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**The Elusive Productivity Effect of  
Trade Liberalization in the  
Manufacturing Industries of Emerging  
Economies**

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# The Elusive Productivity Effect of Trade Liberalization in the Manufacturing Industries of Emerging Economies

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# The Elusive Productivity Effect of Trade Liberalization in the Manufacturing Industries of Emerging Economies

## Abstract

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Using a model that admits variable returns and imperfect competition, we investigate the impact on total factor productivity of trade liberalization in six emerging economies. Regressions based on panel data for 28 three-digit manufacturing industries show that productivity growth is insensitive to tariff reduction. These results are at variance with country-specific studies which, using firm-level data, generally find a positive association between liberalization and productivity growth. While aggregation effects may matter, our results can also be explained thusly: significant productivity gains by latecomers via technological assimilation do take time and require appropriate sequencing of reforms of trade and industrial policies.

# 1 Introduction

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Longstanding economic globalization in goods and services has recently been complemented by a robust mobility of capital and skill across firms of different national origin. Although the dogma of a positive relationship between openness and long-term economic growth has had an impressive pedigree since the time of Adam Smith, serious theoretical and empirical problems continue to bedevil the claim. More specifically, whether trade liberalization by developing countries boosts growth through productivity gains is very much a question that is yet to be satisfactorily answered. The trade-growth nexus encapsulates two contentious issues: do lower trade barriers impose greater competitive discipline, facilitate greater diffusion of superior technology, or enable fuller exploitation of scale economies by latecomers thereby raising their steady-state income levels? If so, what are the channels of transmission (scale, productivity, reallocation, etc.) that feed accelerated growth?

This paper addresses the vexed question of whether trade reform leads to TFP growth in manufacturing industries that have experienced significant reductions in trade barriers. Most studies which find a positive relationship between trade liberalization and productivity-driven growth test for the often ambiguous predictions of endogenous growth and trade models (Grossman and Helpman, 1990; and Helpman, 2006 survey the literature). The underlying premise of these models is that a movement toward free trade can permanently increase growth rates by accelerating the transmission of knowledge from leaders to followers which is taken to be less costly than undertaking innovation by the followers. Technological diffusion from leaders to followers thus takes place through knowledge spillovers, access to greater varieties of intermediates, and scale effects arising from market integration.

Other researchers have noted that trade liberalization may, at least initially, lead to a slowdown in trend productivity for several reasons including the fact that technologically lagging local firms in liberalizing countries may have to divert scarce resources from production to R & D activities or may exit the domestic market due to the discouragement effect. The productivity enhancing effect of intensified competition is tempered by the inevitable contraction of market size even for the more promising domestic firms which, facing high adjustment costs, may fail to adapt quickly and sufficiently. In other words, even highly promising local firms may face premature demise as a result of such inevitabilities as intensified competition for domestic credit which is often biased toward short-term finance. Subsequently, latecomers with poor initial factor endowments and low levels of technological capability predictably experience diminished growth from endogenous technological change (Rodrik, 1992; Levinsohn, 1993; Rodriguez and Rodrik, 1999; Hay, 2001; Amsden, 2001).

The notable implication of conventional trade and growth theories that openness boosts growth but only temporarily has been subjected to a number of empirical tests over the past fifteen years. By level of aggregation, they fall in three categories: economy-wide, industry-



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level, and firm- or plant-level. At the macro level, Wacziarg and Welch (2008) show that over the 1950-98 period, countries that liberalized their trade regimes experienced sizable gains in average annual growth rates and investment rates. Several studies show that structural changes such as discernible reductions in tariff and non-tariff barriers, especially at both ends of the trade partnership, do increase, albeit modestly, the productivity of manufacturing industries (see, for example, Economidou and Murshid, 2008, for 12 OECD economies). Some of the more notable developing-country case studies along this line include Tybout, et al. (1991) and Pavcnik (2002) for Chile, Harrison (1994) for the Ivory Coast, Iscan (1998) for Mexico, Kim (2000) for Korea, Krishna, and Mitra (1998) and Milner, et al. (2007) for India, Moreira, and Correa (1998), Hay (2001) and Sachor (2004) for Brazil, Fernandes (2003) for Colombia, and Mahadevan (2007) for Malaysia.

And yet, many have questioned the case for the beneficial growth effects of trade liberalization in developing economies on both theoretical and empirical grounds (see Baldwin, 2003 or Lopez, 2005, for a review). Some of the most outstanding concerns with these studies include the perennial problems of identifying the direction of causality (from exports/imports to productivity or the reverse), the precise channels of transmission from openness to growth (intensified foreign competition and interaction with customers, or reduction in the cost of imported intermediates with embodied technologies), constructing robust measures of openness itself (tariff, non-tariff, or macro policies), disentangling short-run effects from long-run effects on productivity (labor or TFP), and the inherent endogeneity of openness with input allocations (see Rodriguez and Rodrik (2000), and Erdem and Tybout (2003), for a critique).

Furthermore, these studies often yield rather ambiguous policy implications. A strategy of openness might, for example, recommend a bewildering number of industrial-cum-trade-policy measures including, *inter alia*, uniformly low trade barriers, minimal impediments to flows of capital and skills, political and macroeconomic stability, optimal deregulation, and even selective industrial policies designed to accelerate learning by latecomer domestic firms of high promise (Sachs and Warner, 1995; Noland and Pack, 2003). It is thus fair to note that the theoretical and empirical literature is rather thin concerning two dimensions of the trade-productivity nexus. The first pertains to the direction of causality between liberalization and TFP. The second deals with the channels through which trade liberalization affects the productivity of manufacturing industries. With respect to directionality, one plausible reading of the evidence is a sequential one. The micro-econometric literature suggests that exporters, being more productive and having deeper pockets to overcome entry barriers than non-exporters, tend to be forward-looking and self-select as exporters (Lopez, 2005; Wagner, 2007). This would imply that, *ex ante*, causality runs from higher TFP to higher exports. Later on, greater access to export markets and foreign exchange enables these same firms to boost their productivity further. *Ex post*, then, learning-by-exporting would reverse the direction of causality to go from exports/imports to productivity growth. The latter is clearly much weaker than the former, *i.e.*, exporting does not necessarily improve productivity (Wagner, 2007).

With respect to the channels, many of which have been alluded to above, four are prominent and are best understood as complementary to each other. The first mechanism through

which liberalization of manufacturing trade enhances economic growth is the selection effect operating through trade in goods and services, both inter as well as intra-industry. Improved access to intermediate and capital inputs that embody superior foreign technology is one typically postulated pathway to productivity gains (Schor, 2004). Exports might also have a similar effect since higher international standards of quality and closer buyer-seller interactions are likely to enhance knowledge spillovers (Keller, 2004). Higher domestic productivity then leads to higher competitiveness in export markets whose foreign exchange earnings also finance increased non-competitive or insufficiently available inputs at home.

Second, short-term spurts of growth in productivity may also benefit, at least in the long run, from intensification of product-market competition from abroad resulting in more efficient inter-sectoral reallocation of resources, and the elimination of slack, deadweight losses and excessive economic rents. To this may be added demand-side complementarities arising from a larger market and access to more extensive global chains (Hoff and Stiglitz, 2001; UNIDO, 2002). This channel, frequently invoked in the empirical literature, presumes that trade liberalization intensifies competition for domestic firms in import-competing industries. This induces gains primarily in allocational efficiency. The reasoning is that ISI-favored industries tend to grow slower than comparative-advantage-favored industries (Dodzin and Vamvakidis, 2004).

