model, trade and investment liberalization increase the relative demand for skilled labor in both regions, and can thus potentially explain the worldwide increase in the skill premia.

The argument put forth by Feenstra and Hanson is consistent with the main stylized facts concerning the labor market dynamics in both the developed and the developing world. Its empirical relevance deserves further scrutiny, however. As argued, for instance, by Robbins (1996), this model can be relevant for countries, such as Mexico, that experienced large FDI inflows in the last

[17] The prediction is based on the simple Stolper-Samuelson theorem. However, as noted by Turrini (2002), in a more realistic higher dimensional setting, i.e., in the presence of many countries, sectors and production factors, it is hard to discern empirically in which factor a country is relatively abundant and in which trade context that factor is going to gain from trade liberalization. For instance, Turrini performs computable general equilibrium simulations to show that the effects of trade liberalization on the relative wage of the unskilled in Latin America critically depends on whether or not agriculture is also liberalized. A similar point is made by Harrison and Hanson (1999). They argue that the dramatic increase in wage inequality after the 1985 trade reform in Mexico does not necessarily contradict the Stolper-Samuelson theorem. The reason is that, prior to reform, protection in Mexico was skewed toward low-skilled intensive sectors, and it fell most in these sectors after trade reform.

decades. It is less so, however, for much of trade-liberalizing Latin America, which did not receive substantial FDI in the 1980s.

Intra-industry trade and wage inequality

Dinopoulos, Syropoulos and Xu (1999) are the first to investigate the potential role of intra-industry trade for wage inequality. They build a one sector model which features monopolistic competition and plant-level increasing returns to scale on the production side, and love for variety on the consumption side. As in Krugman (1979), they assume that the price elasticity of demand faced by each producer increases with the number of competitors. Further, they assume that the skill-intensity of production increases with firm size. In this model, trade liberalization raises the number of competitors, which implies that prices fall. As a consequence, some firms are forced to exit, thereby raising the average size of surviving firms. The effect of trade on the skill premium follows immediately from the assumption that firm size is skill-biased. This latter assumption finds support in several plant-level empirical studies, e.g., in Idson and Oi (1999), who report that large firms tend to employ a higher proportion of skilled workers.

Related work by Epifani and Gancia (2002) illustrates a new channel through which intra-industry trade may increase wage inequality. The authors formulate a two-sector general equilibrium model which features monopolistic competition in both sectors to show that an elasticity of substitution in consumption greater than one and higher scale economies in the skill-intensive sector imply that any increase in the volume of trade, even between identical countries, is skill-biased. The intuition is simple. Trade expands the market size of the economy, which is beneficial because of increasing returns. In relative terms, however, output increases by more in the skill-intensive sector, since it is characterized by stronger economies of scale, and the relative price of the skill-intensive good therefore falls. With an elasticity of substitution in consumption greater than one, the demand for skill-intensive goods increases more than proportionally, raising their share of total expenditure and therefore also the relative wage of skilled workers.

This result implies that, if the skill-biased scale effect is strong enough to overcome the standard factor proportions effect, international trade will spur inequality even in the skill-poor developing economies, making the model consistent with the evidence of rising skill-premia in developing countries that have experienced trade liberalizations.

The authors also show that physical capital accumulation leads to higher skill premia, and that the intersectoral mobility of capital is likely to magnify the effects of trade integration on wage inequality. These findings are consistent with both the evidence on capital relocation towards skill-intensive sectors (Caselli, 1999) and the large literature on capital-skill complementarity (Krusell et al, 2000).

Manasse and Turrini (2001) are the first to study the effects of intra-industry trade on labor market outcomes in the presence of heterogeneous firms and workers. They build a one sector monopolistic competition trade model *a là* Krugman (1980). Production of each variety involves a constant marginal requirement in terms of a raw input and one unit of skilled labor as a fixed cost. Workers are heterogeneous in terms of skills. High-skilled workers produce high quality varieties and earn higher wages, since quality is valued by consumers. Trade liberalization has striking implications for income distribution. Because of foreign competition, all firms loose market shares in their domestic market. At the same time, the access to foreign markets represents a concrete opportunity to expand total sales and profits only for some firms. The reason is that access to foreign markets entails a fixed cost. Hence, only those firms whose profits are higher than the fixed cost of exporting can effectively break into foreign markets. As a consequence, high-skilled workers employed in firms producing high quality goods see their earnings rise after trade integration. Conversely, less-skilled workers employed in firms producing only for the domestic market see their earnings fall after trade integration. Thus, the model provides a trade-induced mechanism of reallocation of resources and increasing wage dispersion which operates at the firm rather than the sectoral level. Further, it is in line with the plant-level empirical evidence (reported below) showing that changes in the skill premia are significantly associated with the export status of firms.

Trade-induced skill-biased technical change

The main alternative explanation for the worldwide increase in wage inequality is exogenous skill-biased technical change. It has been argued that technology can be at the root of the increase in inequality because recent innovations in the production process, such as the widespread introduction of computers, have boosted the relative productivity of skilled workers.[18] A recent literature on *directed technical change*, initiated by Acemoglu (1998, 1999), asks whether the bias of technological change is endogenous. In these models, innovation originates in the skill abundant North and is then exported to the South. An important implication is that innovation responds to economic incentives in the North. In particular, it is shown that skill-complement innovations are more profitable in a country relatively endowed with skilled workers. This implies that the skill bias of technological change depends positively on the relative endowment of skilled workers in the North. This result may help explain the puzzling concomitant increase both in the skill premium and in the relative supply of skilled workers experienced by most advanced countries in the last decades. The intuition is that the increase in the relative supply of skilled workers, which would ceteris paribus depress the skill premium, strengthens the incentive to skill-complement innovations. Under certain conditions (in particular, a high elasticity of substitution between high and low skilled-workers) the latter effect prevails and determines a rise in the skill premium in the North. As far as the South is concerned, since it passively adopts the technology developed for the needs of the North, it is bound to import more and more skill-complement machines, with a consequent generalized increase in the relative demand for skilled labor and in the skill premium.

