MANUFACTURING FIRMS IN DEVELOPING COUNTRIES:

HOW WELL DO THEY DO, AND WHY?

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Abstract

The manufacturing sectors of less developed countries (LDCs) have traditionally been relatively protected. They have also been subject to heavy regulation, much of which is biased in favor of large enterprises. Accordingly, it is often argued that manufacturers in these countries perform poorly in several respects: (1) markets tolerate inefficient firms, so cross-firm productivity dispersion is high; (2) small groups of entrenched oligopolists exploit monopoly power in product markets; and (3) many small firms are unable or unwilling to grow, so important scale economies go unexploited.

In this paper I assess each of these conjectures, drawing on plant and firm-level studies of LDC manufacturers. I find none to be systematically supported. Productivity dispersion among LDC plants is not obviously higher than it is among plants in industrialized countries. Convincing demonstrations of monopoly rents are generally lacking, and unexploited scale economies are modest. Finally, while the evidence suggests that protection increases price-cost mark-ups and dampens productive efficiency, the general movement toward trade liberalization in LDCs has made this less of an issue today than it was 20 years ago.

Each of these inferences is based on a limited body of crude evidence. There is substantial scope for improvement in the empirical literature, especially in terms of better measures of productive efficiency and the costs that firms incur to achieve it; better analyses of spillovers, and more attention to the effects of volatility and uncertainty on firm behavior. Progress on any of these fronts is likely to require improvements in the quality and quantity of primary data collection.

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I. OVERVIEW

The manufacturing sector is often the darling of policy makers in less developed countries (LDCs). It is viewed as the leading edge of modernization and skilled job creation, as well as a fundamental source of various positive spillovers. Accordingly, although many LDCs have scaled back trade barriers over the past 20 years, the industrial sector remains relatively protected in the typical country (Schiff and Valdez, 1992, chapter 2; Erzan, et al, 1989; Ng, 1996).[1] Governments also promote manufacturing with special tax concessions, and relatively low tariff rates for importers of manufacturing machinery and equipment.

At the same time, many observers believe that the maze of business regulations is unusually dense and unpredictable in LDCs.[2] Summarizing an extensive survey of managerial attitudes around the world, Brunetti, Kisunko and Weder (1997) report that LDC firms generally consider the institutional obstacles to doing business more burdensome than their OECD counterparts.[3] The regulatory problems that they view as more severe include price controls, regulations on foreign trade, foreign currency regulations, tax regulations and/or high taxes, policy instability, and general uncertainty regarding the costs of regulation. Other types of regulation—including business licensing and labor laws—are not viewed as especially burdensome *on average* in the LDCs, but constitute major problems in certain developing countries.[4]

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[1] The need for revenue is a second motivation for relatively high tariffs in developing countries, although non-tariff barriers seldom serve this function.

[2] A well-known example of the problem was generated by the Institute for Liberty and Democracy in Peru, which attempted to register a fictitious clothing factory in the mid-1980s. "To register the imaginary factory took 289 days and required the full-time labor of the group assigned to the task, as well as . . . the equivalent of 23 minimum monthly wages" (de Soto, 1989, p. xiv).

[3] For purposes of this paper I will ignore the fact that Turkey, Mexico and Korea are members of the OECD.

[4] There were no major differences between the LDCs and OECD in terms of the regulations concerning new business start-ups or safety and environmental standards; further, LDC firms viewed labor regulations as less of a problem

Moreover, within the manufacturing sector, it is also often argued that policies favor large firms while inhibiting growth among small firms (e.g., Little, 1987). In some cases, investment incentives are available only to projects above a minimum scale, and large-scale producers are singled out for special subsidies.[5] Anti-trust enforcement is typically weak, and special tax breaks are sometimes meted out to large, influential corporations (e.g., Gauthier and Gersovitz, 1997).

Even when policies do not explicitly favor large firms, these firms may enjoy *de facto* advantages. Banks view them as relatively low risk and cheap to service (per unit of funds lent), so they have preferential access to credit.[6] This phenomenon is relatively marked in developing countries because private sector credit is relatively scarce there, information networks are poorly developed, and binding interest controls are relatively common (Levine, 1997; Little, 1987; Ty-bout, 1984).

Protectionist trade regimes are also more likely to favor large firms, both because their products compete more directly with imports, and because sectors with large, capital-intensive firms lobby the government more effectively. Further, while many of the costs of dealing with dense regulatory regimes are fixed, the payoffs from doing so probably increase with the scale of operations. For example, access to the legal system, access to the formal banking sector, and publicly administered employee benefits are relatively valuable to large producers (Levenson and

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than did OECD firms. But licensing and labor laws have been flagged as major problems in India and some Latin American countries, inter alia. For country-specific discussions of the regulatory burden, see de Soto (1989) on Peru; World Bank (1995a) and Biggs and Srivastava (1996) on Sub-Saharan Africa; Little, Mazumdar and Page (1987) and Pursell (1990) on India. Severance laws in developing countries are discussed in (World Bank, 1995b, Chap. 4), and in more detail for the Latin American case in Cox-Edwards (1993).

[5] See Pack and Westphal (1986) on Korea; Cortes, et al (1987) on Colombia; Wade (1990) and Bruch and Hiemenz (1984) on E. Asia. India is an exception—see, for example, Little et al (1987).

[6] Levine (1997) provides references.

Maloney, 1997). Hence, moderate-sized firms, which are large enough to show up on regulators' radar screens but too small to gain much from compliance, may be punished the most.

These basic tendencies of LDCs—toward industrial sector promotion, dense, unpredictable regulatory regimes, and credit markets or commercial policies that favor large firms —raise a number of fundamental empirical issues. First, do the regulatory regimes and the bias against small producers prevent small firms from growing, and thereby create losses due to unexploited scale economies? Second, if these regimes prevent small firms from threatening the larger incumbents, do LDC industries lack dynamism and competition? That is, have entrenched oligopolies emerged that are neither innovative, technically efficient, nor likely to price competitively? Finally, has trade protection compounded the technical inefficiencies and monopoly power that arise from regulatory regimes? In this paper I selectively take stock of what we have learned about these issues from firm- and plant-level data sets over the past 20 years.

I shall begin by briefly reviewing some of the distinctive features of the environment in which LDC manufacturers operate. This will serve as background for the discussion that follows, and help to distinguish those features of LDC manufacturers that trace to structural characteristics of their economies from those induced by industrial, trade or labor policies. Next, drawing on the available evidence, I will take up the issue of whether small firms have been somehow suppressed, and more generally, whether the LDC business environment has bred non-competitive pricing behavior and low productivity. Finally, I will address the question of how trade protection has conditioned pricing, efficiency, and productivity growth.

II. THE BUSINESS ENVIRONMENT: WHAT'S DIFFERENT IN LDCs?

In terms of income levels and business environment, the countries typically labeled "developing" are a very heterogeneous group. By the World Bank's reckoning they currently span the per capita income range from $US 80 (Mozambique) to $US 8,380 (Argentina).[7] Nonetheless, looking across countries, some distinctive features of the business environment become increasingly evident as one moves down the per capita income scale. At the risk of over-simplifying I will begin by mentioning the most striking and widely acknowledged among them.

Market size: Although some developing economies are quite large, most are not. Hence, excepting countries like Brazil, China, India and Indonesia, the size of the domestic market for manufactured products is relatively limited (figure 1). Further, among the least developed countries, Engel effects favor basic subsistence needs over all but the most basic manufactured products (figure 2). So when transport costs are significant and the OECD countries are distant, demand for the more sophisticated manufactured goods is small.

Access to manufactured inputs: The menu of domestically produced intermediate inputs and capital equipment is also often limited in developing countries. Thus producers who might easily have acquired specialized inputs if they were operating in an OECD country must either make do with imperfect substitutes or import the needed inputs at extra expense. This latter option is the dominant choice among smaller countries.[8]

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[7] This income range describes all countries that are not clasified by the World Bank as high income or transition. Figures are taken from the World Development Indicators, 1998, and are based on the Atlas method of conversion to dollars.

[8] As a crude exercise, one can designate industries 382 (non-electrical equipment), 383 (electrical machinery) and 384 (transport equipment) of the International Standard Industrial Clasification system as the machinery and equipment industries. Then using domestic production data from the World Bank and trade data from the COMTRADE system, the ratio of net imports to domestic consumption for this group of products can be constructed product by product. For the 53 countries with complete data, 75 percent of the cross-country variation in this measure is explained by the logarithm of GDP and a dummy for transition economies. The coefficient on the logarithm of GDP is

Human capital: Low rates of secondary education and a scarcity of technicians and scientists also affect the mix of goods manufactured and the factor proportions used to produce them.[9] Similarly, many have argued that flexibility in production processes and the ability to absorb new technologies is directly related to the stock of indigenous human capital (e.g., Nelson and Phelps, 1966; Evenson and Westphal, 1995; Keller, 1996).

Infrastructure: Roads, ports, airports, communication facilities, power, and safe water access tend to be relatively limited in LDCs (World Bank, 1994, figure 1, p. 3, table 1.1, p. 13, and figure 1.1, p. 14). Production techniques are directly affected, as are the costs of servicing distant markets. Poor transportation networks are particularly limiting in the least developed, more agrarian economies, where consumers are spread throughout the countryside. In instances where infrastructure services are missing or unreliable, some firms must produce their own power, transport and/or communication services.

Volatility: Macroeconomic and relative price volatility is typically more extreme in developing countries. Historically, Latin America and Sub-Saharan Africa have stood out among the developing countries as the most volatile, but all developing regions have done worse than the industrialized countries (The World Bank, 1993; Hausmann and Gavin 1996).

–0.14 and it carries a t-ratio of 9.69. (Surprisingly, the log of GDP *per capita* adds no additional explanatory power to the regression.) The predicted share of imports in domestic consumption of machinery and equipment is greater than .6 for economies with GDPs less than 12.5 billion 1987 US dollars.

