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Dynamic Gains from Trade: Evidence from South Africa

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This paper examines the empirical relationship between trade and total factor productivity (TFP) in South Africa. Using data on actual trade protection across different manufacturing sectors, it is shown that trade liberalization had a positive impact on TFP growth during the 1990s. In addition, time-series evidence on macro data supports a positive long-run relationship between TFP and openness. [JEL F14, F43, O40]

The pendulum of academic research on the positive relationship between trade and economic growth appears to be swinging from near universal to more qualified acceptance.[1] The spate of cross-country empirical evidence—marshaled by Dollar (1992), Sachs and Warner (1995), and Edwards (1998)—that asserts the positive impact of trade on economic growth has recently been questioned, most notably by Rodriguez and Rodrik (1999). While not arguing for the converse proposition, namely, that trade has a negative impact on growth, they assert that earlier authors did not consistently and reliably (in a statistical sense) demonstrate the regularity in the observed data. A reading of the literature yields the impression that the recent skepticism is an outgrowth of a more generalized dissatisfaction with the cross-

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[1]Throughout this paper, the term "trade" will encompass two distinct concepts: the first, trade liberalization, will denote explicitly the reduction of domestic trade policy barriers, while the second, openness, will refer to trade outcomes.

country approach per se (see, e.g., Srinivasan, 1997), which therefore argues for a research strategy that focuses on exploring more contingent or situation-specific relationships. This paper attempts to do this for the particular case of South Africa.

More specifically, this paper examines the empirical relationship between trade and total factor productivity (TFP) in South Africa, where the hypothesis is that enhanced trade in recent years has improved efficiency in the South African economy. The study would be important from a policy perspective, as trade liberalization constitutes an important element in the government's efforts to boost the underlying supply capacity of the economy. But in light of the ambiguity of the empirical results described above, it would also be interesting from a research perspective to see whether and how the South African experience differs from that of other countries.

Moreover, South Africa affords the possibility of an interesting case study on account of a rich variation in trade policy orientation and productivity performance across the manufacturing sectors and to a similar rich variation in degree of openness over time owing both to external sanctions and trade liberalization. The availability of disaggregated data—on capital stock, employment, and trade policy—also permits such questions to be examined. Thus, a distinctive feature of the paper is that the issue of trade and TFP growth is examined from both a cross-section and a time-series perspective.

I. Previous Research

In theoretical models, the impact of trade liberalization on economic growth is either absent or ambiguous. In a conventional neoclassical growth model, trade does not affect the equilibrium or steady-state rate of output growth because, by assumption, growth is determined by an exogenously given technological progress.[2] In two-sector models of this kind, trade policy affects the allocation of resources between sectors and, hence, the steady-state level of savings and capital accumulation. This can have a one-off effect on the steady-state level of output (which can be positive or negative depending on how savings and capital accumulation are affected by trade policy) but not on the rate of growth. Nevertheless, even in the neoclassical model, trade policy can have transitional growth effects as the economy converges toward the steady state.[3]

However, in endogenous growth models, the impact of trade liberalization on output growth can be positive or negative, depending on model-specific assumptions. Increased trade can have a number of generalized positive impacts.[4] For example, trade enables a country (i) to employ a larger variety of intermediate

[2]In static models without market imperfections (such as monopolistic market structures, internal and external economies of scale, or other distortions), trade restrictions reduce the level of real GDP (equivalent to welfare when measured at world prices). The presence of imperfections opens up a plethora of possibilities in which the effects of trade policies are typically indeterminate, depending on the prior distortion (see Bhagwati, 1971).

[3]The distinction between the transitional path and the steady state is well-defined in theory, but less easily applied empirically. If transitions are sufficiently long, the actual data could exhibit growth effects from trade policy changes.

[4]See, for example, Grossman and Helpman (1991), and the references therein.

goods and capital equipment which could enhance the productivity of its other resources; (ii) to acquire technology developed worldwide, especially in the form of embodied capital goods; (iii) to increase the variety of products produced and consumed; and (iv) to improve the efficiency with which resources are used, which can help to change market structures and reduce markups, thereby imparting dynamic efficiency benefits (Levinsohn, 1992). However, the impact of trade policy changes cannot be unambiguously signed. If the resource allocation effects of trade policy changes promote sectors or activities that generate more long-run growth, the impact is positive, and negative otherwise. The question, then, is really an empirical one of determining the impact of trade policy in specific cases.

The empirical evidence on trade and economic growth has two distinct strands. The first and perhaps the largest is based on cross-country studies—see, for example, Dollar (1992), Sachs and Warner (1995), Ben-David (1993), Edwards (1998), and Coe, Helpman, and Hoffmaister (1997).[5] This literature has focused either on the direct impact of trade on growth in output (the first three studies) or in TFP (the last two studies). While all of these studies reach the broad conclusion that increased trade has a positive impact on growth, they have now been critically reviewed by Rodriguez and Rodrik (1999) and Rodrik (1999), who call their results into question.

The critique can be thought of as comprising the following elements: first, that the really meaningful question to ask is not whether openness, defined in terms of outcomes, helps growth but whether more liberal trade policy helps growth. In this view, the trade outcome approach suffers from conceptual and empirical shortcomings, including the endogeneity of outcomes, the failure to specify the mechanism through which exports and imports affect growth, and measurement problems. Second, that recent prominent studies do not incontrovertibly support the positive relationship between trade policy and growth either because they mismeasure trade policy (Dollar, 1992), or that the trade policy variable they employ is actually picking up other effects such as macroeconomic stability or regional dummies (Sachs and Warner, 1995), or because their results are not robust to alternative specifications (Edwards, 1998).

The second strand in the empirical literature comprises intra-country studies based either on plant-level data or industry-level data.[6] Although it is difficult to summarize the results of this strand of literature, it indicates that the causal link between trade and total factor productivity is less evident in the data. For example, Harrison (1994) finds that, while TFP growth and trade policy orientation do not appear to be correlated at the industry level, a correlation can be detected when TFP is measured appropriately by taking into account the biases emanating from the presence of nonconstant returns to scale and imperfect competition. Bernard and Jensen (1999) suggest that while efficiency and trade orientation are correlated, the causation appears to run from the former to the latter in the sense that efficient firms tend to self-select into export markets rather than openness leading to increased efficiency. Finally, one of the few papers that examines the empirical

[5]Edwards (1993) surveys trade and growth studies covering the 1970s and 1980s.

[6]See, for example, Tybout (1992), Bernard and Jensen (1999), and Harrison (1994).

relationship between trade and growth from a time-series perspective is Coe and Moghadam (1993) for the case of France. They find a robust long-run relationship among growth, factor inputs, and openness (which is intended to capture the effects of total factor productivity).

II. Trade Policy and Trade Developments in South Africa

Trade Policy Prior to the 1990s

Trade policy, or rather, trade protection has played an important role not only in South Africa's economy but also in the country's politics. The appeal of economic self-sufficiency—that pervaded the developing world during the 1960s and 1970s—was heightened in the case of South Africa by political imperatives. Self-sufficiency was seen as a necessary precautionary response to an "inimical" external world that could—and eventually did—cut off supplies to the country.

During the 1960s and 1970s, South Africa's trade regime was characterized by high tariffs and extensive import controls, including through formal import quotas. In response to the perception that growth through import substitution was being exhausted and in the wake of declining manufacturing production and trade, attempts were made to mitigate the anti-export bias of the system. Formal import quotas gave way to import licensing, but the focus, however, was on export promotion measures. Beginning in 1983, the first systematic attempt was made to eliminate import licensing which then covered 77 percent of imports. In 1985, South Africa switched from a positive list of permitted imports (i.e., imports not subject to licensing) to a negative list of prohibited imports covering about 23 percent of imports so that more than three quarters of imports were exempt from licensing (see GATT, 1993).

However, with the imposition of financial sanctions and the debt standstill in 1985, balance of payments pressures halted, and even reversed, progress on trade liberalization. An import surcharge of 10 percent was introduced in 1985, which was increased to 60 percent on some items in 1988, and by 1990 there were three rates (10 percent, 15 percent, and 40 percent) for the surcharge. During the 1980s, a number of export schemes were introduced to alleviate the burden on exporters. In 1990, these were consolidated into one scheme—the Generalized Export Incentive Scheme (GEIS)—that provided a tax-free subsidy to exporters related to the value of exports, the degree of processing of the exported product, the extent of local content embodied in exports, and the degree of overvaluation of the exchange rate.

