

Trade and Growth: The Case of Brazil

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October 31, 2003

Trade openness and growth tend to be positively associated. Both cross-country evidence and recent micro-econometric studies suggest this. However, cross-country comparisons leave many questions open. Apart from measurement problems with openness, causality is hard to establish. Recent micro-econometric evidence on the effects of trade reform sheds a clearer light on efficiency change and turnover. In general, micro-econometric studies find that higher efficiency and faster turnover follow trade liberalization. However, Tybout (forthcoming) concludes in a recent literature review: “It is difficult to find studies that convincingly link these processes to the trade regime.”

Most studies to date give little indication as to *how* trade liberalization benefits a country’s growth trajectory, and *what microeconomic processes* would underly the impact of trade reform on productivity change and, ultimately, economy-wide growth. Figure 1 presents a simple framework to unify micro-econometric evidence. The figure depicts a production possibility frontier and illustrates three important macroeconomic consequences of the *microeconomic processes* that trade reform can spur: (1) Trade-induced efficiency change, (2) trade-induced factor reallocations, and (3) trade-induced technology upgrading. Many micro-econometric studies to date tend to focus on these processes, either directly or indirectly. Needless to mention, there are several further effects of trade reform on domestic markets. I will briefly comment on some of those later.

Trade allows firms and plants to raise their efficiency through access to world markets for intermediate and capital goods. In addition, fiercer

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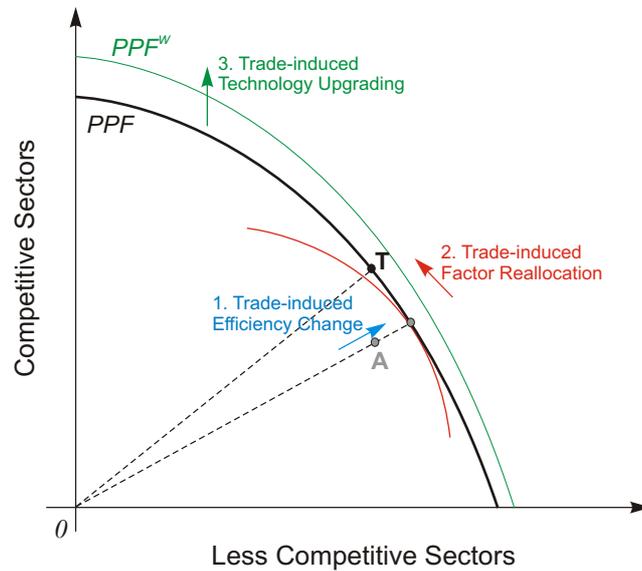


Figure 1: Trade reform and its relation to growth

foreign competition instills productivity change among active firms and forces the least efficient firms to exit. I summarize these effects under headline (1): **Trade-induced Efficiency Change**. The economy moves from an autarky point *A* closer towards the production frontier. In Muendler (2003), I investigate in detail three distinct *channels* through which Brazil's trade reform may have induced a process of efficiency change among its manufacturers. Findings suggest that (a) the use of foreign inputs plays a minor role for productivity change, whereas (b) foreign competition pressures firms to raise productivity markedly. (c) The exit probability of inefficient firms rises with competition from abroad, thus contributing positively to aggregate productivity. Counterfactual simulations indicate that the competitive push (b) is a salient source of immediate productivity change, while the elimination of inefficient firms (c) unfolds its impact slowly.

As plants or firms raise their efficiency in response to fiercer foreign competition, workers are displaced and productive capital needs to be put to alternative use. However, displaced workers and capital goods may face prolonged transition times to reemployment. I call this process (2): **Trade-induced Factor Reallocations**. Figure 1 depicts imperfections with

the red reallocation curve. The temporary transition costs from the reallocation of factors may be small compared to the lasting productivity gains from trade, but permanently lost sector-specific human capital can loom more problematic. Divestment of capital is not always conducted efficiently, and capital goods in shrinking or closing firms may be lost rather than reemployed. Information from a matched firm-worker panel data set for Brazil, currently under construction, shows that displacement probabilities for manufacturing workers increase strongly after trade reform and that reemployment chances differ widely across sectors (Menezes, Muendler and Ramey 2003).