[9] The wages of scientists and engineers in manufacturing firms constitute 0.2 percent of GDP in the most technologically primitive of the developing countries, while they account for 1.0 percent of GDP in the OECD (Evenson and Westphal, 1995, table 37.1). A logarithmic regression of the secondary school enrollment rate on GDP per capita yields an elasticity of 0.62 and an R-squared of 0.65. (Data are taken from Barro's data base, EVIEWS version, and describe 118 countries.)

Governance: Finally, legal systems and crime prevention are also relatively poor in developing countries, and corruption is often a serious problem (World Bank, 1997; Brunetti et al, 1997). Hence the protection of property rights and contract enforcement can be problematic.

III. PLANT SIZES AND SCALE EFFICIENCY

Combined with industrial sector policies, the above circumstances (and others I have neglected to mention) lead to several distinctive features of LDC manufacturing sectors. Perhaps the most striking of these is their dualism. In many industries, large numbers of micro enterprises and a handful modern, large-scale factories produce similar products side by side.[10] The small producers frequently operate partly or wholly outside the realm of government regulation, and rely heavily on informal credit markets and internal funds for finance. They are relatively labor intensive, so they account for a larger share of employment than of output.

A. The Size Distribution

The contrast between the size distribution of plants in developing countries and that found in the OECD is dramatic. Table 1 provides some crude comparisons. Note that there is a large spike in the size distribution for the size class 1-4 workers, and it drops off quickly in the 10-49 category among the poorest countries.[11] This is not true in the United States or other industrialized countries. The emphasis on small scale production not only correlates negatively

[10] In Colombia, for example, more than half of the 5-digit ISIC industrial sectors that contain plants with less than 10 workers also contain plants with more than 200 workers. I base this statement on Colombia's annual manufacturing survey, which neglects most plants with less than 5 workers, so this statistic substantially understates the prevalence of micro-enterprises.

[11] Many micro enterprises are invisible to official census takers because they do not have postal boxes, are impermanent, and/or are part of farm compounds. Thus Table 1 substantially understates their prevalence. "[C]omparison of village by village enterprise censuses conducted by [Michigan State University] and local scholars with 'official' censuses shows that the latter not infrequently undercounted the number of enterprises by a factor of two or more." (Leidholm and Mead, 1987, p. 20)

with per capita income levels across countries (Liedholm and Mead, 1987, p. 16, Banerji, 1978), but also within countries through time (Little, et al, 1987; Steel, 1993).

What accounts for this phenomenon? One might approach this question using dynamic models in which the size distribution evolves with stochastic shocks to demand and technologies (Sutton, 1997, provides a review.) Indeed, as I will argue in section IV, that literature can be usefully exploited to study LDCs. But most explanations for the size distribution in developing countries have focused instead on the static effects of taxes and regulations.

Rauch (1991) provides one of the few analytical contributions. Modifying Lucas's (1978) model with heterogeneous worker/entrepreneurs, he shows that minimum wages, enforced exclusively among large firms, can create a "missing middle." The most talented entrepreneurs operate big plants to exploit their productivity advantage, and the extra profits they earn from being big more than cover the wage premium they pay. Less talented entrepreneurs stay small and informal, leaving a gap in the middle. It never pays to be just large enough to attract regulation.

Descriptive country studies support and elaborate upon this basic story. Writing on Peru in the 1980s, de Soto (1989) argues that many entrepreneurs remained small to avoid excessive regulation, and thus failed to challenge entrenched large firms, who moved relatively easily in the regulatory maze. On Cameroon in the early 1990s, Gauthier and Gersovitz (1997) show that small firms remained informal and avoided taxes, while large firms were influential enough to obtain special treatment. Mid-sized firms bore the highest tax burden. On India, which is unusual in the favoritism it has shown to small firms, Little *et al* (1987, p. 32) write: "Not only would small firms [that graduate] have to cope with a much more difficult licensing policy, but they

would also have to contend with higher labor costs (including wages and fringe benefits as laid down by labor laws) and substantially higher excise duties."

These arguments help to explain the size distribution in those developing countries with heavy regulation. But the pervasiveness of small firms in LDCs suggests that other more universal forces are at work. For example, as noted in section II, the poorest countries tend to be the least urbanized, and transportation networks tend to be underdeveloped. So small, diffuse pockets of demand lead to small scale, localized production.[12] (This phenomenon is central to some "big push" models of industrialization—e.g., Murphy, *et al*, 1989.) In many countries a majority of the small scale producers are located in rural areas, absorbing workers when seasonal effects reduce agricultural employment (Liedholm and Mead, 1987, p. 28).

Underdevelopment also spawns small firms because Engel effects skew demand for manufactured products toward simple items like baked goods, apparel, footwear, metal products, and furniture. All of these products can be efficiently produced using cottage technologies, so there is little incentive to consolidate production in several large plants and incur the extra distribution costs.

Further, plentiful unskilled labor and the lack of long-term finance create incentives to economize on fixed capital. Since most machinery and equipment must be imported, the trade regime and the lack of local technical support may further militate against factory production in small markets.[13] In the presence of wage rigidities, abundant labor and scarce capital can also

[12] Liedholm and Mead (1987) report that "in the four survey countries where relevant data were collected, direct sales to final consumers dominated [sales to businesses, government sales and exports], and, in fact, exceeded 80 percent in three of the countries." (pp. 46-47)

[13] Cortes et al (1987, pp. 153-154) note that "the increasing availability of skill machine operators [in Colombia] has also contributed to the establishment of local importers and reconstructors of used equipment . . ."

mean that formal sector jobs are rationed, hence workers unable to find employment in the formal sector may create their own micro enterprises to survive.[14]

Finally, volatility in the business environment—both regulatory and macroeconomic—can discourage mass production techniques. Investments in fixed capital involve long-term commitments to particular products and production volumes. If there is substantial uncertainty about future demand conditions for these products, it often makes sense to choose production techniques that do not lock one in; that is, to rely more heavily on labor (Lambson, 1991; Brunetti et al, 1997).

B. Are small firms scale efficient?

Does the preponderance of small firms imply that scale inefficiency is a serious problem in developing countries? Many have argued that it does, particularly in the simulation literature, where analysts often assume that the ratio of average to marginal cost is above 1.10 for the typical plant.[15] However, survey-based evidence suggests that the potential efficiency gains from increases in plant size—induced, for example, by trade liberalization—are probably much smaller than these studies suggest.

The simplest studies of micro enterprises relate output per worker and output per unit capital to plant size. In addition to the shortcomings of partial productivity measures, this literature suffers from several data problems. One is that the boundaries of very small firms are often ill-defined because they are part of a household or a farm, or because they are vertically inte-

[14]The evidence on this effect is mixed. Liedholm and Mead (1995) argue that it is important in Sub-Saharan Africa, while Levenson and Maloney (1997) and Cunningham and Maloney (1998) downplay its significance in Mexico.

[15] For example, Devarajan and Rodrik (1991) assume a ratio of 1.25 for Cameroonian manufacturing, Brown, Deardorff and Stern (1991) assume a ratio of 1.33 for most Mexican manufacturing industries, and de Melo and Roland-Holst (1991) assume ratios varying between 1.10 and 1.20 for the Republic of Korea. Further details are provided in Tybout and Westbrook (1996).

grated with non-manufacturing activities. Another problem, stressed by Little (1987), is that many of these studies pool data on plants producing a diverse range of products. It is worth noting, however, that when Little, *et al* (1987) focus on four narrowly-defined Indian industries, they find "it is difficult to detect any systematic variation in labor or capital productivity with firm size." (p. 186)

Conceptually, studies of micro enterprises that attempt multi-factor productivity measures are more appealing. One strand of this literature is based on social cost-benefit ratios, constructed as the cost of labor and capital at shadow prices, relative to value-added in world prices. As discussed by Leidholm and Mead (1987), these studies have differed in their conclusions, with some finding that small enterprises are at least as efficient as others, and others finding their efficiency relatively low.[16] As for the *very* small, Liedholm and Mead (1987) do find that one-person establishments are systematically less efficient than others, perhaps because many are created as occupations of last resort for those who cannot find work in the job market.

Taking a parametric approach, some analysts have related size to multi-factor productivity by estimating production functions. In this branch of the literature, the message is more consistently that scale economies are missing. Little et al (1987) and Ramaswamy (1994) fit simple functions to cross-sectional data on small-scale Indian producers, and report returns to scale very close to unity in all of the industries they treat. Hill and Kalijaran (1993) obtain analogous results among small-scale Indonesian garment producers. Similarly, using firm-level African data collected by the Regional Program on Enterprise Development (RPED), Biggs et al (1995) fit the

[16] Leidholm and Mead (1987) find that small enterprises in Sierra Leone, Honduras and Jamaica are at least as efficient as others. On the other hand, Ho (1980) and Cortes, et al (1987) find some evidence of scale economies in Korea and Colombia, respectively. Small enterprises are typically less capital intensive, so one reason for the discrepancy may be that Leidholm and Mead use a rather high shadow price of 20 percent per annum for capital services.

same estimator to four manufacturing sectors in Ghana, Kenya and Zimbabwe. Interestingly, even when the sample is limited to firms with 3 to 20 workers, they estimate returns to scale very close to unity. And when the entire stratified sample is used for each industry (covering the entire size spectrum), returns to scale are still close to unity in food and textiles/garments, while mild increasing returns are found in wood products and metal products.[17]

Finally, a larger number of studies have econometrically estimated returns to scale using data on plants with *at least* 10 workers. These have found constant or mildly increasing returns (between 1.05 and 1.10) in the various manufacturing sectors of Latin American, Asian, and North African countries.[18]

All of these studies are plagued by measurement error problems, omitted variables, aggregation bias, and simultaneity bias (Tybout and Westbrook, 1996; Levinsohn and Petrin, 1997; Tybout 1992a). Nonetheless, their basic message seems consistent with engineering studies: the efficiency costs of being small are not crippling—if present at all—once the one-worker threshold has been traversed. Put differently, small firms in developing countries tend not to locate in those industries where they would be at a substantial cost disadvantage relative to larger incumbents.

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[17] This is all the more remarkable when one considers that inherently inefficient firms tend to stay small, so even in the absence of scale economies the data should exhibit some correlation between size and productivity due to selection effects (e.g., Olley and Pakes, 1996).

