MEASURES AND DETERMINANTS OF PRODUCTIVITY GROWTH IN THE SOUTH AFRICAN MANUFACTURING SECTOR

THESIS

Submitted in Fulfilment of the requirements for the

Degree of

MASTER OF COMMERCE

of Rhodes University

by

Anthony John Wright

JANUARY 1994

ABSTRACT

The *neoclassical "sources-of-growth"* approach is applied to derive total factor productivity (TFP) growth measures for manufacturing industries in South Africa. Although South Africa's recorded industrial TFP growth measures have been persistently low in absolute terms, this performance is not significantly worse than the industrial TFP growth performance of other developing countries. In some periods there is evidence of a significant variability in TFP performance across industries. The measures also indicate that TFP growth has worsened in the 1980s, particularly in the intermediate-capital intensive and labour intensive industries. However, there are various problems with interpreting neoclassical TFP growth measures as indicators of production efficiency. In fact, as TFP growth is derived as a residual, it may measure many factors besides production efficiency. Alternative growth theories are used to assess the fundamental determinants of productivity growth. These provide a more plausible conceptualisation of the process by which productivity growth is generated than the neoclassical growth theory does. However, this analysis also provides little empirical evidence of which underlying factors have had the most influence on productivity growth in South African manufacturing. Hence, the relative importance of possible candidates can only really be assessed qualitatively and on the basis of micro evidence. However, these assessments, and the assumptions underlying the postulated causal connections (between the identified factors and productivity growth), have a major impact on policy design. In this respect, on the basis of the framework provided by the evolutionary and other recent growth theories, various policy implications are drawn, and these are contrasted with the policy proposals of other South African analysts. This thesis concludes that policies need to be designed with the central objective of enhancing the technological capabilities of South African firms. Trade policies will not be sufficient for achieving this objective. Education and training policies, technology, competition and labour market policies are also crucial. However, since the fundamental causes of productivity growth remain somewhat of a mystery, there is a need to be sceptical of simple policy prescriptions. In this respect, this thesis is highly critical of the World Bank's position that productivity gains will be reaped from the exposure of firms to international competition that trade liberalisation policies entail.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ACKNOWLEDGMENTS

I would like to thank both my supervisors, Professor R.T. Bell and Dr M.V. Leibbrandt, for the comments and assistance they provided.

The financial assistance of the Centre for Science Development towards this research is hereby acknowledged. Opinions expressed in this publication, or conclusions arrived at, are those of the author and are not necessarily to be attributed to the Centre for Science Development.

Finally, I would like to thank my family and friends for the support and encouragement given to me during the writing of this thesis.

Chapter 1

Introduction

1.1 Purpose and Basic Outline of the Thesis

This thesis consists of two parts. The first part of the thesis, consisting of chapters one to three, aims to assess the productivity performance of South African manufacturing industries since World War 2. This assessment is undertaken by comparing South Africa's performance with that in other countries and against the background of earlier studies of South Africa's industrial productivity growth. The second part of this thesis, consisting of chapters four and five, aims to enhance our understanding of the causes of South Africa's productivity growth performance. Finally, in chapter six, conclusions are reached, various policy implications are inferred and the existing South African debate on industrial policy and productivity growth is addressed.

1.2 Assessing the Productivity Growth Performance of South African Manufacturing

For the purpose of assessing the productivity growth performance of South African manufacturing industries, the following issues will be addressed in the first three chapters:

(1) What production efficiency improvements have been achieved by manufacturing industries in South Africa since World War 2 ?

(2) Has this growth been poor in comparison with other countries, and what countries could South African industries have realistically expected to outperform ?

(3) Do the achievements of aggregate manufacturing reflect the performance of individual industries, and if not, which industries have performed well and which badly ?

These issues are addressed by deriving productivity growth estimates for the 26 industries in manufacturing in 5 sub-periods in the interval 1945-90 using the conventional neoclassical growth accounting approach. The productivity growth estimates derived using this method are contrasted with existing estimates by other authors. It is emphasised though, that with any method of estimating productivity growth certain theoretical and empirical limitations arise. These issues are discussed in some detail because of their important bearing on the interpretation of productivity growth estimates as indicators of production efficiency changes.