Access to new technology and the opportunity to outsource parts of the value chain internationally may affect production directly. Whether or not an economy's production possibilities expand due to (3) **Trade-induced Technology Upgrading** is hard to assess. However, inasmuch as technical change and capital deepening favor certain skills of workers more strongly than others, changes to production techniques can be measured. For a matched firm-worker data set of the Brazilian manufacturing sector and after carefully assessing complementarities for nine groups of educational attainment, we find that the elasticity of skill-capital substitution remains constant between 1992 and 1998 (Corseuil and Muendler 2002). We tend to view this as evidence against trade-induced technical upgrading.

Finally, countries that open to free trade may tend to specialize in products and industries that exhibit less linkages, spill overs and potential for productivity improvement than others. These issues remain largely unexplored at the micro-econometric level.

Brazil is a particularly interesting case to study. Brazil substantially reduced its tariff and non-tariff barriers in the early 1990s. But reductions were partly reversed in the mid 1990s. These changes and the cross-sectional variation in protection levels offer identification for many micro-econometric questions. Moreover, firm and worker data can be matched to a employer-employee panel and are of outstanding quality. The data include information on firms' foreign inputs and workers' tenure and educational attainment. Being a middle-income country, Brazil may provide insights both for emerging and more advanced economies.

Given limits to the availability of data, most microeconomic studies tend to focus on the manufacturing sector. So will I in this summary of research on Brazil's trade reform. Of course, improvements in manufacturing productivity are only one of many effects that trade may have on

factor use and accumulation.

This paper discusses evidence on (1) trade-induced efficiency change in section 1, initial conjectures on (2) trade-induced factor reallocations in section 2, and first findings on (3) trade-induced technology upgrading in section 3. I briefly comment on trade-induced innovation patterns and potential further effects of trade on growth in section 4. The micro-econometric evidence in these three or four areas is indicative about likely changes to an economy's production possibility frontier, the macroeconomic counterpart to the microeconomic processes.

1 Trade-induced Efficiency Change

Recent micro-econometric evidence indicates that efficiency improvements at the level of plants or firms may be induced through trade liberalization or continued trade exposure (Levinsohn 1993, Tybout and Westbrook 1995, Kim 2000, Pavcnik 2002, Muendler 2003; Bartelsman and Doms 2000 provide a survey of studies on productivity turnover). Trade reform can affect efficiency change through three primary "channels".

- a. *Foreign Input Push*: High-quality equipment and intermediate goods allow firms to adopt new production methods. Their use can raise efficiency.
- b. *Competitive Push*: The removal of import barriers increases competition on the product market side. This can allow firms to remove agency problems and induce them to innovate processes.

These two effects tend to shift a *firm's* efficiency. In addition, a separate group of trade effects on efficiency can only be observed at the level of *sectors or industries*. The present analysis focuses on

- c. *Competitive Elimination*: Fiercer foreign competition makes less efficient firms shut down and enables surviving, competitive firms to raise market share. This turnover increases average efficiency.

Brazilian manufacturer data allow for the separation of these three channels and a comparison of their relative importance. Investigating (a) the foreign input push, Feenstra, Markusen and Zeile (1992, for Korean business groups) and Fernandes (2001, for Colombian manufacturers) trace effects of inputs on efficiency at the micro-level. Their studies

Table 1: COUNTERFACTUAL SIMULATIONS

Counterfactual		log <i>TFP</i>				
		1986	1990	1992	1995	1998
<i>De facto</i>		1	.9809	.9956	.9999	1.0294
Ch. 1 off	Less foreign input use ^a	1	.9773	.9953	.9998	1.0289
Ch. 2 off	Tariffs unchanged ^b	1	.9772	.9858	.9979	1.0303
Ch. 3 off	Tariffs unchanged ^c	1	.9809	.9955	.9998	1.0288

^aBased on regression estimates, a one percentage point higher tariff is taken to result in a 26.2 percentage point lower demand for foreign inputs relative to domestic inputs.

^bTariffs assumed to affect *TFP* change according to the estimate in Muendler (2003), table 3, column 2.

^cTariffs assumed to affect exit according to estimates in Muendler (2003), table 5, columns 3 and 6. In the counterfactual sample, an according share of exiting firms is randomly kept (with productivity at the level of their *de facto* exit).

suggest that efficiency is positively related to the use of high-quality inputs. In Muendler (2003) I show, however, that this effect is relatively small compared to the other two channels. Microeconomic studies on the competitive push (b) and competitive elimination (c) include Cox and Harris (1985), Levinsohn (1993), Roberts and Tybout, eds (1996) and Pavcnik (2002). For Brazil, Cavalcanti Ferreira and Rossi (1999) find a positive impact of trade reform on efficiency in sector-level data and Hay (2001) in a sample of 320 large manufacturers. In general, these studies suggest that higher efficiency and faster turnover follow trade liberalization. In Muendler (2003), I aim at approaching causal relationships between efficiency and trade exposure for several possible measures of total factor productivity in Brazil.