[18] See Pitt and Lee (1981) on Indonesia; Fikkert and Hassan (1996) on India, Page (1984) on India, Tybout and Westbrook (1995) on Mexico, Westbrook and Tybout (1993) on Chile, Tybout (1992a) on Chile, Aitken and Harrison (1994) on Venezuela, Lee and Tyler (1978) on Brazil, Haddad and Harrison (1993) on Morocco, Chen and Tang (1987) on Taiwan, and Aw and Hwang (1995) on Taiwan.

IV. BARRIERS TO ENTRY AND GROWTH IN THE LDCs

Even if the potential gains from scale economy exploitation are small, one might argue that the prominence of small-scale producers in LDCs is symptomatic of other problems. For example, if excessive taxation and regulation keep many firms small and informal, these policies may be stanching the selection process through which better managers and/or technologies gain market share.[19] Severance laws and restrictions on the use of temporary workers may also inhibit the expansion and contraction of formal sector plants, limiting competitive pressures. Similarly, producer turnover may be dampened by policies that prop up "sick" firms, thereby saturating the market with inefficient producers, and discouraging better firms from entering.[20] Poorly functioning credit markets may further inhibit entry and expansion.

A. Analytical Models of Industrial Evolution

What might constitute evidence on these relatively subtle effects? Dynamic models of industrial evolution provide some guidance. These models generally include representations of the processes that generates each firm's entry, exit, productivity growth, and market share or factor use. In most modern treatments, each dimension of performance is depicted as the optimal behavior of forward-looking entrepreneurs with rational expectations but limited information.[21]

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[19] Of course, taxation and regulation are not inefficient per se. As Levenson and Maloney (1997) note, firms that register with tax authorities and regulators also enjoy the benefits of enforceable contracts, better access to credit, and—in the form of publicly administered fringe benefits for workers—access to risk-pooling mechanisms.

[20] Pursell (1990) notes that "sick" enterprises propped up by the Indian government tied up roughly 14 percent of total bank credit to industry in 1986. Fikkert and Hasan (1996) review the various licensing requirements and approval procedures for capacity expansion that have prevailed in India, and provide further references.

[21] Nelson and Winters (1982) argue that managers do not have the knowledge or the time to solve stochastic dynamic optimization problems, so these authors model entry, growth and exit as deriving from rules of thumb that managers follow. The assumption of relentlessly optimal behavior is doubtless a caricature of the real world, but it is not obvious that alternative representations of behavior are more defensible. I will thus couch my discussion in terms of the optimizing literature.

The literature is complex, but Hopenhayn (1992) provides a relatively tractable formulation. In his model, firms differ only in terms of their productivity levels, each of which evolves according to an exogenous Markov process. New firms enter when the distribution from which they draw their initial productivity level is sufficiently favorable that their expected future profit stream, net of fixed costs, will cover the sunk costs of entry. Firms exit when they experience a series of adverse productivity shocks, driving their expected future operating profits sufficiently low that exit is their least costly option. All firms are price takers, but the prices of their inputs and outputs depend upon the number of active firms and their productivity levels.

This model shares a number of implications with other representations of industrial evolution developed by Jovanovic (1982) and Ericson and Pakes (1995). At any point in time, an entire distribution of firms with different sizes, ages and productivity levels coexists, and simultaneous entry and exit is the norm. Young firms have not yet survived a shakedown process, so they tend to be smaller and to exit more frequently. Large firms are the most efficient, on average, so their mark-ups are the largest. Nonetheless, despite all the heterogeneity, equilibria in both Jovanovic's and Hopenhayn's model maximize the net discounted value of social surplus. Thus market interventions—like artificial entry barriers, severance laws, or policies that prop up dying firms—generally make matters worse.[22]

Under certain regularity conditions, Hopenhayn shows that an increase in the sunk costs of entry protects incumbent firms from the upward pressure on input prices and the downward pressure on output prices that new entrants create. Thus high entry costs not only reduce the amount of entry, they encourage incumbents with relatively low productivity to stick around, and

[22] Product markets are not perfectly competitive in Ericson and Pakes (1995) so this statement does not hold for that model.

thereby increase the amount of productivity dispersion among active firms.[23] In addition, the market shares of the largest, most efficient firms rise with entry costs, skewing the size distribution (Hopenhayn, 1992, p. 1142). The shares of the largest firms also respond negatively to market size, since an outward shift in demand leave the plant size density function and the underlying entry/exit processes unchanged.[24]

Policies that inhibit expansion or contraction have similar consequences. Using a variant on the model described above, Hopenhayn and Rogerson (1993) simulate the effects of severance laws. They find that increases in the rate at which laid off workers must be compensated increase the degree of persistence in firms' market shares, increase average firm size, increase price-cost mark-ups, reduce average productivity, and reduce the job turnover rate.

If we think of sunk costs as deriving from formal sector entry rather than the creation of a micro enterprise, these industrial evolution models provide a crude basis for inference.[25] Specifically, they imply that among formal sector producers, low plant or job turnover, high mark-ups, and the frequent survival of inefficient plants are symptoms of high sunk entry costs. Similarly, Hopenhayn and Rogerson's (1993) simulations imply that persistence in market shares and low turnover among formal sector firms are symptoms of binding severance laws or restrictions on the use of temporary workers.

In addition to studies of the size distribution of firms, at least three empirical literatures provide evidence on these symptoms. The first summarizes the extent of productivity dispersion,

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[23] Exit costs have qualitatively similar effects to those of sunk entry costs because they reduce the amount of one's initial investment that can be recovered by quitting the industry.

[24] For example, if one doubles demand, concentration ratios drop by a factor of 2 and Herfindahl indices drop by a factor of 4, but turnover rates and the market shares of each quantile in the size distribution remain unaffected.

[25] Caves (1998, pp. 1959-1960) takes a similar perspective on sunk costs in his discussion of entry patterns and hazzard rates.

usually in the context of efficiency frontier estimation. The second, relatively recent literature documents the extent of plant turnover, and in some cases relates this turnover to productivity growth. Finally, an older literature on industrial concentration is potentially relevant. Let us take each in turn.

B. Is Productivity Dispersion Higher in LDCs?

Many analysts have studied the amount of productivity dispersion in LDCs. A sampling of results is presented in Tables 2 and 3, and compared to those from a recent multi-country study of the OECD. Each study is done by estimating the "frontier" production technology, which defines the maximum amount of output, y^*, attainable from a given vector of inputs, $\boldsymbol{x}$: $y^* = f(\boldsymbol{x})$. Then, for observed combinations of output and inputs at the ith plant (y_i, $\boldsymbol{x}_i$), the ratio $y_i / f(\boldsymbol{x}_i)$ is interpreted either as an efficiency index itself, or as an efficiency index contaminated by measurement error and transitory shocks beyond the control of plant managers. These two approaches are known as the "deterministic frontier" and the "stochastic frontier" approach, respectively.[26] Cross-plant mean efficiency levels, and standard deviations in efficiency levels are the most commonly reported summary measures of an industry's performance. These bear a negative monotonic relationship to one another in most cases, so I report only the former.

Some caveats are in order. First, these studies are done at differing levels of aggregation. One would expect that the finer the industry, the less dispersion due to pooling heterogeneous technologies. Second, there are differing degrees of measurement error in outputs and inputs. Much of the cross-plant heterogeneity in capital and labor is unobserved by the econometrician,

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[26] The literature can be further sub-divided according to whether $f(\boldsymbol{x}_i)$ is estimated parametrically or non-parametrically (known as "data envelopment analysis"), and whether econometric or programming techniques are used. Greene (1993) provides a recent summary of the various approaches to efficiency measurement.

and most studies describe output in terms of revenue rather than physical product, blurring the distinction between factor productivity and price-cost mark-ups. Third, as is well known, the results depend to a large degree upon whether stochastic or deterministic frontiers are used, and upon the assumed distribution of the error terms (Corbo and de Melo, 1986).

Finally, unless they are estimated with panel data, stochastic frontier models separate technical inefficiency from noise by treating $\ln[y_i / f(\boldsymbol{x}_i)]$ as the sum of two orthogonal error components—one reflecting inefficiency and the other reflecting measurement error or shocks beyond the control of managers. Typically, the negative of the inefficiency component (hereafter denoted u) is assumed to have a half-normal, gamma or exponential distribution, and the noise component is assumed to have a normal distribution. Greater skewness—measured by the negative of the third moment of the compound error—thus implies more productivity dispersion. However, the data often imply that the distribution of $\ln[y_i / f(\boldsymbol{x}_i)]$ is skewed in a way that is inconsistent with these assumptions, so in practice many industries do not fit the model. Such industries are typically dropped from the analysis, and the reported average efficiency levels are based only on the industries that remain.

To control for differences in methodology, I have sorted studies according to whether they presume deterministic or stochastic frontiers, and wherever possible, in the latter case I have used the results based upon the half-normal distribution for the efficiency component of the error term. Among the deterministic frontier studies, there is still some variation in the methodologies across studies because some use linear programming to identify the production function while others use quadratic programming. More importantly, some (like Page, 1980) impose a distribution on the efficiency measures while others do not.

The deterministic frontier studies (Table 2) generally yield lower average efficiency levels than the stochastic frontier studies (Table 3), since the former attribute all unexplained variation in *y* to inefficiency. Unfortunately, they are also very sensitive to the specific assumptions behind the calculations, and do not appear to convey any clear messages. Notice, for example, that Corbo and de Melo's (1986) deterministic frontier results imply that Chile was very inefficient relative to other countries, but their stochastic frontier results imply Chile was average. Given this sensitivity, as well as the lack of good comparator studies from industrialized countries, I shall hereafter focus on the stochastic frontier results.