The literature on directed technical change can also shed light on the relation between international trade and the skill bias of technical change. It is shown, in particular, that North-South trade liberalization, by increasing the relative price of skill-intensive goods in the North, increases the profitability of skill-complement innovations relative to unskill-complement innovations, thereby magnifying the skill bias of technical change.

It is worth mentioning two other recent works investigating the link between international

[18] See, among others, Autor et al. [1998].

trade and technical choice. Neary (2001) formulates a general oligopolistic equilibrium model where a reduction in trade barriers encourages more strategic investment by incumbent firms in order to deter entry. In particular, it is shown that, as the number of competitors in an industry increases after trade liberalization, each firm has a greater incentive to increase its investment in order to improve its position in the strategic oligopolistic game. Strategic over-investment by incumbent firms thus raises the ratio of fixed to variable costs. Assuming that fixed investment costs are skill-intensive relative to variable costs, the model predicts that a move towards free trade induces a higher skill premium, a higher ratio of skilled to unskilled workers in all sectors (i.e., skill upgrading) and little changes in trade volumes. Hence, the model predicts that trade liberalization can affect technical change and skill premia even in the absence of significant increases in actual trade volumes.[19]

In the same vein, Ekholm and Midelfart-Knarvik (2001) develop a model where trade liberalization affects the technical choice of firms and can thus lead to skill-biased technical change. They assume the existence of two technologies: one is characterized by a high (skill-intensive) fixed cost and a low (unskill-intensive) marginal cost, while the other features a low fixed cost and a high marginal cost. It is then shown that the market size expansion induced by trade liberalization increases the relative profitability of firms characterized by a high fixed cost and a low marginal cost, thus inducing the adoption of the more skill-biased technology.

5.1 Plant-level evidence on the determinants of skill upgrading

5.1.1 The role of imported technology

A recent work by Pavcnik (2000) is one of first attempts to analyze the determinants of skill upgrading in developing countries. She uses data on 4547 Chilean manufacturing plants spanning

[19] There is another important channel through which trade may increase wage inequality in the presence of oligopolistic markets. For instance, Borjas and Ramey (1995) formulate a model where the traded sector is an oligopoly and is low-skilled intensive relative to the rest of the economy. Firms and workers share oligopolistic rents in the traded sector. In this setting, an exogenous increase in imports reduces rents in the oligopolistic sector, thereby reducing the relative wage of the unskilled. Hence, the trade-induced fall of rates of returns in highly concentrated and unionized industries, such as the automobile industry, may contribute to a worldwide increase in wage inequality.

the years 1979-1986. Chile represents an interesting setting to study the relation between trade liberalization and skill upgrading in developing countries since, between 1974 and 1979, most non-tariff barriers were eliminated and tariff rates were reduced from more than 100% to 10%. Following this drastic trade liberalization, from 1979 to 1986, the share of skilled workers in total manufacturing employment increased by almost 17%, and the skill premium grew by more than 10%.

One possible explanation for these trends is the following. Falling trade and investment barriers bring about a decrease in the relative price of imported technology in developing countries such as Chile, thereby stimulating technology adoption.[20] If the adoption of new technology is a skill-intensive activity, then skill upgrading and rising skill premia may be closely linked to the trade-induced process of technology advancement.

The data used by Pavcnik provide several plant-level variables to measure technology, such as imported materials, expenditures on patent use and rights, and expenditures on foreign technical assistance. All of these technology measures, together with new capital investment, show a dramatic increase in the period following trade liberalization. In order to test whether skill upgrading in Chile was influenced by the process of technology adoption, Pavcnik partitions plants according to whether or not they used imported materials (or received foreign technical assistance, or used patented technology) in the years following the trade reform. She then studies the distribution of the wage bill share of skilled workers (which proxies for plants' skill-intensity) for the two groups of plants. The results are striking: the distribution of the wage bill share of plants investing in new technology is markedly right-skewed with respect to that of non-investing firms, which means that the probability of observing a skill-intensive plant is much higher among plants investing in new technology. This result suggests that technology adoption is a skill-biased activity, so that plants endowed with a higher share of skilled workers invest more in new technology.

Pavcnik also performs a regression analysis which confirms that technology measures are pos-

[20] The evidence reported by Eaton and Kortum (1996) confirms that the international diffusion of technology is significantly influenced by the degree of protectionism.

itively correlated with the plants' share of skilled workers. However, the correlation disappears when plant-specific fixed effects are included in the estimating equation. Hence, the evidence reported by Pavcnik does not allow to conclude that plants investing in new technology become more skill-intensive over time. However, the strong evidence reported in the paper concerning the skill-biased nature of investment in new technology still helps explain within-industry skill upgrading, as firms investing in new technology, thanks to their investment, expand their employment share relative to non-investing firms. In other words, it is the reallocation of resources towards more skill-intensive plants, rather than plants' skill upgrading, which might explain why industries become more skill-intensive over time.