By 1992, only 15 percent of tariff lines in the manufacturing sector were subject to import licensing which had become virtually automatic and hence less restrictive. Only agriculture (74 percent of tariff lines) and five manufacturing sectors—food, beverages, rubber, and tobacco (about 90 percent) and clothing (59 percent)—remained subject to licensing (GATT, 1993). The tariff regime was highly complex. By the end of the 1980s, South Africa had the most tariff lines (greater than 13,000), most tariff rates (200 ad valorem equivalent

rates), the widest range of tariffs, and the second highest level of dispersion (as measured by the coefficient of variation) among developing countries (see Belli, Finger, and Ballivian, 1993). In sum, South Africa had a highly distorted system of protection (see Table 1).

Trade Policy in the 1990s

The impetus for liberalization started gaining momentum in the early 1990s, reflected in a consultative process under the auspices of the tripartite National Economic Forum involving government, labor, and organized business. As a result, South Africa adopted a two-pronged approach to trade liberalization during the 1990s. These included (i) unilateral trade liberalization and (ii) multilateral trade liberalization in the context of the Uruguay Round of trade negotiations.

Unilateral trade liberalization, 1990–94

Between 1990 and 1994, trade liberalization largely took the form of eliminating the remaining import licensing procedures that were in place and reducing import tariffs. The average tariff was reduced from 28 percent to 16 percent while the import surcharge was eliminated. Thus, the sum of all charges on imports was reduced from 34 percent to 16 percent.

Unilateral trade liberalization, 1994–98

South Africa announced, in 1994, a schedule of unilateral tariff liberalization expiring in 1999 that went beyond the Uruguay Round commitments. As a result, its average (import-weighted) tariffs in manufacturing declined from 16 percent in 1994 to 10 percent in 1998. The current average (import-weighted) tariff is below the level committed by South Africa in the WTO by more than 5 percentage points,[7] although the "water in the tariff" varies considerably between sectors.

As a result of these changes, South Africa's trade regime has been considerably liberalized since the early 1990s. Virtually all quantitative restrictions have been eliminated, including those operating through agricultural marketing boards; the tariff regime has been rationalized, with the number of lines having been reduced from over 13,000 in 1990 to about 7,900 in 1998 and the number of tariff bands having been reduced from well over 200 to 72. In addition, the tariff regime was simplified, as the number of lines carrying formula duties (which acted like variable import levies) was reduced from 1,900 in 1993 to 28 in 1997, and the number of lines facing specific tariffs was reduced from 500 to 227, respectively.

Multilateral trade liberalization, 1995–2002

In the context of the Uruguay Round, South Africa made a tariff offer phased over five years that took effect on January 1, 1995 (except in the case of three sectors

[7]The average bound tariff in the WTO in 2004 will be about 16 percent.

Table 1. South Africa: Trade Regime, 1990 and 1998

(In percent, unless otherwise indicated)

	1990	1998
Tariffs		
Manufacturing		
Maximum tariff	1,389	72
Average import-weighted tariff	28	10
Average unweighted tariff	30	14
Number of tariff bands	> 200	72
Standard deviation	43	15
Number of tariff lines[1]	>13,000	7,814
Percent of tariff lines with non–ad valorem duties[1]	28	26
Range of effective protection[2]	189 to –411	204 to –2
Average import-weighted surcharge[3]	6	0
Import surcharge bands	10, 15, and 40	Eliminated
Agriculture		
Average tariff	25	2.2
Average import surcharge	8	0
Export subsidy[4]	17	Eliminated
Export taxes		
Diamonds	15	15
Quantitative restrictions on imports[5]	15	Virtually eliminated
of which:		
Agriculture	74	Virtually eliminated
Manufacturing	14	Virtually eliminated
Quantitative restrictions on exports; goods[3]	Diamonds 21 agricultural commodities	Diamonds
Memorandum items:		
Trade tax revenue as share of total revenue	7.9	4.0
Import taxes as share of imports	10.8	4.1
Export subsidies as a share of GDP	0.3	0.0

Sources: GATT (1993); WTO (1998); IDC South Africa; and Belli, Finger, and Ballivian (1993).

[1]The figure for 1998 refers to June 1997.

[2]At ISIC three-digit level; excludes import surcharge.

[3]The figure for 1990 refers to 1992.

[4]Actual subsidy disbursements were 2.7 percent of exports in 1990/91.

[5]The figure for 1990 refers to 1992. As percent of total tariff lines (other than those maintained for health, security, and environmental reasons).

where the reductions were phased over a longer period, see below). This offer was publicly announced in 1994 after extensive consultations with civil society within South Africa. Given the prior progress with liberalizing the quantitative restrictions, the offer, particularly in the manufacturing sector, was focused on tariffs. The offer aimed to:

- reduce the number of tariff lines (from over 13,000) at the six-digit level by 15 percent in the first year and by 30 percent or higher by 1999;
- convert all quantitative restrictions (QRs) on agricultural imports to bound ad valorem rates; lower all bound agricultural tariffs by 21 percent on average and reduce export subsidies by 36 percent;
- increase the number of bindings[8] on industrial products from 55 percent to 98 percent; replace formula duties with tariffs; and reduce the number of tariff rates to six—0, 5, 10, 15, 20, and 30 percent rates—with the exception of the "sensitive" industries (textiles, clothing, and motor vehicles);
- liberalize the sensitive industries over an eight-year period; and
- phase out the General Export Incentive Scheme by 1997.[9]

Figure 1 depicts tariff levels and their changes in the different manufacturing sectors during the 1990s. Tariff levels varied considerably across sectors. In 1990, many of the sectors producing inputs (equipment, iron and steel, and chemicals) faced the lowest tariffs, while sectors producing consumer goods such as textiles and clothing, footwear, and automotive products faced very high tariffs. Tariff cuts during the subsequent years also varied considerably across manufacturing sectors. In general, sectors with the highest tariffs in 1990 witnessed the largest cuts between 1990 and 1998. However, these sectors will continue to be the most protected even after the current phase of tariff reductions is implemented.

To summarize, during our focus period, 1990–98, liberalization of the trade regime for manufacturing products resulted in: the elimination of the few quantitative restrictions that remained; reduction in the average tariff (including all charges) from 34 percent in 1990 to 10 percent in 1998; considerable variation in tariff cuts across sectors; and simplification of the tariff regime.