A comparison of the LDC results in Table 3 with those from industrialized countries (listed under Caves, 1992) yields a surprising message. It is often observed that the cross-firm variance in productivity levels is high in developing countries—e.g., Pack (1988), Evenson and Westphal (1995), Blomstrom and Kokko (1997). Nonetheless, table 3 suggests that average deviations from the efficient frontier are *not* typically larger than what we observe in the industrialized countries. The standard methodology, when it "works," yields mean technical efficiency levels around 60 to 70 percent of the best practice frontier in both regions. Hence the studies surveyed provide little support for the view that LDC markets are relatively tolerant of inefficient firms.[27]

One exception is provided by Biggs *et al* (1995), who report an unusually large amount of productivity dispersion in Ghana, Zimbabwe and Kenya. However, these results are based on relatively broadly-defined industries, so they may be a simple consequence of aggregation bias. In a particularly detailed study, Pack (1987) finds average deviations among Kenyan textiles pro-

[27] Measurement problems make this finding all the more remarkable. Noisy data—due to high and variable inflation cum historic cost accounting—is likely to be more of a problem in LDCs, and this should exaggerate measured productivity dispersion there.

ducers comparable to those in other studies, even though his methodology is based on deterministic frontiers. Similarly, Page (1980) finds dispersion levels typical of other countries in his early study of Ghana.

Although the studies summarized in Table 3 do not find higher productivity dispersion in LDCs, they are not very informative. Most of them are based on out-dated methodologies. With a few exceptions, they rely on cross-sectional data, and hence must infer efficiency dispersion from the skewness of the production function residuals. Further, because most measure output as real revenue, they misattribute cross-plant mark-up differences to productivity dispersion. Finally, for lack of data, they typically equate high productivity with superior performance, ignoring many of the costs that firms incur to enhance their technical efficiency.[28] It is surely not optimal to continually be the most productive firm (Stigler, 1976). But without measuring the net present value of firms' efficiency-enhancing expenditures and the associated changes in their productivity trajectories, one cannot know whether observed patterns of productivity dispersion are problematic.

C. Plant and Job Turnover in LDCs

The literature on plant and job turnover may be a better place to look for evidence on the strength of competitive pressures in the LDCs. If extensive regulation and taxation combine with credit market problems to keep small firms from challenging their entrenched larger competitors, we should observe few firms graduating from informal to formal status. Further, those firms that do graduate should show relatively little mobility up the size distribution, and markets shares should be relatively stable among the largest firms.

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[28] These include training programs, employee recruitment costs, technology purchases, and R&D expenditures. When labor inputs are measured by work hours rather than by worker compensation, wage premiums to retain high-quality workers also belong on the list.

Unfortunately, turnover figures are unavailable for many of the countries where one would expect the policy regime to inhibit mobility. However, a handful of studies on Latin American, East Asian and North African countries provide some preliminary evidence. These studies typically document entry rates, exit rates, net job creation and net job destruction patterns among the population of plants with at least 10 workers. (Variable definitions are provided in the footnote to Table 4.) Most firms above the 10-worker threshold participate wholly or partly in the formal sector, so measured entry rates crudely describe formal sector entry—both through new plant creation and through the graduation of informal plants to formal status.[29] Similarly, the job turnover rates reported give us a crude sense for the stability of market shares among formal sector firms.

Surprisingly, although Cox-Edwards (1993, p. ii) argues that Latin American countries "have a long tradition of trying to protect employment stability," there appears to be *more* plant and job turnover in these developing countries than others have found in the United States and Canada (Table 4).[30] Over a five-year interval, entering plants with at least 10 workers captured 15 percent of the market in Chile, and entering plants with at least 10 workers captured 20 percent of the market in Colombia. On the other hand, in the more inclusive population of plants with at least *five* workers, entrants in the United States captured an average of only 10 percent of

[29]At that scale it is difficult to avoid detection by the government, and the costs of forgoing business dealings with other formal firms and creditors are substantial. (e.g., Klein and Tokman, 1996).

[30] Among other distinctive features, Cox-Edwards (1993) notes that "The Latin American legislation, with a few exceptions, including Mexico, is very strict in limiting the use of temporary contracts . . . firms cannot rely on a mix of permanent and temporary labor force, as is the case in Japan and increasingly the United States . . ." (p. 14). Hence it is difficult to avoid severance payments by relying on temporary workers. On the other hand, as Cox-Edwards emphasizes, severance payments are often legally tied to number of years on the job, so, subject to the temporary worker constraints, firms may be encouraged to "maintain a very young work force with high rotation . . ." (p. iii)

the market.[31] In terms of job creation and job destruction, Chile and Colombia average 25 and 27 percent annual turnover rates, respectively, while the United States and Canada average 19 percent and 22 percent, respectively.

Outside Latin America, some analysts have found even more flux in plants and jobs. In Morocco the annual manufacturing job turnover rate was 31 percent. In Korea and Taiwan, over five-year intervals, new entrants captured an average of 33 percent and 44 percent of the market, respectively, compared to 10 percent in the United States.[32] Finally, although studies of the complete size distribution are unavailable for sub-Saharan Africa, Liedholm and Mead (1995) find that turnover rates among micro and small enterprises are very high, ranging from 19 to 25 percent per annum (not in Table 4).

Why is there so much flux in these LDCs? In some cases—especially in Latin America—high turnover partly reflects the relatively dramatic business cycles found there. In others—especially Korea and Taiwan—it partly reflects rapid expansion of the manufacturing sector. But even if one focuses on the *minimum* of the entry rate and the exit rate, turnover is relatively rapid in the developing countries that have been studied.

Another part of the explanation lies with Engel effects and low levels of human capital, which encourage turnover by skewing the output mix toward simple products with relatively low start-up costs, like baked foods, footwear, apparel, and metal products (figure 2). The dominance

[31] Since turnover takes place mainly among small plants, the contrast between these North and South American countries would have been even greater if all studies had been done on a comparable basis. Turnover figures from European countries are available, but they are reported with insufficient documentation to be useful for present purposes (Cable and Schwalbach, 1991).

[32] The market share figures for Korea and Taiwan cover all producers with at least 5 workers, as are the United States figures. However, the Taiwanese data describe firms while the Korean and U.S. data describe plants.

of these sectors and technologies is probably amplified by macro uncertainty, which creates incentives to be flexible in terms of productive capacity.

Finally, policies seem to matter. Market share turnover rates are higher in Korea and Taiwan than they are in Latin America, where labor markets are relatively regulated. Indeed, turnover rates are highest in Taiwan, where labor markets are least regulated among the sample countries (Lee and Park, 1995) and sunk entry costs are relatively modest because the business environment makes sub-contracting easy (Levy, 1990).

Of course, the turnover rates discussed above don't reveal which plants in the population are expanding or contracting. It is possible that nearly all of the turbulence takes place among plants in the 10-50 worker range, and that these moderately small producers never seriously challenge the larger, entrenched incumbents. Indeed, one might argue that high turnover rates in LDCs simply reflect the relative importance of small and medium enterprises there (Table 1), and need not imply that large firms' market shares are more at risk.

For most LDCs that have been studied we cannot rule out this possibility. For example, Chilean and Colombian plants with at least 10 workers lost 15 and 20 percent of their markets, respectively, over a five year period (Table 4). But plants with less than 50 workers account for more than half of total manufacturing employment in these countries (Table 1), so all of the market share loss *could* have come at the expense of small producers. Similar comments apply to Korea. However, a very different picture emerges in relatively unfettered Taiwan. There the population of plants observed in 1981 had lost 44 percent of the market to new entrants by 1986, and it had lost 63 percent of its market share by 1991 (Table 4)! Taiwanese plants with less than 100 workers account for less than half of output (Table 1), so some of this market share erosion clearly came at the expense of large firms in this country.

D. Turnover and productivity growth

High turnover does not necessarily imply that inefficient producers are rapidly driven from the market. For example, when the Argentine exchange rate regime collapsed in the early 1980s, it left many firms with dollar-denominated debt in serious trouble, and the resulting exit patterns had little to do with productive efficiency (Swanson and Tybout, 1988). To investigate how well turnover "cleanses" LDCs of their least productive plants, several studies have quantified the effects of exit and entry on sector-wide productivity growth. Each is subject to the measurement-error problems that I mentioned in section IV.B. Nonetheless, keeping this caveat in mind, it is worth reviewing the main findings.

In Chile and Colombia, as in developed countries, exiting plants are typically much less productive than incumbents (Liu and Tybout, 1996, Liu, 1993, and Tybout 1992b). Indeed, the productivity of exiting Chilean plants has often begun to deteriorate several years before they actually exit (Liu, 1993)—a phenomenon that Griliches and Regev (1995) dubbed the "shadow of death" effect in their study of Israeli turnover. Similarly, Taiwanese plants doomed to disappear in the next five years exhibit below-average efficiency (Aw, Chen and Roberts, 1997). So there is evidence that a shakedown process is at work.

However, in Chile and Colombia, entering plants are *also* less productive than incumbents on average. Further, neither entrants nor dying plants account for more than 5 percent of total output in a typical year.[33] So inefficient plants are being replaced with plants that are only slightly more efficient, and neither group is a source of much production. This implies that if the

[33] The low average productivity of entering plants might seem at odds with the results I discussed earlier which suggested small plants are not much less efficient than large ones. These two findings are not contradictory because, while most new plants are small, most small plants are not new.

turnover process were suddenly arrested, the impact on productivity in the first year would initially be small.

Nonetheless, over time the costs of policies that prevent turnover quickly mount for several reasons. First, the "shadow of death" effect suggests that exiting plants are on a downward trajectory, and might well continue to get worse. Second, entering cohorts typically undergo a shakedown period in which the least efficient entrants drop out and the survivors quickly improve their productivity. Liu and Tybout (1996) find that this process brings the average productivity of new cohorts up to industry-wide norms after three or four years in Colombia, and Aw *et al* (1997) find similar catch-up patterns in Taiwan, although the process is not complete there after 5 years in some industries. Finally, while the firms turning over account for a small share of production in any one year, the cumulative effects of turnover on the population of plants quickly mount.

To empirically link the business environment with turnover-based productivity gains, and to be rigorous about it, one would need to fit a dynamic structural model of industrial evolution to firm-level panel data. That has yet to be accomplished, so in the meantime one is tempted to look at cross-country correlations between productivity gains and policies that affect turnover. Unfortunately, even this is problematic because only two country studies have calculated turnover-based productivity figures on a roughly comparable basis. We are thus left with the single tantalizing observation that turnover-based productivity growth has been higher in Taiwan than in Colombia. [34] Those who are pre-disposed to do so might conclude that Taiwan's relatively *laissez faire* policies are responsible.