A third channel posits trade liberalization as reducing the cost of imported inputs. This comes via the diffusion of embodied technology (in capital and intermediate goods and services) and the expansion of efficiency-seeking (rather than tariff-jumping) inward foreign direct investment (FDI). Trade in asset markets, especially FDI and outsourcing, may also enhance productivity via imported product innovation and process innovation. Studies that do not take account of this channel of transmission run the risk of mistakenly confounding the impact of exports and imports on growth (Mahadevan, 2007).

A fourth channel highlights the impact of economic globalization (scale effect) since larger and more diversified markets are expected to raise the returns to innovation and imitation. Firm-level econometric studies typically find that trade liberalization reduces price-cost margins in import-competing industries and that heightened competition and the resultant market share reallocations induce improvements in productivity (Erdem and Tybout, 2003). Others suggest that the exploitation of scale economies by firms constrained by small domestic markets has a salutary level effect, but rarely a growth effect, on TFP (Wagner, 2007).

The theoretical ambiguity regarding the net effects of trade liberalization on productivity growth renders the issue ultimately an empirical one. This paper is one such exercise in cross-country empirics to complement the myriad country-specific studies. It does this by exploiting a three-digit manufacturing data set for a cross-section of rapidly industrializing countries. The results suggest that that trade liberalization, which generally boosts growth via capital accumulation and reallocation, does not seem to do so via growth in TFP—at least for manufacturing industries.

The discussion proceeds as follows. Section 2 reviews the extant empirical literature on the subject. Section 3 discusses the theoretical model used for deriving the estimating equations.

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Section 4 presents the econometric model and the data. Section 5 discusses the empirical results. The concluding section summarizes the findings and their implications.

## 2 Review of Existing Empirical Studies

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A number of concerns must be addressed toward a definitive empirical assessment of the relationship between trade reform and productivity change. First, there is the need to identify the underlying market structure for each industry, pre-reform and post-reform. In particular, industries in less developed countries start life almost invariably protected and cannot realistically be assumed to be perfectly competitive. Second, there is the need to make allowances for the prevalence of non-constant returns to scale in many industries. The third concern has, as noted above, to do with possible endogeneity between productivity and openness. Does openness enhance productivity in hitherto sheltered industries or do productive domestic firms become receptive to openness precisely because they have become mature enough to be internationally competitive?

A small number of econometric studies have appeared in the past ten years that identify the channels (notably, markup and scale effects) through which trade liberalization affects productivity growth at the level of specific industries. The findings of eight country case studies, covering seven semi-industrial countries in three continents, are distilled in Table 1. All but one employ a production function framework to derive the productivity regressions; half rely on firm- or plant-level data rather than on industry-level data; and most allow for variable returns to scale and imperfect competition. However, only two of the studies that use panel data, Harrison (1994) and Krishna and Mitra (1998), share our methodology and time span.

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Table 1: Recent Studies on the Impact of Trade Liberalization on Manufacturing Productivity in Emerging Economies

Author (observation unit)	Sample Period and Size	Returns to Scale Assumed	Imperfect Competition?	Dummy Variable?	Notable Finding (s)
Chand and Sen, 2002 (PFA: industry)	<ul style="list-style-type: none"> <li>• India, 1973-88</li> <li>• 30 industries</li> </ul>	Variable	Yes	No	<ul style="list-style-type: none"> <li>• Reform raised productivity growth</li> </ul>
Jonsson and Subramanian, 2001 (PFA: industry)	<ul style="list-style-type: none"> <li>• South Africa, 1990-98</li> <li>• 24 industries</li> </ul>	Constant	No	No	<ul style="list-style-type: none"> <li>• Reform raised productivity growth</li> </ul>
Kim, 2000 (PFA: industry)	<ul style="list-style-type: none"> <li>• Korea, 1966-88</li> <li>• 36 industries</li> </ul>	Variable	Yes	No	<ul style="list-style-type: none"> <li>• Reform raised productivity growth</li> <li>• Reform lowered markups</li> </ul>
Krishna and Mitra, 1998 (PFA: firm)	<ul style="list-style-type: none"> <li>• India, 1986-93</li> <li>• 4 industries</li> </ul>	Variable	Yes	Yes	<ul style="list-style-type: none"> <li>• Reform raised productivity growth</li> <li>• Reform lowered markups</li> </ul>
Tybout and Westbrook, 1995 (Share Shift: firm)	<ul style="list-style-type: none"> <li>• Mexico, 1984-90</li> <li>• 19 industries</li> </ul>	Variable	Decomposition of cost and output	No	<ul style="list-style-type: none"> <li>• Reform raised productivity growth due to residual effect</li> <li>• Reform had minor scale effects</li> </ul>
Harrison, 1994 (PFA: plants)	<ul style="list-style-type: none"> <li>• Cote d'Ivoire, 1979-87</li> <li>• 9 industries</li> </ul>	Variable	Yes	Yes	<ul style="list-style-type: none"> <li>• Reform raised productivity growth substantially</li> <li>• Reform did lower markups</li> </ul>
Levinsohn, 1993 (PFA: firm)	<ul style="list-style-type: none"> <li>• Turkey, 1983-1986</li> <li>• 10 industries</li> </ul>	Variable	Yes	Yes	<ul style="list-style-type: none"> <li>• Reform lowered markups confirming the imports-as-market-discipline hypothesis</li> </ul>
Tybout, de Melo and Corbo, 1991 (PFA: industry)	<ul style="list-style-type: none"> <li>• Chile, 1967-79</li> <li>• 21 industries</li> </ul>	Variable	Yes	No	<ul style="list-style-type: none"> <li>• Reform has little effect on productivity</li> </ul>
Abegaz and Basu: This Paper (PFA: industry)	<ul style="list-style-type: none"> <li>• Panel Data for Chile, Korea, Indonesia, Mexico and Turkey, 1981-97</li> <li>• 28 three-digit industries</li> </ul>	Variable	Yes	No	<ul style="list-style-type: none"> <li>• Reform did not boost productivity growth</li> <li>• Reform did not alter returns to scale or price-cost margins</li> </ul>

*Key:* PFA = production function analysis  
 Dummy Variable = dummy variables are used to capture liberalization episodes.

Using various indexes of trade reform, a majority of existing studies suggest that reductions in trade impediments have a positive impact on productivity growth. Furthermore, trade reform contributes to falling markups as suggested by the imports-as-market-discipline hypothesis (Levinsohn, 1993). Finally, reforms seem to have little or no scale effects for manufacturing industries. There also exist other studies that provide similar analyses for manufacturing as a whole. Iscan (1998), for example, finds no statistically significant effect of trade liberalization on long-term productivity growth rates for Mexican manufacturing. Moreira and Correa (1998) find positive effects of liberalization on productivity growth for Brazilian manufacturing for the period, 1989-96. Hay (2001) also finds large TFP gains for manufacturing from the 1990 Brazilian trade reform, which he attributes to intense competitive pressures that followed the reform.