Results for the foreign input push (a) indicate that, on average, the efficiency of foreign equipment and intermediate inputs is higher than the efficiency of domestic inputs. To measure their effect, foreign inputs are included in the production function and distinguished regarding their role as capital goods or intermediate inputs. However, their overall efficiency contribution is minor. The adoption of new technologies can reduce efficiency initially. Firms need to put high-quality inputs to adequate use in order to achieve efficiency gains. In several sectors, Brazilian firms do not appear to succeed with necessary rearrangements in the short term.

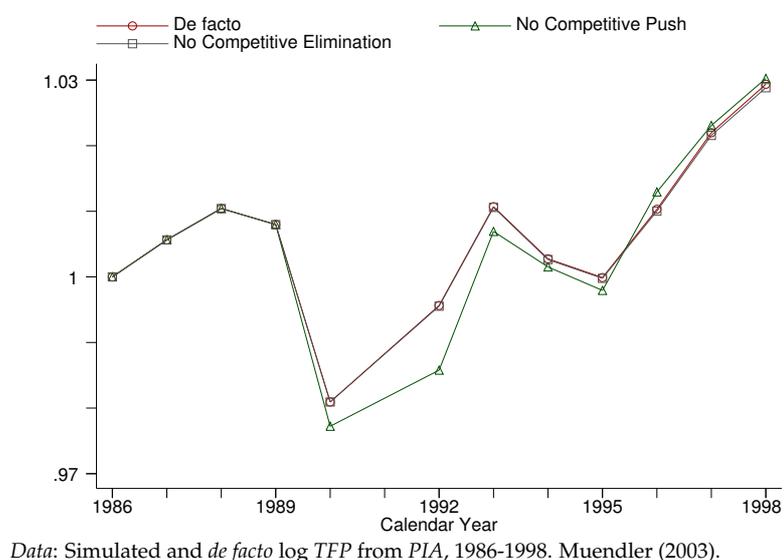


Figure 2: **Productivity under three scenarios**

Evidence on the competitive push (b) indicates that firms respond to increased competitive pressure and raise their efficiency. To draw a closer to causal conclusion, the analysis employs components of sector-specific real exchange rates as instrumental variables and controls for the endogeneity of foreign market penetration and trade policy. Third, firm turnover and the exit of the least productive firms contributes positively to efficiency change in the aggregate. In an effort to evaluate this competitive elimination (c) structurally, probabilities of Markov transitions between states of operation are estimated as a function of the trade regime. The exit probability increases strongly with foreign competition both for Brazilian exporters and non-exporters.

To understand the relative importance of the three channels *vis à vis* each other, counterfactuals are evaluated in simulations. The uppermost row in table 1 shows how productivity evolves in the sample of medium-sized to large Brazilian manufacturers. Productivity change during the 1990s was disappointingly slow in general, as Bugarin, Ellery Jr., Gomes and Teixeira (2002) estimate too. To assess the relative importance of the three channels, one can switch them off individually and calculate total

factor productivity in their absence. Trade reform took effect in 1990, whereas previous tariff reductions most likely did not matter for productivity change because non-tariff barriers remained binding. Only the effect of tariffs, not that of foreign market penetration, is considered in the simulations. The counterfactuals ask how much less efficiency change would have occurred through each channel had Brazil not reduced tariffs. These simulations show that the use of foreign inputs has an instantaneous but limited effect. The competitive push (b) is an important source of immediate efficiency change, while competitive elimination (c) unfolds its impact over time. Figure 2 depicts the latter two channels graphically.

2 Trade-induced Factor Reallocations

Two striking puzzles arise from Brazil's recent productivity experience. First, productivity estimates indicate that the Brazilian economy today employs its factors of production less efficiently than 20 years ago (Bugarin et al. 2002). Second, similar estimates show that, following the two rapid total factor productivity declines in 1980-82 and 1988-89, the Brazilian economy made up for the efficiency losses only over prolonged periods of recovery. Decompositions of productivity change in Muendler, Servén and Sepúlveda (2001) indicate that reallocations of market shares from less to more efficient firms do not occur systematically. Taken together, these findings may mean that factor reallocations in Brazil do not take place smoothly.