[34] Taking a weighted average of industry-specific results, one may calculate that the productivity gains from replacing exiting plants with entering plants was 3.2 percent over a five year period in Taiwan. The (roughly) comparable figure from Colombia is 2.2 percent.

E. Concentration and market power

Unlike studies on productivity dispersion and turnover, industrial concentration studies often suggest that big firms in LDCs enjoy *more* market power than their counterparts in the developed countries. [35] This reading of the evidence makes sense if cross-country variation in the market shares of the largest firms is generated by associated variation in sunk entry barriers and labor market flexibility, or if variation in concentration—due to exogenous country-specific factors like market size—affects the sustainability of collusive arrangements. Simulations of an industrial evolution model with non-competitive market structures verify that when countries differ for these reasons, concentration is positively related to market power and monopoly rents (Pakes and McGuire, 1994).

However, even when firms are price *takers* and entry barriers are held constant, Hopenhayn's industrial evolution model predicts that concentration is inversely related to market size. So high concentration in the LDCs need not mean that monopoly power is greater there; it may simply reflect the fact that markets are smaller. (In Latin America, two-thirds of the variation in industrial concentration measures is explained by the logarithm of GDP alone.[36]) Further, the relatively large mark-ups of large firms—which are found in both the OECD and the LDCs—can be interpreted in the context of industrial evolution models as reflecting their relatively efficiency.

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[35] Lee (1992) surveys the empirical literature on concentration in LDCs so I will not repeat the exercise here. Theorists have also been known to view high concentration in the LDCs as signalling relatively uncompetitive markets there (Krugman,1989, Rodrik, 1988).

[36] This is the r^2 I obtain using Mellor's (1978) concentration measures, which were constructed the same way for 10 Latin American countries using their industrial census data. A number of studies have commented on the negative correlation between market size and concentration—Lee's (1992) survey provides further details.

If we eschew concentration ratios as signals of market power, what other evidence is available? Some studies have exploited Schmalensee's (1985) methodology, which " . . . amounts to asking whether cross-plant variations [in price-cost margins] are due to industry-wide effects or to plant-specific market shares. Efficient plants should be larger and have higher profits, so a positive correlation is generally expected between market shares and price-cost margins, regardless of whether firms have market power." (Roberts and Tybout, 1996, p. 196) But cross-industry variation in mark-ups, controlling for capital intensity, suggest that profit differentials are not arbitraged away; that is, that entry costs limit competition. There are many problems with this application of Schmalensee's logic, including the poor correspondence between price-cost margins and economic profits (Fisher and McGowan, 1983). But taken at face value, the results for Chile, Colombia, and Morocco show no more evidence of market power than Schmalensee (1985) found in the United States (Roberts and Tybout, 1996).[37]

The above notwithstanding, it would be foolish to conclude that market power is not an issue in developing countries. For example, in Chile and Colombia during the 1970s, a handful of closely held conglomerates controlled large shares of certain industries, as well as portions of the financial sector (Dahse, 1979; Superintendencia de Sociedades, 1978). Countries that privatize natural monopolies should also be on guard, needless to say. The methodologies I have discussed here give one a general sense for the extent of competition, but they are unlikely to detect the pockets of non-competitve behavior that result from these conditions. Careful case studies that collect detailed price data and monitor the behavior of the individual players are probably the only means through which convincing conclusions can be reached.

[37] The country studies in Roberts and Tybout (1996) did find that the time series correlation between margins and import penetration (trade barriers) was largest negative (positive) among big firms, suggesting that they are most directly in competition with foreign suppliers.

F. The bottom line

To summarize, because of institutional entry barriers, labor market regulations, poorly functioning financial markets, and limited domestic demand, the industrial sectors of developing countries are often described as insulated, inefficient oligopolies. To date, however, there is little empirical support for this characterization. Turnover is substantial in the countries that have been studied, unexploited scale economies are modest, and evidence of widespread monopoly rents is lacking.

Nonetheless, the issue of competitive pressures remains open. High turnover in the LDCs need not imply vigorous competition among the largest producers. Most studies of these countries do not rule out the possibility that flux is concentrated among small plants, which are relatively common there. Further, in the exceptional case of Taiwan, where businesses are relatively unfettered by regulations, the larger plants routinely lose market share and turnover-based productivity gains are relatively high. One interpretation is that LDCs with more restrictive policies are sacrificing substantial efficiency and productivity growth. Finally, monopoly power that is localized in one or several industries is unlikely to reveal itself in the type of study I have surveyed here.

Clearly, further documentation of the facts would be helpful. We lack studies on the economies most famous for excessive regulation—India and various countries in Sub-Saharan Africa come to mind. Countries where public enterprises are common in the manufacturing sector are also missing from the existing body of evidence. Cross country comparisons could be refined by better controlling for differences in productivity measures, survey coverage and industry-mix. Finally, there is a need for studies that relate policy to welfare. This will require esti-

mating and calibrating structural models of industrial evolution for the LDCs—an endeavor that researchers are only beginning to pursue.

V. TRADE PROTECTION, MARKET STRUCTURE AND PRODUCTIVITY

Although competition in some developing countries may be vigorous, it is nonetheless imperfect. Entry and exit costs matter, and products are differentiated. Further, even when the resulting market power is minimal, learning spillovers and other externalities are surely present in some form. Hence protectionist trade policies, where they still exist, may do more than affect domestic relative prices and inter-sectoral resource allocation—they may change *intra*-industry mark-ups, productivity, or productivity growth. In this section, after briefly recounting the relevant theoretical literature, I consider the firm-level econometric evidence on each possible effect.

A. Possible Effects of Trade Policy

Static arguments: There are numerous static arguments why trade protection might affect the performance of domestic firms in LDCs. Most involve the effects of trade policy on the competitive pressures that these firms face, the size of the market that they operate in, or both. Firms' responses often depend upon whether entry and exit barriers are substantial, whether scale economies—internal or external—are important, and whether protection takes the form of tariffs or quantitative restrictions. [38]

I will limit myself to several examples. Consider a tradeable goods industry with substantial entry barriers, composed of Cournot-competing firms. If the industry has zero net exports

[38] Many of the relevant models are summarized in Helpman and Krugman (1985) and a number of the seminal contributions are collected in Grossman (1992).

under free trade, the main effect of import prohibitions is to eliminate the threat of foreign competition. Domestic firms may exploit their enhanced market power by curtailing production and increasing their price-cost mark-ups, perhaps sacrificing some scale efficiency in the process.

On the other hand, if the industry begins from substantial import penetration, the dominant effect of protection may be to increase the market size for domestic producers. Firms are likely to respond by expanding, perhaps exploiting scale economies as they do so. (Mark-ups may still rise.) In either scenario, the higher profits that result from protection may allow relatively inefficient firms to survive, driving up productivity dispersion. Alternatively, if we drop the assumption of prohibitive entry barriers—which seems sensible, given our findings in section IV—the higher profits may eventually entice new, inefficiently small domestic producers to enter (Krugman, 1979).[39]

External economies of scale further expand the list of possible effects of trade policy on productivity. Suppose, for example, that the external economies occur at the industry level, and are national rather than global.[40] Then the net effect of trade liberalization depends upon which sectors expand and which contract, as well as the magnitude of traditional gains from comparative advantage effects. It is possible that the losses can outweigh the gains (e.g., Helpman and Krugman, 1985, chapter 3).

Finally, when employee effort is a choice variable, trade policy can affect the amount of "managerial slack" or "X-inefficiency" among manufacturers. The dominant view among devel-

[39] Head and Reis (1999) summarize the analytical and empirical literature on trade liberalization and the size distribution of firms, while providing some new evidence from Canada.

[40] Industrial expansion generally deepens the market for specialized labor, material inputs, and networked support services. Thus, even if no technology spillovers take place, external scale economies at the industry level may be present when there are increasing returns to scale in the production of these inputs, or when risk-averse specialized workers prefer regions with many job opportunities (e.g., Rivera-Batiz and Rivera-Batiz, 1990; Stewart and Ghani, 1992).

opment economists is that protection induces managers in import-competing industries to relax and enjoy the "quiet life." In early versions of the argument, protection increases profits among domestic firms. This relaxes the consumption-leisure budget constraint that their managers face, who respond by choosing more of both if they are on the backward-bending portion of their labor supply schedule (Corden, 1974). In more recent treatments, protection affects the payment schedule that owners (principals) must offer to managers (agents) to induce them to reveal their endowed abilities.[41] If the cost to owners of truthful revelation rises with protection, they may opt for equilibria at lower output and effort levels, but the effect of protection on effort is sensitive to modeling details (e.g., Vousden and Campbell, 1994).

Dynamic arguments: Further effects of trade policy on performance have been demonstrated in explicitly dynamic frameworks. Again, most anything can happen, depending upon modeling assumptions and the particular policy experiment. One issue that has attracted attention is whether trade protection will induce technologically backward producers to invest in catching up. In theory it may, if it increases the effective market size and the associated pay-off from marginal cost reductions for domestic firms (Miyagiwa and Ohno, 1995, and Rodrik, 1992). On the other hand, protection may facilitate collusion among domestic producers and induce them to collectively stick with backward technologies (Rodrik, 1992). A modest permanent quota may also delay technology adoption because, with continuously binding quantity constraints, foreign suppliers do not cut back their shipments to the domestic market when the home firm becomes more efficient (Miyagiwa and Ohno, 1995).

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[41] Given his or her endowed ability, each manager chooses an effort level in response to the reward structure and market conditions. By the revelation principle, contracts that induce managers to be truthful about their (unobservable) abilities yield at least as high a value to the owner as any other mechanism.

Catch-up models describe a one-time transition from dated to new technologies, but they do not link trade policies to ongoing productivity growth. For that, theorists have developed general equilibrium frameworks with continual knowledge production and diffusion. In such models, protection changes the relative prices of the inputs involved in product development, affects the set of imported products that innovators compete with, and affects the ease with domestic innovators can access foreign technical expertise.