Sanctions and Trade Developments

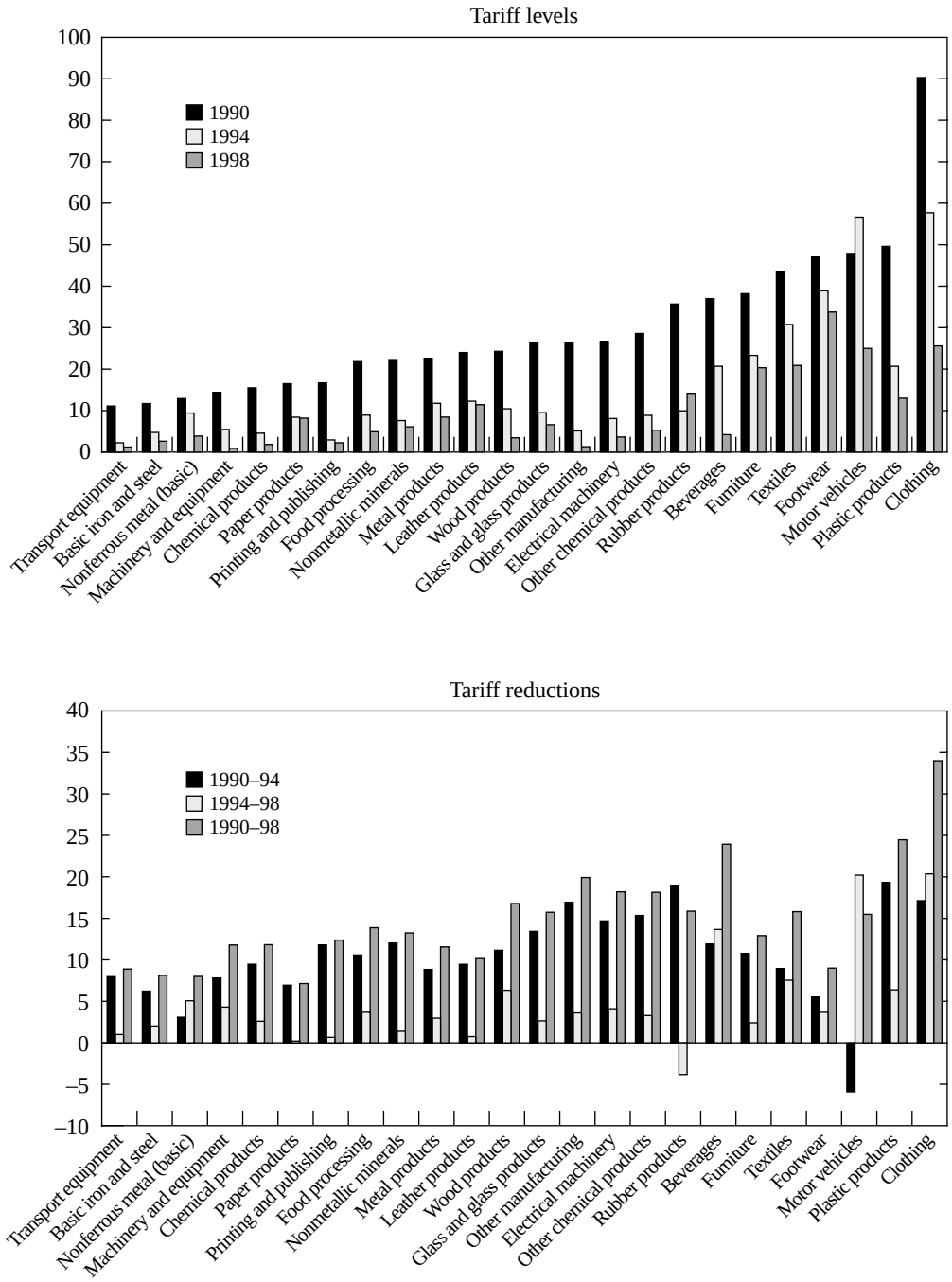
One important feature of the economic landscape in the 1980s was the imposition of trade and financial sanctions on South Africa. While capital flight from South Africa dates back to the early 1960s, more concerted action by creditors was precipitated in 1985 when a U.S. bank announced that it would not be rolling over its short-term loans to South Africa. Other U.S. banks followed suit, causing a full-blown liquidity crisis for the South African economy. The South African authorities responded by imposing exchange controls and a moratorium on payments to foreign creditors. By the mid to late 1980s, spurred by action in the United States, the Nordic countries, and within the Commonwealth, South Africa faced formal sanctions on its exports of coal, iron and steel, uranium, and agricultural products to a number of industrial countries, and on its imports of petroleum, computer, and high-technology (including nuclear) equipment.

[8]A binding represents a legal commitment to not raise tariffs beyond the level embodied in the binding.

[9]The GEIS was altered in 1995 in two ways: the magnitude of support was scaled down, and payments under it were made taxable. In 1996, the GEIS was limited to fully manufactured products, and in July 1997 it was entirely eliminated.

Figure 1. Tariff Protection, 1990–98

(In percent)



Financial sanctions forced South Africa to move from running current account deficits in the early 1980s of over 5 percent of GDP to current account surpluses until the early 1990s.[10] It is less clear, however, whether financial and trade sanctions had a significant impact on South Africa's trading possibilities—either in reducing the actual volume of trade and/or worsening the terms of trade (which could have been the cost of evading the sanctions).[11] Trade data suggest that the impact on trade volumes may not have been significant. Imports actually grew somewhat during the late 1980s, although it accelerated sharply after the removal of sanctions. Likewise, exports increased during the sanctions, and picked-up strongly in the 1990s.

III. Methodology and Data

As indicated in Section I, some of the empirical studies have focused on the determinants of growth in TFP rather than in real GDP. The advantage with such an approach is that there is a stronger presumption that growth in TFP is positively related to trade. As discussed above, trade policy might also affect factor accumulation, but in ways that are theoretically ambiguous, and a study focusing exclusively on output growth would be unable to isolate and capture the effects working through increased efficiency. Thus, in the current study we examine the impact of trade on TFP growth rather than output growth.

The cross-section analysis is based on pooled data for the years 1990–94 and 1994–98 for 24 manufacturing industries (defined at the ISIC 3-digit level). TFP growth was defined as the difference between growth in real value added and real factor accumulation in each sector, with the factor shares—obtained from industry-specific data—used to weight the growth in factors (see Appendix for further details). Figure 2 shows the TFP growth in the 24 manufacturing sectors during the 1990s. It can be noticed that the growth rates tended to be higher after 1994, but also that there was substantial variation in the TFP growth rates across sectors.

The trade variable (*Tariff*) is a policy variable, namely, the sum of all import charges (tariff and import surcharge) for each sector. The variable *DTariff* is measured as the change in tariff divided by 1 plus the initial tariff and, hence, reflects the percentage change in domestic price owing to the tariff reduction.[12] Data on tariffs (and all other import charges) were available for the years 1990, 1994, and 1998, although for three sectors (textiles, clothing, and motor vehicles) the announced tariffs for 2002 were used, rather than the actual 1998 tariffs, in order to capture any forward-looking behavior.[13]

That we do not take into account some of the quantitative restrictions that were eliminated during the period 1990–94 could lead to some mismeasurement of our

[10]During the late 1970s, South Africa ran current account surpluses, but this was due to the sharp improvement in the terms of trade associated with a boom in gold prices.

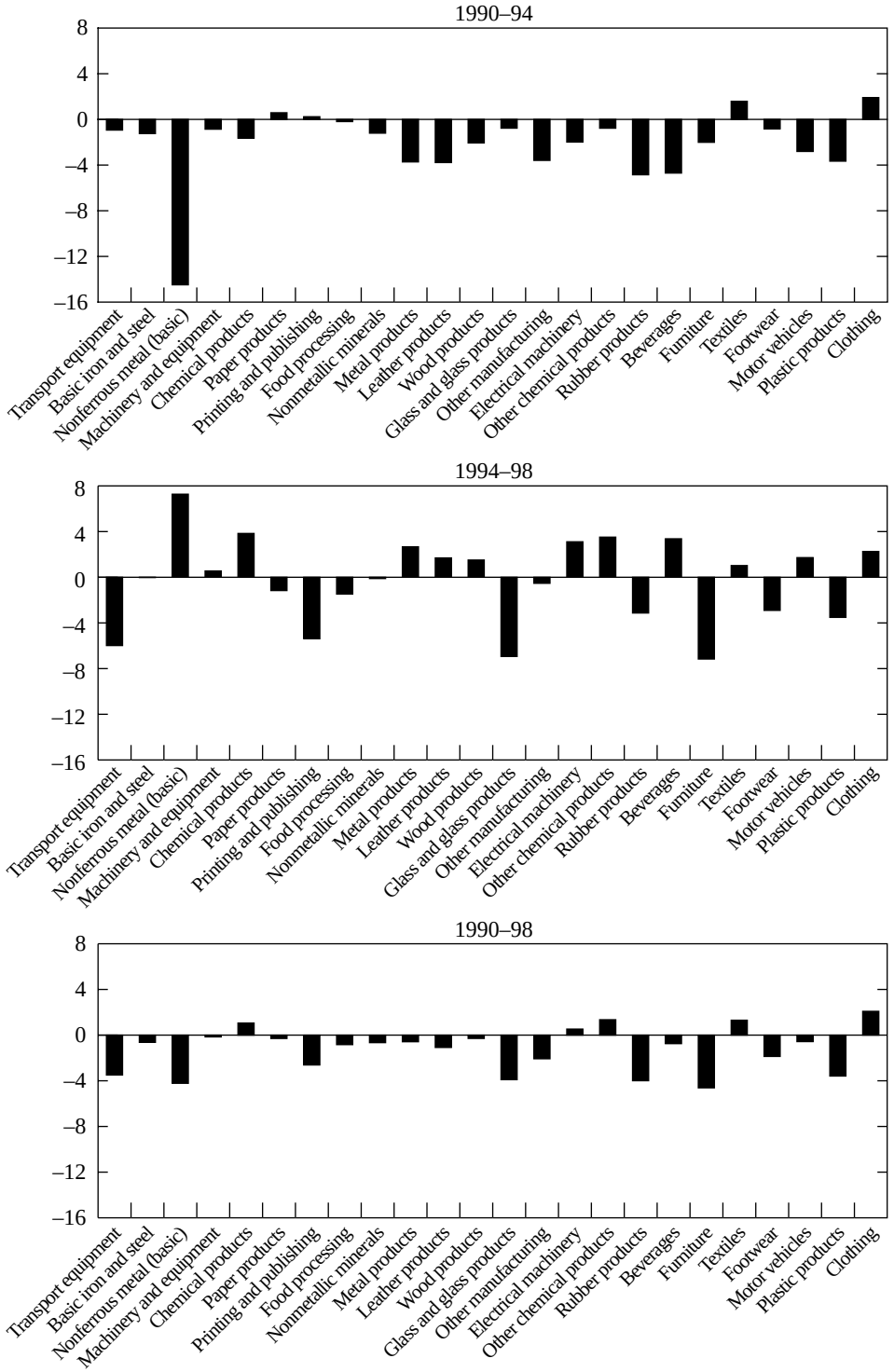
[11]See Lipton (1988) for a more elaborate discussion of this issue.