In a recent World Bank assessment of the South African economy Belli et al. (1993 : 73) point out that several groups have reached the following conclusion:

> **"It is a striking feature of the performance of manufacturing industry in South Africa that productivity has been stagnant for the past 20 years."**

Using neoclassical total factor productivity measures, Belli et al. (1993) estimate productivity growth for manufacturing as a whole at 0.05% per annum in the period 1972-83 followed by a TFP growth rate of 0.55% per annum in the 1983-90 period[1]. Also using TFP measures, but different data sources, Moll (1990) estimates productivity growth for manufacturing as a whole at -0.8%, 1.9%, 1.0%, 0.7% and -1.9% per annum for the periods 1948-54, 1954-63, 1963-74, 1974-81 and 1981-90 respectively. Like Belli et al. (1993), Moll's estimates indicate low absolute productivity growth, but in addition suggest that the recent TFP growth performance has not been significantly worse in the last twenty years than in previous periods[2].

[1] However, it is also important to note that a closer look at Belli et al's TFP measures reveals considerable variation across industries which is not reflected in these aggregate figures.

[2] Estimates by the NPI (1990) and Joffe et al. (1993) also lead them to conclude that the TFP performance of South African Manufacturing has been poor. See Appendix A, which shows the estimates made by different authors.

In addition to productivity growth comparisons over time and across industries, this thesis derives a new set of estimates and stresses the importance of comparing South Africa's productivity growth record with the achievements of other countries that are in a similar situation to South Africa.

However, having derived TFP growth measures there is a need for careful interpretation since there are many empirical and conceptual problems with this estimate of productivity growth. In the light of this, the present study tries to assess the usefulness of this measure as an indicator of changes in production efficiency. It is concluded that the TFP measure can be useful as an indicator of trends in production efficiency so long as its limitations are appreciated.

1.3 Current Perspectives on the Causes of Productivity Growth and the Role of the State

The main purpose of the second part of the thesis is to understand the causes of productivity growth trends. This will be addressed by focusing on the following issues:

(1) What have been the fundamental determinants of the productivity growth performance in the South African manufacturing sector ? ;

(2) What role has the state played in facilitating or hindering productivity growth in manufacturing ? ;

(3) Have the major productivity influences changed over time ? ; and,

(4) To what extent are these key factors specific to South Africa ?

Having put South Africa's industrial productivity growth performance in context, the issues considered here are important for ensuring that an accurate diagnosis of this performance is made. The nature of this diagnosis has important implications for the growth and efficiency prospects of South African industry. Such a diagnosis should also provide a useful basis for designing policies to enhance South Africa's industrial productivity growth.

However, many of the determinants of productivity growth are qualitative, and therefore cannot be empirically proven. As such, the current state of the ideological debate on the role of industrial policy will in practice be the main guide to policy. Hence, the prevailing dominant wisdom on the State's role in industrialization and the perceived link between state intervention and productivity growth is very relevant to an analysis of the causes of productivity growth. Thus, in the final part of the thesis, some of the dominant views on the causes of South Africa's poor industrial productivity growth will be discussed critically.

The role of the state in the growth and industrialization of the economy is an important issue in South Africa, given the political transition underway, the high expectations accompanying it, and the current state of the economy. However, the nature and extent of the state's role is a highly contentious issue. Internationally this issue has been receiving much attention from economists. In South Africa it has also become a focal point of discussion among economists, in their quest to attribute blame for the poor recent performance of the economy.