Whether protection reduces ongoing productivity growth in these models depends partly upon the way in which knowledge diffuses (inter alia).[42] Suppose that trade policy does not affect the ease with which foreign knowledge can be accessed, perhaps because it is readily available over the internet. Further, suppose that to build domestic know-how in LDCs, there is no substitute for learning-by-doing in the high-tech sectors and the spillovers it generates. Then trade protection *may* improve productivity growth and welfare if it promotes the high-tech activities that generate the highest learning rates and the most valuable spillovers.[43]

On the other hand, if domestic producers acquire some of their knowledge through exposure to foreign clients, technologically sophisticated imports, or knowledgeable competitors, protection may slow growth by constricting important channels of knowledge transmission (e.g., Grossman and Helpman, 1991, Chap. 6). Similar comments apply to policies that discourage foreign direct investment if the local presence of multinational plants facilitates technology diffusion.

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[42] Another key issue is the strength of spillover effects. Diffusion of knowledge through technology purchases or licensing agreements is not enough to establish a link between steady state growth and trade policies. Knowledge spillovers are typically needed, and they must be strong enough that the private return to innovation does not fall with increases in the stock of knowledge (Jones, 1995).

[43] Although they have not endorsed it, this argument for protection has been formalized by Krugman (1987), Stokey (1988), Young (1991) and Grossman and Helpman (1991).

Overall, the most striking conclusion that emerges from the analytical literature discussed above is that almost anything can happen when a country protects its manufacturers, depending upon the assumptions one invokes. Hence many empiricists have attempted to determine what happens in practice by studying patterns of association between trade policy, pricing behavior, productivity, and productivity growth. Others have attempted to chip away at ambiguities by asking which modeling assumptions best describe the data. Let us now consider the evidence.

B. Openness and Pricing Behavior: The Evidence

One of the more robust analytical results on trade with imperfect competition is that policies that constrain imports tend to increase the market power of domestic producers. To look for evidence of this phenomenon, many researchers have regressed price-cost margins on proxies for import competition or trade protection, usually looking across industries at a point in time.[44] The correlation between import penetration (trade protection) and margins is typically negative (positive), and the standard interpretation is that foreign competition squeezes monopoly rents, or "disciplines" the pricing behavior of domestic producers.

In a variant on this theme, a number of authors have recently used Hall's (1988) methodology for measuring mark-ups to gauge the effects of import competition on pricing behavior.[45] The typical exercise is to regress output growth on a share-weighted average of input growth rates, and interpret the coefficient on input growth as a monotonic function of the price-cost mark-up. Allowing the coefficient to shift with trade liberalization, most studies in this genre

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[44] Lee (1992) surveys this literature.

[45] Levinsohn (1993), Harrison (1994), Foroutan (1996) and Krishna and Mitra (1997) study Turkey, Cote d'Ivoire, Turkey (again), and India, respectively.

find that openness is associated with reductions in price-cost margins, and they interpret this to support the "import discipline" hypothesis.[46]

However, even if one ignores the econometric problems, other interpretations are possible. Suppose that increased import-penetration reflects real exchange rate appreciation, which squeezes output prices relative to input prices in the tradeable goods industries. In the short run, so long as revenues still cover variable costs, all firms—competitive or otherwise—will produce at lower margins and the competitive sectors will make negative economic profits. Alternatively, suppose that heightened import penetration reflects the removal of trade barriers. Then relative prices have been twisted in favor of exportables and against importables. Stolper-Samuelson effects should drive down the relative price of the input used intensively by the import-competing sectors, which is likely to be capital in the developing countries. Similarly, in cross sectional studies, suppose that protection is attracted to the industries in the country's comparative disadvantage, which are likely to be capital intensive. These same industries should exhibit relatively high price-cost margins simply because relatively large amounts of capital are used per unit output.

C. Openness and Productivity Levels: The Evidence

In addition to falling mark-ups, empiricists tend to find that trade liberalization is associated with rising average efficiency levels (Nishimizu and Page, 1982; Tybout et al, 1991; Tybout and Westbrook, 1995; Harrison, 1996). Similarly, protected industries tend to exhibit heightened productivity dispersion (Tybout et al, 1991; Haddad, 1993; Haddad and Harrison, 1993). The standard interpretation of these results is that foreign competition drives inefficient domestic

[46] This methodology is likely to suffer from simultaneity bias because transitory productivity shocks appear in the disturbance term, and are likely to be correlated with input growth. Appropriate instruments are nearly impossible to find (Abbott, Griliches and Hausman, 1989).

producers to exploit scale economies, eliminate waste, adopt best practice technologies, or shut down.

However, as with the mark-up studies, a number of caveats apply. First, simultaneity bias creates the usual problems. Inefficient, influential firms often lobby for protection, and sometimes they succeed. Further, as already discussed, in most firm-level data sets output is measured as revenue divided by an industry-wide deflator. So reductions in measured "productivity" dispersion may simply mean that mark-ups have fallen the most among firms with the largest initial margins. That is, when efficiency is equated with low dispersion—as it is in the efficiency frontier literature—improvements in productivity cannot be distinguished from the mark-up squeeze often associated with trade liberalization. Conversely, if trade liberalization is associated with a major devaluation, the favorable twist in prices for tradeables should increase their profitability, at least in the short run. This looks just like an increase in average efficiency among tradeable goods producers if physical units of output cannot be observed.

Going beyond the association between measured efficiency and openness, a number of authors have attempted to determine *why* the two are correlated. There is some evidence that internal scale effects are *not* the main reason. If trade liberalization forces inefficiently small firms down their cost curves, one should observe plant sizes rising in import-competing sectors rise as protection is removed. However, micro panel studies consistently find that increases in import penetration are associated with *reductions* in plant size, as are reductions in protection (Dutz, 1996; Roberts and Tybout, 1991; Tybout and Westbrook, 1995). Thus liberalization may work *against* scale efficiency, at least in the short run. The impact on efficiency of these plant size adjustments is probably small, however, since adjustments take place mainly among large plants

that are operating in the constant returns range of their cost curves (Tybout and Westbrook, 1995).

Although external scale economies are probably present, they too are unlikely to account for large protection-related efficiency effects. Using plant-level panel data and the methodology developed by Caballero and Lyons (1990), Krizan (1997) finds significant external returns to scale in many Moroccan industries.[47] He then embeds his estimates in a computable general equilibrium model of Morocco developed by Rutheford, Rustrom and Tarr (1993) and simulates the effects of trade liberalization *vis a vis* Europe. His findings imply that external economies compound the gains from liberalizing, but the effects are quite small.[48] Further, to obtain large efficiency gains or losses one would have to assume implausibly large external returns.

In sum, when trade liberalization improves productive efficiency, it is probably largely due to intra-plant improvements that are unrelated to internal or external scale economies. The elimination of waste, reductions in managerial slack, heightened incentives for technological catch-up, and access to better intermediate and capital goods are all possible explanations, but there is little direct evidence on the importance of any of these. Detailed analysis of task-level efficiency and technological choice within narrowly defined industries—before and after a major change in trade policy—is probably the most promising direction for further work on the topic.[49]

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[47] Other evidence that external scale effects are present comes from the locational choices of new firms (e.g., Henderson and Kuncoro, 1996).

[48] In the scenario with the largest externality effects, the positive effects of trade liberalization on welfare increase from a .9 percent gain to a 1.1 percent gain.

[49] Pack (1984) and Mody et al (1991) provide excellent examples of research at this level of detail, but neither study directly examines the link between performance and trade reforms.

D. Openness and Productivity Growth: The Evidence

Static and dynamic effects of trade policy are conceptually distinct in that the latter involve a time dimension. However, all responses to policy take time, even those that can be analytically described with a static model. Given the short time periods spanned by micro data, it thus is rarely possible to distinguish transitory one-shot adjustments in productivity levels from lasting changes in the rate of productivity growth. Hence, to assess the relevance of the dynamic analytical models I mentioned in part A, I will limit my discussion to the issue of how technology diffuses.

Technology transfers through trade Other things equal, outward-oriented policies are more likely to facilitate long-run growth if technology diffuses through international transactions. For example, LDCs may acquire new technologies by de-engineering imports, or simply by deploying the innovative intermediate and capital goods that they acquire in foreign markets. They may also learn about product design and new technologies or management techniques from the foreign buyers to whom they export. Once acquired through these channels, new foreign technologies may diffuse to other domestic firms not directly engaged in trade. Are these processes important?

There is very little micro-econometric evidence on the productivity enhancing effects of importing sophisticated intermediate and capital goods, although the fact that many LDCs import most of their machinery and equipment speaks for itself. Several studies do report a positive correlation between access to imported intermediate goods and performance (Handoussa, et al, 1986; Tybout and Westbrook, 1995), and Feenstra *et al* (1992) report evidence that Korean firms improved their productivity by diversifying their input bundles. Thus imported capital and inter-

mediate goods *may* be the most important channel through which trade diffuses technology, but clearly, further work is needed to quantify the effects.

More detailed evidence is available on technology acquisition through exporting. In support of a "learning by exporting" effect, most studies that compare the productivity of LDC exporters with that of others in the same industry and country find that exporters do better.[50] Case studies confirm that OECD buyers sometimes provide their LDC suppliers with blueprints and technical advice (e.g., Rhee et al, 1984). But firms that are relatively efficient—perhaps for the reasons described in the industrial evolution literature—are also relatively likely to self-select into foreign markets (Clerides et al, 1998). Hence the cross-sectional correlation between exporting and efficiency may reflect causality in either direction, or both.

Several recent studies attempt to address the causality issue by tracking firms through time and asking, first, whether those that became exporters were more efficient beforehand, and second, whether exporters showed improvement relative to industry norms after entering foreign markets. Most find that exporters were substantially more efficient than non-exporters *before* they started selling abroad, so the higher efficiency of exporters appears to be at least partly a self-selection effect.[51] These studies also find that, in most industries, the efficiency gap between exporters and non-exporters does not grow over time, suggesting that learning is not a general

[50] This result is reported in Aw and Hwang (1995); Aw and Batra (1998); Chen and Tang (1987); Haddad (1993); Handoussa, Nishimizu and Page (1986); Tybout and Westbrook (1995); and Aw, Chen and Roberts (1997). See, however, Sinha (1993).