[12]All variables beginning with the operator "*D*" refer to the change in the underlying variable.

[13]As explained in Section II, under the Uruguay Round commitments, South Africa announced tariff reductions for these three sectors that would extend to 2002.

Figure 2. TFP Growth, 1990–98

(Annual percentage change)



trade policy variable for this period. However, as noted above, the QRs that did remain in place were small in magnitude and "soft" in terms of their impact as they took the form of automatic import licensing. Moreover, the sectors in which import licensing remained and were eliminated were also the ones that saw the greatest tariff reductions; hence our measure for tariff changes would be highly correlated with a broader measure that took into account the vestigial import restrictions. Our trade policy variable, of course, does not capture the improvements stemming from the reduction in complexity of the tariff regime, but our results should not be overly affected by these changes unless there is reason to believe that their impact was different across manufacturing sectors.[14]

The time-series variations in the data were examined for the period 1971–97.[15] Total factor productivity growth was calculated as the growth in private nonagricultural GDP less the growth in capital and labor, weighted by their respective shares in output derived from the national income accounts (see Subramanian, 1998).[16] Openness was measured as the ratio of the sum of real imports and real exports of goods and nonfactor services to real GDP.[17] The use of this variable is open to the criticism that it measures an outcome and, hence, may not have policy implications. The preferred estimation strategy in this view would be to use direct measures of trade policy. However, it is difficult to compute a reliable series of "trade policy" over the sample period, especially because of the pervasiveness of nontariff barriers until the late 1980s.

Time series data for R&D in South Africa are not easily available. However, following De Long and Summers (1991), we used the share of investment in equipment and machinery in total investment as the proxy for technology. Insofar as South Africa does not undertake significant amounts of R&D activity, we would expect the bulk of the R&D to be embodied in capital equipment, especially that imported from abroad. By looking at total investment in machinery and equipment, our specification implicitly aggregates R&D undertaken at home and abroad and assumes that the two have similar effects on TFP. An alternative approach that could have disentangled the effects of foreign and domestic R&D would have been to use separate measures for domestic and imported capital goods (or even construct an imported R&D variable à la Coe, Helpman, and Hoffmaister, 1997), but this course was rendered difficult by the absence of data on imported capital goods for the entire sample period.

[14]Although we had data on effective protection, we chose not to use them for three reasons: first, the data were based on statutory tariffs alone and did not incorporate the impact of the import surcharges, which varied substantially across sectors; second, the effective protection data series contained a few outliers, which raised doubts about its accuracy; and third, nominal protection has a more natural metric and is therefore more easily interpretable.

[15]See Appendix for data description and sources.

[16]The time-series analysis was also carried out using an alternative methodology for computing TFP growth based on Sarel (1997). The results obtained were very similar to those reported in the next section (see Jonsson and Subramanian, 2000).

[17]As alternatives, we used this ratio in nominal terms, as well as the ratio of exports and imports of goods alone to GDP; the results were similar but less robust.

We also tried alternative specifications, including a proxy for human capital, but we dropped these subsequently as the proxy was likely mismeasured.[18] Similarly, exogenous influences, such as terms of trade developments and the aggregate capital-labor ratio, were initially included in the analysis, but they did not turn out to be important.[19]

IV. Results

Cross-Section Evidence

This section focuses on how variations in TFP growth across 24 different manufacturing sectors are related to tariff reductions during the period 1990–98. More precisely, TFP growth across manufacturing sectors for the two sub-periods 1990–94 and 1994–98 are explained in terms of the trade policy changes during these sub-periods. Compared to the time-series analysis discussed below, there are three advantages with this approach: first, the problem in separating true technological progress from aggregate demand-related effects is mitigated, as aggregate shocks are likely to affect all sectors. Similarly, the effect of the lifting of sanctions and its impact on TFP growth, which may be inadequately captured in the time-series analysis, is less of a problem in the cross-section analysis, unless sanctions had a differential impact across manufacturing sectors. Second, the number of observations for measuring the long-run effects is greatly increased. Finally, the independent variable is actual trade policy (import tariffs) rather than trade outcomes.

As mentioned earlier, it is difficult to measure trade policy—both conceptually[20] and empirically—at the aggregate level. However, in the cross-section analysis, we have a fair degree of confidence that we accurately measure the trade policy variable: we include all the charges on imports (surcharges and tariffs); we do not have to worry about the effect of quantitative restrictions as those in manufacturing were virtually eliminated before 1990; and we also measure the impact of the export subsidies.

Table 2 reports the results from regressions of TFP growth on changes in tariffs (*DTariff*). To ensure that this effect was not picking up the impact of other variables, we included four additional variables: the capital-labor ratio (*CLR*), the share of exports in total domestic production (*Exportshare*), the share of imports in total domestic sales (*Importshare*), and the initial level of *Tariff*. The square values of the levels and changes in tariffs were also included in one specification to test for any nonlinear effects. The regression was pooled over the periods 1990–94 and 1994–98, and all regressors, except for *DTariff*, were measured at their initial level in 1990 and

[18]The Nehru-Swanson-Dubey (1995) human capital stock series does not cover South Africa. The Barro-Lee (1997) series does cover South Africa but exhibits anomalous movements that raise doubts about its quality. In private correspondence, the authors agreed that this series required further refinement.

[19]Macroeconomic policy could also have been considered as a possible determinant of TFP growth, but we chose to ignore it as this variable in general is more important in influencing capital accumulation than TFP growth (see Collins and Bosworth, 1996).

[20]There are well-known problems relating to finding a scalar measure that successfully aggregates protection across sectors. One exception is the measure developed by Anderson and Neary (1994), but its data requirements are fairly onerous.

Table 2. Trade Liberalization and TFP Growth

(Pooled results, 1990–94 and 1994–98)

	Dependent Variable: *DTFP*			
Constant	–3.96	–4.39	–5.35	–5.93
	[–3.18]	[–3.56]	[–3.36]	[–2.85]
*Dum*9498	2.89	2.69	3.11	3.28
	[2.64]	[2.79]	[2.72]	[2.87]
CLR		0.01	0.01	0.01
		[2.39]	[2.23]	[2.33]
Exportshare		–0.07	–0.08	–0.07
		[–0.90]	[–0.95]	[–0.80]
Importshare		0.04	0.04	0.05
		[1.12]	[1.20]	[1.38]
Tariff				–0.02
				[–0.31]
Tariff–sq				0.00
				[1.47]
DTariff	–0.17	–0.16	–0.48	–0.59
	[–2.17]	[–2.65]	[–2.15]	[–2.85]
DTariff–sq			0.02	0.03
			[1.67]	[2.59]
R-square	0.15	0.25	0.28	0.33
Number of obs.	48	48	48	48

Note: OLS estimations; the *t*-statistics (in brackets) are based on a heteroskedastic-consistent covariance matrix, see White (1980).

1994, respectively. A time-dummy for the second subperiod (*Dum*9498) was included, implying that the results are mainly driven by cross-sectional variations in the data.

The results show that there is a significant negative relationship between changes in tariffs and TFP growth across the manufacturing sectors, and this result is robust to the inclusion of the other variables that are possibly important for TFP growth.[21] Of these variables, only *CLR* enters significantly, indicating that more capital intensive sectors tend to exhibit higher TFP growth rates. The initial level of the tariff, and the

[21]Our results are susceptible to a potential endogeneity problem. It is conceivable that the sectors that exhibited faster TFP growth were the ones that would have been politically easier to liberalize and hence selected for deeper tariff cuts. In other words, TFP growth may have determined tariff cuts rather than the other way around. However, this argument is empirically implausible because the tariff changes were announced and made in advance of changes in TFP, which the authorities could not have reasonably and accurately predicted. In fact, the only pattern discernible in the tariff actions seems to be that larger reductions took place in sectors with high initial tariffs.

degree of export orientation of, and import penetration in, a sector, appear to be less important in explaining TFP growth rates.

