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Dynamic Gains from Trade: Evidence from South Africa

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Abstract

This paper examines the empirical relationship between trade and total factor productivity (TFP) in South Africa. It uses (i) a time series approach where trade is defined in terms of aggregate outcomes, i.e., as the share of imports plus exports in GDP, and (ii) a cross sectional approach, where trade is defined in terms of trade policy, i.e., as actual trade protection across different manufacturing sectors. The results indicate that there is a significant positive relationship between trade and TFP growth both over time and across sectors.

JEL Classification Numbers: F14, F43, O40

Keywords: Openness, trade liberalization, growth, total factor productivity

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I. INTRODUCTION

The pendulum of academic research on the positive relationship between trade[2] and economic growth appears to be swinging from near universal to more qualified acceptance. The spate of cross-country empirical evidence marshaled by Dollar (1992), Sachs and Warner (1995), and Edwards (1998) asserting 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 a descendant of a more generalized dissatisfaction with the cross-country approach (see, e.g., Srinivasan (1997)) per se, which therefore argues for a research strategy that focuses on exploring more contingent or situation-specific relationships. This paper attempts to do so for the particular case of South Africa.

More specifically, the purpose of this paper is to examine 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 general 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 a rich case study on account of the substantial variation in degree of openness over time (owing both to external sanctions and trade liberalization) and to a similar rich variation in trade policy orientation and productivity performance across sectors. 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 time-series and a cross-section perspective.

The rest of the paper is organized as follows. Section II reviews some earlier studies related to trade and growth, while Section III describes trade policy developments in South Africa since the 1970s. Section IV discusses some methodological issues and describes the data, while the results are presented in Section V. Section VI offers some concluding observations.

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

II. 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.[3] 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.[4]

However, in endogenous growth models, the impact of trade liberalization on output growth can be positive or negative, hinging on model-specific assumptions. Increased trade per se can have a number of generalized positive impacts.[5] For example, trade enables a country (i) to employ a larger variety of intermediate 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. However, as emphasized by Rodriguez and Rodrik (1999), 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 is then 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, e.g., Dollar (1992), Sachs and Warner (1995), Ben-David (1993), Edwards (1998), and Coe et. al. (1997).[6] This literature

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[3] 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).

[4] 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.

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

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

has focused either on the direct impact of trade on growth in output (the first three studies mentioned above) or in TFP (the latter two studies). While all 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) who call into question their results.

The Rodriguez and Rodrik (1999) 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 within country studies based either on plant-level data or industry-level data.[7] 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 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 (1998) 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 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).

III. Trade Policy and Trade Developments in South Africa

A. Trade Policy Prior to the 1990s

During the 1960s and 1970s, South Africa's trade regime was characterized by high tariffs and extensive import controls. 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. The focus, however, was on export promotion measures rather than on liberalization of the import regime. It was

[7] See, for example, Tybout (1992), Bernard and Jensen (1998), and Harrison (1994).

only in 1983, when about 77 percent of imports were subject to direct import controls, that the first systematic attempt was made to dismantle the controls, and in 1985 South Africa switched from a positive list of permitted imports to a negative list of prohibited imports covering about 23 percent of imports (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.

In terms of import controls, 15 percent of tariff lines were affected by them by 1992, with great sectoral variation; while most sectors were relatively free of controls, some sectors were highly restricted, including agriculture (74 percent of tariff lines), food, beverages, rubber, and tobacco (about 90 percent), and clothing (59 percent), see GATT (1993). In addition, the trade 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),[8] the widest range of tariffs, and the second highest level of dispersion (as measured by the coefficient of variation) among developing countries (see Belli et. al. (1993)). In sum, South Africa had a highly distorted system of protection (see Table 1).

B. 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) multilateral trade liberalization in the context of the Uruguay Round of trade negotiations, and (ii) unilateral trade liberalization.

Multilateral trade liberalization. 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 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. The offer aimed to:

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[8] The 200 ad valorem equivalent rates comprised 35 ad valorem rates and about 2,865 tariff lines with either formula or specific rates (Belli et. al. (1993)).

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 et. al. (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).

- 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[9] on industrial products from 55 percent to 98 percent; replace all QRs and formula duties with tariffs; and reduce the number of tariff rates to six—0 percent, 5 percent, 10 percent, 15 percent, 20 percent, and 30 percent—with the exception of the "sensitive" (textiles, clothing, and motor vehicles) industries;
- liberalize the sensitive industries over an eight-year period; and
- phase out the General Export Incentive Scheme by 1997.[10]

Unilateral trade liberalization. South Africa also 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 15.8 percent in 1994 to 10.3 percent in 1998.[11] The current average (import-weighted) tariff is below that bound in the WTO in 2004 by more than 5 percentage points,[12] 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

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

[10] 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.

[11] In 1990, the average (unweighted) tariff was about 30 percent, while the average (weighted) tariff including import surcharges was 36 percent. These surcharges were eliminated in 1994.

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

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.

C. 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 US bank announced that it would not be rolling over its short-term loans to South Africa. Other US 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.

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 (see Figure 1).[13] 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).[14] Figure 1 suggests 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.

IV. Methodology and Data

As indicated above, some of the empirical cross-country (or cross-sectional) 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. Therefore, a study focusing exclusively on output growth would be unable to isolate and capture the effects working through increased efficiency.