[51] Clerides *et al* (1998) report this result for Colombia, Mexico and Morocco; Aw, Chen and Roberts (1997) find the same pattern in Taiwan. Both sets of findings are consistent with those that Bernard and Jensen (1999) report in a related study of U.S. exporters.

phenomenon. However, firms in several industries do exhibit relative efficiency gains after becoming exporters, so the learning-by-exporting hypothesis cannot be ruled out entirely.[52]

Regardless of whether they acquire their expertise from abroad, technology may also diffuse from exporters to non-exporters in the same country, region or industry through demonstration effects, skilled worker training (and subsequent labor turnover), or expertise imparted to their local suppliers. Looking at the intensity of exporting activity through time, Clerides *et al* (1998) find that when many firms have been exporting from a particular region, all firms in that region tend to enjoy lower average costs. Spillovers are one interpretation, but this finding may simply reflect the fact that regions with cheap labor or materials are attractive export platforms.[53]

Technology transfer through FDI: Even if they are not innovative themselves, multinational (MNC) affiliates in LDCs may transfer expertise to locally held firms through the same diffusion channels I mentioned in connection with exporters. Indeed, FDI does seem to bring relatively efficient technologies into host countries: most studies find that foreign-owned firms are more productive than their domestically owned competitors (Haddad and Harrison, 1993; Sinha, 1993). But it is unclear how extensively these technologies diffuse among domestically owned firms. On the one hand, case studies suggest that substantial diffusion occurs (Blomstrom and Kokko, 1997). Further, firms in sectors with relatively high MNC presence tend to be more productive in Uruguay, Mexico, Morocco and Venezuela (Kokko et al, 1997, Haddad and

[52] Kraay (1997) and Bigsten et al (1997) also find that firms become more efficient relative to others after becoming exporters in China and sub-Saharan Africa, respectively. However, because of data limitations, their econometric models are relatively restrictive. In particular, since the auto-regressive process generating average costs is constrained to be first-order, the effects of more distant cost lags may be coming through their lagged exporting dummies. (Clerides et al, 1998, find that cost processes are second or third order in Morocco and Colombia.)

[53] A different kind of productivity spillover from exporters occurs if their activities ease the way for other firms to break into foreign markets. Demonstration effects and the development of specialized support services like port facilitates and intermediaries are possible reasons this might occur. Aitken, et al (1997) and Clerides *et al* (1998) report some evidence that this phenomenon is present in Mexico and Colombia, respectively.

Harrison, 1993, and Aitken and Harrison, 1994). On the other hand, when industry effects are controlled for with dummy variables, domestically-held Venezuelan firms actually do *worse* as the MNC presence in their industry increases (Aitken and Harrison, 1994). Hence cross-sectional studies may suffer from simultaneity bias because MNCs are attracted to profitable sectors, and *negative* spillover effects may occur in the short run because MNCs siphon off domestic demand and/or bid away high quality labor when they set up shop in the host country (Aitken and Harrison, 1994).

learning-by-doing and learning spillovers As already discussed, theory tells us that protection may facilitate productivity growth by promoting domestic production in the learning-intensive sectors. Is this argument for protection empirically relevant? In developing countries, technology acquisition often amounts to adapting existing methods to local circumstances (Evenson and Westphal, 1995). Hence, instead of focusing narrowly on R&D or technology purchases, the rate at which firms generate knowledge may be better proxied by the intensity with which they rely on engineers, technicians, and scientists—hereafter ETS employees. If protection encourages learning and productivity growth, one would thus expect that it helps ETS-intensive firms, and that these firms exhibit rapid productivity growth and/or generate positive spillovers.

However, it is not obvious that productivity growth and learning spillovers are greater among import-competing manufacturers than among non-tradeable goods producers or export-oriented producers. Arguably, the best documented case of spillovers in LDCs is the Green Revolution. Further, within each industry, the firms that export—and thus the firms that benefit

from openness—tend to be more skill-intensive than others (Batra ant Tan, 1997; Revenga and Montenegro, 1997; Clerides et al, 1998).[54]

The presumption that ETS-intensive firms exhibit the most rapid efficiency growth is also tenuous. Firms with high ETS intensity do tend to get more output per unit bundle of capital and labor (e.g., Page, 1980 and 1984; Little et al, 1987; Cortes, et al, 1987; Biggs et al, 1995). But the fact that ETS workers are more productive need not signal relatively rapid learning-by-doing, much less spillovers from one firm to another. In fact, in Colombia and Morocco, ETS-intensive do not exhibit higher productivity growth than other firms (Hunt and Tybout, 1997).

Finally, although common sense and case studies tell us that learning by doing among domestic firms is important, the available evidence suggests that it complements, rather than substitutes for, access to the international knowledge stock (Evenson and Westphal, 1995; Basant and Fikkert, 1996). In sum, the case for fostering growth by protecting learning industries seems weak.

VII. SUMMARY

The manufacturing sectors of developing countries have traditionally been relatively protected. They have also been subject to heavy regulation, much of which is biased in favor of large enterprises. Accordingly, it is often argued that manufacturers in these countries perform poorly in several respects: (1) markets tolerate inefficient firms, so cross-firm productivity dispersion is high; (2) small groups of entrenched oligopolists exploit monopoly power in product markets;

[54] This is true despite the fact that their marginal production costs tend to be lower, so it appears that highly efficient firms hire the most skilled workers and, because they are efficient, they also stand to gain the most from participation in foreign markets.

and (3) many small firms are unable or unwilling to grow, so important scale economies go unexploited.

The proliferation of very small plants and the large market shares of big plants in LDCs are sometimes interpreted to support this position. However, these distinctive features may simply trace to the general economic environment. Small geographically diffuse markets and a demand mix skewed toward simple consumer goods lead naturally to large numbers of small plants. Indeed, although the issue remains open, the existing empirical literature does not support the notion that LDC manufacturers are relatively stagnant and inefficient. Turnover rates in plants and jobs are at least as high as those found in the OECD, and the amount of cross-plant dispersion in productivity rates is not generally greater. Also, although small-scale production is relatively common in LDCs, there do not appear to be major potential gains from better exploitation of scale economies.

In many countries, therefore, the main manufacturing sector problems may not be of the variety that keep firms small, inhibit entry and exit, and/or create market power. Rather, uncertainty about policies and demand conditions, poor rule of law, and corruption may be the priority areas for reform. These are certainly the areas that managers identify as most problematic in qualitative surveys (Brunetti, *et al*, 1997). Also, for those countries that have not already done so, the removal of barriers to trade is likely to improve efficiency. Falling price-costs mark-ups and rising productivity have accompanied trade liberalization episodes in many LDCs.

As for future research, progress on a number of fronts would seem especially useful. First, given the fundamental importance of efficiency and productivity growth, improvements in the way that we measure these concepts should be a priority. For lack of detailed price information, most of the work thus far has equated physical output with real revenue, thereby blurring the

distinction between technical efficiency and profitability. Comprehensive reckonings of the *costs* of productivity gains are also needed. The present value of training costs, worker recruiting and retention expenditures, technology purchases, and research programs are seldom tallied up and weighed against the present value of the productivity gains they generate. But only this kind of calculation can reveal which firms have been economically efficient.

Second, given the central role that endogenous growth models assign to spillovers, any improvement in our understanding of their form and magnitude should help us to chip away at the mystery of growth. This will require better productivity measurement, as discussed above, and it will probably mean tracking individual firms over periods of time long enough to deal with impact lags. To the extent that technology diffusion takes place through labor turnover, data sets that merge households responses with those of their employers would also be useful. Progress in this arena is likely to be gradual and painful.

Third, studies that link firms' behavior to uncertainty in the policy regime and the macro environment are scarce, given the importance that LDC entrepreneurs attach to these phenomena. In a similar vein, models that link labor market regulations and regime volatility to entry, exit and productivity growth would address some major unanswered questions. Rigorous empirical analysis of these topics is difficult because it involves solving forward-looking optimization problems in the presence of uncertainty and sunk costs, sometimes with strategic interactions among firms and potential firms. Nonetheless, recent theoretical work has laid some of the groundwork for empirical modeling (e.g., Ericson and Pakes, 1995; Dixit and Pyndyck, 1994) and estimation techniques are improving. The next decade is likely to bring real progress.

Clearly, all of these suggested directions for research require improvements in the quality of data. Better measurement of inputs (including training, R&D, and other non-traditional fac-

tors), outputs, and prices are needed if we are to have much confidence in findings on plant-level productivity measures, or simply to document the incentive structure firms face at the ground level. More attention to comparability across countries would also be welcome. Unfortunately, the returns to data collecting and cleaning are very small because these activities do not demonstrate cleverness to the economics profession in any obvious sense. (They are sometimes interpreted to demonstrate the opposite.) Thus data base building is generally under-funded, and in cases where the investments have been made, the results have sometimes been jealously guarded rather than disseminated for widespread analysis.