In terms of theory, this paper builds on these studies in two respects. For one, it lets the sectoral mark-up rate over marginal cost to be tested within a model that endogenizes the market structure for specific industries. Furthermore, it allows for variable returns to scale by industry. By so doing, one can tell whether trade reform has led to greater competition by dissipating oligopoly rents or by minimizing x-inefficiency losses. Empirically, this inter-country study contributes to the literature on the subject in two related ways. First, it employs a common framework of analysis of the data for six diverse but emerging economies (Chile, India, Indonesia, S. Korea, Mexico, and Turkey). Since technology within an industry may not differ greatly across developing countries, this approach helps us get a sense of whether the effects of trade liberalization are applicable to the universe of late industrializers or they are at variant across rapidly industrializing economies. We therefore include country-specific variables as controls to pick up fixed effects.

The sample countries undertook significant liberalization of their trade regimes in the mid-1980s. This period, falling between the second oil shock and the East Asian financial crisis, is characterized by economic reform mania. Along with Brazil and China (both of which were left out of the sample due to unavailability of comparable data), these countries are ideally suited for such a study. They boast a strong domestic industrial capability to respond to greater opening; they account for the bulk of manufactured exports from and FDI to developing countries; and they represent the full spectrum of size, resource endowments, and pre-reform policy regimes.

Second, unlike most country-specific studies, this paper appraises the productivity consequences of trade liberalization for 28 three-digit manufacturing industries using internationally comparable panel data. A similar work by Miller and Upadhyay (2000) uses data for a cross-section of developed and developing countries. However, the Miller-Upadhyay paper differs from ours in important respects: it looks at the effects on TFP of openness and human capital in addition to those of trade orientation; and its scope is the entire economy rather than manufacturing industries. It can be rightly argued that the country case studies offer the potential advantages of context-specific analyses, but the cross-sectional approach employed here also provides a much-needed test of the generalizability of their findings.

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Our findings can be summarized as follows. Although higher markups are correlated with the growth of output, liberalization left competitiveness unaffected in two-thirds of the industries. Moreover, TFP is not a noticeable source of growth for industrial output, and only a quarter of the industries did experience a boost in TFP growth from liberalization. Finally, eight out of ten industries continued to exhibit constant returns to scale in the post-reform period.

### 3 Theoretical Framework

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The framework commonly used in the literature to analyze the effects of technological change is ironically the exogenous growth model pioneered by Solow (1957). Solow's measure of productivity, also known as total or multi-factor productivity, is based on two underlying assumptions: constant returns to scale and perfect competition. Any empirical estimate that is based on a presumed prevalence of perfect competition is likely to yield biased estimates of TFP growth subsequent to trade reform. Much like Levinsohn (1993), Harrison (1994), and Krishna and Mitra (1998), we derive inspiration from the seminal work of Hall (1988) and Domowitz, Hubbard and Peterson (1988) to derive estimating equations that are not constrained by these two assumptions.

Consider the production function of firm  $i$  in industry  $j$  at time  $t$  in its implicit form:

$$Y_{ijt} = A_{jt} F(L_{ijt}, K_{ijt}, M_{ijt}) \quad (1)$$

where  $Y_{ijt}$  is gross output produced with inputs of labor (L), capital (K) and materials and energy (M) inputs.  $A_{jt}$  is an industry specific index of total productivity. Assume away firm-specific differences in technology. To fix ideas, specify a parsimonious Cobb-Douglas production function of the form:

$$Y_{ijt} = A_{jt} L_{ijt}^{\lambda} K_{ijt}^{\beta} M_{ijt}^{\delta} \quad (2)$$

where the sum of factor shares,  $\lambda + \beta + \delta = \nu$ , is the returns to scale parameter.

Total differentiation of (2), after taking the logs of both sides and allowing for imperfect competition, yields:

$$(dY/Y)_{ijt} = (dA/A)_{jt} + \mu_j [\lambda (dL/L)_{ijt} + \beta (dK/K)_{ijt} + \delta (dM/M)_{ijt}] \quad (3)$$

where  $\mu$  denotes industry markup over the weighted averages of factor shares ( $wL/PY$ ,  $rK/PY$  and  $mM/PY$ ) in gross revenue (PY). Note that the share of capital,  $\beta$ , is unobservable.

This formulation assumes perfect competition but allows for the price over cost markup,  $\mu_j$ , to vary across industries. Under imperfect competition, however, the sum of the markup-weighted factor shares,  $\mu_j (\lambda + \beta + \delta) = \nu_j$ , is the industry-specific scale parameter. To normalize  $Y$ ,  $L$  and  $M$ , we add and subtract the same ratio ( $dK/K$  or  $\beta dK/K$ ) to each applicable term and then rearrange to convert (3) into a per-unit-of-capital format. Using lower case  $y$ ,  $l$ , and  $m$  to denote  $\ln(Y/K)$ ,  $\ln(L/K)$ , and  $\ln(M/K)$ , respectively, and suppressing subscripts to minimize unnecessary clutter, we obtain:

$$dy = dA/A + \mu(\lambda dl + \delta dm) + (\nu-1)k \quad (4)$$

where  $k = dK/K$ .

Following Harrison (1994), scale effects are taken into account by distinguishing between the *observed* TFP ( $\varphi$ ) and the *true* TFP ( $dA/A$ ). By moving the second and third terms



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to the LHS of (4), the contributions of capital and TFP to the growth rate of industrial output per unit of capital ( $\varphi$ ) take the form:

$$\varphi = dy - \lambda dl - \delta dm \quad (5)$$

if constant returns ( $v = 1$ ) and perfect competition ( $\mu = 1$ ) prevail. In other words, the observed and the actual TFPs are equal (or  $\varphi = dA/A$ ), and the Solow residual measure of total factor productivity is, therefore, unbiased. For industry-level analysis, this formulation is based on two simplifying assumptions: that all firms in an industry have the same markup, and that market imperfection is limited only to output markets.

Moreover, if  $v > 1$ , then observed productivity is true productivity plus the gains from increasing returns which is positive when capital accumulation occurs. If, on the other hand,  $v < 1$ , then observed productivity equals true productivity minus the efficiency loss from decreasing returns from capital accumulation as trade reform comes into effect. When observed productivity ( $\varphi$ ) differs from true productivity ( $dA/A$ ) due to scale effects, one can also argue that this difference is not necessarily due to bias. The reason is that observed productivity may reflect Hicks-neutral technical progress as well as scale effects.

## 4 Industry Data

The data on the 28 three-digit industries and six countries (Chile, India, Indonesia, S. Korea, Mexico and Turkey) analyzed in this paper come from the United Nations Industrial Development Organization (UNIDO) database. This database provides the most standardized, and hence internationally comparable, data on manufacturing industries in developing economies. Production and factor input data (value added, gross output, gross fixed capital formation and employment) were extracted from UNIDO, *Industrial Statistics Database: 4-digit Level of ISIC Code* (2003 edition).

Trade data (imports, exports, apparent consumption) for the same industries were obtained from UNIDO, *Industrial demand-Supply Balance Database: 4-digit Level of ISIC Code* (2003 edition). We aggregated up the annual 4-digit values for each variable to derive the 3-digit equivalents. Manufacturing-wide deflators (with varying base years) were obtained from the World Bank's *World Development Indicators* (2003 edition). Additional data, mostly for comparative purposes, was obtained from the World Bank's WITS data base (see Nicita and Olarreaga, 2001). The latter also contains good but not comprehensive data on tariffs by industry and country (from UNCTAD or WTO) on which we rely.