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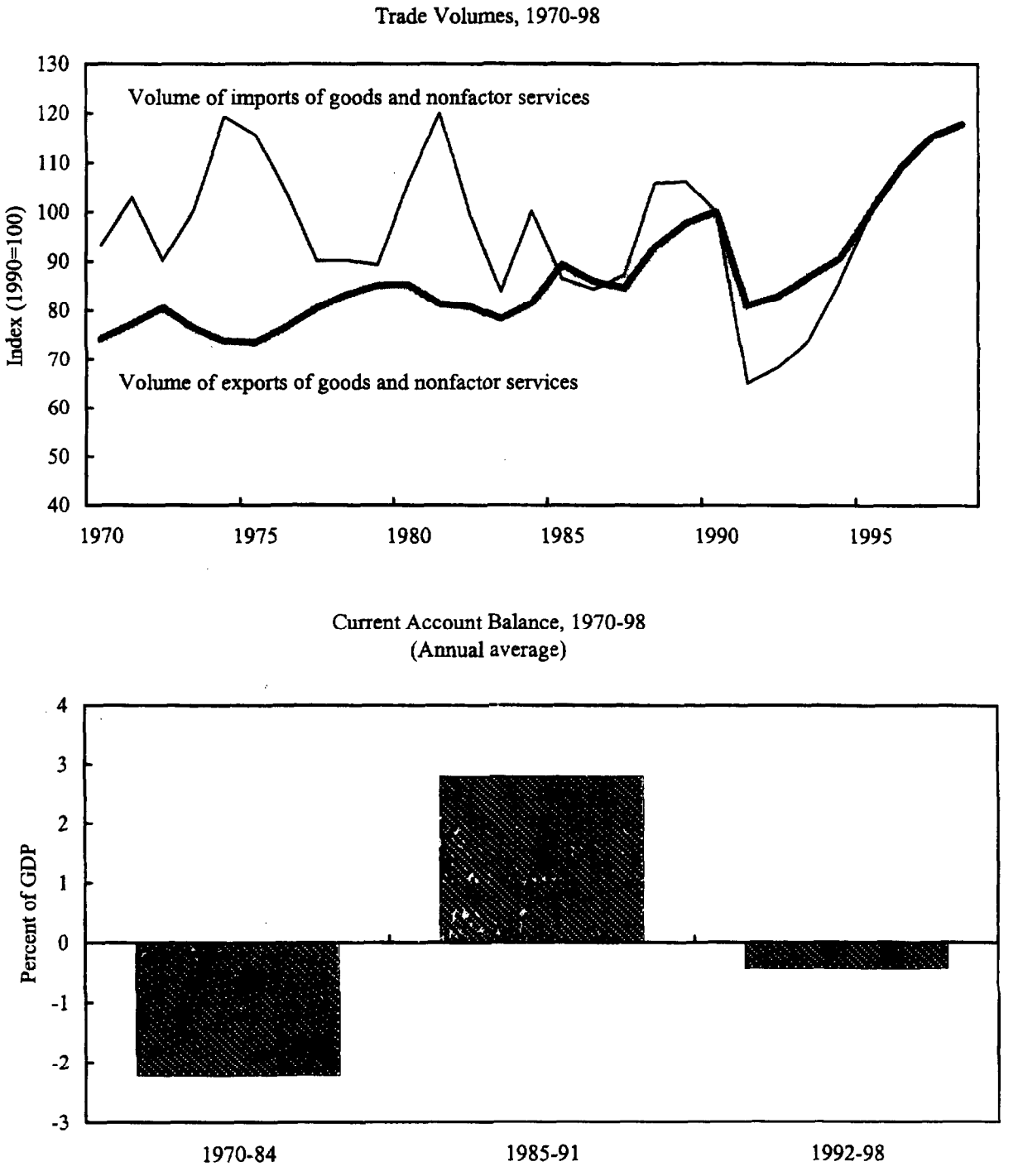
[13] During the late 1970s, South Africa ran current account surpluses, but this was due to the sharp improvement in the terms of trade associated with a boom in gold prices.

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

Figure 1. South Africa: Trade Volumes and Current Account Balance, 1970-98



Source: South African Reserve Bank, *Quarterly Bulletin*.

In addition to using different measures of trade policy to explain fluctuations in TFP growth, previous studies have included various factors that are assumed to be conducive to technological development. These include, for example, investment in machinery and equipment as a share of total investment, research and development (R&D) activities, measures of human capital, terms of trade developments, macroeconomic stability, efficiency of the domestic financial system, and other institutional variables.[15] In the current study, we followed a fairly eclectic and pragmatic approach in narrowing the possible determinants of South Africa's TFP growth. Parsimony in the choice of explanatory variables was also dictated by our relatively small sample size.

A. Data Used in Time-Series Analysis

The time-series variations in the data were examined for the period 1971-97 (see Figure 2).[16] Two measures of TFP, based on alternative approaches to measuring the factor shares, were used (see Subramanian (1998)): one calculates these shares using the national income accounts, while the other (*TFP-alt*) employs the methodology developed in Sarel (1997).[17] Because the latter approach yields consistently lower capital shares than the former and because capital growth exceeds labor growth, the TFP series resulting from the Sarel methodology lies consistently above the series based on the national income accounts. Nevertheless, the developments over time of the two series are fairly similar.

Openness was measured as the ratio of the sum of real imports and real exports of goods and nonfactor services to real GDP.[18] The use of this variable is open to the Rodriguez and Rodrik (1999) critique 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.