To assess factor allocation following trade reform, we currently study job turnover in manufacturing during the 1990s and the absorption of workers in other sectors of Brazil's economy. We hypothesize that trade liberalization raises the rates of both job destruction and creation. However, we expect lasting durations of unemployment and transitions out of the formal labor force.

Gonzaga, Pazello and Bivar (2000) and, more recently, Menezes-Filho, Corseuil, Santos, Servo, Ribeiro and Gonzaga (2002) report substantial job turnover in Brazilian industry. As of now, changes in turnover could not be related directly to firm-level characteristics and economic reform. We are investigating this link with a matched firm-worker panel data set for the Brazilian manufacturing sector in São Paulo state (where more than half of value added in Brazilian manufacturing is created). The data set

Table 2: JOB TURNOVER IN SÃO PAULO STATE, 1991-1998

Sector	Hiring rate ^a	Displacement rate ^b	Net hiring rate ^c	Employment share
Agriculture	.9798	.9599	.0199	2.92
Manufacturing	.4400	.4534	-.0134	22.49
Utilities	.1501	.1838	-.0337	1.62
Services	.4185	.4015	.0170	30.79
Retail	.5700	.5450	.0250	11.97
Construction	1.1495	1.1355	.0140	5.01
Public Admin.	.1049	.0749	.0300	25.20

Data: RAIS São Paulo state 1991-2000, Menezes et al. (2003).

^aHiring rate in sector s : $H_s \equiv \sum_{t=1991}^{2000} \left(\sum_{j=1}^{J_{st}} n_{jt}^{\text{hired}} / \sum_{j=1}^{J_{st}} \frac{1}{2} (\bar{n}_{j,t} + \bar{n}_{j,t-1}) \right)$

^bDisplacement rate in s : $D_s \equiv \sum_{t=1991}^{2000} \left(\sum_{i=1}^{I_{st}} n_{it}^{\text{displaced}} / \sum_{i=1}^{I_{st}} \frac{1}{2} (\bar{n}_{i,t} + \bar{n}_{i,t-1}) \right)$

^cNet hiring rate in sector s : $H_s - D_s$

allows to trace competitive effects, job creation, job destruction and salary responses to trade reform. To our knowledge, our matched employer-employee panel for manufacturing workers in São Paulo state is the first of its kind for a developing country.¹

We identify all workers that were employed at a medium-sized to large manufacturing firm in São Paulo state in at least one year between 1990 and 1998. We subsequently trace every worker through his or her jobs in São Paulo state between 1990 and 1998. In particular, we use a worker's subsequent employment in any sector (agriculture, manufacturing, utilities, services, retail, construction, and public administration) if displaced from a manufacturing firm.²

Table 2 exhibits first summary statistics from our data. Over the period 1991-1998, the manufacturing sector displaced more workers than it hired. Apart from manufacturing, only the (privatized) utilities sector experienced net displacement. The absorption capacity of the public sector

¹In Corseuil and Muendler (2002), we successfully match Brazilian manufacturing firms and workers from these two sources for the first time.

²We lose workers who take a job in the informal sector, who migrate out of São Paulo state, or who leave the labor force. We can distinguish retirements from voluntary and involuntary separations to capture likely exits from the labor force.

may have been sufficient to reemploy the displaced manufacturing workers. However, the precise worker flows, their causes and consequences, remain to be investigated at the firm and worker level.

Kletzer (2001) compares labor market performance of US manufacturing workers who lose their jobs after import competition to the performance of workers who are displaced for other reasons. Kletzer does not detect marked differences in the wage profiles over time. However, wage losses are the smallest when workers find re-employment within the same sector. In general, empirical research on displacement in the US and elsewhere has identified lasting effects of displacements on annual incomes and wages (Topel 1990, Ruhm 1991). Stevens (1997) shows that income differences between workers of similar qualifications can be explained through repeated job losses. After displacement, annual incomes can fall up to 40% in the short term—partly due to unemployment and less hours worked after displacement but also due to wage losses upon reemployment, especially for workers with longer tenures. Jacobson, LaLonde and Sullivan (1993a,1993b) show that income losses in fact set in before displacement. Beyond many studies in the literature, our data do not only cover a period of strong trade reform but will also allow us to identify firm and worker effects simultaneously.