It is also interesting to notice that tariff changes seem to have a nonlinear effect on TFP growth; the marginal effect on TFP growth tends to decline as the tariff reductions become larger. One possible explanation is that this nonlinear impact simply reflects some exogenous limit to TFP growth within the estimated four-year period. These results are illustrated in Figure 3, where the conditional TFP growth is shown on the y-axis. The figure (and the regression results) also illustrate that the quantitative effect of trade liberalization is sizeable; for example, the results indicate that the annual growth rate in TFP was nearly 3 percentage points higher in sectors where tariffs were reduced by 10 percent (or rather, where the price reduction was 10 percent due to tariff reductions) compared with sectors where tariffs were unchanged.

Table 3 depicts the results for the estimations for the two different subperiods, 1990–94 and 1994–98, respectively. It can be noted that the estimated coefficients on *DTariff* are negative and significant in both subperiods, but that the quantitative effect is somewhat stronger in the latter subperiod. In this subperiod, it was also possible to examine the lagged effects of changes in tariffs on TFP growth. However, the coefficients on these lagged variables were small and insignificant. For the second subperiod we also tested whether changes in the export subsidy affected TFP growth.[22] The export subsidy variable was positively signed (implying that reductions in the GEIS could have adversely affected TFP growth) but insignificant.[23] More importantly, the inclusion of the export subsidy variable does not affect the coefficient of the tariff change variable.

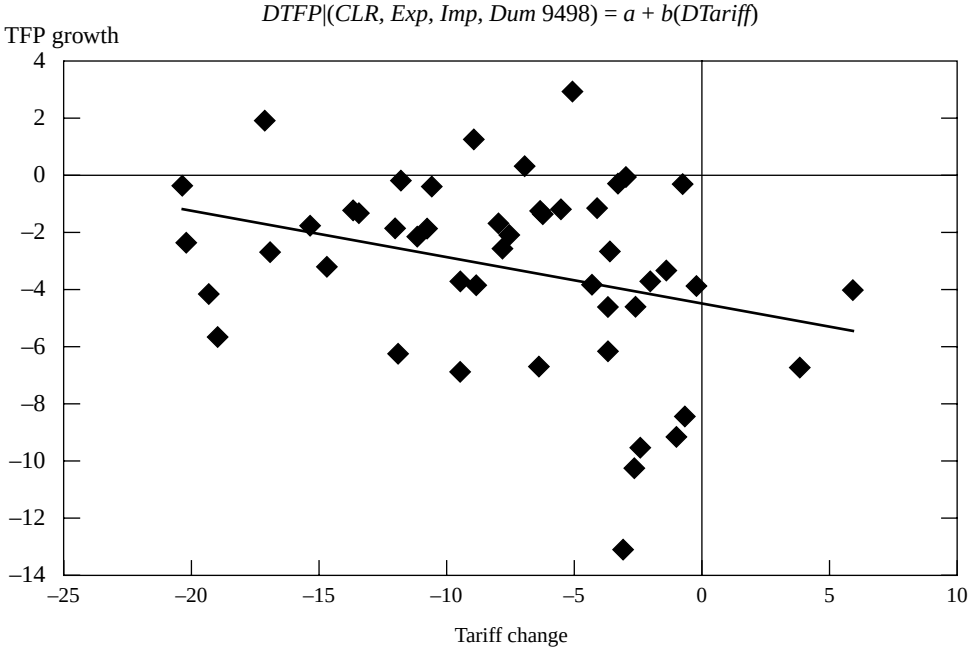
The robustness of the results was examined in several ways. First, to test the sensitivity of the results to individual sectors, 24 additional regressions were run in which the observations from a single sector were dropped alternatively. The estimated coefficient on *DTariff* always remained negative and significant at the 5-percent level, except in one case where it remained significant at the 10-percent level. Second, to test whether the impact of trade liberalization was confined to the import competing sector, the observations for the two most export oriented sectors were excluded; again the results remained broadly unaffected by this reduction in the sample. Also, various measures of the extent to which a sector is a net exporter were included in the regressions. This variable was added separately (as an alternative to *Exportshare* and *Importshare*) but also interacted with *DTariff*. Neither of these coefficients turned out to be significant, but the estimated coefficient on *DTariff* remained negative and significant. Finally, the average capacity utilization of individual sectors was included in the regressions to capture the possibility of idiosyncratic shocks affecting TFP growth differen-

[22]It should be recalled that over the first sample period, 1990–94, the export subsidy remained broadly unchanged.

[23]One point on the measurement of the export subsidy should be noted. On the one hand, the subsidy provided effective protection to those sectors that received it; on the other hand, insofar as the subsidy was linked to the use of locally produced inputs, its effect was diluted (on the reasonable assumption that the local content requirement was binding). It is not clear that the manner in which the subsidy is measured adequately captures the latter effect.

Figure 3. Conditional TFP Growth and Tariff Changes

DTFP|(*CLR, Exp, Imp, Dum* 9498) = *a* + *b*(*DTariff*)



DTFP|(*CLR, Exp, Imp, Dum* 9498) = *a* + *b*(*DTariff*) + *c*(*DTariff-sq*)

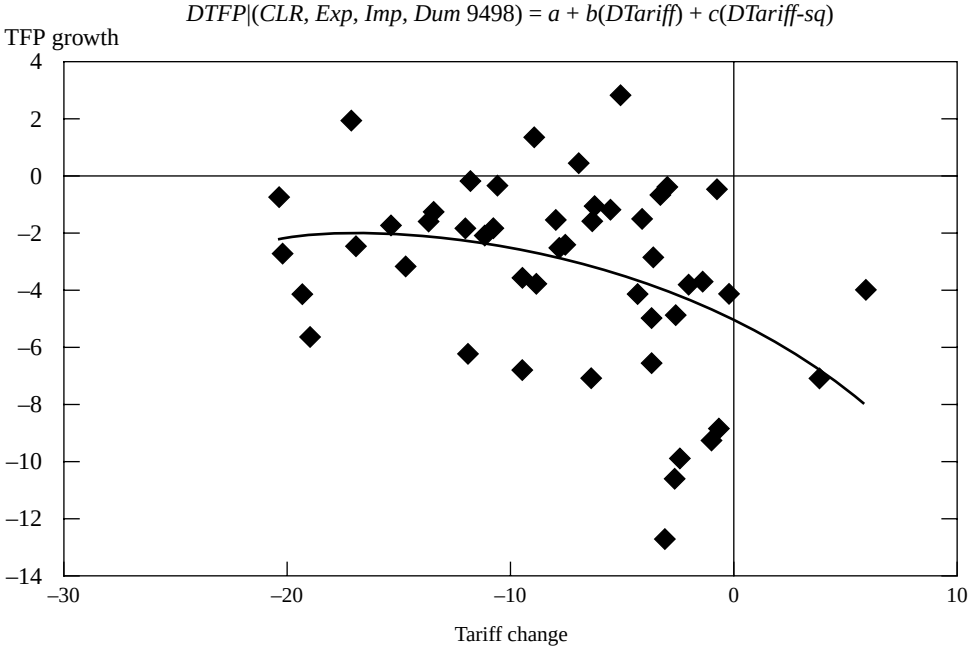


Table 3. Trade Liberalization and TFP Growth; Results for Subperiods

	Dependent Variable: DTFP					
	1990–94			1994–98		
Constant	–2.03	–0.69	–4.16	–4.34	–4.64	–2.22
	[–1.96]	[–0.17]	[–2.78]	[–2.21]	[–2.14]	[–1.05]
CLR	0.00	0.00	0.01	0.01	0.01	0.01
	[–0.04]	[–0.02]	[3.52]	[3.75]	[3.46]	[2.38]
Exportshare	–0.19	–0.20	0.04	0.04	0.04	0.03
	[–1.95]	[–1.93]	[0.50]	[0.48]	[0.57]	[0.45]
Importshare	0.02	0.03	0.03	0.03	0.03	0.03
	[0.52]	[0.67]	[0.56]	[0.71]	[0.55]	[0.84]
Tariff		–0.11		0.07		
		[–0.87]		[0.43]		
Tariff–sq		0.00		0.00		
		[1.56]		[–0.89]		
DTariff	–0.43	–0.46	–0.63	–0.51	–0.63	–0.74
	[–2.57]	[–1.75]	[–2.77]	[–2.02]	[–2.18]	[–3.57]
DTariff–sq	0.02	0.03	0.02	0.00	0.02	0.02
	[2.45]	[1.92]	[1.69]	[0.08]	[1.10]	[2.08]
DTariff (–1)					–0.05	
					[–0.17]	
DTariff–sq (–1)					0.00	
					[0.07]	
DGEIS						0.11
						[1.39]
R-square	0.40	0.49	0.39	0.41	0.39	0.43
Number of obs.	24	24	24	24	24	24

Note: OLS estimations; the *t*-statistics (in brackets) are based on a heteroskedastic consistent covariance matrix (see White (1980)).

tially across sectors. This variable was not significant and it did not affect the importance of the tariff change variable.