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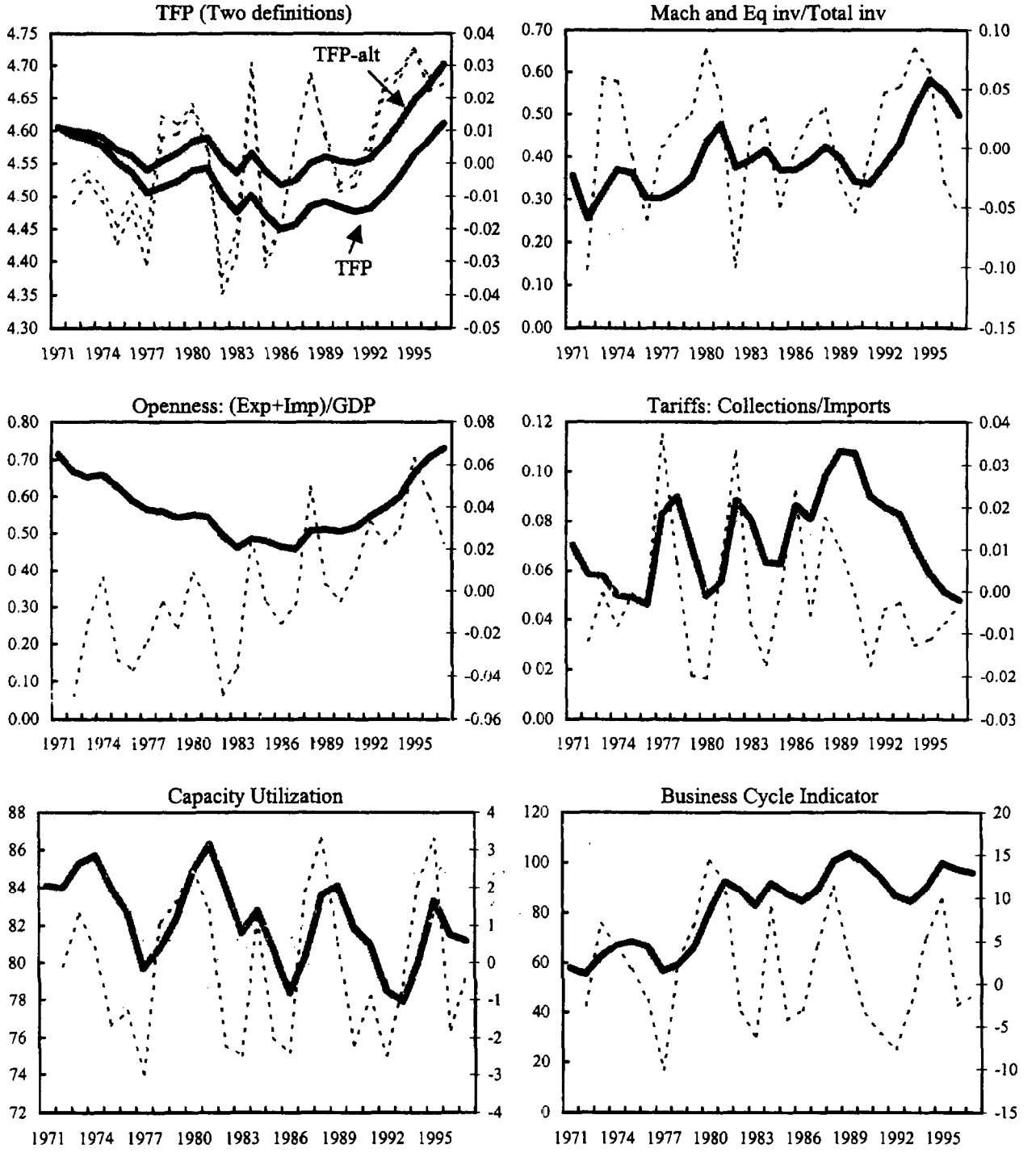
[15] See, for example, DeLong and Summers (1991), Collins and Bosworth (1996), Rodriguez and Rodrik (1999), and Edwards (1998).

[16] See Appendix for data description and sources.

[17] Sarel's (1997) methodology involves computing sector-specific capital shares based on data for a cross section of OECD and developing countries, and then using these to compute the economy-wide capital share. Under this approach, capital shares vary across countries only to the extent of differences in the sectoral composition of output.

[18] 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.

Figure 2. South Africa: Time-Series Data, 1971-97
(Levels (solid lines) on left-hand scale; first-difference (dashed lines) on right-hand scale)



Sources: South African Reserve Bank, *Quarterly Bulletin*; and Fund staff estimates.

Time series data for R&D in South Africa are not easily available. However, following DeLong 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 et. al. (1997)), but this course was rendered difficult by the absence of data on imported capital goods for the entire sample period.[19]

We also tried alternative specifications, including a proxy for human capital, but we dropped these subsequently as the proxy was likely mismeasured.[20] 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. While recent work in explaining growth in East Asia has focused on the role of the financial sector and the efficiency of its intermediation, we chose not to explore this aspect as it seemed less important in the case of South Africa, which has had well-developed and well-regulated financial institutions for a long time.[21]

B. Data Used in Cross-Section Analysis

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 analogous to that in the time-series analysis, with the nominal factor shares for each sector —obtained from industry-specific data—used to weight the growth in factors (see Appendix for further details). The trade variable (*Tariff*) is a policy variable, namely, the sum of all import charges (tariff and import surcharge) for each sector. Data were available for the years 1990, 1994, and 1998, although for three sectors (textiles, clothing, and motor vehicles) the

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[19] These data were only available from 1979.

[20] 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.

[21] 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)).

announced tariffs for 2002 were used, rather than the actual 1998 tariffs, in order to capture any forward-looking behavior.[22]

V. Results

A. Time-Series Evidence

The time-series properties of the variables were analyzed before any regressions were run. The relatively few number of observations implies that traditional non-stationarity tests do not have great power, especially when several lags are included in the models. Nevertheless, the (Augmented) Dickey Fuller tests indicate that total factor productivity (*TFP*), share of machinery and equipment investment in total investment (*MachInv*), and openness (*Open*), are all integrated of order 1 (see Table 2); the first-difference of *TFP* and *MachInv* appears to be stationary, while the first-difference of *Open* appears to be trend stationary.[23] Given these non-stationarity results, 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 3) clearly indicate that there exists one long-run cointegrating vector among *TFP*, *Open*, and *MachInv*. Moreover, the coefficients of this vector have the expected signs: *TFP* is positively related to *Open* and *MachInv*,[24] and all three variables contribute significantly to the cointegrating vector.[25] An examination of the speed of convergence coefficients (the 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 turns out to be a small sample problem rather than a true simultaneity problem, as various stability tests clearly show that only *TFP* is error-correcting.

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

[23] Broadly similar results were obtained when the Johansen procedure was used to test for the order of integration of the variables.

[24] 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.

[25] Using the alternative measure of TFP (*TFP-alt)* generated qualitatively the same results (bottom panel of Table 3).