3 Trade-induced Technology Upgrading

Changes to an economy's production possibilities are hard to measure and I can only offer indirect evidence for the case of Brazil. Technical change and capital deepening tend to favor some worker skills more than others. In this dimension of technical upgrading, the presence or absence of change can be partly inferred from labor market effects. Companies in a relatively low-skill abundant country such as Brazil may seek low-skill *or* high-skill complementing technologies after trade reform. Acemoglu (2001) argues that two competing market forces induce economies to adopt skill-biased technical change: The 'price effect' and the 'market-size effect.' While the price effect encourages innovations directed at scarce factors, the latter leads to technical change favoring abundant factors. The elasticity of substitution between different factors regulates how powerful these effects are. In general, capital-skill interactions may affect skill groups in emerging economies in different ways than in more advanced

Table 3: CAPITAL-AFFECTED SKILL GROUPS IN BRAZILIAN MANUFACTURING, 1992-1998

	Sector	<i>bc</i>	<i>bcd</i>	<i>bi</i>	<i>bine</i>	<i>bk</i>	<i>bket</i>	<i>ext</i>
Skill group		(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	Illiterate							
2	Primary school dropout							
3	Primary school graduate	✓	✓	✓				
4	Lower sec. sch. dropout	✓	✓	✓	✓			
5	Lower sec. sch. graduate	✓	✓	✓	✓			
6	Upper sec. sch. dropout	✓		✓	✓	✓	✓	
7	Upper sec. sch. graduate	✓	✓	✓	✓	✓	✓	
8	College dropout	✓	✓	✓	✓	✓	✓	
9	College graduate		✓	✓	✓	✓	✓	

Data: RAIS 1992-1998, Brazilian manufacturing. Corseuil and Muendler (2002).

bc: Non-durable consumption goods, *bcd:* Durable consumption goods, *bi:* Advanced intermediate goods, *bine:* Basic intermediate goods, *bk:* Capital goods, *bket:* Transport equipment, *ext:* Mining and oil production.

economies.

Existing studies typically pre-impose a given cutoff level of skills—such as the cutoff between high-school and college education—, and rarely vary the cutoff level to check for sensitivity. Then, high-skilled (college-educated) workers are assumed to interact with capital more strongly than unskilled (high-school educated) workers and production functions are specified accordingly.

In Corseuil and Muendler (2002), we relax both assumptions and show that typical approaches are misleading at least in the case of Brazil. We distinguish nine schooling (skill) levels in a matched firm-worker data set for Brazilian manufacturing during 1992-98 and devise a novel procedure to test for skill-complementarities through the impact of capital accumulation on skill demand. We then estimate production functions that group skills in a way consistent with the test results on complementarities.

Table 3 shows the results from complementarity tests. There is not a unique threshold level that would justify a division into ‘unskilled’/non-complementary and ‘skilled’/complementary labor for Brazil. In fact, we show that middle skill groups are affected by capital accumulation in most

Table 4: ELASTICITY OF SUBSTITUTION BETWEEN CAPITAL AND LABOR

	<i>bc</i>	<i>bi</i>	<i>bine</i>	<i>bkcd</i>
	(1)	(2)	(3)	(4)
ρ	1.034 (.337)	.649 (1.117)	1.599 (.256)	.358 (.125)
$\rho_{1992-94}$.056 (.051)	.267 (.032)	1.751 (.282)	.749 (.247)
$\rho_{1995-98}$	-56.304 (181970.2)	.256 (.046)	1.559 (.239)	.529 (.202)

Data: PIA and RAIS 1992-1998, Corseuil and Muendler (2002).

bc: Non-durable consumption goods, *bi*: Advanced intermediate goods, *bine*: Basic intermediate goods, *bkcd*: Durable consumption and capital goods.

sectors, whereas less educated workers are not affected. Looking at more disaggregate sector levels, the most skilled are affected in some sectors and unaffected in others, giving rise to two relevant cutoff levels in those sectors. Capital is found to affect mostly workers with secondary schooling.

However, capital is not a complement to the capital-affected intermediate skills in Brazil. To the contrary, production function estimation shows that equipment investment is a substitute to intermediate skill levels. Table 4 summarizes the production function estimates. The complementarity coefficient ρ in CES production functions is theoretically bounded above at unity and indicates strong substitutability in the range between zero and unity. Despite a continuing replacement of domestic equipment for imported capital goods, the elasticity of skill-capital substitution remains constant throughout the 1990s.