While the results thus far appear strong, it is possible that they are driven by the impact of trade liberalization on employment. If this impact is negative, TFP growth may have increased because firms have fired less productive workers as tariffs were reduced in order to stay competitive. This is an important issue to

clarify in the case of South Africa because employment fell almost continuously during the 1990s; in the manufacturing sector, employment fell in 18 of the 24 sectors examined in this study between 1990–98. However, although this is a plausible hypothesis, the data do not lend support to it.

Table 4 reports regression results similar to those discussed above, but in which the dependent variable is employment growth, capital growth, or the growth in capital intensity (*C*/*L*), rather than TFP growth. There is no evidence for the hypothesis that the tariff reductions are positively related to the employment decline across the manufacturing sectors. In fact, the coefficient on *DTariff* is negatively signed, indicating that, if anything, employment has fallen less in the sectors where tariffs have been reduced more aggressively.[24] Instead, it can be noticed that capital growth is positively related to changes in tariffs. This result suggests that in sectors that experienced larger tariff reductions, firms have tended to use the existing capital stock more efficiently. Taken together, the data reveal that capital intensity increased more in the sectors that remained relatively highly protected (i.e., where tariffs were reduced less) during the 1990s, rather than the opposite.

Time-Series Evidence

This section provides time-series results that corroborate the cross-sectional evidence. A cursory examination of the data indicates that both total factor productivity (*TFP*) and openness (*Open*) increased during the 1990s (see Figure 4). Following the discussion in Section III, a series of machinery and equipment investment in total investment (*MachInv*) was also included in the model as a proxy for R&D activities. Conventional tests of the time-series properties of the three variables—*TFP*, *Open*, and *MachInv*—indicate that they are individually integrated of order one.[25] Thus, the long-run relationship among the variables was estimated using the cointegration tests proposed by Johansen (1988) and Johansen and Juselius (1990).

The results from the Johansen tests (see Table 5) clearly indicate that there exists one long-run cointegrating vector among *TFP*, *Open*, and *MachInv*. Moreover, restricted cointegration tests indicate that all three variables are individually non-stationary;[26] at the same time, all three variables contribute significantly to the cointegrating vector. In addition, the coefficients of the cointegrating vector have the expected signs: *TFP* is positively related to *Open* and *MachInv*.[27] An examination of the speed of convergence coefficients (the

[24]The regressions in Table 4 are not structural equations for factor accumulation and should therefore be interpreted with caution. However, even after controlling for variables such as nominal and real wage growth and labor productivity, the basic conclusion with regard to the relationship between employment growth and tariff reductions remains robust.

[25]The results are reported in Jonsson and Subramanian (2000).

[26]It can be noted that these tests have stationarity as the null hypothesis, as opposed to the more conventional Dickey-Fuller type of tests. Nevertheless, both tests indicate that it is appropriate to treat the series as non-stationary.

[27]One lag was included in the cointegration models. Although a visual inspection of the cointegrating vector suggests that a time trend should be included in the model, a formal test rejected this hypothesis.

Table 4. Trade Liberalization and Factor Accumulation

(Pooled results, 1990–94 and 1994–98)

Dependent Variable:	Employment Growth		Capital Growth		Growth in *C/L*	
Constant	–2.55	–3.04	6.15	7.61	8.93	10.94
	[–2.69]	[–2.72]	[3.36]	[4.21]	[4.49]	[4.91]
*Dum*9498	2.33	2.54	–0.22	–0.85	–2.84	–3.72
	[2.73]	[2.67]	[–0.14]	[–0.55]	[–1.60]	[–2.04]
CLR	0.00	0.00	–0.01	–0.01	–0.01	0.00
	[–0.93]	[–1.08]	[–1.65]	[–1.41]	[–1.17]	[–0.87]
Exportshare	–0.12	–0.12	0.22	0.22	0.37	0.37
	[–3.55]	[–3.52]	[1.86]	[1.93]	[3.09]	[3.22]
Importshare	–0.02	–0.02	–0.11	–0.12	–0.09	–0.09
	[–0.61]	[–0.59]	[–2.56]	[–2.64]	[–1.55]	[–1.60]
DTariff	–0.16	–0.32	0.27	0.75	0.44	1.10
	[–3.06]	[–1.78]	[2.59]	[2.90]	[3.80]	[3.23]
DTariff–sq		0.01		–0.03		–0.04
		[1.02]		[–1.83]		[–2.04]
R-square	0.29	0.33	0.28	0.31	0.41	0.44
Number of obs.	48	48	48	48	48	48

Note: OLS estimations; the *t*-statistics (in brackets) are based on a heteroskedastic consistent covariance matrix, see White (1980).

alpha matrix) indicates that both *TFP* and *Open* are "error-correcting" whereas *MachInv* can be treated as weakly exogenous. The absence of a weak exogeneity result for *Open* implies that the estimation of a single first-difference equation with *TFP* as the dependent variable could be problematic. However, as will be discussed below, this apparent absence of weak exogeneity for the openness variable seems to be a small sample problem rather than a true simultaneity problem, as various stability tests clearly show that only *TFP* is error-correcting.

Hence, in a second step, a single equation error-correction model was used to examine the annual fluctuations in the variables (see Table 6). The fit of these regressions was remarkably good, considering the small sample size. Moreover, the estimated coefficients for both *DOpen* and *DMachInv* have the expected positive sign and are significant,[28] while the estimated coefficient for the lagged error correction term (*EC*) is negative, as expected, and significant.

Recursive regressions show that the estimated coefficients in the error correction model are stable, and no trend breaks could be detected (see Figure 5a). These results tend to support the case for treating the openness variable as weakly exogenous. Indeed, recursive regressions using *DOpen* as a dependent variable show that the estimated coefficient on the error-correction term is highly unstable and

[28]The first lags of all variables were included in a first specification, but the estimated coefficients were insignificant and the lags were dropped.

Figure 4. South Africa: Time-Series Data, 1971–97

(Levels (solid lines) on left-hand scale; first-differences (dashed lines) on right-hand scale)