Table 2. Augmented Dickey-Fuller Tests of Unit Root, 1971-97

Variable	Levels (max four lags)			First Differences (max four lags)			Additional Regressors
	Obs.	Lags 1/	*t*-value 2/	Obs.	Lags 1/	*t*-value 2/	
TFP	22	1	-0.99	21	0	-3.00	Constant
TFP-alt	22	0	1.10	21	0	-2.97	Constant
Open	22	4	-0.91	21	3	0.04	Constant
MachInv	22	1	-2.33	21	1	-4.12*	Constant
Capacity	22	1	-3.82*	21	4	-4.95*	Constant
TFP	22	0	-0.16	21	0	-3.70	Constant and trend
TFP-alt	22	0	0.06	21	0	-3.60	Constant and trend
Open	22	2	1.43	21	1	-5.23*	Constant and trend
MachInv	22	1	-3.38	21	1	-3.84*	Constant and trend
Capacity	22	4	-4.64*	21	4	-4.80*	Constant and trend

Variable	Levels (zero lags)			First Differences (zero lags)			Additional Regressors
	Obs.	Lags	*t*-value 2/	Obs.	Lags	*t*-value 2/	
TFP	26	0	-1.10	25	0	-3.06*	Constant
TFP-alt	26	0	0.69	25	0	-3.03*	Constant
Open	26	0	-0.75	25	0	-2.95	Constant
MachInv	26	0	-1.50	25	0	-4.51*	Constant
Capacity	26	0	-2.34	25	0	-3.81*	Constant
TFP	26	0	0.23	25	0	-3.95*	Constant and trend
TFP-alt	26	0	0.38	25	0	-4.04*	Constant and trend
Open	26	0	0.37	25	0	-4.47*	Constant and trend
MachInv	26	0	-2.65	25	0	-4.28*	Constant and trend
Capacity	26	0	-2.68	25	0	-3.72*	Constant and trend

1/ The lag length was chosen using the Schwarz Bayesian Criterion and assuming a maximum of four lags.
2/ The *t*-value is the test statistic from the (Augmented) Dickey-Fuller test; * indicates rejection of the null hypothesis of non-stationarity at the 5-percent significance level.

Hence, in a second step, a single equation error-correction model was used to examine the annual fluctuations in the variables (see Table 4). The fit of these regressions was remarkably good, considering the small sample size. Moreover, the estimated coefficients for both *DOpen*[26] and *DMachInv* have the expected positive sign and are significant,[27] while the

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

[27] The first lags of the variables were insignificant and dropped.

Table 3. 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

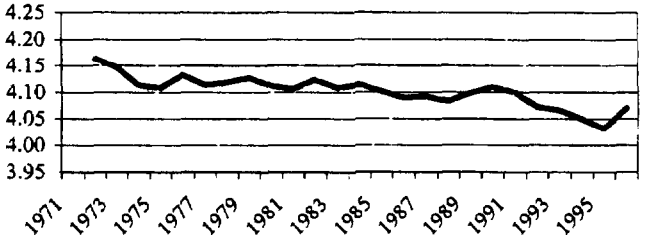
Tests for significance of a given variable

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

Tests for Weak Exogeneity

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

Cointegrating Vector



As Above, but with Alternative Measure of TFP (*TFP-alt*)

Rank	Eigenvalue	Lambda	Critical Value (95%)	Trace	Critical Value (95%)
r = 0	0.57	21.77*	21.0	32.08*	29.7
r <= 1	0.32	10.11	14.1	10.31	15.4
r <= 2	0.01	0.20	3.8	0.20	3.8

Standardized Eigenvectors

TFP-alt	*Open*	*MachInv*
1	**-0.38**	**-0.65**

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 4. The Error Correction Model: TFP Growth and Openness, 1971-97

	Dependent Variable: *DTFP*						
Constant	1.08	1.02	0.90	1.00	0.89	0.82	0.77
	[2.29]	[2.89]	[2.47]	[2.88]	[2.48]	[2.89]	[2.75]
EC(-1) 1/	-0.26	-0.25	-0.22	-0.24	-0.22	-0.20	-0.19
	[-2.29]	[-2.89]	[-2.46]	[-2.88]	[-2.48]	[-2.89]	[-2.74]
DOpen	0.34	0.27	0.32	0.26	0.31	0.31	0.34
	[2.50]	[2.60]	[2.87]	[2.54]	[2.75]	[3.55]	[3.82]
DTariff				-0.17	-0.16	-0.19	-0.17
				[-1.39]	[-1.27]	[-1.62]	[-1.41]
DMachInv	0.16	0.07	0.04	0.05	0.03		
	[2.52]	[1.21]	[0.77]	[0.92]	[0.56]		
DCapacity		0.38	0.37	0.36	0.35	0.40	0.37
		[4.18]	[4.06]	[4.08]	[3.96]	[4.86]	[4.51]
Dum8592			-0.004		-0.004		-0.005
			[-1.16]		[-1.03]		[-1.29]
DW-statistic	2.07	2.06	2.04	2.18	2.11	2.21	2.13
R-square	0.78	0.88	0.89	0.89	0.90	0.89	0.90
Number of obs.	25	25	25	25	25	25	25

Note: *t*-statistics in brackets.
1/ The error-correction term is derived from the cointegration relation among *TFP, Open,* and *MachInv*.

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 3a). 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 shifts sign over time, indicating that this variable is not really error-correcting but rather should be treated as weakly exogenous (Figure 3b). Further, when the long-run Johansen equation was estimated using the alternative definition of TFP, weak exogeneity of the openness variable could not be rejected at the 5 percent significance level, and the TFP variable remained error-correcting. We take these findings as

Figure 3. Stability Tests of Error-Correction Model (Beta-coefficients ± 2 standard errors and Chow tests)