5.1.2 The role of exporters

While Pavcnik (2000) focuses on the role of imported technology, a related paper by Bernard and Jensen (1997) centers instead on the role of exporting plants for skill upgrading and wage inequality.[21] Contrary to previous studies on the determinants of skill upgrading in manufacturing, that analyze within-industry and between-industry shifts in employment using fairly aggregated data, Bernard and Jensen look at the contribution of individual (exporting and non-exporting) plants to the aggregate increase in the relative demand for skilled labor. In particular, they ask whether skill upgrading and the rise in the skill premia stem from within-plants increases in the relative demand for skilled labor or from a reallocation of resources toward the more skill-intensive plants. The question is of particular interest since it can shed light on the relative contribution of trade and technology to the increased demand for skilled labor. More precisely, within-plants skill upgrading can be mostly attributed to skill-biased technical change, i.e., to changes in production practices (such as the widespread introduction of computers and related technologies) that have increased the relative demand for more educated workers. On the other hand, between-plants employment shifts can be mostly attributed to cross-plants demand shifts, and in particular to

[21] The data used by Bernard and Jensen come from U.S. manufacturing plants and cover the period 1973-1987. Sample plants account for almost two thirds of total manufacturing employment in the U.S..

trade-induced demand shifts.

The decomposition performed by Bernard and Jensen reveals that between-plants shifts explain 46% of the total increase in the relative demand for skilled labor and 58% of the total increase in the skill premium. These results stand in sharp contrast to previous studies carried at the industry level, where the within-industry component explain virtually all of the increase in the relative demand for skilled labor (Katz and Murphy, 1992; Berman, Bound and Griliches, 1994), and hence suggest that decompositions based on industry-level data hide substantial within-industry plant heterogeneity and potentially overestimate the importance of skill-biased technical change.

In order to determine the role of the export status of firms for the dynamics of relative wages and employment, Bernard and Jensen look at the contribution of exporting plants to the within and between increases. They find that non-exporters have a within effect on relative employment 21% larger than exporters, whereas the between effect on employment is entirely explained by the exporters. As for wages, the role of exporters is even stronger. The within effect on wages is 26% larger for exporters than non-exporters, whereas the between effect on wages is entirely explained by the exporters. These results suggest that the rise in wage inequality is due to employment gains at exporting plants, even though skill upgrading is taking place at both exporters and non-exporters.

Finally, in order to test more directly the role of technology and product demand shifts for labor market dynamics, Bernard and Jensen regress the within and between components of relative wage and employment increases on changes in export sales, domestic sales and technology variables, such as the change in the R&D to sales ratio or in computer investment. The main results are that between-plants changes (both in wages and employment) are strongly positively related to increases in both foreign and domestic demand, with the coefficient of the former three times larger than the latter. The impact of technology measures on the between components is instead weaker. These results suggest that the between-plants movements of workers and wages, which are crucial for the increase in the skill premium, are largely determined by demand shifts across plants and in particular by export demand shifts. As for the impact of demand increases and technology variables on the within components of wage and employment increases, it is shown, instead, that the impact of technology measures is relatively stronger than that of demand increases, confirming that within-plants skill upgrading is mainly driven by skill-biased technical change.

The main conclusion from the work of Bernard and Jensen is that looking at plant-level evidence instead of aggregate industry-level data reveals that trade-induced demand shifts are responsible for substantial relocation of resources across plants, and in particular in favor of exporting plants, and that this might explain much of the recent increase in wage inequality.

6 Trade and Labor Demand Elasticities

In the previous section we have summarized the main findings of the theoretical and empirical literature on the determinants of the rise in wage inequality in trade liberalizing developing countries. However, the rise in wage inequality is not the only adverse effect of globalization on the welfare of workers. A new strand of literature, initiated by Rodrik (1997), argues that there are more subtle ways through which globalization may reduce the welfare of workers and jeopardize social stability. The main argument, set out informally by Rodrik, is that reduced barriers to trade and investment exacerbate the asymmetry between groups that can cross international borders and those that cannot. The former groups, which include skilled workers, professionals and owners of capital, are freer to take their resources where their reward is highest. The latter groups, which mainly include unskilled workers, are instead tied to their country of origin because they are less capable of taking advantage of the richer menu of opportunities offered by the global market. The main consequence is that the demand for large segments of the working population becomes more elastic, since these workers can be more easily substituted by other workers across national borders.

Rodrik argues that a trade-induced increase in labor demand elasticities has the following adverse consequences for the welfare of workers: 1) a shift of the incidence of non-wage labor costs towards labor and away from employers; 2) more uncertainty due to more volatile responses of wages and employment to any exogenous shock to labor demand; 3) a reduced bargaining power of workers.

Given the relevance of the labor demand elasticity for the welfare of workers, it is useful to see more formally how it can be influenced by trade liberalization. As shown by Hamermesh (1993) and Slaughter (2001), an industry's labor demand elasticity, η, can be decomposed as follows:

$$\eta = [1 - s]\epsilon + s\sigma \tag{21}$$

where s is the labor share of total industry revenue, ϵ is the constant-output elasticity of substitution between labor and all other factors of production, and σ is the industry product-demand elasticity.[22] Equation (21) shows that η consists of two parts. The first, $[1 - s]\epsilon$, captures the substitution effect. It tells, for a given level of output, how much the industry substitutes away from labor towards other factors when wages rise. The second part, $s\sigma$, captures the output effect: higher wages imply higher costs and thus a lower demand for an industry's output, which translates into a lower demand for labor. Thus, both the substitution and the output effects contribute to reduce labor demand when wages rise. Finally, note that the higher the share s of labor in total cost, the higher the relative importance of the product demand elasticity for the labor demand elasticity.