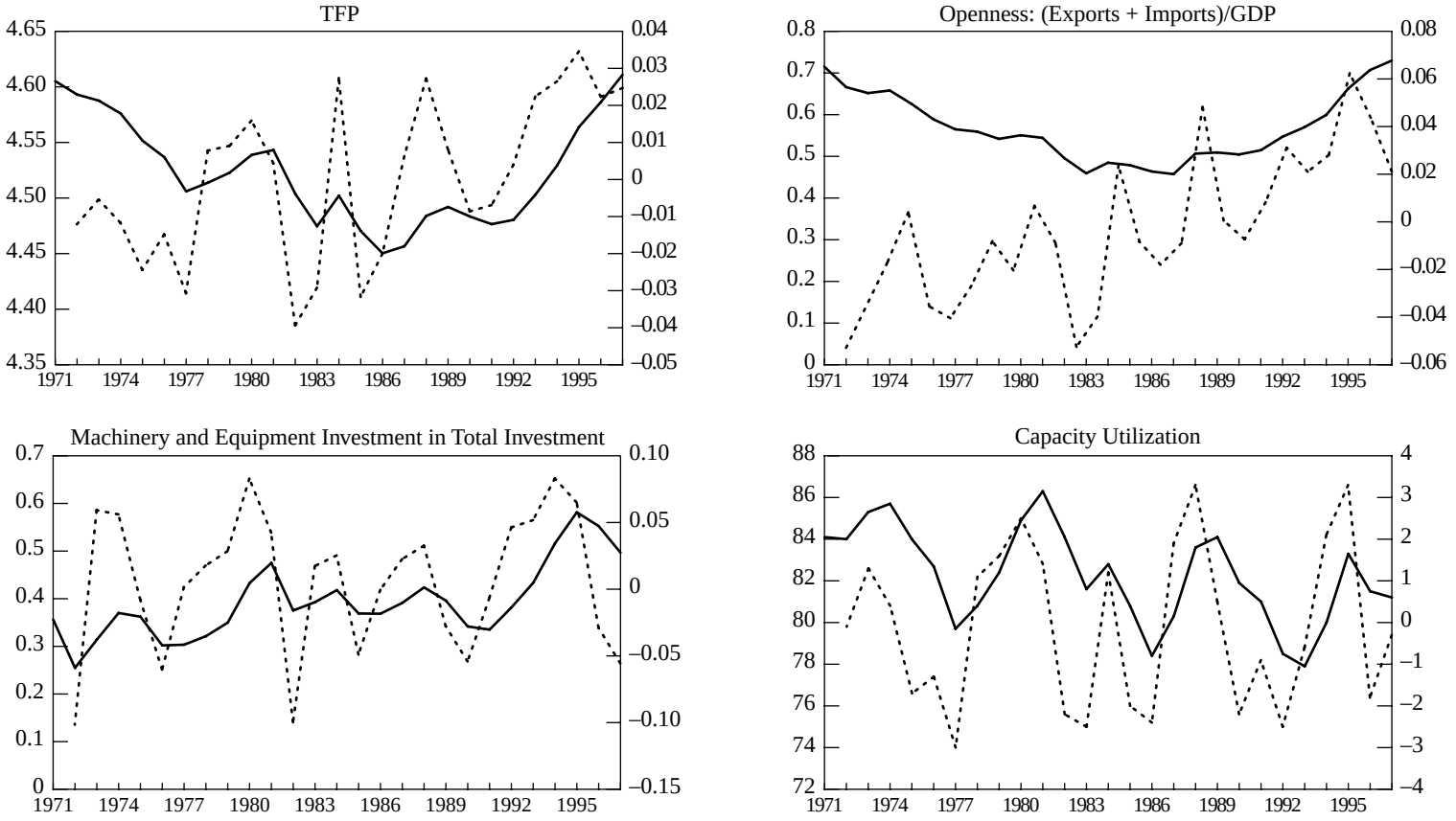


Table 5. Cointegration Analysis of TFP, Openness, and Machinery Investment

Rank	Eigenvalue	Lambda	Critical Value (95%)	Trace	Critical Value (95%)
r = 0	0.67	29.08**	21.0	36.92**	29.7
r <= 1	0.18	5.22	14.1	7.85	15.4
r <= 2	0.10	2.63	3.8	2.63	3.8

Standardized Eigenvectors

TFP	*Open*	*MachInv*
1	**–0.52**	**–0.32**
–1.92	1	–0.28
3.57	–8.70	1

Tests for Stationarity of a Given Variable

	TFP	*Open*	*MachInv*
Chi-sq (1)	25.53**	26.33**	8.98*
p-value	(0.00)	(0.00)	(0.01)

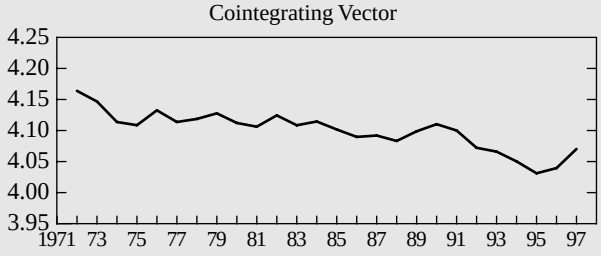
Tests for Significance of a Given Variable

	TFP	*Open*	*MachInv*
Chi-sq (1)	8.91**	7.59**	17.44**
p-value	(0.00)	(0.01)	(0.00)

Tests for Stationarity of Weak Exogeneity

	TFP	*Open*	*MachInv*
Chi-sq (1)	9.77**	10.76**	0.30
p-value	(0.00)	(0.00)	(0.58)

Cointegrating Vector



Notes: See Appendix for definitions of variables. * and ** indicate rejection of the null hypothesis at the 5-percent and 1-percent significance level, respectively.

Table 6. The Error-Correction Model: TFP Growth and Openness, 1971–97

	Dependent Variable: *DTFP*		
Constant	1.08	1.02	0.90
	[2.29]	[2.89]	[2.47]
EC(–1)[1]	–0.26	–0.25	–0.22
	[–2.29]	[–2.89]	[–2.46]
DOpen	0.34	0.27	0.32
	[2.50]	[2.60]	[2.87]
DMachInv	0.16	0.07	0.04
	[2.52]	[1.21]	[0.77]
DCapacity		0.38	0.37
		[4.18]	[4.06]
*Dum*8592			–0.004
			[–1.16]
DW-statistic	2.07	2.06	2.04
R-square	0.78	0.88	0.89
Number of obs.	25	25	25

Note: *t*-statistics in brackets.

[1]The error-correction term is derived from the cointegration relation among *TFP*, *Open*, and *MachInv*.

shifts sign over time, indicating that this variable is not really error-correcting but rather should be treated as weakly exogenous (Figure 5b). We take these findings as broadly supportive of the proposition that causation runs from increased openness to higher TFP growth, rather than the converse.

One potentially important problem with the short-run growth regressions is the sensitivity of the measured level of TFP to the business cycle. For example, if it is difficult to adjust the capital stock in the short run, and/or if the labor market is inflexible, leading to labor hoarding behavior on the part of firms, the measured level of productivity would be higher during booms and lower during recessions. Such an omitted variable problem could, in turn, generate a simultaneity problem: depending on the magnitude of the export and import elasticities, output fluctuations related to the business cycle could lead to fluctuations in import and export shares of GDP, that is, openness.

To deal with this problem, the change in capacity utilization in the manufacturing sector (*DCapacity*) was added as an independent variable in the error-correction model. As expected, the estimated coefficient on this variable came out positive and strongly significant, indicating that the growth rate in *TFP* in a

Figure 5. Stability Tests of Error-Correction Model

(Beta-coefficients ± 2 standard errors and Chow tests)

Figure 5a. *DTFP* as Dependent Variable

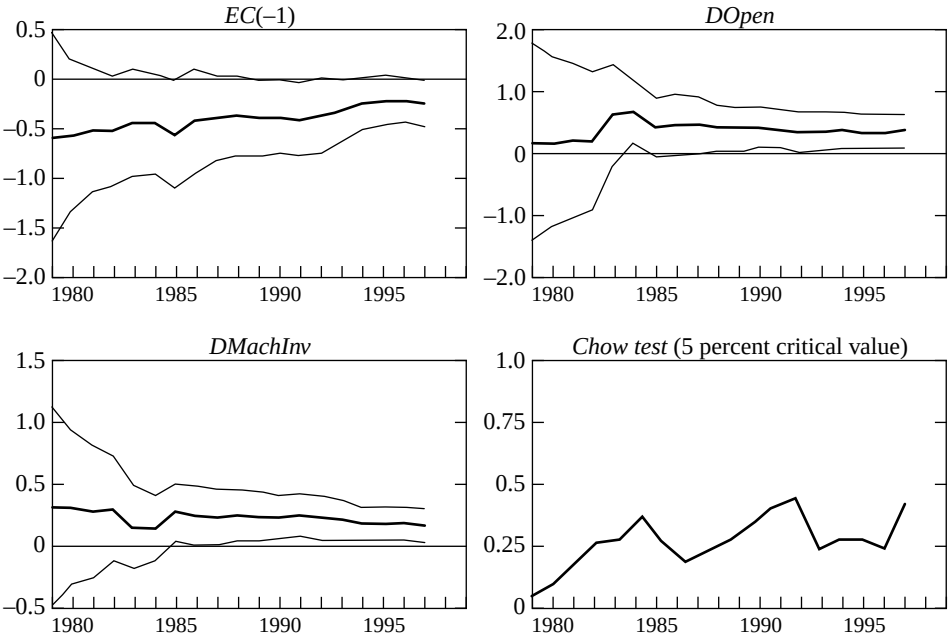
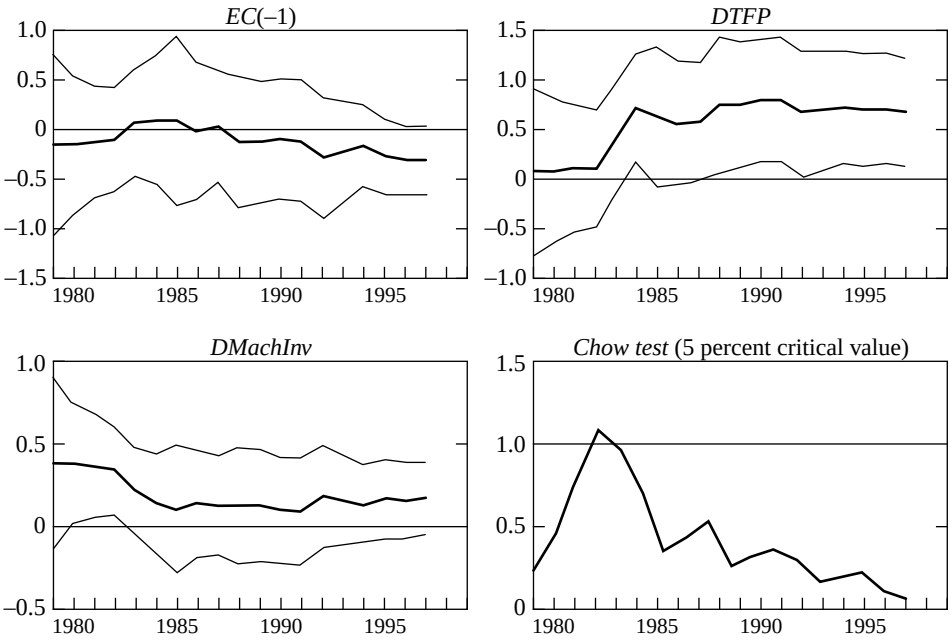