Figure 3a. *DTFP* as Dependent Variable

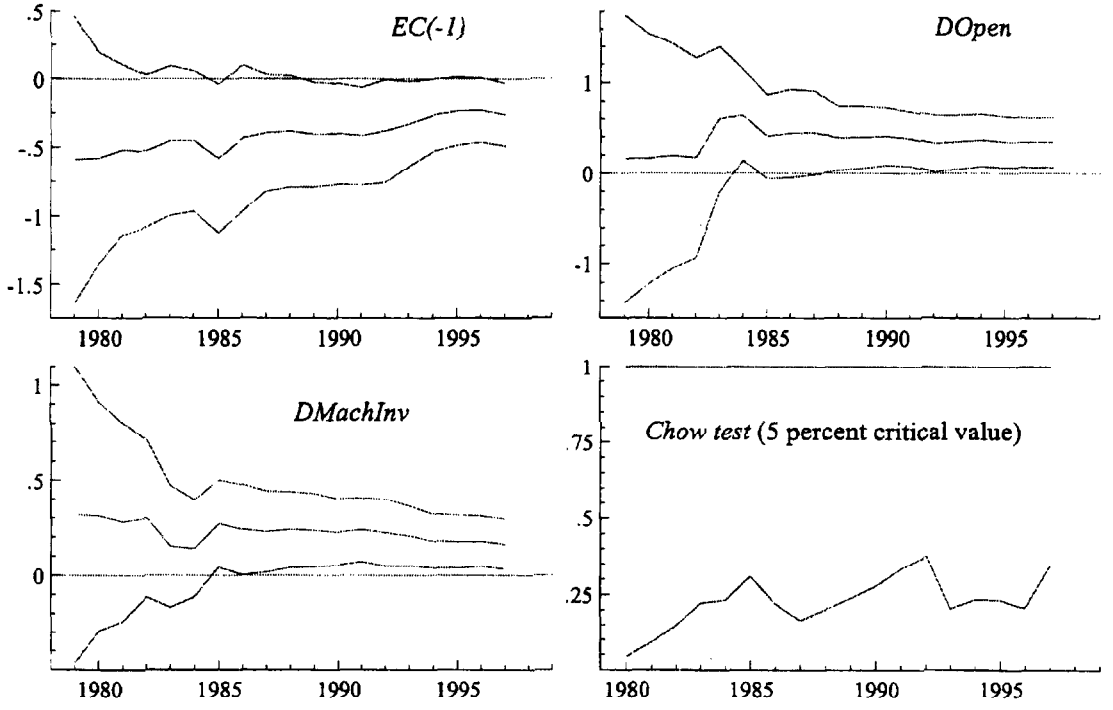
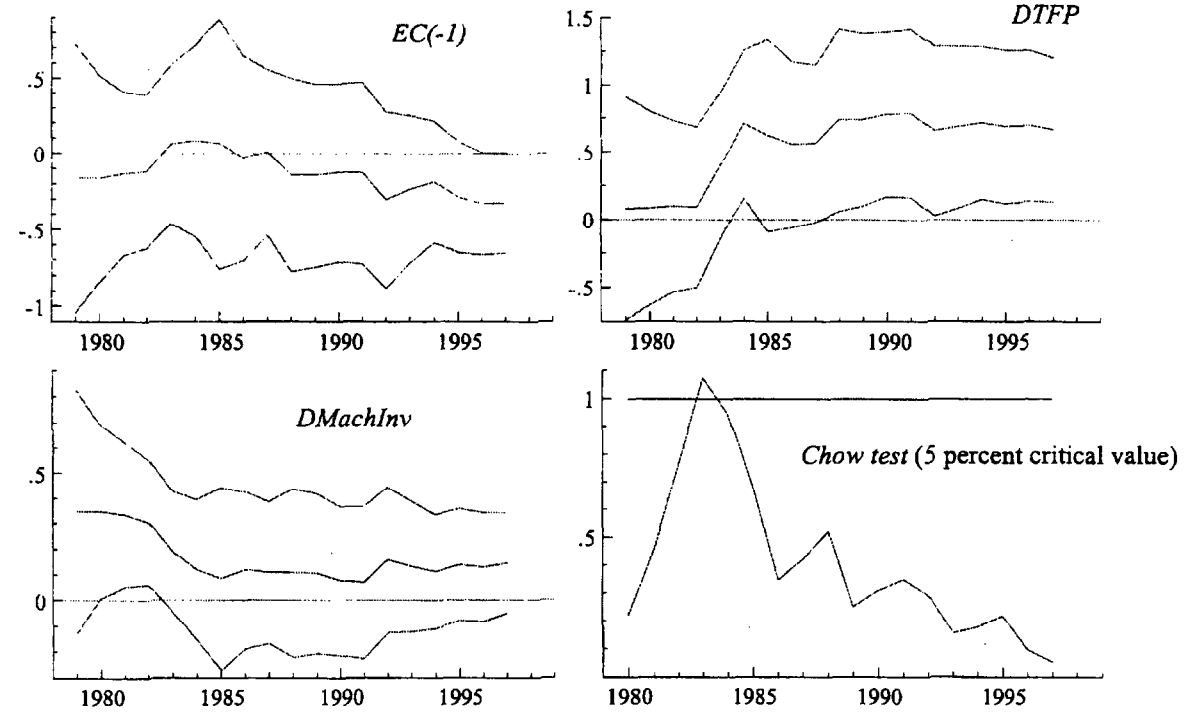


Figure 3b. *DOpen* as Dependent Variable



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.[28] As expected, the estimated coefficient on this variable came out positive and strongly significant, indicating that the growth rate in *TFP* in a particular year does not necessarily reflect an improvement in technology. 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.

As emphasized by a number of authors (e.g., Rodriguez and Rodrik (1999)), openness is somewhat difficult to interpret in a growth regression, as it captures a number of different aspects that contribute to the outcomes; these include not only actual trade policy variables, such as tariffs and surcharges, export incentives, and quantitative restrictions, but also variables such as size, geography, foreign demand conditions, transport costs, and preferences. In an attempt to control for some of these aspects, two additional variables were included in the specification: a dummy variable for the period 1985-92, during which South Africa was subject to trade and financial sanctions (*Dum*8592), and the trade policy variable *DTariff*, defined as the change in the ratio of import duties and surcharges to import value.

These variables are clearly not an ideal measure of the annual change in trade policy in South Africa. Nevertheless, both of their estimated coefficients have, as expected, negative signs, indicating that TFP growth was somewhat lower during the sanctions period and during the years when tariffs were increased, although the coefficients were in general insignificant or only marginally significant. Moreover, the estimated coefficient on *DOpen*—which in this context should be interpreted as fluctuations in imports and exports that are not driven by the

[28] The level of capacity utilization, a business cycle indicator proposed by the Economics Department of the South African Reserve Bank, and fluctuations in the terms of trade were used as alternative measures. The results were qualitatively the same, in the sense that the estimated coefficients on *DOpen* and *DMachInv* were virtually unaffected by the choice of the proxy for cyclical fluctuations.

sanctions or changes in tariff collections—remains positive and strongly significant. Likewise, the *EC*-term is virtually unaffected by the inclusion of the additional variables.