The industry regressions are based on panel data covering a maximum of 18 years (1980-97) for each economy in the sample. Inspection of the data (and the second-last column of Table 2) clearly shows that recovery from the negative effects of pre-reform crisis and disruptive reforms was evident three years into the post-reform period.

Table 2: Indicators of Openness for Sample Countries

Country	(P, C)	Unweighted Average Nominal Tariff (%)			Productivity Dip <sup>1</sup>	Year of Decisive Liberalization
		P	C	C/P		
Chile	(1984, 1991)	35	11	0.31	1985-87	1976
India	(1990, 1997)	125	40	0.32	None	1993
Indonesia	(1985, 1990)	27	22	0.81	1983-88	1970
Korea	(1984, 1992)	24	10	0.42	1984-85	1968
Mexico	(1985, 1987)	29	10	0.34	1986-87	1986
Turkey	(1981, 1994)	49	10	0.20	1983-85	1989

Sources: Greenaway, Morgan and Wright (2002); Levinsohn (1993) and Togan (1997) for Turkey; Milner, et al. (2007) for India; data on year of openness from Sachs and Warner (1995).

P = pre-reform

C = current

[1]. Trough of labor productivity during liberalization episode, based on value-added per employee for the entire manufacturing sector (ISIC 300). UNIDO database (2003).

The key variables, prior to modification, are defined by UNIDO as follows:

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*Establishment* = a unit such as a factory that engages, under a single ownership or control, in one kind of activity at a single location.

*Number of employees* = the total number of persons engaged other than working proprietors, active business partners and unpaid family workers. Due to data constraints, adjustment for hours worked could not be made.

*Output* = gross census output minus the revenue from non-industrial activities.

*Value added* = the value of census output less the value of census input which covers the value of materials and supplies for production and the cost of industrial services received.

*Gross fixed capital formation* = the value of purchases and own-account construction of fixed assets (with a productive life of one year or more) during the reference year less the value of corresponding sales. Fixed assets include: (a) land; (b) buildings, other construction and land improvements; (c) transport equipment; and (d) machinery and other equipment.

All relevant values are expressed in constant prices using the deflator for manufacturing as a whole. We constructed the following variables:

*Intermediate inputs* = gross output minus value added which includes purchases of material inputs, energy and services.

*Capital stock* = stock of fixed assets built up from data on gross fixed capital formation (GFCF). The literature underscores two points regarding the relationship between TFP and capital stock: capital is systematically mis-measured in level terms mainly due to data constraints which distort measures of TFP levels in growth accounting, and the various ways of estimating capital do not seem to have a discernible effect on estimates of TFP growth. Since comparable cross-country data on capital stock is not available in the UNIDO data set, we constructed the initial capital stock and the subsequent annual series using the perpetual inventory method. The initial (for 1980) capital stock is estimated using Solow's steady-state condition:  $K^* = \text{GFCF}/[g + d]$  where  $K$  is the capital stock, GFCF is the average annual investment of fixed capital,  $g$  is the average growth rate investment for the period (1980-97) by industry branch,  $d$  is the annual depreciation rate of 6%.<sup>1</sup>

*Tariff (T)* = an industry-specific average tariff level—one for the pre-reform period and one for the post-reform period. Since many years have missing data, we assumed that the data for the highest tariff year that prevailed in the years prior 1989 also applied to all the pre-reform years (1980-88). Similarly, the data for lowest tariff year is assumed to have prevailed in every year after 1988 (1989-97). This procedure obviously accentuates the degree of liberalization besides being analogous to using time dummies that are differentiated by industry.

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<sup>1</sup> Unavailability of data compelled us to omit inventory investment from the numerator and the technical-progress index from the denominator. They hopefully cancelled each other out. Using this procedure, we generated annual fixed-capital stock series for the period by cumulating the annual investment data net of depreciation under three alternative assumptions for the straight-line depreciation rate: 4%, 6%, or 8%. Since the regression results are insensitive to the different assumptions about the value of  $d$ , we report the results based on 6%. This implicitly imposes an average service life of 17 years which is the 15-20 year range commonly employed in the literature. While buildings last over 40 years, the service life of machinery is conventionally taken as 12 years, and other office equipment generally lasts 5-10 years (Meinen, et al., 1998; Isaksson, 2007).

*Instqual* (Q) = the Sachs-Warner index of overall institutional quality (ICRGE80)<sup>2</sup> of the country.

To help with the interpretation of the regression coefficients, we present in Table 3 data on changes in trade intensity in manufactures before and after liberalization. The period average on the patterns of imports, exports, apparent consumption, and intersectoral linkages suggest that large changes in trade intensity were not induced by trade liberalization. On the whole, trade liberalization appears to have a marginal impact on trade intensity. Of the industries that experienced the greatest changes, three skill-intensive branches (industrial chemicals, non-electrical machinery and professional-scientific equipment) suffered declines in both import and export ratios. On the other hand, four other industries (furniture and fixture, petroleum refining, petroleum and coal products, and electrical machinery) experienced the highest rates of import and export penetration. That net imports of manufactures which signals a noticeable loss of competitiveness is captured by the decline in the index of apparent consumption for technology-intensive (group 3) industries. The implication is that liberalizers are likely to lose market shares in those industries where they have static comparative disadvantage or have over-protected in the hope of gaining dynamic comparative advantage.

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<sup>2</sup> ICRGE80 is a general institutional quality index that is an average of 5 sub-indexes (rule of law index, bureaucratic quality index, corruption in government index, risk of expropriation index, government repudiation of contracts index).

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**Table 3: The Impact of Trade Liberalization on Trade Intensity**