Figure 5b. *DOpen* as Dependent Variable



particular year does not necessarily reflect an improvement in technology.[29] Still, the coefficients on *DOpen* and *EC* were virtually unaffected by the inclusion of *DCapacity*. In contrast, the coefficient on *DMachInv* drops sharply and becomes insignificant, suggesting that firms invest less in machinery and equipment during recessions. Finally, a dummy variable for the period 1985–92, during which South Africa was subject to trade and financial sanctions (*Dum*8592), was also included in one specification, but did not turn out to be significant.

To summarize, the time-series evidence goes in the same direction as the cross-sectional results: there exists a robust long-run relationship among TFP, the degree of openness (measured as imports plus exports over GDP), and the share of machinery and equipment investment in total investment. In addition, annual growth in TFP is positively (and significantly) related to contemporaneous changes in openness, and temporary deviations from the long-run relationship are restored primarily by adjustments in the level of TFP, rather than through changes in imports and exports or in investment in equipment and machinery. The quantitative effects seem to be quite large: the estimated coefficients indicate that a 10 percentage point increase in openness is associated with an increase in TFP by about 5 percent in the long run. Similarly, an increase in the share of machinery and equipment investment of 10 percentage points is associated with an increase in TFP by about 3 percent in the long run.

V. Discussion and Conclusions

The proposition that trade is beneficial to dynamic efficiency (and not just to static economic welfare) is theoretically ambiguous and the empirical evidence supporting it has been questioned. In this paper, we have tested this proposition for South Africa using a cross-section approach covering the manufacturing sectors for the period 1990–98 when South Africa witnessed major trade reform, and an aggregate time-series approach (covering the period 1970–97). Both approaches validate the above proposition with a high degree of statistical reliability.

The results obtained in this paper indicate that trade liberalization has contributed significantly to augmenting South Africa's long-run growth potential via its impact on TFP growth. For example, the average price reduction in the 1990s due to the tariff changes was about 14 percent in manufacturing, which translates to higher TFP growth of about 3 percent per year. The time-series analysis yields surprisingly similar results; the openness ratio increased by about 3.2 percentage points per year on average during the period 1990–97 which, according to our long-run results, contributed to TFP growth of about 1.6 percent per year. The actual annual growth in TFP between 1990–97 was 1.8 percent, implying that increased openness accounted for close to 90 percent of the actual TFP growth in that period.

[29]It should be noted that the variable *Capacity* was not included in the cointegration setup, as fluctuations in this series would mainly be important in explaining short-run developments. Nevertheless, the desirable statistical properties of the error correction model should be unaffected, since *DCapacity* clearly is stationary. Other measures of the business cycle, including an indicator proposed by the Economics Department of the South African Reserve Bank, generated qualitatively the same results.

The high level of unemployment is, arguably, the most serious macroeconomic problem in South Africa. A concern among policymakers and analysts has been that trade liberalization could aggravate the unemployment problem, as firms might reduce the size of the workforce to remain competitive. However, the results in this study indicate that this concern is unfounded; employment has tended to fall less in the sectors where tariffs have been reduced more aggressively.

A comparison of the "footwear" and "chemical" sectors vividly illustrates this point. The "footwear" sector employed 33,000 people in 1990 and was relatively highly protected by an import tariff of 47 percent. The sector remained quite protected during the 1990s, as the tariff was reduced to only 34 percent by 1998. Despite this continued protection, employment fell on average by 5 percent per year to 22,000 by 1998. Moreover, total factor productivity fell on average by 1.9 percent per year, and value added fell on average by 5.1 percent per year. In contrast, the sector "other chemical products" employed 64,000 people in 1990, and the tariff was 29 percent. By 1998, the tariff had been slashed to 5 percent. Nevertheless, employment had increased on average by 1 percent per year to 68,000, and, at the same time, the sector had improved its efficiency: total factor productivity increased on average by 1.3 percent per year, while value added grew on average by 2.6 percent per year.

The time-series results regarding the joint importance of the openness and the technology variable draw attention to two key and complementary channels of influence on the economy's productivity. While R&D, as embodied in investment in machinery and equipment, augments productivity, it also appears to be important to provide an open or liberal environment in which the gains from R&D can be maximized. A policy corollary of this finding could be that emphasis on increasing an economy's access to foreign capital goods—by, say, selectively liberalizing imports of capital goods—might be insufficient to harness the benefits from technology absorption. By the same token, the results suggest that an open environment needs to be complemented by appropriate avenues for the creation and absorption of technology.

While we find the results in this paper encouraging, there remains considerable scope for refining and deepening the research agenda. In particular, it would be interesting to explore the impact of trade liberalization at plant-level. Plant-level data exist for the manufacturing sector (in the form of the manufacturing census) for 1991 and 1993 and those for 1996 were expected to be released in 2000. These would constitute a rich data set for examining issues related to trade, concentration, and efficiency, as has been done for Turkey (Levinsohn, 1992) and Côte d'Ivoire (Harrison, 1994).

APPENDIX
Data Description and Sources

A. Cross-Sectional Analysis[1]

Variable	Definition	Source
DTFP	Annual average of growth in real value added in a sector minus the factor share weighted growth in capital stock and employment; factor share is in nominal terms.	Industrial Development Corporation of South Africa (IDC)
Exportshare	Exports divided by production (in current prices).	IDC
Importshare	Imports divided by domestic consumption (in current prices).	IDC
Tariff	Sum of statutory tariffs and import surcharges.	Belli, Finger, and Ballivian (1993) for tariff data for 1990; IDC for tariff data for 1994 and 1998; and GATT (1993) for import surcharge data.
Dtariff	Change in tariff divided by 1 plus initial tariff.	
*Dum*9498	Dummy variable that takes a value of 1 for the period 1994–98 and 0 otherwise.	
Generalized Export Incentive Scheme (GEIS)	Export subsidy.	Belli, Finger, and Ballivian (1993)
C/L	Capital stock in constant prices divided by employment.	IDC

[1]The data refer to the following 24 International Standard Industrial Classification (ISIC) three-digit subsectors within the manufacturing sector: food processing, beverages, textiles, clothing, leather, footwear, wood and wood products, furniture, paper and paper products, printing and publishing, basic chemicals, other chemical products, rubber products, plastic products, glass and glass products, other nonmetallic minerals, basic iron and steel, basic non-ferrous metals, metal products, machinery and equipment, electrical machinery, motor vehicles, transport equipment, and other manufacturing.

B. Time-Series Analysis

Variable	Definition	Source
TFP	Index (in natural logarithms) of growth in private nonagricultural GDP minus growth in capital and labor, weighted by their respective shares in output; factor shares based on national income accounts.	Subramanian (1998)
Open	Real imports and real exports of goods and nonfactor services divided by real GDP.	South African Reserve Bank (SARB), *Quarterly Bulletin*, 1998
MachInv	Share of investment in machinery and equipment in total gross fixed capital formation.	SARB, *Quarterly Bulletin*, 1998
DCapacity	Change in capacity utilization in manufacturing.	SARB, *Quarterly Bulletin*, 1998
*Dum*8592	Sanctions dummy taking a value of 1 for the period 1985–92 and 0 otherwise.	

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