Note that trade liberalization can influence the elasticities ϵ and σ, and thus also the derived labor demand elasticity η. First consider σ. As shown in Section 2, trade models based on imperfect competition generally imply that trade liberalization increases the product-market demand elasticity. Consider now the constant-output elasticity of substitution ϵ between labor and all other factors. Suppose that an industry is vertically integrated with a number of production stages. With international trade, stages can move abroad either within firms by establishing multinational corporations with foreign affiliates (as in Helpman, 1984), or by buying the output of those stages from other firms (as in Feenstra and Hanson, 1996). Trade thus gives access to foreign production

[22] In equation (21) all the elasticities are defined to be positive.

factors either directly through foreign affiliates or indirectly through intermediate inputs. As a consequence, trade and investment liberalization expand the set of factors an industry can substitute towards in response to higher domestic wages, thus increasing ϵ.

To summarize, trade and investment liberalization can *potentially* increase the labor demand elasticity either by increasing the product-market demand elasticity or by increasing the elasticity of substitution between labor and all other production factors. Next, we turn to the empirical evidence to see whether trade liberalization *actually* increased labor demand elasticities.

6.1 Evidence on patterns in labor demand elasticities

6.1.1 Industry-level evidence

The first rigorous attempt to estimate the impact of international trade on labor demand elasticities is provided by Slaughter (2001). He uses the NBER Productivity Data Base to estimate time series of labor demand elasticities from 1961 to 1991 for production and non-production workers for U.S. manufacturing overall and for eight manufacturing industries. The estimated elasticities are then regressed on several trade measures to see whether patterns in trade can explain the estimated patterns in the labor demand elasticities.

The main trade measures used by Slaughter include exports, imports or net exports as a share of shipments, measures of trends in transport costs (e.g., the ratio of c.i.f. import value to customs import value), measures of outsourcing (e.g., the share of imported intermediates), multinational measures (e.g., foreign affiliate share of U.S. multinationals' total employment), et cetera.

The main findings of Slaughter can be summarized as follows. In the period of analysis, the demand elasticity for production labor has increased in manufacturing overall and in most manufacturing industries (in particular, it has almost doubled since the mid-1970s). On the other hand, there is no sign of an increase over time in the demand elasticity for non-production labor (indeed, this elasticity has fallen in the last decades).

As far as the effect of trade on production labor is concerned, Slaughter finds that most of his trade measures have a positive impact on the elasticity of demand for production labor and are generally statistically significant. The results turn insignificant, however, when time dummies or a time trend are included in the regressions.[23] One possible explanation for the lack of robustness of trade measures to the inclusion of time controls may be the high collinearity between time and these trade measures. However, the high statistical significance and robustness of the coefficient of the time trend suggests that time is picking up some force constantly making production labor more elastic over time. In this respect, it is likely that it is not actual trade that matters, but rather potential trade. That is, what might matter for labor demand is just the ability to transact internationally regardless of whether such transactions actually occur. Thus, trade might be playing an important role independent of changes in observables such as trade and foreign direct investment flows.

Finally, as far as the effect of trade on non-production labor is concerned, Slaughter finds that many of his trade measures have a negative and significant effect on the elasticity of demand for non-production labor, and that, contrary to the case of production labor, these measures are generally robust to the inclusion of time controls.

6.1.2 Plant-level evidence

Krishna, Mitra and Chinoy (2001) use Turkish plant-level data spanning the course of a dramatic trade liberalization to test whether greater openness led to an increase in labor demand elasticities. Until the early 1980s, the manufacturing sector in Turkey received an extraordinarily high level of protection: the average tariff in 1981 was estimated to be 49%. Further, for over half of the products, tariff equivalent of non-tariff barriers were estimated to be over 100%. An import liberalization program was announced in December 1983 and implemented soon after, leading to a dramatic fall of both tariff and non-tariff barriers.

Krishna et al. use annual data from the Turkish manufacturing census for 10 three-digit ISIC

[23]Similarly, using data from a broad sample of OECD countries, Bruno, Falzoni and Helg (2001) find little impact of various trade measures on labor demand elasticities in most of these countries.

industries covering all plants in the greater Istanbul area and spanning the years 1983-1986. Eight of the ten industries saw a dramatic fall in protection after trade reform. The labor demand elasticity is estimated for each of the ten industries separately, including firm-specific dummies to control for firm heterogeneity. The main result is that, although most elasticities are precisely estimated and fall in a reasonable range, estimates of the changes in labor demand elasticities are small in magnitude and largely insignificant.[24]

The failure to reject the nul of no changes in labor demand elasticities is somewhat surprising, since previous studies using the same data (e.g., Levinsohn, 1993) strongly suggest that trade liberalization in Turkey led to substantial increases in product-market demand elasticities. From (21) we know that higher product demand elasticities should have translated into higher labor demand elasticities. One possible explanation for this contradictory evidence is that labor demand decisions by firms are subject to several frictions, so that it takes time before changes in product demand elasticities lead to observable changes in labor demand elasticities.

7 Evidence on the Effects of Trade Reform in India

7.1 Salient aspects of trade and investment reforms

Until the late eighties India's economic system was highly regulated, so much to lead some commentators to lump (erroneously, according to Basu and Pattanaik, 1997, p.123) India together with Russia and China as examples of centrally planned economies. In June 1991, following a balance of payment crisis, a newly elected government manifested its willingness to undertake deep structural reforms and introduced drastic policy changes in the subsequent years. The main features of these policy changes can be summarized as follows.

The *trade policy regime* changed abruptly and dramatically. Prior to the reform, it was one of the world's most regulated and protectionist trade regime, characterized by severe quantitative

[24]Fajnzylber and Maloney (2001) use plant-level panel data for Chile, Colombia and Mexico across their periods of reform to estimate labor demand elasticities in these countries. Their results show little evidence of structural breaks after trade reform in these countries, and of trade-induced increases in labor demand elasticities.

restrictions and very high import tariffs. On the export side, there were both export controls and export incentive schemes. Following the reform, the maximum tariff was reduced from 400% to 150% in July 1991 and still further later to reach 64% in 1994. The average tariff was reduced from 128% to 94% in 1992 and then to 55% in 1994. In 1992, import licences were abolished except for a limited group of sectors mainly producing consumption goods. Export subsidies and controls were abolished.