Many liberals are convinced that the issue has essentially been resolved. In short, they see limited state intervention and liberal trade policies as sufficient for ensuring sustainable growth and industrialisation. The poor economic performance of many developing countries, which attempted to encourage industrialization through intervention and protection, is regarded as ample proof of the myopia of active state involvement. In this respect, Holden (1992) regards the liberalisation policy trends in Eastern Europe, Latin America, and in parts of Africa, as nothing short of an "economic revolution". However, there is no doubt that the conditionality of IMF and World Bank loans provided a strong inducement to liberalise for many countries facing severe debt problems. Rodrik (1992) also argues that the severity of the macroeconomic crises experienced in many Latin American and East European countries set the stage for the introduction of what would have previously have been regarded as very radical liberal political and economic reforms. In the light of these issues, Rodrik (1992) argues that it would be wrong to interpret these policy reversals as indicative of a growing acceptance of the efficacy of liberal policies. Indeed, despite the popular dominance of this dogma, the economic theory and empirical evidence used to support the case for liberalisation is open to considerable debate (Rodrik, 1992)[3].

More pragmatic economists have abandoned the distinction between state and market as a guide to policy, acknowledging the possibility of both market failure and government failure. Insights from micro-based organisational and institutional theories suggest that the nature, design and implementation of state intervention is far more important than its extent. From this perspective, the state is seen as an important facilitator of an institutional environment where organisational efficiency is rewarded and inefficiency is penalised. Further, it is recognised that the state can play a vital role in correcting for market failures where the prospect of government failure is not probable (Ranis, 1989; Nabli and Nugent, 1989).

[3] Also see Dornbusch (1992) for an alternative perspective and the local reviews of this debate in Bell (1992) and Holden (1992).

South Africa, like many other countries, has begun to liberalise its economy. It is clear that the whole issue of productivity has become deeply enmeshed in the debate surrounding the efficacy of liberalisation, with unfavourable productivity growth trends being cited as "evidence" of the consequences of state intervention. The failure of any movement towards consensus in the light of productivity "evidence", is partly due to the nature of the productivity concept itself (see below), and partly due to the inability to establish robust correlations between productivity growth and various indicators of state intervention. As such, despite claims to the contrary by various authors, it is generally acknowledged that economists have been unable to establish conclusive evidence of causality between hypothesised factors and productivity growth. This is highlighted by what has come to be known as the "productivity puzzle". Despite almost two decades (and a great deal of research) since the worldwide productivity slowdown in the early 1970s, its causes still remain elusive to economists (Denison, 1984). Much research has also focused on the link between trade orientation and productivity growth, but again the results appear inconclusive (Havrylyshyn, 1990, Nishimizu and Robinson, 1984, Helleiner, 1993[4]).

In South Africa many authors[5] have attributed a large portion of the blame for the poor economic performance of the South African economy, particularly its productivity growth performance, to state intervention. In general, the system of apartheid is seen as having had an "ossifying" effect on South Africa's output and productivity growth performance (Moll, 1990). In particular, state intervention in the form of misguided trade and industrial policies,

[4] However, see Edwards (1991) who believes there is conclusive evidence of a positive correlation between degree of openness and productivity growth (see section 5.3.3 for a fuller discussion of this). In the South African context see Belli et al. (1993) who also infer a similar relationship as Edwards (1991). Note however that Belli et al. (1993) do not appear to interpret their findings as carefully as Nishimizu and Robinson (1984) recommend (also see 5.3.3).

[5] Becker and Pollard (1990), Moll (1990), Belli et al. (1993), Holden (1992).

economically irrational labour market and long term educational policies are regarded as being amongst the key factors undermining South Africa's productivity growth performance. With regard to trade policy, Moll (1990) notes some of the conventional liberal arguments for the inferiority of the import substituting industrialisation strategy pursued in South Africa, while Becker and Pollard (1990), amongst others, suggest that this trade strategy adopted by the nationalist government was partly strategic, and not purely economic, since it represented an attempt to guard against the perceived threat of sanctions and disinvestment.