Industry	Name	IP <sub>b</sub>	IP <sub>a</sub>	EO <sub>b</sub>	EO <sub>a</sub>	AC <sub>b</sub>	AC <sub>a</sub>
<b>I. Consumer Non-Durables:</b>							
311	Food Products	0.1264	0.1405	0.1801	0.1675	0.9454	<b>0.9724</b>
313	Beverages	0.0217	0.0304	0.0264	0.0548	0.9951	<b>0.9757</b>
314	Tobacco	0.0177	0.0393	0.0623	0.0307	0.9550	<b>1.0087</b>
322	Apparel	0.0678	0.6638	0.2295	0.2351	0.3202	<b>0.3938</b>
324	Footwear	0.0478	0.1761	0.1445	0.3854	0.4898	<b>0.6163</b>
332	Furniture & Fixture	0.1064	0.3706	0.1708	0.1784	0.9284	<b>0.5861</b>
342	Printing & Publishing	0.1103	0.3581	0.0374	0.0808	1.0796	<b>1.1833</b>
361	Pottery & China	0.1235	0.2621	0.1493	0.2131	0.9717	<b>1.0490</b>
390	Other Manufacturing	0.7128	1.4880	0.2563	0.3340	1.1228	<b>1.1012</b>
<b>II. Resource Based / Supplies:</b>							
321	Textiles	0.1544	0.4198	0.1954	0.3076	0.9577	<b>1.0255</b>
323	Leather & Fur	0.1285	0.3680	0.2465	0.3238	0.8453	<b>1.0531</b>
331	Wood & Cork Prod	0.1288	0.7234	0.2469	0.2267	0.7731	<b>0.9360</b>
341	Paper & Products	0.3160	0.3155	0.1085	0.1684	1.2185	<b>1.1471</b>
351	Ind. Chemicals	0.9740	0.8289	0.2134	0.3045	1.7324	<b>1.5355</b>
352	Other Chemicals	0.1894	0.2457	0.0643	0.1099	1.1294	<b>1.1357</b>
353	Petroleum Refining	0.0669	2.5887	0.0261	0.0287	1.0649	<b>1.1940</b>
354	Petrol/Coal Products	0.0530	0.5132	0.0109	0.0500	1.0538	<b>1.5053</b>
355	Rubber Products	0.1324	0.3088	0.0731	0.2004	1.0613	<b>1.1107</b>
356	Plastic Products	0.0986	0.5033	0.0773	0.1514	1.0233	<b>1.2207</b>
362	Glass & Products	0.1870	0.2537	0.1202	0.2103	1.0691	<b>1.0443</b>
369	Non-metallic, nec	0.0783	0.0767	0.0493	0.0664	1.0307	<b>1.0106</b>
371	Iron & Steel	0.1686	0.3061	0.0929	0.1549	1.0948	<b>1.1512</b>
372	Non-ferrous Metals	0.1774	0.4124	0.1967	0.3844	0.9505	<b>1.0280</b>
381	Metal Products	0.4374	0.6038	0.1597	0.1668	1.2873	<b>1.3550</b>
<b>III. Capital Goods/Consumer Durables:</b>							
382	Machinery, Non-Elect	3.7249	2.7682	0.1947	0.1856	4.6217	<b>3.2860</b>
383	Machinery, Electrical	0.8661	1.6997	0.1265	0.2226	1.6445	<b>1.8507</b>
384	Transport Equipment	0.7571	0.5987	0.1784	0.1823	1.5987	<b>1.3677</b>
385	Prof/Scientific Equipment	8.5358	4.0447	0.2468	0.2051	9.8126	<b>3.9828</b>

IP = import penetration (imports as % of gross output);

EO = export orientation (exports as % of gross output);

AC = apparent consumption (gross output plus net imports as % of gross output).

b, a = before liberalization or after liberalization.

Classification (Abegaz, 2002): Group I is low-tech; Group II is low-tech except for 351-356 (medium-tech); and Group III is high-tech except 382 (medium-tech).

Disaggregation by country also shows some interesting patterns (see Table 4). Using the share of industrial value added in GDP as a yardstick, two-thirds of manufacturing value added (MVA) in the sample countries originates in just ten branches. In fact, half of the MVA is concentrated in food, beverage, textiles and apparel. Judging from the shares of group 1 and group 3 industries, Chile and Turkey have the least sophisticated industrial structures, and India and S. Korea the most sophisticated. Mexico and Indonesia fall in between. In terms of export orientation, S. Korea and Mexico have the advantage in terms of the diversification of manufacturing exports while Chile and Indonesia rely on processed primary exports reflecting a

resource-based industrialization. We now turn to the issues of model specification and estimation.

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Table 4: The Output Structures (OS) and Export Orientation (EO) of Manufacturing Industries in the Sample Countries

ISIC3 (CRGE80)	Branch (Institutional Quality)	CHILE (6.33)		INDONESIA (3.67)		INDIA (5.76)		KOREA (6.36)		MEXICO (5.41)		TURKEY (5.28)	
		OS	OE	OS	EO	OS	EO	OS	EO	OS	EO	OS	EO
<b>I.</b>	<b>Consumer Non-Durables</b>												
311	Food Products	0.2036	0.2393	0.0944	0.3199	0.0784	0.1099	0.0547	0.1069	0.0968	0.1267	0.1090	0.1792
313	Beverages	0.0498	0.0930	0.0088	0.0337	0.0097	0.0091	0.0137	0.0139	0.1029	0.0654	0.0224	0.0238
314	Tobacco	0.0343	0.0167	0.0869	0.0145	0.0130	0.0890	0.0159	0.0242	0.0435	0.0494	0.0269	0.1073
322	Apparel	0.0221	0.0485	0.0372	1.1585	0.0200	1.1983	0.0321	0.7109	0.0053	2.8206	0.0457	0.7678
324	Footwear	0.0143	0.0500	0.0315	0.4238	0.0031	0.8362	0.0072	1.4041	0.0025	0.7327	0.0029	0.2213
332	Furniture & Fixture	0.0077	0.0916	0.0111	0.4910	0.0003	0.0947	0.0104	0.0985	0.0019	2.1202	0.0041	0.1896
342	Printing & Publishing	0.0348	0.0763	0.0158	0.0497	0.0172	0.0163	0.0259	0.0406	0.0059	0.3629	0.0094	0.0151
361	Pottery & China	0.0024	0.2314	0.0066	0.0924	0.0019	0.0524	0.0022	0.3153	0.0057	0.4097	0.0127	0.0591
390	Other Manufacturing	0.0017	0.3513	0.0078	0.5961	0.0087	2.0021	0.0109	0.5270	0.0029	2.6658	0.0025	0.3206
<b>II.</b>	<b>Resource Based</b>												
321	Textiles	0.0261	0.0583	0.1165	0.2359	0.0849	0.1782	0.0557	0.4541	0.0191	0.5146	0.1178	0.3226
323	Leather & Fur	0.0036	0.0322	0.0032	0.3519	0.0037	0.7532	0.0068	0.4783			0.0032	0.1363
331	Wood & Cork Prod	0.0335	0.3713	0.0779	0.6808	0.0026	0.0504	0.0082	0.1371	0.0017	1.9188	0.0071	0.0972
341	Paper & Products	0.0965	0.3986	0.0345	0.1689	0.0224	0.0092	0.0224	0.0654	0.0253	0.1273	0.0238	0.0513
351	Ind. Chemicals	0.0288	0.6454	0.0480	0.1979	0.1340	0.0585	0.0387	0.2898	0.0987	0.3827	0.0504	0.1658
352	Other Chemicals	0.0713	0.0343	0.0369	0.0963	0.0676	0.0714	0.0356	0.1161	0.0976	0.1378	0.0624	0.0629
353	Petroleum Refining	0.0511	0.0123	0.0009	.	0.0449	0.0442	0.0327	0.0817	.	.	0.1223	0.0364
354	Petrol/Coal Products	0.0085	0.0156	0.0005	0.2308	0.0064	0.0011	0.0022	0.0408	0.0066	0.0253	0.0138	0.0045
355	Rubber Products	0.0105	0.1183	0.0190	0.0485	0.0161	0.0554	0.0105	0.2834	0.0140	0.1421	0.0213	0.1496
356	Plastic Products	0.0282	0.0230	0.0270	0.1419	0.0111	0.0388	0.0483	0.1876	0.0166	0.5244	0.0179	0.0657
362	Glass & Products	0.0076	0.0292	0.0069	0.2563	0.0052	0.0671	0.0104	0.0973	0.0249	0.3151	0.0162	0.2418
369	Non-metallic, nec	0.0350	0.0062	0.0239	0.0682	0.0420	0.0228	0.0346	0.0781	0.0410	0.1142	0.0403	0.0655
371	Iron & Steel	0.0243	0.0739	0.0626	0.0885	0.0827	0.0250	0.0552	0.2439	0.0760	0.1547	0.0522	0.2005
372	Non-ferrous Metals	0.1146	0.7240	0.0130	0.7759	0.0359	0.0411	0.0133	0.1057	0.0308	0.4384	0.0151	0.1238
381	Metal Products	0.0372	0.0886	0.0385	0.0837	0.0277	0.1281	0.0513	0.3152	0.0330	0.4951	0.0325	0.1195
<b>III.</b>	<b>Capital Goods/C-Durab.</b>												
382	Machinery, Non-Elect	0.0223	0.0678	0.0139	0.2559	0.0789	0.0572	0.0852	0.2627	0.0313	1.3650	0.0456	0.1055
383	Machinery, Electrical	0.0126	0.0885	0.0588	0.2378	0.0717	0.0395	0.1942	0.4403	0.0484	2.2658	0.0505	0.1361
384	Transport Equipment	0.0158	0.1626	0.1157	0.0442	0.1022	0.0518	0.1129	0.4196	0.1643	0.4975	0.0662	0.0661
385	Prof/Scientific Equipment	0.0017	0.1944	0.0024	0.9069	0.0078	0.1100	0.0088	0.4893	0.0033	3.1669	0.0057	0.2267