The *industrial policy* was completely overhauled.[25] Most barriers to entry into industries were removed. Industrial licensing was abolished in almost all sectors. Controls over investment and expansion by large industrial firms were also abolished, while the list of industries reserved for the public sector was drastically reduced.

The *foreign investment policy* was also completely restructured. Prior to the reforms, India's policy toward foreign investment was very restrictive. Equity participation was limited to 40%, except in a few high-tech or export-oriented sectors. With the reform, this limit was raised to 51% and foreign investment was permitted in a much larger number of sectors. Further, the Foreign Investment Promotion Board was created to stimulate FDI in India and the country entered into bilateral and multilateral investment guarantee schemes.

Finally, the *exchange rate regime* was restructured. The highly controlled regime based on a chronically overvalued exchange rate was dismantled. In 1992, a dual exchange rate was introduced, and in 1994 the rupee became fully convertible on the current account. The capital account has not yet been liberalized. The restructuring of the exchange rate regime was accompanied by two substantial devaluations of the rupee. However, due to an immediate pass-through to domestic inflation, the real devaluation of the rupee was less than 7% (annually) in the years following the reforms.

In the rest of this section, we review the main empirical studies which have used firm and plant-level panel data to investigate the effects of this dramatic trade and investment liberalization

[25] See, *inter alia*, Jha (2000).

on the performance of Indian manufacturing firms and labor markets.

7.2 Trade liberalization and firm performance in Indian manufacturing

Two recent studies, Krishna and Mitra (1998) and Balakrishnan et al. (2000), provide an attempt at a rigorous test of the effects of trade liberalization on firm performance in Indian manufacturing. Both studies use firm-level data obtained from the Center for Monitoring Indian Economy (CMIE). In both papers, the empirical analysis draws on the methodology developed by Hall (1988) and Harrison (1994), which allows to examine the effects of the 1991 trade liberalization on firms' mark-ups, productivity growth and the degree of exploitation of returns to scale. Notwithstanding these similarities, the two papers reach completely different conclusions.

The data used by Krishna and Mitra (1998) spans the years 1986-1993 and cover the following manufacturing industries: Electronics, Electrical machinery, Non-electrical machinery and Transport equipment. The authors find that in all industries except Electrical machinery there were reductions in returns to scale after 1991. This reduction in returns to scale may reflect an increased exploitation of returns to scale by firms operating at too small a scale prior to the reform. Krishna and Mitra also find evidence of significant reductions in mark-ups in the same industries in the years following the reform.[26] Finally, they find evidence of increases in the growth rate of productivity (ranging from 3 to 6%) in all industries except Transport equipment. This evidence suggests that the 1991 trade liberalization in India was associated with a strong pro-competitive effect leading to falling mark-ups, to an increased exploitation of scale economies and an increased growth rate of total factor productivity. Notice that these effects are in line with the predictions of the simple model illustrated in Section 2.

The data used by Balakrishnan et al. (2000) span the years 1988 to 1998 and cover the following manufacturing industries: Machinery, Transport equipment, Textiles, Textile products and Chemicals. In contrast to Krishna and Mitra (1998), these authors find a 1% fall in the annual

[26] For Electrical machinery, Krishna and Mitra find a slight increase in the mark-up. They argue, however, that mark-up estimates for this industry are little reliable.

rate of productivity growth in the post-trade liberalization period. Further, they find a slight increase (rather than a reduction) in returns to scale after the trade reform, although the returns to scale estimated by these authors for the pre-reform period are much lower than those estimated by Krishna and Mitra (1998). Indeed, Balakrishnan et al. (2000) find evidence of decreasing returns to scale, whereas Krishna and Mitra (1998) find evidence of strong increasing returns to scale in all sectors except Electrical machinery.

Given the substantial overlap between the time periods and industries covered by the data used in the two studies, the striking differences in the results are likely to be caused by differences in the methodology used to measure factor inputs and in the econometric strategy. In particular, Balakrishnan et al. (2000) use the fixed-effects estimator, use instrumental variables to control for the endogeneity of factor inputs and pool together firms belonging to different sectors. In contrast, Krishna and Mitra (1998) use the random-effects estimator, do not control for the endogeneity of inputs and perform separate regressions for each sector.

Finally, notice that, similar to Balakrishnan et al. (2000), other works find a reduction in the rate of productivity growth of Indian firms in the post-liberalization period. Srivastava (2000) uses data for about 3000 Indian companies for the period 1980 to 1997. He finds a decline in the rate of productivity growth in the 1990s as compared to the 1980s. Kumari (2000) uses firm level data relative to engineering industries (electrical and non-electrical groups) for the period 1985 to 1995. She finds that productivity growth of engineering firms has declined in the post-reform period as compared to the pre-reform period.

To sum up, contrary to other trade liberalizing developing countries, the available micro-level evidence does not allow yet to discern the effects of the 1991 trade reform in India on firms' mark-ups, on the degree of exploitation of returns to scale and on productivity growth. Aside from methodological issues (see section 3.2), one possible explanation for this lack of positive results is that India is still a highly regulated economy, and hence the expected beneficial effects of the trade-induced reallocation of resources will take longer to materialize.