Other factors (where the state is not explicitly blamed) which have been regarded as underlying the productivity growth performance of the South African economy include: deficiencies in the education and training system with resulting technical and managerial skill deficiencies of the workforce (NPI, 1990); weakness in the research institutions and a general underinvestment in research and development by private firms, coupled with the packaged nature of foreign technology, its inappropriateness and relatively slow application in South Africa (NPI, 1990; Moll, T, 1990; du Plooy, R, 1988, Joffe et al., 1993); the effects of sanctions and disinvestment, in reducing trade and undermining technological development (NPI, 1990; du Plooy, 1988); low rates of investment undermining technological embodiment as well as the inappropriately capital-intensive nature of investment (Joffe et al., 1993); and even, a "lack of awareness of productivity" (NPI, 1990).

This thesis seeks to isolate the key productivity determinants from amongst this long list of plausible factors influencing South Africa's productivity growth performance. More importantly though, the thesis aims to clarify the causal mechanisms through which these factors influence productivity growth and, in so doing, to make clear *why* they are important.

As such, the last section of this thesis will try to isolate the key causes of South Africa's industrial productivity performance. Furthermore, the thesis will emphasise how these findings differ from the various existing interpretations of the determinants of productivity growth in South Africa.

Productivity can be a fruitful concept for understanding what factors are most fundamental to the long term growth prospects of the South African manufacturing sector, and what sort of industrial policy can enhance these prospects. However, it is all too easy for productivity measures to be inappropriately used for ideological purposes. Nevertheless, with a thorough understanding of the nature and limitations of the productivity concept a careful interpretation of productivity measures can provide useful insights for policy.

1.4 Defining Productivity Growth as a Long Term Concept

Before a serious analysis can be made of the productivity growth performance of the manufacturing sector it is crucial to have a clear understanding of what is meant by the concept of productivity. Unfortunately, there is no unanimity on how this concept should be defined. Different people have taken it to mean different things. Generally, productivity growth should be equated with a rising output/input ratio. In other words, a society with given human and natural resources is able to produce a higher rate of output over time. However, it is not this general definition of productivity that presents a problem. It is the process by which inputs are transformed into outputs that presents the valuation, measurement and relational problems in providing an operational definition of productivity growth. In this thesis productivity growth is regarded as a long term concept and will be denoted by τ. At the macro level then, productivity growth should indicate the increase in wealth achieved by a society in a particular period - if a society is able to produce more output from its fixed resources it will have become wealthier. At the level of the individual firm, the welfare of producers and consumers will be optimised when production is carried out as efficiently as possible - so that the fewest possible inputs are used to produce a given output. Having defined τ as an ideal measure of productivity growth, estimates of productivity growth will be evaluated against this benchmark; i.e., insofar as their theoretical design and empirical application do measure rising production efficiency.

It has already been pointed out that productivity growth is best understood as a long run concept since it underlies a nation's long run growth and wealth. A simple distinction between the short run and long run should help emphasise the long term nature of the productivity concept as well as indicating the scope of the present thesis. A simple macroeconomic aggregate demand and supply analysis is sufficient for this purpose. As **Figure 1.1 (a)** illustrates, short-run macroeconomics is usually concerned with the gap between actual output (Y) and potential output (Y^*), where Y^* indicates the economy's capacity for production and is normally taken as given. In general, most economists have devoted their attention to the short term gap between aggregate demand and long-run aggregate supply[6]. In contrast, the present thesis is concerned with those factors influencing Y^*. **Figure 1.1 (b)** helps illustrate that it is long-run supply side forces which underlie the expansion of an economy's capacity for production from Y_0^* to Y_1^*. It is argued in this thesis that these long term supply side determinants of productivity growth must be considered in

[6] This interest stems from a concern with the inherent short-run stability of the economy and the hope that policy can be devised to dampen fluctuations around the given potential output.

order to gain a better understanding of South Africa's current economic performance[7].