To summarize, the time-series data indicate that 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. The coefficient on the error-correction term indicates that nearly a fourth of a given deviation from the long-run equilibrium is adjusted within one year by changes in TFP.

B. Cross-Section Evidence

This section provides cross-sectional evidence that corroborates the time-series results. The focus is on how variations in TFP growth across 24 different manufacturing sectors are related to tariff reductions during the period 1990-98. There are three advantages with this approach: first, the problem in separating true technological process from aggregate demand-related effects is mitigated, as aggregate shocks are likely to affect all sectors; second, the number of observations for measuring the long-run effects is greatly increased; and third, 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[29] 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.[30]

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[29] 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.

[30] 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.

Figure 4 shows the degree of trade protection—measured as level of import tariffs—in the 24 manufacturing sectors in 1990, 1994 and 1998. In general, tariffs were reduced substantially during the 1990s, but the magnitude of reduction varied significantly across the sectors. Figure 5 shows the TFP growth in the same 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 the sectors.

Table 5 reports the results from regressions of TFP growth on changes in tariffs (*DTariff*).[31] To ensure that this effect is 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 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. 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 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.[32] 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 6, where the conditional TFP growth is shown on the y-axis. The figure (and the regression results) also illustrates 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.

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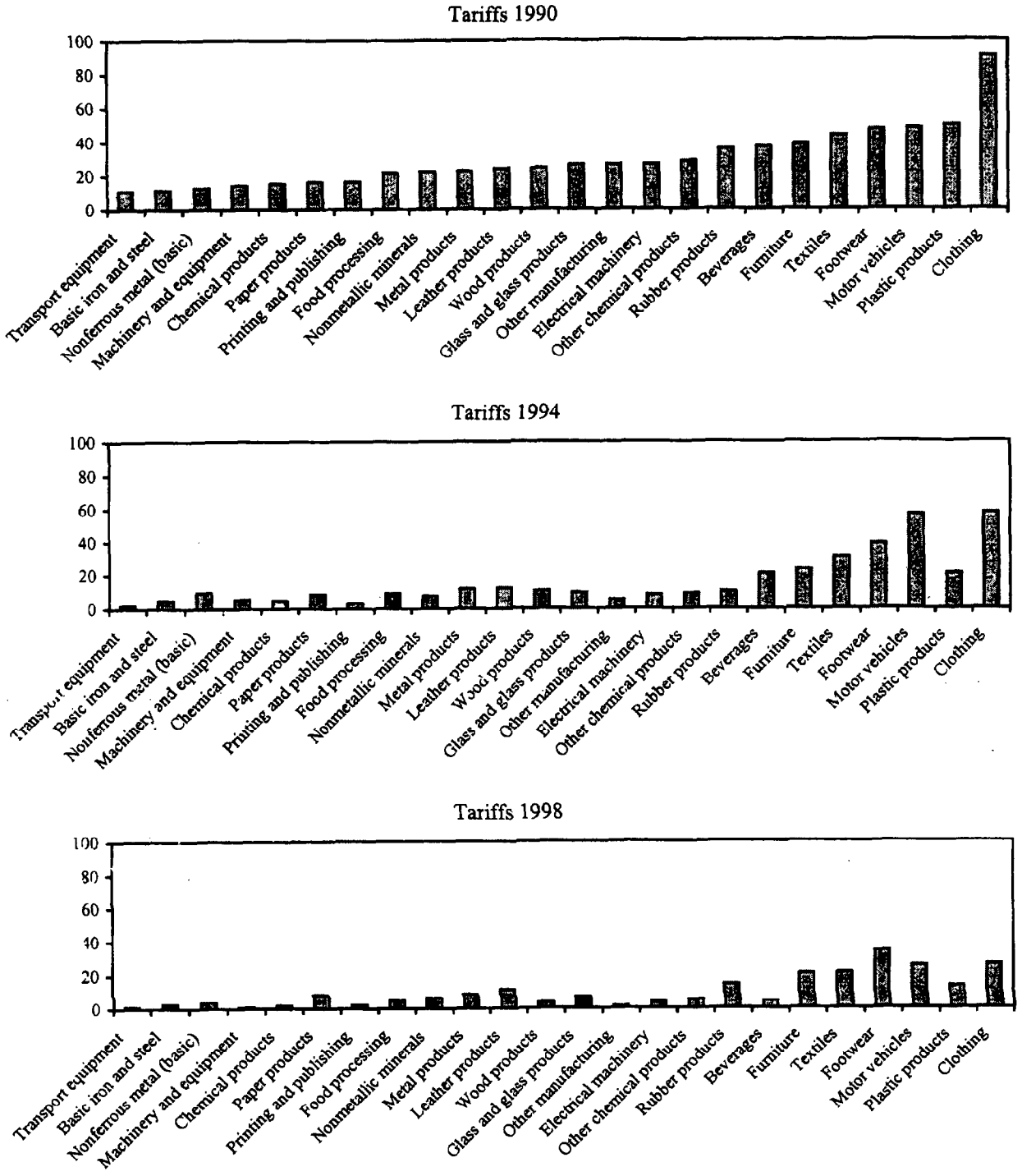
[31] The variable *DTariff* is measured as the change in tariff divided by 1 plus the initial tariff and, hence, reflects the percentage change in domestic price owing to the tariff reduction.