## 5 Econometric Model and Estimation

Since the Cobb-Douglas production function imbeds constant elasticity of output with respect to capital, the baseline estimating equation, based on (4), takes the form:

$$dy_{jct} = \alpha_{1jt} + \mu_j dlm_{jct} + \alpha_{2j}k_{jct} + \alpha_{3j}T_{jc} + \alpha_{4j}Q_c + \alpha_{5j}[dlm \bullet T]_{jct} + \alpha_{6j}[k \bullet T]_{jct} + \varepsilon_{jct} \quad (6)$$

where:

$dy$  = difference in the logs of the productivity of capital [ $d \ln(Y/K)$ ],

$dlm = \lambda dl + \delta dm$  = sum of share-weighted log differences in labor/capital and materials/capital ratios,

$k = dK/K$  = growth rate of the capital stock ,

$T$  = industry-specific tariff levels before and after 1989, and

$Q$  = Sachs-Warner (1997) measure of the institutional quality of a country.

The subscript,  $c$ , denotes country-specific observations. The rest of the variables are defined as in (4). The error term,  $\varepsilon_{jct}$ , captures all remaining shocks to industry-wide productivity and is assumed to be *iid*. The estimated parameters and their definitions are as follows:  $\alpha_1$  = TFP effect,  $\mu$  = markup level effect,  $\alpha_2 = (\nu-1)$  = scale level effect,  $\alpha_3$  = liberalization effect,  $\alpha_4$  = institutional quality effect,  $\alpha_5$  = markup change effect, and  $\alpha_6$  = scale change effect. The coefficient restrictions are that the mark-up rate,  $\mu = \alpha_2/\lambda = \alpha_4/\delta$ .

### 5.1 Measures of Liberalization

A good trade policy index would ideally incorporate effective rates of protection, real exchange rates, quantitative restrictions, and licensing procedures. Such an index is, however, hard to construct for a large number of countries. We use the narrow measure of changes in tariff levels<sup>3</sup>.

<sup>3</sup> Another concern might well be our choice of using tariff rates in the six emerging economies as a measure of trade liberalization instead of using import penetration as the relevant measure. We refrain from using import penetration as a measure of liberalization on three grounds: (i) as stated earlier we follow the existing literature of Levinson (1993), Harrison (1994) and Krishna and Mitra (1998) in relating TFP to reductions in the tariff rates. As such our theory and the subsequent empirical study can be contrasted easily with the existing studies in the literature; (ii) indexes of trade restriction are ex-ante measures of the degree of openness which are theoretically preferable. Import penetration, on the other hand, is an ex-post measure of observed trade flows which fails to capture the potential level of imports if the trade barriers were at the lowest possible level and (iii) existing literature on the relationship between trade protection and import penetration is mixed. Studies by Anderson (1980), Finger and Harrison (1994) and Lee and Swagel (2000) find the relationship to be positive, i.e., protection seems to be higher in sectors with greater import penetration, but Trefler (1993) finds that the relationship is negative but not significant. This endogeneity issue between trade protection and import penetration aside, incorporation of import penetration as a



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There is widespread consensus in the literature that significant episodes of trade reform took place in the chosen countries during 1984-86 although Chile had started the process a full decade earlier. India engaged in a treadmill of reforms before it embarked on a decisive liberalization program around 1990. Turkey joined the European custom union in 1996 and reduced even more markedly its overall trade barriers.

If trade liberalization raises industry-wide productivity, we would expect  $\alpha_3$  to be negative. If trade liberalization leads to an increase in competition, we would expect the coefficient  $\alpha_5$  to be statistically significant and negative reflecting reduction in markups. If trade reform produces positive shocks to TFP growth, we would expect  $\alpha_1$  to be statistically significant and positive. We would also expect higher institutional quality, *ceteris paribus*, to have a positive impact on productivity ( $\alpha_4 > 0$ ).

### 5.2 Estimation Issues

As noted above, there are number of perennial econometric concerns with the basic model<sup>4</sup>. One concern is heterogeneity of countries and industries. The first is attenuated by the fact that we have chosen emerging economies with comparable industrial capabilities, while the latter is addressed by the industry-specific regressions since the (imported) technology employed at the three sector level tends to be quite comparable across emerging economies.

A second concern is with possible endogeneity between output growth and the measures of openness may be attributable to the political economy of tariffs or the non-neutrality of much macroeconomic policy. Nominal tariff levels, for example, will be endogenous in cases where lack of competitiveness induces industry groups to lobby successfully for protection. Generally, endogeneity introduces an upward bias in the OLS estimates.

In addition to ideally having an explicit theoretical model which delineates the variables of interest, econometric methods exist to deal with the problem of endogeneity. One is instrumentation by substituting for industry-specific tariffs a variable that affects growth as much as tariffs but is not correlated with the error term. Due to data constraints, we could only experiment with replacing tariff levels by a measure of market competition indexed by the ratio of the average number of establishments in an industry for the years before and after 1989. This alternative specification showed little variation over time and the coefficient estimates were hardly different from those based on the tariff variable.

A second method is to test for stationarity and co-integration. Since the regression model (6) contains a mixture of differenced variables and level variables, we conducted unit-root and

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measure for trade liberalization would necessitate a new theoretical model as well as a different estimation procedure – both of which remains a future agenda for research.