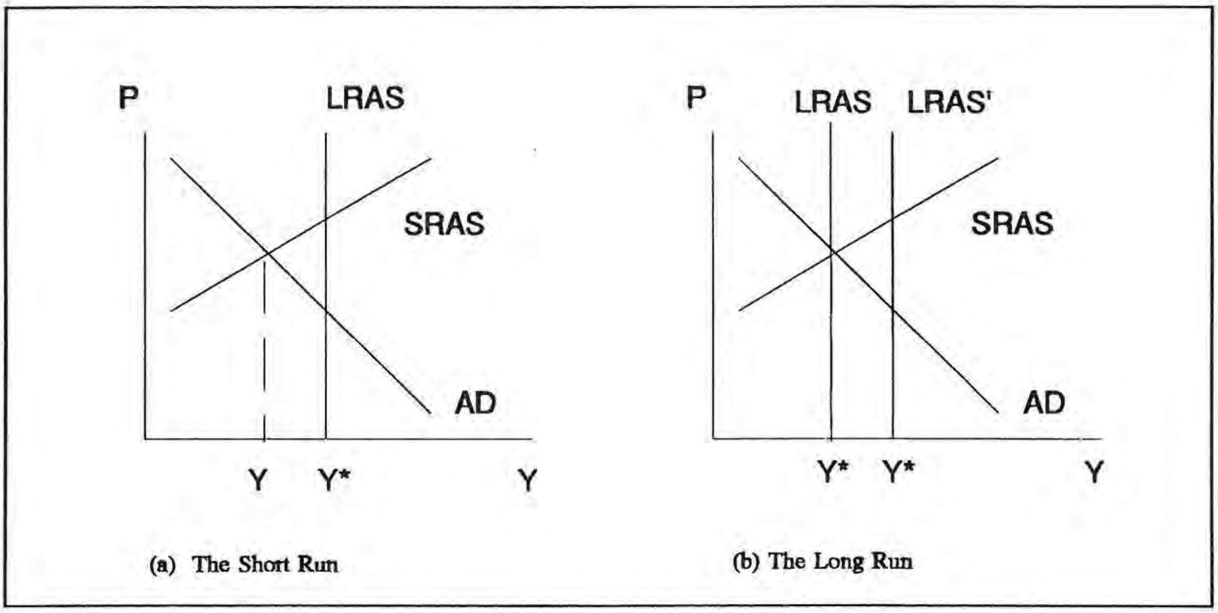


Figure 1.1: Aggregate Demand-Supply Analysis and the Short-Run Long-Run Distinction

1.5 Structure of the Thesis

The thesis is broken down into six chapters. Chapter two derives estimates of productivity growth in manufacturing by adopting the conventional neoclassical approach. This method is applied for manufacturing as a whole and for individual industries. The role of resource reallocation is also considered. The rationale for such an approach is that the productivity performance of manufacturing as a whole needs to be understood in the light of the performance of individual industries and changes in the structure of the manufacturing sector.

Chapter three considers the most appropriate way to interpret these productivity estimates. As such, this chapter takes a closer look at the "proximate sources" of output growth. In

[7] Of course this simple depiction of a sharp distinction between the short-run and long-run is unrealistic. Many short-run influences will have long-term consequences, and a fuller treatment of South Africa's productivity growth performance should try to analyze these links. This analysis has not considered short-run links in the interest of keeping to a manageable area of enquiry and because economic theory provides us with little insight into these links.

particular, it is emphasised that an adjustment needs to be made for the utilisation of factors since fuller utilisation should not be regarded as an improvement in production efficency. In this chapter it is also pointed out that the neoclassical model is fraught with other definitional and measurement problems which affect the interpretation of TFP growth measures.

Chapter four is theoretical. Firstly, an assessment is made of the importance of theoretical and empirical problems involved in the neoclassical TFP measure. This assessment suggests that there is a need to question the usefulness of TFP measures as indicators of production efficiency. In the light of these issues some recent advances in the theory of economic growth and technical change are considered. In particular, Romer (1990) has developed a model which significantly enhances the neoclassical model by making technological change endogenous like other factors. In contrast, Scott (1989) argues that growth cannot be adequately analyzed by modifying the neoclassical model. In Scott's model investment is the key force driving growth and it cannot be separated from the process of technological change. Scott argues that what should be assessed is the "efficiency of investment". This chapter also considers some of the insights from the "evolutionary" theorists, Nelson and Winter (1982) and Lall[8] (1992), who emphasise the processes by which firms evolve and acquire the necessary technological capabilities for survival and growth. While little progress has been made in operationalizing these theories, they do highlight a multitude of factors that affect productivity growth. However, given such a multitude of factors, a cynic might despairingly conclude that "everything" determines productivity growth. While these sentiments are understandable, it is argued that it is possible to build up a coherent framework for assessing