Pavcnik, Blom, Goldberg and Schady (2002) make the case that technical change after Brazil's trade reform would favor high-skilled workers and that investment in foreign capital goods and technical progress were bound to worsen wage inequality. They suppose that imported capital goods from more developed countries tend to be technically advanced and would favor skilled workers. Moreover, foreign competition on final-goods markets may force Brazilian firms to advance production technology faster, which tends to increase demand for skilled workers.

Results in Corseuil and Muendler (2002) cast doubt on both implicit hy-

potheses: That wages for the high-skilled went up and that there are the same capital-skill complementarities as conjectured for advanced economies. Two salient facts arise from Brazilian wage data in the 1990s. Middle skill groups lose to workers both with less and with more schooling, while college graduates gain relative to middle education groups but not necessarily relative to illiterate and unskilled workers. Results in Corseuil and Muendler (2002) indicate that equipment investment reduces precisely the demand for middle education levels because their skills are strong substitutes to equipment. So, equipment investment tends to reduce the wage differential of workers with secondary schooling *vis à vis* both less and more educated workers. Moreover, the elasticity of skill-capital substitution does not appear to change after trade reform. Reduced tariffs make foreign investment goods less costly and lead to a gradual replacement of existing domestic capital goods with foreign equipment. However, the elasticity of substitution remains virtually constant. In this dimension, production technologies do not seem to have changed after trade reform.

4 Trade-induced Innovation Patterns and Further Effects

Bugarin et al. (2002) argue that total factor productivity in Brazil trails below potential performance. Accumulation of physical and human capital, additional sources for per-capita income growth, remain at relatively low rates. Bugarin et al. (2002) argue further that Brazil now trails as much as 70 percent below world-wide best practice. They measure the distance to best practice by the ever widening gap between total factor productivity in the US and Brazil.

Beyond its purely microeconomic traces, trade also exerts effects in the aggregate of industries. A classic effect of trade is *induced specialization*. However, obeying the Ricardian or Heckscher-Ohlin type forces of trade, a country may specialize in sectors where the innovative potential is largely exhausted. This can lower average productivity change in the economy as a whole. Theoretical contributions in favor of this hypothesis include Young (1991) and Xie (1999). (I express theoretical doubt in Muendler 2001.) Using cross-country data, Weinhold and Rauch (1999) find empirical evidence against the hypothesis.

Innovation through entry is both an aspect of turnover and of innovation. Fiercer foreign competition can deter entry—a competitive elimination of business projects before they are realized. In general, it is hard to assess how many more business proposals would have been pulled out from the drawers had trade not been reformed. It is likely that only the most productive projects will be realized after trade reform. Then the net effect on efficiency is ambiguous. Less but more productive entrants can move aggregate productivity either way.

5 Conclusion

Despite policy reform—including macroeconomic stabilization, trade and capital account liberalization, and privatization—, growth in Brazil did not recover, let alone return to the rates of the 1960s and 1970s. This suggests that more deeply rooted causes hold back income growth in Brazil. Trade reform cannot do wonders. There is micro-econometric evidence, however, that Brazilian managements improved efficiency in the face of fiercer product market competition from abroad, while keeping basic technologies in use, and that more efficient firms performed relatively better. At the same time, displacement of workers from manufacturing firms was strong and likely due to trade reform. Potential losses from imperfect factor reallocations will have to be set against the immediate efficiency gains from trade reform in future research.

Trade openness can be viewed as a force that brings an economy's *effective* production possibility frontier into closer reach of its *potential* production frontier. In the most favorable case, an open country's production frontier would get into and remain in synchronization with advances in the world-wide production frontier. However, the skill-bias in technology use did not undergo detectable changes in Brazil during the 1990s. This suggests that very similar production technologies remained in place after trade reform. Some measures suggest that Brazil now trails further below world-wide best practice than three decades ago and that Brazil faces an ever widening gap to best practice.

Overall, the effects of trade reform on growth are more elusive at the micro-level than they would appear in cross-country comparisons. However, Brazil's trade reform during the 1990s did exert a detectable and immediate effect on productivity change. The competitive push from world

import markets pressured firms to raise productivity. In addition, the exit probability of inefficient firms rose with competition from abroad and contributed positively to aggregate productivity. Simulations show that the (disappointing) 5%-change in Brazilian manufacturing productivity between 1990 and 1998 might have been up to .5% slower in the absence of trade reform, and could have been pushed further had reform not been reversed in the mid 1990s. While trade reform cannot do wonders, it does seem to foster efficiency change.

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