7.3 Trade and technical efficiency of Indian manufacturing firms

Parameswarn (2000) uses firm-level data to analyze the evolution of technical efficiency of Indian firms. The data (obtained from CMIE) span the years 1989 to 1998 and are relative to 640 firms belonging to four industries: Electrical machinery, Non-electrical machinery, Electronics and Transport equipment. In order to estimate technical in/efficiency, the author uses the stochastic frontier production approach developed by Battese and Coelli (1995), which involves estimating a production function of the type:

$$y_{it} = f(k_{it}, l_{it}, m_{it}, t) - u_{it} + \varepsilon_{it} \quad (22)$$

where all variables are in logarithms, and y_{it} is output of firm i at time t. The function $f(\cdot)$ represents the frontier technology, whose inputs are physical capital (k_{it}), labor (l_{it}), materials (m_{it}) and time t (to allow the frontier to shift over time). ε_{it} is an error term, and u_{it} is a non-negative random variable that captures technical inefficiency. Parameswarn asks which variables affect technical efficiency in Indian manufacturing industries. His main findings are the following. Technical efficiency ($-u_{it}$) is positively and significantly correlated with R&D intensity in all sectors, suggesting that R&D activities may contribute to reduce technical inefficiency of Indian firms. Export intensity has a positive effect on technical efficiency in all sectors except Electronics, where it has instead a negative and significant effect on technical efficiency. Technology import intensity has a positive and significant effect on technical efficiency in Electrical machinery and Transport equipment and a negative and significant effect in the other two sectors. The negative impact of technology imports on technical efficiency in high-tech sectors such as Electronics and Non-electrical machinery is indeed surprising. Another surprising finding is that in all sectors technical efficiency is negatively correlated with a time dummy variable which takes a value of zero up to 1991 and a value of one thereafter. Hence, trade liberalization seems to be associated with an increased average technical inefficiency in Indian manufacturing.

One possible explanation for these results is the failure by Indian firms in the adoption and mastering of new technology. Another possible explanation is that trade liberalization may have changed the kind of technology imported by Indian firms. In particular, technology imports may have shifted away from technology which contributes to profits and productivity within a relatively short time lag and toward technology which makes a more direct contribution to firms' technological capabilities but requires a longer gestation lag. If this is the case, this shift in the kind of technology imports may contribute to explain why most studies find that trade liberalization in India is associated with a reduced productivity growth.

7.4 Trade liberalization and R&D effort in Indian manufacturing

Kumar and Aggarwal (2000) uses firm-level data for the period 1992-1997 to study the trend and determinants of R&D activity in Indian manufacturing after trade liberalization. The analysis is motivated by the concern for the declining importance of R&D activity in India. In particular, while the proportion of world GDP devoted to R&D has steadily increased in the last decades to reach 2.5% in the 1990s, the opposite occurred in India, where the proportion of national resources devoted to R&D fell from 0.98% in 1988 to 0.66 in 1997. Since more than 70% of R&D expenditure in India is financed by the government, much of this downward trend is explained by the fiscal reform of the 1990s, which drastically reduced investment expenditure and subsidies to firms in order to reduce the fiscal budget deficit. At the micro-level, the evidence shows different patterns in R&D expenditure between local firms and MNE affiliates in India. In particular, while in the 1990s the average R&D intensity (the ratio of R&D spending to sales) of local firms is still slightly higher than that of MNE affiliates (0.854% versus 0.818%, respectively), the trend for local firms is declining (from 0.868% to 0.831%), while that for MNE affiliates is steadily increasing (from 0.766% to 0.852%). These trends suggest an increasingly central role of MNE affiliates for technological upgrading of Indian manufacturing.

The firm-level econometric analysis performed by Kumar and Aggarwal shows that firms' R&D

intensity is positively and significantly correlated with technology imports, outward orientation and capital goods imports. However, when performing separate regressions for local firms and MNE affiliates, it turns out that, in contrast to local firms, MNE affiliates' R&D effort is not correlated with export intensity and capital goods import intensity. MNE affiliates' R&D intensity is instead positively correlated with their profitability, as measured by the price-cost margin. According to the authors, one possible explanation for these findings is that local firms direct their R&D activity toward absorption of imported technology and outward expansion. In contrast, given their captive access to the laboratories of their parents and associated companies, MNE affiliates' R&D effort is primarily directed toward customization of their parents' technology for the local market in those activities that are more profitable.

7.5 Employment effects of trade reform in Indian manufacturing

According to the traditional trade theory, trade liberalization expands the (comparative advantage) exporting sector at the expense of the (comparative disadvantage) import competing sector. However, this trade-induced sectoral reallocation of resources has no effect on aggregate employment, because of the assumption of factor market clearing. In practice, in the presence of frictions in the labor market and of a sluggish intersectoral mobility of resources, a drastic trade liberalization, such as the one experienced by India in recent years, can reduce employment in the import competing sector and thus raise the short-run rate of unemployment. Indeed, fear of increased unemployment in the import competing sector has often been the main reason against trade liberalization in developing countries pursuing a development strategy based on import substitution. However, as noted by Harrison and Revenga (1994), contrary to the predictions of the standard trade theory, most empirical studies find only a modest effect of trade liberalization in developing countries on the employment level in import competing sectors.[27]

Kambhampati et al. (1997) examine the effects of the 1991 trade reform in India on employment

[27] See, for instance, Rama (1994) on Uruguay, Revenga (1994) on Mexico, Currie and Harrison (1994) on Morocco. See also Harrison and Hanson (1999) on Mexico and Morocco.

in five import competing sectors.[28] They use firm-level data taken from CMIE. The data cover the period 1987-1993. Similar to the results from previous studies, they find no significant employment effect of trade reform overall and in each of the five sectors studied. More interestingly, the authors formulate and test a specific explanation for the lack of employment contraction in the import competing sectors. They argue that, in the presence of imperfect competition, trade liberalization raises firms' perceived product demand elasticity and hence induces them to lower mark-ups and expand output. Hence, the pro-competitive effect of trade liberalization may involve an increase in the demand for labor. This effect may partially offset the labor demand reduction in import competing sectors induced by the forces of comparative advantage.[29]