[8] Lall (1992) essentially extends and deepens Nelson and Winter's (1982) analysis into the developing country context. Also see Dosi et al. (1988) which provides a fairly comprehensive coverage of recent theoretical developments, of an evolutionary nature, in the field of economic growth and technical change.

the key determinants of productivity growth from the insights of these recent theories.

Chapter five then applies this framework to South African manufacturing. On the basis of this framework, various inferences are made about the fundamental causes of the past productivity growth performance of South African manufacturing. This framework also suggests the need to be sceptical of simplistic and general policy prescriptions given the complex nature of the processes by which production efficiency improvements are generated.

Finally, chapter six summarises the essential findings of the thesis and reaches some overall conclusions. In addition to drawing some tentative policy inferences for improving South Africa's industrial productivity growth, a critical assessment is made of the policy prescriptions advanced by other economists in South Africa.

Chapter 2

The Productivity Growth Performance of South African Manufacturing

2.1 Methodology - Deriving Neoclassical Total Factor Productivity (TFP) Measures

Typically the neoclassical sources-of-growth analysis has been applied to measure productivity growth in South African manufacturing[1]. This analysis suggests that a society's welfare depends on the resources (capital, labour - skilled and unskilled, land and natural resources) it has at its disposal, as well as how productively it utilizes these resources. Thus, growth accounting decomposes output growth into two sources: that attributable to the growth of factor inputs, and that attributable to 'Total Factor Productivity' (TFP) growth. As such, one country grows faster (over time and/or relative to other countries) either because of an increase in the resources at its disposal, or because it uses them more productively:

$$G_V = [\alpha G_K + \beta G_L] + G_{TFP} \qquad (2.1)$$

This approach decomposes value added growth (G_V) into three "proximate sources" of growth: Capital growth (G_K), labour growth (G_L) and residual TFP growth (G_{TFP}). The latter is typically labelled technological progress. Here, α is the elasticity of output with respect to capital, while β is the elasticity of output with respect to labour. Therefore, α indicates the impact on output of a unit increase in capital, while β indicates the impact on output of a unit increase in labour. The production function underlying this specification usually assumes constant returns to scale[2] and neutral technological progress[3]. TFP growth is derived as a

---

[1] Moll (1990); Fourie (1978); NPI (1990), Belli et al. (1992), Joffe et al. (1993).

[2] $\alpha \equiv \frac{\partial V}{\partial K} \cdot \frac{K}{V}$; $\beta \equiv \frac{\partial V}{\partial L} \cdot \frac{L}{V}$ Since the simple neoclassical model assumes perfect competition and rational optimising behaviour, marginal products should equal factor returns. Hence : $\alpha = S_K$; $\beta = S_L$ where S_K and S_L are respectively the shares of labour and capital in output. hence $S_K + S_L = 1$ therefore $\alpha + \beta = 1$, therefore $\alpha = 1 - \beta$.

[3] This follows from the assumption that α and β remain constant over the period of the analysis.

residual once the contribution of input growth to output growth has been accounted for:

$$G_{TFP} = G_V - [\alpha G_K + \beta G_L] \tag{2.2}$$

Equation 2.1 can be rewritten as follows[4]:

$$G_{V/L} = \alpha G_{K/L} + G_{TFP} \tag{2.3}$$

This alternative formulation decomposes labour productivity into the contribution of capital deepening, that is, increases in the capital labour ratio, and a residual. In this formulation then, there are two "proximate sources" of labour productivity growth: the growth in the amount of capital per worker and the residual TFP growth.