4 It bears emphasis that our theoretical model and ensuing empirics relating trade liberalization and Total Factor Productivity (TFP) while allow for imperfect competition and scale economies follows established studies that uses firm level data (notably, Levinson (1993) and Harrison (1994)). The contribution of this paper primarily lies in empirically employing an inter-country comparison that employs a common framework of analysis of the data for six diverse economies. As we stated earlier, while technology within an industry may be quite similar across developing countries, our approach allows for an identification of whether the effects of trade liberalization are common across a set of rapidly industrializing economies.

cointegration tests to avoid spurious results. For the entire sample, a panel unit root tests indicated the absence of a unit roots.<sup>5</sup> Cointegration, based on the Johansen method, was rejected at the 5% level based on the MacKinnon-Haug-Michells critical values.<sup>6</sup> An additional concern is possible endogeneity between productivity and input choice. The reason is that firms that are subjected to productivity shocks may respond by altering input mixes. If this is the case, then, markups are likely to be overestimated. The reason is that input choice and the error term may be correlated (Levinsohn, 1993; Harrison, 1994). The simultaneity biases from many inputs may, however, counteract each other's effects (Fernandes, 2003). Ways to handle this simultaneity bias include instrumenting inputs with factor prices or investment, using lagged values of inputs (investment, intermediates) as instruments, or using a two-stage approach (see Levinsohn and Petrin, 2003; Schor, 2004). Unlike many econometric studies on the subject (see, for example, Krishna and Mitra, 1998; Kim, 2000; Fernandes, 2003), we do not have firm-level data where managerial decisions on input mixes can be modeled in the context of known productivity shocks. Furthermore, since (6) is estimated in log differences, lagged changes in the inputs could not serve as good instruments. Finally, the log specification also mitigates possible biases related to heteroskedasticity.

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<sup>5</sup> The test with a 1% significance level was based on the following assumptions: individual effects and individual linear trends, 5 lags, and Newey-West bandwidth selection using Barlett kernel. The methods used for the 5 variables were: Levin, Lin and Chu, ADF-fisher Chi-square, and PP-Fisher Chi-square.

<sup>6</sup> We used the least restrictive model specifications (linear with intercept and trend versus quadratic with intercept and trend). The Log Likelihood, Akaike and Schwartz criteria rejected cointegration. However, the Akaike Criteria could not reject the cointegration rank of 5 for the quadratic-intercept specification with trend.

## 6 Results

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Given the greater depth of the time-series dimension of the pool, the error terms are unlikely to be independent across time. We, therefore, chose to model the error term as an AR(2) autoregressive process and employed Maximum Likelihood estimation (Greene, 2000). To control for differences in country size and level of industrial development, we experimented with various conditioning variables including GDP, the share of manufacturing value added in GDP, country dummies, and a measure of institutional quality. Institutional quality is the only index that has some explanatory power and it is included in the specification we chose for the 28 industries. Higher institutional quality is related positively to productivity in six of the twenty-eight branches spanning the entire gamut of skill intensity. The estimates of the relationships among changes in markups, scale economies, and productivity growth induced by trade reform are also reported in Table 5. Since the results are invariant with respect to the depreciation rate (4%-8%), Table 5 is based on a 6% assumed rate of depreciation. The regression model (6), judging by the sizes of the adjusted- $R^2$  and F-stat, provides a good overall fit.

Table 5: Effect of Nominal Tariff Levels on Productivity by Industry Sector (d = 6%)

	Branch	$\alpha_1$	M	$\alpha_2$	$\alpha_3$	$\alpha_4$	$\alpha_5$	$\alpha_6$	N	adj-R <sup>2</sup>	F
<b>Group 1</b>	311	-0.0465	0.6315***	-0.7773	0.0001	0.0246	0.0015	0.0375	80	0.29	12.82
	313	-0.0539	1.5351***	0.2348	0.0005	0.0035	-0.0041**	-0.0017	80	0.7	33.31
	314	-0.3077	0.1228	0.6052	0.0016	0.0686	0.0071	-0.0075	65	0.07	3.25
	322	-0.1206	1.0884***	-0.1629	0.0008	0.033	0.0008	-0.002	76	0.75	45.05
	324	-0.1667	1.2506***	-0.2927*	0.0002	0.0332	-0.0065	-0.0001	70	0.73	29.93
	332	-0.0557	1.1057***	-0.153	0.0005	0.0196	-0.0034	0.002	76	0.69	40.19
	342	-0.0191	1.1774***	0.0202	-0.001	0.0037	-0.0008	-0.0011	76	0.68	32.68
	361	-0.2209	0.7766***	-0.2428	0.0002	0.0424	0.0092**	0.0077	74	0.87	87.78
	390	-0.0364	1.2059***	0.5645***	0.0001	0.0086	-0.0059**	0.0259**	76	0.74	38.58
<b>Group 2</b>	321	-0.0303	0.9827***	-0.1654	-0.001	0.0095	0.0075	0.0128	80	0.69	35.26
	323	-0.1894	0.9156***	0.0245	0.0002	0.0434	0.0012	-0.0145	70	0.7	26.87
	331	-0.0198	1.3164***	-0.0863	-0.011	0.0091	-0.0032	0.0058	80	0.79	53.73
	341	-0.0935	1.0366***	-0.2615*	-0.004	0.0218	0.0043	0.0059	80	0.86	85.1
	351	-0.1737	1.0770***	0.0511	-0.002	0.0393	0.0063	-0.0011	80	0.81	50.57
	352	-0.0859	0.6499***	0.2585	0	0.0256	0.0106	-0.016	78	0.69	35.54
	353	-0.0056	0.1844*	-0.5132*	0.0001	...	0.0272***	0.0025	53	0.69	18.01
	354	-0.0098	0.3071**	-0.5097	0.0018	...	0.014	0.0053	64	0.23	17.8
	355	-0.0432	1.0966***	0.3445	0.0006	0.0074	-0.001	0.0021	80	0.81	61.19
	356	-0.0678	0.9237***	0.3106*	0.0003	0.0121	0.0011	0.0004	76	0.74	39.16
	362	0.0776	1.0731***	-0.0888	-0.004	-0.0123	0.0039	0.0018	80	0.66	28.25
	369	-0.0333	1.3835***	-0.2127	-0.0007	0.0098	0.0023	0.0082	80	0.75	43.61
	371	0.0086	0.8743***	-0.4496	-0.0005	...	0.009	0.0017	70	0.77	49.34
	372	0.0137	0.8210***	-0.6601**	-0.0013	...	0.0180*	0.0237**	70	0.72	41.17
	381	-0.0967	1.0130***	-0.4381*	0.0002	0.0225	0.0103*	0.0449**	80	0.83	72.08
<b>Group 3</b>	382	0.2612**	0.9506***	-0.1654	-0.0001	0.0487**	0.0024	0.0238*	80	0.89	96.4
	383	-0.0696	1.5377***	0.1124	-0.0002	0.014	-0.0125*	0.0112	80	0.86	64.42
	384	-0.3517*	1.2827***	0.3677	-0.0007	0.0685**	-0.0085	-0.0327*	80	0.87	65.07
	385	-0.1723	0.9716***	0.1332	0.0004	0.0287	0.0016	-0.0042	72	0.65	23.36
		# Significant:	2	27	7	0	2	7	5		

Significance levels: 1% (\*\*\*), 5% (\*\*), or 10% (\*). (...): dropped due to collinearity.

Estimated equation:  $dy_{jct} = \alpha_{1jt} + \mu_j dlm_{jct} + \alpha_{2j}k_{jct} + \alpha_{3j}T_{jct} + \alpha_{4j}Q_c + \alpha_{5j}[dlm \bullet T]_{jct} + \alpha_{6j}[k \bullet T]_{jct} + \epsilon_{jct}$  (6)

## 6.1 Returns to Scale (RTS)

The only standard assumption of the Solow model that can be taken as a reasonable approximation of reality is constant returns to scale. The distribution of industries by the pre-reform returns-to-scale parameter,  $v (= 1 + \alpha_2)$ , shows that 24 out of 28 branches have constant returns, two branches (transport equipment, and other manufacturing) show decreasing returns, and metal products and non-ferrous metals exhibit moderately increasing returns.