In order to test this prediction, Kambhampati et al. (1997) estimate the following equation:

$$l_{it} = \beta_0 + \beta_1 \omega_t + \beta_2 \theta_{it} + \beta_3 k_{it} + \beta_4 m_{it} + \beta_5 D + \varepsilon_{it} \tag{23}$$

Here, l, ω, θ, k and m are the natural logs of L, w/P, Θ, K and M, respectively; D is a liberalization dummy, which takes a value of zero for the years 1991 and before and a value of 1 for the years after; ε is a stochastic error.[30] The regression results reported by the authors, obtained by using the random-effect estimator, show that, overall and in four of the five sectors studied[31], both the real wage and the mark-up are negatively and significantly correlated with firms' labor demand. This evidence suggests that when the import competing sectors of a liberalizing country are imperfectly competitive, then the output contraction in these sectors (and the consequent short-run surge in unemployment) may be much less dramatic than expected in the light of the traditional trade theory.

[28]The five import competing sectors are: Electronics, Electrical machinery, Non-electrical machinery, Transport equipment and a sector that only includes firms that produce Diversified products.

[29]See also Harrison and Hanson (1999) on this point.

[30]The first order conditions for profit maximization imply that the demand for both K and M is a function of L. Hence, there is a simultaneity problem in the estimation of the labor demand equation. In order to correct for this endogeneity of capital and materials, the authors use as instrumental variables the predicted values of K and L obtained by regressing them on a set of exogenous variables.

[31]Results for the sector producing Diversified products turn out to be statistically insignificant.

7.6 Trade liberalization in India: greater uncertainty versus a richer menu of opportunities ?

In Section 6, we have shown that a trade-induced increase in product demand elasticities should also bring about an increase in the derived labor demand elasticities. As shown by Rodrik (1997), this implies that workers exposed to international competition should face a higher volatility of wages and employment in response to exogenous shocks to labor demand. Daveri, Manasse and Serra (2002) argue that trade-induced increases in the volatility of factor prices and employment are only part of the story, since firms and workers exposed to international competition may also have a greater incentive to invest in productivity enhancing activities, such as training and effort, in order to hedge the risk of lower incomes. The aim of the authors is hence to test the empirical relevance, in the case of India, of what they call "the twin effects of globalization", i.e., higher uncertainty versus a richer menu of opportunities for firms and workers involved in international competition.

The data used by the authors come from a survey of 895 Indian firms belonging to five manufacturing sectors: Garments, Textiles, Pharmaceuticals, Electronic consumer goods and Electrical white goods. The data, which cover the period 1997-1999, have recently been collected by the World Bank. In order to test their hypotheses, the authors partition firms into the following three groups. Firms exporting at least 30% of their output are defined as *Exporters* (they represent 37% of the total), non-exporting firms declaring to face foreign competition in their domestic market are defined as *Import-Competing* firms (27% of the total), and the rest of the firms belong to the group of *Protected* firms (36% of the total). Note that firms belonging to the former two groups are directly exposed to international competition and hence, by comparing their evolution to that of protected firms, we can infer something about the pros and cons of globalization. Consider uncertainty first. Let $w_{it} = \mu_i + \upsilon_{it}$ represent a variable pertaining to firm i at time t (i.e., the wage rate, profits, sales, employment or prices), where μ_i and υ_{it} are is its permanent and transitory components. The variance of w_{it} can then be written as the sum of $\sigma_\mu^2 + \sigma_\upsilon^2$, where the former represents cross-sectional variation and the latter temporal variation of w_{it}. Hence, σ_v^2 captures uncertainty due to, e.g., wage volatility. Performing this decomposition shows that exporters and import-competing firms are characterized by a higher transitory variance of wages, employment, sales, prices and (to a lesser extent) profits. The authors also perform a regression analysis in which the transitory component of firm-level variables is regressed on dummies for exporters and import-competing firms, sectoral and regional dummies, and size. Estimation results show that in most specifications the dummies for exporters and import-competing firms are positive, and they are often also highly significant. These results suggest that, consistent with the authors' prior, exposure to international trade is associated with greater uncertainty due to higher volatility of wages, profits and employment.

Consider now the potential pros of trade exposure. The authors focus, in particular, on training and promotions. Their prior is that firms exposed to foreign competition have a greater incentive to train their workforce in order to increase its productivity, thereby reducing the uncertainty due to more volatile profits. At the same time, workers have an incentive to produce a greater effort to obtain promotions, thereby reducing the uncertainty due to higher wage and employment volatility. In this respect, data reveal that the share of workers engaged in training programs is 31% for exporters, 36% for import-competing firms and only 19% for protected firms. Further, the percentage of workers being promoted in the firm's ladder in 1999 equals 4% for exporting firms, 1.4% for import competing firms and 1.7% for protected firms.

The regression analysis performed by the authors shows that the percentage of trained workers is positively and significantly correlated with the dummy for import-competing firms, even after controlling for size and for sectoral and regional dummies. Further, they regress the probability of a promotion on the dummies for exporters and import-competing firms. Estimation results reveal that the former dummy is positive and significant, even after controlling for sectoral dummies, for size and for a proxy of productivity growth.[32]

[32]The authors also check the robustness of their results with respect to the methodology of estimation. In particular, they estimate the impact of trade exposure on uncertainty, training and promotions using a non-parametric

To sum up, evidence on Indian manufacturing firms suggests that, although trade liberalization may have increased uncertainty for firms and workers, it may also have provided them with a powerful incentive to increase productivity, thereby inducing more investment in training of the workforce on the part of firms, and more effort (aimed at promotions) on the part of workers.