2.2 The Productivity Growth Performance of Manufacturing as a Whole

The above formulation is applied to South African manufacturing, and the resulting measures are shown in **Table 2.1**. It is clear from this table that measured TFP growth contributed little to labour productivity growth in all periods and that its contribution was in fact negative in the period immediately after the war (1945-54) and in the most recent period (1981-90). The most alarming feature of these measures is the labour productivity growth slowdown between 1974-81 and 1981-90 from 2.3 to 0.2% per annum, which is associated with a slowdown in both capital deepening and TFP growth (which actually is negative in the 1981-90 period). These estimates appear reasonably consistent with estimates by other authors[5].

[4] This follows from: $G_V = \alpha G_K + G_L - \alpha G_L + G_{TFP}$

$\therefore \quad G_V - G_L = \alpha(G_K - G_L) + G_{TFP}$

$\therefore \quad G_{V/L} = \alpha G_{K/L} + G_{TFP}$

[5] See **Appendix A** for a comparison of estimates by different authors.

Table 2.1: Average Annual Productivity Growth in South African Manufacturing 1945 - 1990. (%)

	1945-54	1954-63	1963-74	1974-81	1981-90
(1) Labour Productivity[a]	0.8	2.5	2.7	2.3	0.2
(2) Capital Deepening[b]	2.0	1.5	2.4	2.0	0.7
(3) Total Factor Productivity	-1.2	1.0	0.3	0.3	-0.5
(4) $G_{TFP}/G_{V/L}$[d]	-	40%	11%	13%	-

Sources:
For the periods 1945-74 Kok (1981); for the periods 1974-90 IDC manufacturing data base (January 1992). Kok's series are in constant 1970 prices and the IDC series are in constant 1990 prices.
Notes:
[a] Growth in value added per worker ($G_{V/L}$)
[b] The contribution of the growth in the capital labour ratio to labour productivity growth $\alpha G_{K/L}$.
[c] Derived as a residual: Row (1) - Row (2)
[d] This shows the contribution of TFP growth to labour productivity growth: Row(3)/Row(1) as a %.
The notes to Appendix D elaborate on the method used to derive α.

A thorough assessment of the performance of South African manufacturing requires a comparative analysis of the performance of other countries. **Table 2.2** provides a comparison over the periods 1960-73 and 1973-81 between South Africa and OECD countries. Clearly, South Africa's labour productivity and TFP growth rates are lower than those of the OECD countries, in both periods shown. This should come as no surprise however, as it is fairly well established by now that the major source of output growth in industrialising countries, as opposed to developed countries, is the growth of factors, rather than productivity growth[6]. It appears from these estimates that South Africa experienced a similar TFP slowdown between the periods 1960-73 and 1973-81 to these countries, but that South Africa's labour productivity slowdown was milder[7]. While the OECD countries do comprise our major trading partners, this does not mean that they are the most suitable benchmark against which to compare South Africa's productivity growth performance. However, the OECD estimates

---

[6] See Pack (1988 : 352), who notes that:

> **"A major difference between the LDCs and DCs seems to be that growth in the former is largely accounted for by the accumulation of inputs rather than the growing efficiency in their deployment."**

See Figure 2.1, which provides some support for this general finding.

[7] Similar comparative data for the 1980s is not available for the OECD. However data from OECD Outlook provides such data on productivity for the whole business sector (not just manufacturing). See Appendix B which helps indicate that although most economies did not improve their productivity performance in the 1980s they did not experience further productivity growth deteriorations as appears to be the case in South African manufacturing.

are useful because they highlight the effect of international factors on the productivity growth performance of the advanced industrialised countries. Indeed, in the 1973-81 period the advanced industrialised economies experienced a major recession, with poor performance being recorded in all spheres of economic activity including productivity growth. This evidence clearly conflicts with conventional theory which suggests that productivity growth (production efficiency improvements) performance is independent of macroeconomic performance. As such, it has remained a puzzle as to why productivity growth (especially TFP) should have been so adversely affected in this period of poor macroeconomic performance. The productivity growth trends of the OECD countries are therefore relevant to understanding productivity trends in the South African manufacturing sector as South Africa was exposed to the same international macroeconomic disturbances in the 1970s.