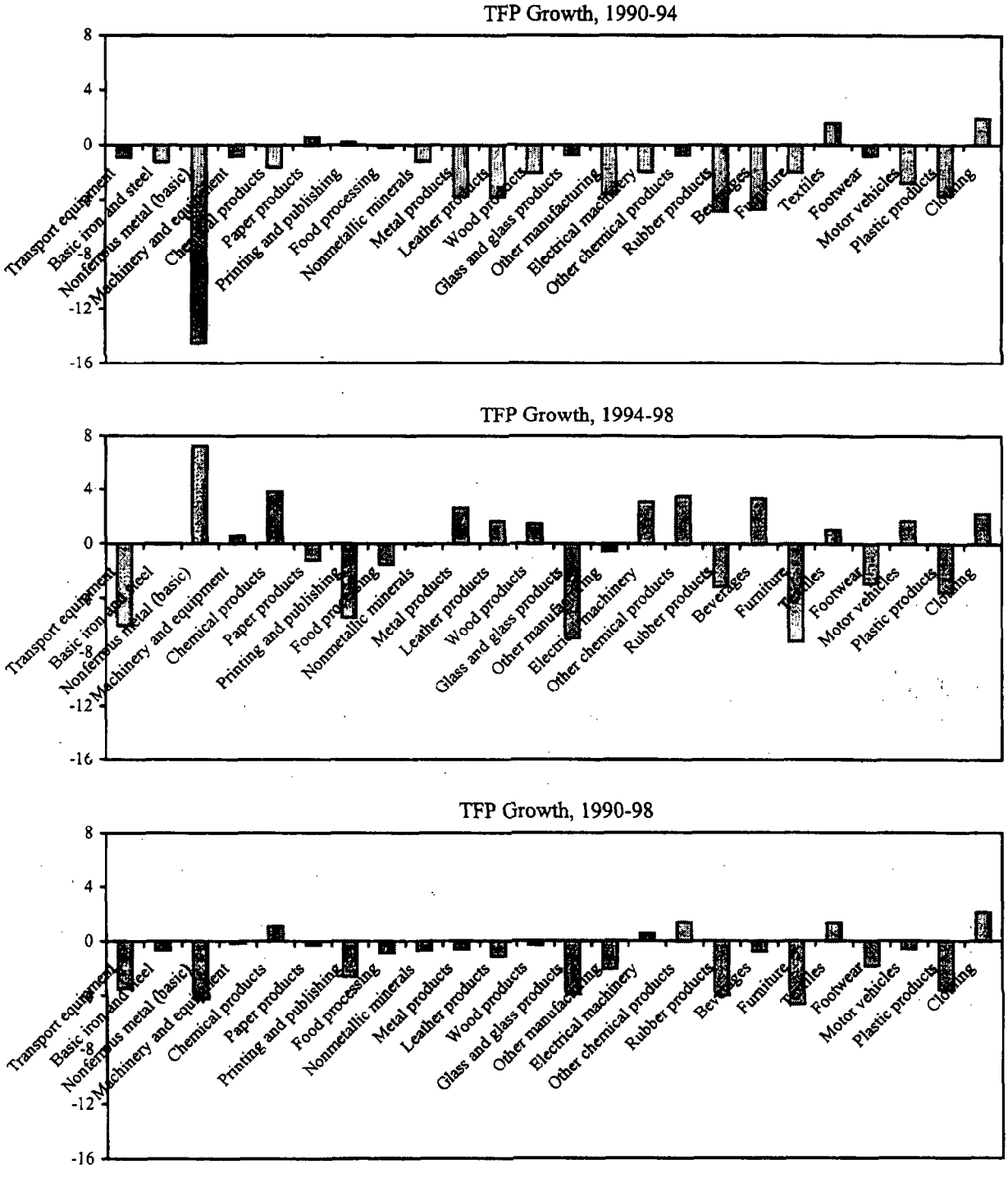
[32] More precisely, given the normalization when calculating *DTariff*, the marginal effect on TFP growth tends to decline as the price reductions due to the tariff changes become larger.

Figure 4. South Africa: Tariff Protection, 1990-98
(In percent)



Sources: Industrial Development Corporation of South Africa; and the World Bank.

Figure 5. South Africa: TFP Growth, 1990-98
(Annual percentage change)



Sources: Industrial Development Corporation of South Africa; and Fund staff estimates.

Table 5. Trade Liberalization and TFP Growth
(Pooled results, 1990-94 and 1994-1998)

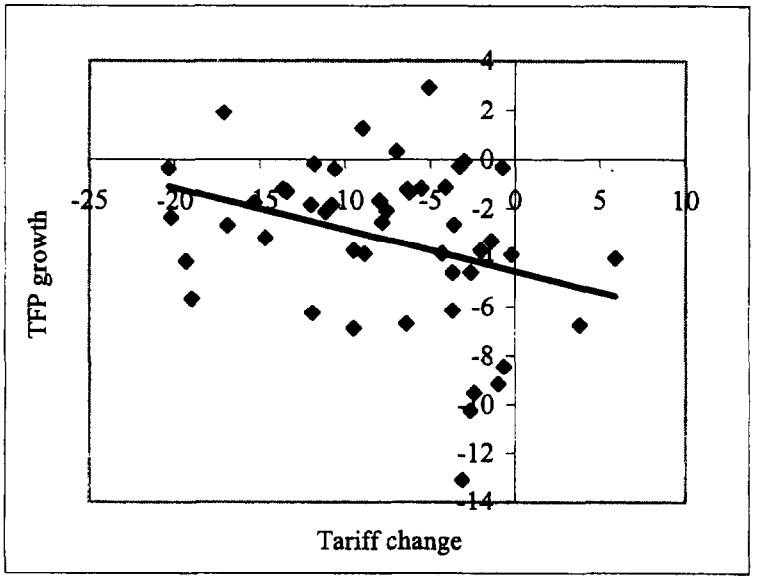
	Dependent variable: *TFP growth*			
Constant	-3.96 [-3.18]	-4.39 [-3.56]	-5.35 [-3.36]	-5.93 [-2.85]
Dum9498	2.89 [2.64]	2.69 [2.79]	3.11 [2.72]	3.28 [2.87]
CLR		0.01 [2.39]	0.01 [2.23]	0.01 [2.23]
Exportshare		-0.07 [-0.90]	-0.08 [-0.95]	-0.07 [-0.80]
Importshare		0.04 [1.12]	0.04 [1.20]	0.05 [1.38]
Tariff				-0.02 [-0.31]
Tariff-sq				0.00 [1.47]
DTariff	-0.17 [-2.17]	-0.16 [-2.65]	-0.48 [-2.15]	-0.59 [-2.85]
DTariff-sq			0.02 [1.67]	0.03 [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).