8 Conclusions

In this paper we have reviewed the micro-level evidence on the effects of trade liberalization in developing countries. We have focused, in particular, on the empirical relevance of the effects predicted by the trade theory in the presence of increasing returns to scale, imperfect competition and firm heterogeneity. The main findings can be summarized as follows.

1) There is indirect evidence of trade-induced productivity gains in the developing countries opting for freer trade. In particular, firms' productivity growth generally rises after trade reforms. More interestingly, the evidence shows that the productivity of firms exposed to international competition (i.e., exporters and import-competing firms) grows much more than that of firms belonging to the non-traded sectors.

2) The evidence suggests that output share reallocations among firms with different productivity levels are the main source of trade-induced productivity gains. This result is in line with trade models, such as Melitz (2002), in which firm heterogeneity and sunk entry costs into foreign markets play a crucial role in the mechanics of efficiency gains from trade liberalization.

3) Firms in import-competing sectors enjoy the highest efficiency gains from trade. One explanation for this result is that the disciplining effect of trade liberalization is stronger in import competing sectors. Another is that the benefits stemming from cheaper imports of (embodied or disembodied) technology are more relevant for firms belonging to the comparative disadvantage technology-intensive sectors.

approach which produces remarkably consistent results.

4) There is no evidence of relevant scale efficiency gains. This result, which runs counter to conventional wisdom about the sources of gains from trade in the presence of scale economies, can be explained as follows. First, the evidence suggests that large firms, which account for a disproportionate share of industry output, are close to minimum efficient scale and hence their scale efficiency is unaffected by trade liberalization. Second, most small firms operating at an inefficient scale are *de facto* insulated from foreign competition, since they only compete for local market niches. Third, the recent episodes of trade reform in the developing world often represent examples of unilateral trade liberalization, which does not imply scale efficiency gains. Indeed, the trade theory suggests that under certain conditions (e.g., competition *à la* Cournot with segmented markets) unilateral trade liberalization reduces scale efficiency in the trade liberalizing country.

5) There is robust evidence of a pro-competitive effect of trade liberalization. The pro-competitive effect shows up as reduced price-marginal cost mark-ups for firms exposed to foreign competition, especially if they belong to highly concentrated industries.

6) There is no evidence, in the short-run, either of learning-by-exporting effects or of beneficial spillover effects from foreign owned firms to local firms. In particular, exporting firms are more efficient than non-exporting firms, but their productivity trajectories do not seem to change after they break into foreign markets. Similarly, foreign owned firms are in general more efficient than local firms, but their presence does not seem to positively influence the productivity of local firms belonging to the same sectors.

7) The plant-level evidence suggests to reconsider the role played international trade in the dramatic increase in wage inequality observed in most trade liberalizing developing countries. In particular, there is weak evidence that skill upgrading is correlated with measures of imported technology. Hence, trade liberalization, by reducing the price of imported technology, may spur the demand for imported technology, which in turn may increase the relative demand for skilled labor, as technology adoption is a skill-intensive activity. Further, there is evidence that exporting plants expand at the expense of non-exporting plants after trade liberalization. Since the former

are skill-intensive relative to the latter, this implies that trade-induced output share reallocations among firms with different skill-intensity can be a crucial determinant of industry skill upgrading and rising wage inequality.

8) There is evidence of a substantial increase in the demand elasticity for unskilled labor and of a stable or decreasing demand elasticity for skilled labor, although it is not clear whether the upward trend in the former is trade-induced. From a theoretical standpoint, the labor demand elasticity is relevant because its rise generally brings about a rise also in wage volatility. As for the latter, however, there is direct evidence that firms exposed to international competition face a higher wage volatility than firms belonging to the non-traded sectors.

9) There is no evidence of substantial employment contraction in import competing sectors after trade reforms. This implies that a dramatic short-run surge in unemployment is not a likely consequence of trade liberalization. One possible explanation for this result is that, at least in the short-run, the tendency toward contraction of the comparative disadvantage sectors is offset by other forces. For instance, in the presence of imperfect competition, trade liberalization, by reducing mark-ups, may force firms to expand output and employment to cover fixed costs.

In short, trade liberalization brings about efficiency gains, mainly through a reallocation of resources toward more efficient, outward oriented and skill-intensive firms. In turn, this involves skill upgrading, higher wage inequality and higher wage volatility. All this suggests that a greater availability of skilled workers may magnify the efficiency gains from trade reform, on the one hand, and dampen its negative distributional effects on the other. These results naturally lead to the policy implication that a successful trade liberalization should be accompanied by policies aimed at improving the average level of education of the workforce. This would in fact facilitate the expansion of more efficient skill-intensive firms and the absorption of imported technology, while at the same time reducing the pressure on the skill premium.

As far as India is concerned, a further policy suggested by the somewhat disappointing evidence on the effects of trade reform on Indian firms' productivity growth is to further deregulate the economy in order to stimulate the firm to firm mobility of resources so as to allow a better exploitation of trade-induced efficiency gains.

It is worth noting, in closing, that the above results are not robust enough, however. They are often plagued by methodological hurdles (in particular, by the difficulty to identify the trade effects), or by the poor quality of the data, and in particular by the fact that, while most trade effects only materialize in the long-run, most empirical analyses are bounded, instead, to look at data which only cover very short time spans. Empirical studies on the effects of India's trade liberalization are not exempt from these problems. This may help explain, for instance, the contrasting results concerning the productivity gains from India's trade reform. Hence more effort is necessary to better our understanding of the effects of trade reforms in developing countries in general, and in India in particular.

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