The estimated values for  $\alpha_6$  indicate that RTS was unaffected by trade liberalization for over eighty percent of the manufacturing industries. Where changes are observed, the signs are mixed. This suggests that larger factories do not necessarily become more competitive as greater access to export markets overcomes the constraints of narrow domestic markets.

## 6.2 Price-Cost Margins

The markup rate before reform ( $\mu$ ) is generally, but not uniformly, high. It is also significantly and positively related to productivity for all but two industries (Tobacco and Petroleum Refining). The theoretical expectations are that changes in price-cost margins ( $\alpha_5$ ) are negative if reform leads to greater competition and hence lower markups. The results suggest, however, that markups remained stable for most branches after trade liberalization. Furthermore, the estimated value of markup parameter is  $\mu \approx 1$  across industries. This suggests the prevalence of conditions that approximate outcomes under perfect competition.

## 6.3 Growth Rate of Productivity

The intercept (TFP),  $\alpha_1$ , which measures the average level of productivity, is statistically insignificant for all but two industries. Where significant, it is negatively correlated with the productivity of capital. The coefficient of the tariff variable,  $\alpha_3$ , measures changes in the growth rate of productivity. Tariff reduction is theoretically expected to be positively correlated with productivity growth. Contrary to expectations, the partial elasticity of overall productivity with respect to the level of nominal tariffs are uniformly zero. The positive impact of trade liberalization on the growth of productivity that shows up in the country case studies that analyze time series data does not find confirmation in this study at the three-digit level of disaggregation.

This may be the case because the positive effects of openness might be outweighed at this level of aggregation by the negative effects of openness such as those resulting from the winnowing out the weakest domestic firms, a possibility underscored by the works of Melitz and others (see Helpman, 2006, for a review). If so, this raises the intriguing possibility that policymakers may inadvertently fail to sequence economy-wide reform measures properly. Simultaneously liberalizing trade and removing the barriers to innovation may, for example, be harmful to promising upstarts in emerging economies which have yet to prove themselves in a sufficiently competitive home market before entering the cutthroat global market for

manufactures. As Aghion and Howitt (2009: 371) observe, “[It] might be better to remove the barriers to innovation first and then to wait until several domestic industries have become world leaders before removing the barriers to international trade.”

## 6.4 Caveats

In judging the results, one must, of course, be mindful of some possible qualifications. The first pertains to the perennial problems of data with data on developing economies. There are measurement errors (especially with the construction of capital stock), and inadequacy of the proxies for openness. However, the results are all the more surprising since we use the ratio of the highest tariff year before reform and the lowest tariff year after reform thereby accentuating the intensity of liberalization. This in effect biases the results in favor of the market-discipline and technological-diffusion arguments for liberalization. Furthermore, since productivity gains occur in the medium-to-long-run, the effects of the chosen time horizon is relevant. Openness has a level effect on TFP from gains in allocational efficiency as well as in the relaxation of the foreign-exchange constraint in the short run. The longer lasting growth effect on TFP via gains in technical efficiency is also confounded by the fact that reforms are often undertaken in times of economic crises which attenuate the positive supply response to greater openness. However, with the exception perhaps of India, the sample countries had a decade or two of post-reform adjustment. Finally, one might object that the cross-section approach may be less useful than the country case study approach if protection focuses selectively on potentially uncompetitive sectors (Harrison, 1994). This means that industries with comparative disadvantages stand little chance of successfully managing the adjustment process following tariff reductions.

The second point deals with the fact that the three-digit level of aggregation may still mask the effects of heterogeneity in firm-level responses to tariff reductions (Schor, 2004). Some industrial firms adapt quickly; others fail because they are creatures of the protectionist policies, and still other promising firms, facing high adjustment costs, fail because of premature exposure to foreign competition (Rodrik, 1992; Stiglitz, 2004). At the aggregate level, therefore, the net effects may well turn out to be insignificant. This can, of course, be taken more as an explanation of our findings than an objection.

The third qualification is that the hypothesis of liberalization automatically leading to productivity gains may be too crude and at variance with the dynamics of latecomer industrialization. That is, TFP growth in manufacturing industries is also be driven by factors other than trade policy. One set of relevant determinants is market expansion or market deepening in a developing economy (due to market liberalization and deregulation, to greater provision of public services). Another candidate is foreign investment, especially FDI that generates knowledge spillovers (tariff jumping, export platform, or global supply chain). Yet another consideration has to do with institutional innovations that reduce transaction costs and enhance security of property rights.

Additional candidates for explanatory variables may, therefore, include such factors as the adequacy of the stock of infrastructure and human capital, the efficiency of institutions at

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home and abroad that shape firm incentives, and the congruence of trade policy with other equally important economic policies. One may also include as an important consideration of dynamics the stage of development (say, in the context of an international product cycle) that various skill-intensive and technology-intensive manufacturing industries find themselves at the time of trade liberalization (Rodríguez and Rodrik, 2000; Wacziarg and Welch, 2008).

## 7 Conclusion

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This paper applies a flexible model to panel data to address the ongoing debate on the effects on industrial productivity of trade liberalization in the manufacturing sectors of emerging industrial economies. Using pooled data from six of the more outward-oriented developing economies, we sought evidence for the generalizability of the results of a number of country case studies. We find that, in the short to medium-run of the aftermath of significant liberalization, (i) the markup rate did not change appreciably, (ii) the vast majority of manufacturing industries did not experience a productivity shock, and (iii) nine out of ten industries continued to exhibit constant returns to scale. However, a handful of resource- and technology-intensive branches seem to have enhanced their markups and productivity subsequent to trade liberalization. The static gains of trade may very well be more significant than the dynamic ones for new trade liberalizers.

These results are at variance with most country-specific studies with firm-level data which find that trade reform enhances productivity growth. However, this variance is unlikely be a reflection of possible aggregation bias for at least two reasons. First, the three-digit aggregation is only one step or so away from the four-digit or five-digit levels that commonly define industries. Second, and more importantly, the studies that utilize micro level data typically focus on one country thereby picking up some of the peculiarities of the country in their results. Cross-country studies such as ours, based as they are on a standardized version of the same establishment-level data, are essential for providing generalizable empirical tests of the claims of theoretical models. Further, our robust cross-country regressions strongly suggest that openness is necessary for capacity utilization but not sufficient for automatic capacity creation. That is, significant productivity gains may require deeper institutional reform and built-up thresholds of domestic capability for technological assimilation.

The potential implications for policy and WTO rules are equally intriguing. Trade liberalization obviously provides a potential opportunity for domestic firms to prove their international competitiveness and thereby deepen their technological and global marketing capability. Success in exploiting this opportunity may, however, involve long gestation lags and high costs of learning (say, moving from original equipment manufacturing to original brand manufacturing). After all, at least for latecomers, it is domestic productivity relative to peers abroad that of competitors that drives the international competitiveness of newcomers. The level-playing-field approach to trade negotiations that is currently in vogue may, therefore, not be appropriate for rapidly changing needs of latecomers.



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