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Figure 1: Size of the Manufacturing Sector and Level of Development

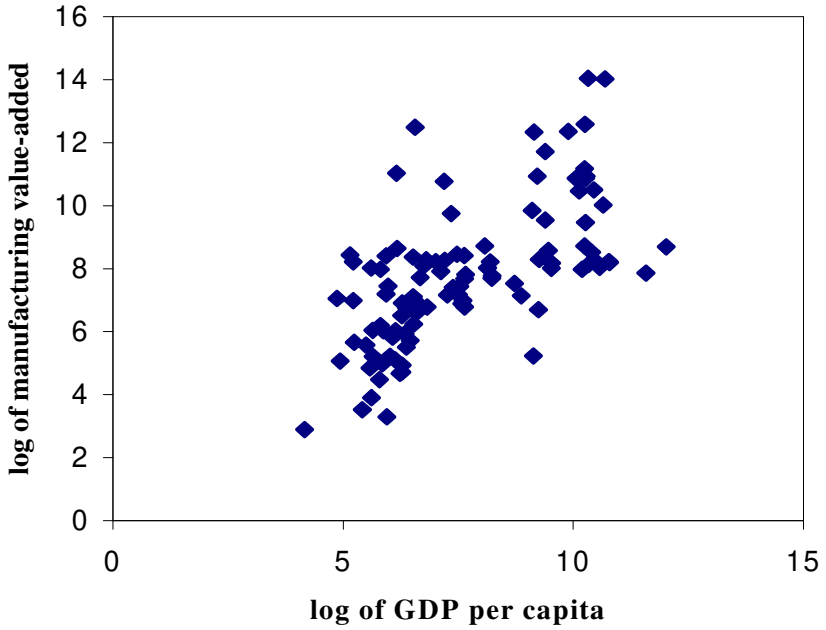
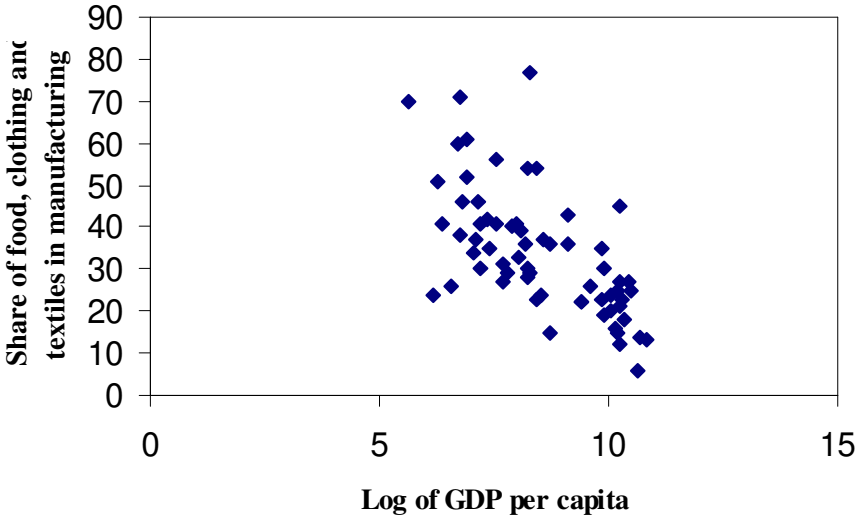


Figure 2: Light Manufacturing and Level of Development



Source: Author's calculations based on World Development Indicators, 1997

TABLE 1: THE DISTRIBUTION OF EMPLOYMENT SHARES ACROSS PLANT SIZES

	Number of Workers					
	1-4	***5-9***	***10-19***	***20-49***	***50-99***	***>99***
United States, 1977[a]	1.2	1.7	3.6	8.7	10.1	74.7
Indonesia, 1986[b]	44.2	17.3		38.5		
S. Korea, 1973[c]	7.9	22.0			70.1	
S. Korea, 1988[e]	12			27		61
Taiwan, 1971 [b]	29.1				70.8	
Taiwan, 1986[e]	20			29		51
India, 1971[d]	42		20		38	
Tanzania, 1967 [d]	56		7		37	
Ghana, 1970 [d]	84		1		15	
Kenya, 1969 [d]	49		10		41	
Sierra Leone, 1974 [d]	90		5		5	
Indonesia, 1977 [d]	77		7		16	
Zambia, 1985 [d]	83		1		16	
Honduras, 1979 [d]	68		8		24	
Thailand, 1978 [d]	58		11		31	
Philippines, 1974 [d]	66		5		29	
Nigeria, 1972 [d]	59		26		15	
Jamaica, 1978 [d]	35		16		49	
Colombia, 1973 [d]	52		13		35	
Korea, 1975 [d]	40		7		53	

[a] source: United States Bureau of the Census (1977).

[b] source: Steel (1993)

[c] source: Little et al (1987, Table 6.5)

[d] source: Liedholm and Mead (1987)

[e] source: Census of Manufacturing, Republic of Korea, calculations of Bee Aw Roberts.

[f] source: Chen, Xiaomin (1997).

TABLE 2: DETERMINISTIC FRONTIERS, AVERAGE EFFICIENCY LEVELS BY INDUSTRY

Industry:	Little *et al* (1987) or Page (1984), India Translog, linear prog.	Cortes, *et al* (1987), Colombia Cobb-Douglas	Ramaswamy (1994), India, Cobb-Douglas, linear prog.	Corbo and de Melo (1986), Chile Cobb-Douglas, linear programming	Tyler (1979) Brazil, Cobb-Douglas, linear programming or quadratic programming	Pack (1984), relative to UK best practice, CES (subs. elasticity of 0.5)	Page (1980), Ghana, Cobb-Douglas with gamma distribution
Food Processing		0.58		0.401			
Shoes	0.424			0.367			
Printing	0.645			0.334			
Soap	0.579			0.344			
Machine Tools	0.688	0.56	0.432	0.372			
Agricultural Machinery			0.349	0.445			
Plastic Products			0.608	0.332	0.48 or 0.65		
Steel				0.435	0.57 or 0.62		
Motor Vehicles			0.638	0.312			
Textiles: Spinning				0.225		0.70 (Kenya) 0.73 (Philippines)	
Textiles: Weaving						0.68 (Kenya) 0.55 (Philippines)	
Saw Mills				0.370			0.710
Furniture							0.743

TABLE 3: STOCHASTIC FRONTIERS: AVERAGE TECHNICAL EFFICIENCY BY INDUSTRY *

	Rataswamy (1994), small- and medium-scale Indian firms	Bhavani (1991), small Indian firms	Hill and Kalirajan, (1993), small Indonesian firms.	Biggs et al (1995), Ghana, Kenya, Zimbabwe	Pitt and Lee (1981), Indonesian firms**	Tyler and Lee (1979), small and medium-scale Colombian firms
Food				0.67		0.642
Textiles and Garments			0.626	0.46	(weaving only) min: 0.618 max: 0.766	0.554 (apparel)
Footwear						0.558
Wood and Furniture				0.42		0.984 (furniture)
Metal Products		0.719 (structural metal products)		0.51		0.987
Machine Tools	0.727	0.704 (agric. hand tools only)				
Plastic Products	0.820					
Motor Vehicles	0.846					

*All figures are estimates of $E\left(e^{-u}\right)$, where the inefficiency measure u is assumed to follow a half-normal distribution.

** Differences in estimated average efficiency reflect differences in the way that labor is measured, and whether plant characteristics like size and foreign ownership dummies are included in the production function.

TABLE 3: STOCHASTIC FRONTIERS, con't.*

	Caves, et al (1992)	Corbo and de Melo (1986), Chilean firms	Kalirijan and Tse [1989], Malaysian firms
Food processing		0.713	0.73
Shoes		wrong skewness	
Printing		wrong skewness	
Soap		0.627	
Machine Tools		wrong skewness	
Agricultural Machinery		0.751	
Plastic Products		wrong skewness	
Motor Vehicles		wrong skewness	
Textiles: Spinning		wrong skewness	
Textiles: Weaving		wrong skewness	
Saw Mills		0.652	
Furniture		wrong skewness	
Japanese manuf., cross-industry average of 144 industries	0.699		
Korea, cross-industry average of 128 industries	0.672		
UK, cross-industry average of 72 industries	0.680		
Australia, cross-industry average of 91 industries	0.699		
United States, cross-industry average of 67 4-digit industries	0.671		

*Refer to note on previous page

TABLE 4: PLANT AND JOB TURNOVER IN DEVELOPING VERSUS DEVELOPED COUNTRIES*

Country *(period covered)*	***Turnover rates***				***Market Shares of Entrants***			***Minimum Plant Size Covered***	***Level of Consolidation***
	Plants		*Jobs*		*<1 year olds*	*<5 year olds*	*<10 year olds*		
	1 year	*5 year*	*1 year*	*5 year*					
Chile (1979-86)	8.5[a]	--	26.9[a]	--	3.6[a]	15.3[a]	--	10 workers	All manufacturing
Colombia (1977-1989)	11.9[a]	--	24.6[a]	--	4.9[a]	19.8[a]	--	10 workers	All manufacturing
Morocco (1984-1990)	9.5[a]	--	30.7[a]	--	3.2[a]	--	--	10 workers	All manufacturing
Korea (1983-1993)	--	64.2[b]	--	--	--	32.5[b] (39.0)	--	5 workers	All manufacturing (2-digit industries)
Taiwan (1981-1991)	--	67.9[c]	--	--	--	43.9[c]	63.2[c]	1 worker [g]	All manufacturing (2-digit industries)
United States (1963-82)	--	26.9[d] (37.7[d])	18.9[e]	58.4[f]	--	10.3[d] (14.1[d])	(27.4[d])	5 workers	All manufacturing (4-digit industries)
Canada (1973-92)	--	--	21.9[e]	--	--	--	--	5 workers	4-digit industries

*Let N_t be the number plants observed in year *t*, E_t be the number of plant observed in year *t* but not *t-1*, and X_t be the number of plants observed in year *t-1* but not in year *t*. Then the entry rate is E_t / N_{t-1} and the exit rate is X_t / N_{t-1}. The plant turnover rate is the average of these two statistics. Similarly, the rate of gross job creation is the number of jobs at entering plants plus the number of new jobs at expanding plants, divided by initial number of jobs, and the gross job destruction rate is the number of jobs that disappear as plants contract or exit divided by the initial number of jobs. The sum of these two rates is the job turnover rate.

[a] Source: Roberts and Tybout (1996), tables 2.3, 9.3, 9.5, 10.3, 10.4, and 12.3
[b] Source: Chung (1999), tables 3.1 and 3.2.
[c] Source: Chen (1997), tables 2.7 and 2.8.
[d] Source: Dunne, Roberts and Samuelson (1988), tables 2, 3, 4 and 8. Figures for all manufacturing are average rates of *new* entry across 4-digit industries; figures for 4-digit industries include entry via product mix switches.
[e] Source: Baldwin, Dunne and Haltiwanger (1998), table 1. These figures are for 1973-1992.
[f] Source: Dunne, Roberts and Samuelson (1989), table 1.
[g] The Taiwanese data set describes firms rather than plants