Table 6 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

Figure 6: 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)

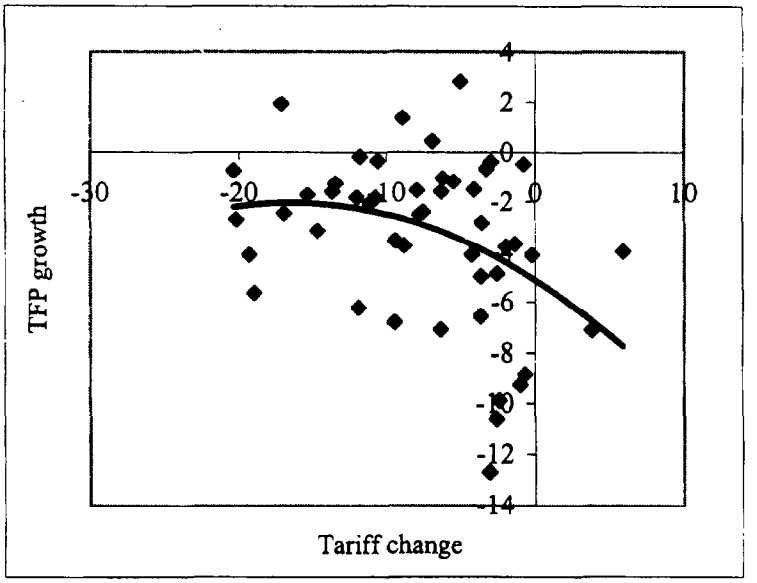


Table 6. Trade Liberalization and TFP Growth; Results for Subperiods

	Dependent Variable: *TFP growth*						
	1990-94		1994-98				
Constant	-2.03	-0.69	-4.16	-4.34	-3.99	-4.64	-2.22
	[-1.96]	[-0.17]	[-2.78]	[-2.21]	[-1.84]	[-2.14]	[-1.05]
Capital Labor Ratio	0.00	0.00	0.01	0.01	0.01	0.01	0.01
	[-0.04]	[-0.02]	[3.52]	[3.75]	[3.36]	[3.46]	[2.38]
Exportshare	-0.19	-0.20	0.04	0.04	0.04	0.04	0.03
	[-1.95]	[-1.93]	[0.50]	[0.48]	[0.51]	[0.57]	[0.45]
Importshare	0.02	0.03	0.03	0.03	0.03	0.03	0.03
	[0.52]	[0.67]	[0.56]	[0.71]	[0.56]	[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	-0.28	-0.63	-0.74
	[-2.57]	[-1.75]	[-2.77]	[-2.02]	[-4.62]	[-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)					-0.03	-0.05	
					[-0.38]	[-0.17]	
DTariff-sq (-1)						0.00	
						[0.07]	
DGEIS							0.11
							[1.39]
R-square	0.40	0.49	0.39	0.41	0.36	0.39	0.43
Number of obs.	24	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)).

export subsidy affected TFP growth.[33] The export subsidy variable was positively signed (implying that reductions in the GEIS could have adversely affected TFP growth) but insignificant.[34] 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.[35] 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 differentially 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 7 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

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

[34] 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.

[35] Thus, the number of observations dropped from 48 to 46 in these regressions.

Table 7. 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]
Dum9498	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).

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.[36] Instead, it can be noticed that capital growth is positively related to changes in tariffs. This result suggests that sectors that have experienced larger tariff reductions, firms have tended to use the existing capital stock more efficiently rather than adding more capital;

[36] The regressions in Table 7 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.

to some extent, this might also have had an indirect effect on the relative improvement in TFP growth in these sectors. 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.

VI. 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 an aggregate time-series approach (covering the period 1970-97) and a cross-section approach covering the manufacturing sector for the period 1990-98 when South Africa witnessed major trade reform. Both approaches validate the above proposition with a remarkably high degree of statistical reliability.

It is generally agreed that the South African economy needs to boost its supply capacity —through increases in factor accumulation and in total factor productivity growth. The results obtained in this paper indicate that trade liberalization has contributed significantly to the growth process through increases in TFP. For example, 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. The cross-section analysis yields surprisingly similar results. The average price reduction in the 1990s due to the tariff changes was about 14 percent, which translates to higher TFP growth of about 2.3 percent per year. In other words, the typical manufacturing industry exhibited higher TFP growth of nearly 3 percent per year because of the trade liberalization.

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.

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.

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 are expected to be released in early 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 Cote d'Ivoire (Harrison (1994)).

Looking ahead, although significant strides have been made in opening up the economy, three significant problems remain with the South African tariff regime: its complexity, the continuing high protection for selected sectors, and the enduring problem of discretionary tariff changes. Addressing these issues could further raise the efficiency gains that can be reaped from greater openness.

Data Description and Sources

A. Time-Series Analysis

Variable	Definition	Source
TFP	Index 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)
TFP-alt	Index of growth in private nonagricultural GDP minus growth in capital and labor, weighted by their respective shares in output; factor shares based on Sarel (1997).	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
CLR	Real private nonagricultural capital stock divided by private nonagricultural employment.	SARB, *Quarterly Bulletin*, 1998
Tariff	Sum of tariff revenues and import surcharges divided by value of imports.	SARB, *Quarterly Bulletin*, 1998
DTariff	Change in tariff divided by 1 plus initial level of tariff.	
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.	

B. Cross-Sectional Analysis 1/

Variable	Definition	Source
TFP growth	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 tariff revenues and import surcharges divided by value of imports.	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.	
Dum9498	Dummy variable that takes a value of 1 for the period 1994-98 and 0 otherwise.	
Generalized Export Incentive Scheme	Export subsidy.	Belli, Finger, and Ballivian (1993)
C/L	Capital stock in constant prices divided by employment.	IDC (1999)

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.