Table 2.2 : Manufacturing Productivity Growth comparisons: South Africa & OECD countries, 1960-1981

	1960-73	1973-81	Change
South Africa			
(1) Labour Productivity	3.2	2.1	-1.1
(2) Capital Deepening	1.9	2.0	0.1
(3) Total Factor Productivity	1.2	0.2	-1.0
OECD			
(1) Labour Productivity	5.9	3.3	-2.5
(2) Capital Deepening	3.0	1.5	-1.4
(3) Total Factor Productivity	2.9	1.8	-1.1
Japan			
(1) Labour Productivity	9.9	4.6	-5.3
(2) Capital Deepening	5.7	2.7	-3.0
(3) Total Factor Productivity	4.2	1.9	-2.3
United States			
(1) Labour Productivity	3.8	2.1	-1.7
(2) Capital Deepening	2.7	1.0	-1.7
(3) Total Factor Productivity	1.2	1.2	0.0

Notes and Sources: South Africa: as for Table 2.1. OECD country estimates: from Aberg (1982) in Lindbeck (1983: Table 1). Aberg uses capital services rather than capital stock (as used to derive the estimates for South Africa) to determine the growth of the capital labour ratio. Note the South African growth rates differ from Table 2.1 because the periods differ slightly.

However, it is the performance of countries at a similar stage of development, with similar attributes, in terms of size, resource endowments and demographic factors, which provide a more relevant benchmark with which to assess the TFP performance of South African manufacturing[8]. The East Asian Newly Industrialising Countries (NICs) pose a clear source of international competition, while other developing countries, such as Argentina, India, Brazil and Mexico, exhibit some similar features to South Africa. Having said this, estimates of manufacturing TFP growth in many developing countries are often crude or non-existent[9].

Nevertheless, Page (1990) provides data on a broader cross-section of countries, since, in addition to data on the industrialised countries he also includes data for thirteen developing countries. **Figure 2.1** shows this data which provides more comprehensive evidence with which to assess the performance of the South African manufacturing sector[10]. This figure shows the relative importance of TFP growth and Total Factor Input (TFI) growth in industrial output growth, and appears to support the observation that developing countries tend to rely more on input growth ("intensive growth") than on productivity growth as a generator of output growth. Hence, South Africa's modest TFP growth but quite rapid input growth, while no cause for congratulation, should not be regarded as particularly abnormal given the fact that South Africa is essentially a developing country. As such, **Figure 2.1** indicates that South African manufacturing TFP growth, TFI growth and output growth is not markedly different from the industrial growth records of Mexico, Japan, Yugoslavia or India. However,

[8] See Mohr (1993) for a good discussion of which countries South Africa should be compared with and what can be learned from their experiences.

[9]This can partly be attributable to the lack of reliable capital stock measures for many LDCs. Some estimates of TFP growth for earlier periods are available at the economy-wide level for a selection of Latin America countries: see Elias (1978); Bruton (1967). However Havrylysyn (1990) points to discrepancies in Bruton's and Elias's productivity growth measures for similar periods in Argentina and argues that:

> **"The wide differences in the output growth rate and the share of the residual, and even the inconsistency in the direction of change between one period to the next, are also found for other countries and periods of the studies." (Havrylysyn,1990:7)**

Chenery (1983) and Chenery and Syrquin (1986) provide more recent estimates, but again only at the economy-wide level. Pack (1988:352) points to other studies that have been undertaken for individual countries.

[10] This analysis is based on data assembled by Nishimizu and Page (1987) for industrial activities at the two-digit ISIC level. The authors note that the measurement methodologies are reasonably comparable among countries, but that the periods vary across countries, falling within the years 1956 to 1982.

Korea, Indonesia, Thailand and Turkey record much better growth in all three (TFP, TFI and output growth), while Argentina, Chile, Hungary and Egypt record better TFP growth, but worse TFI and output growth. Likewise South Africa outperforms the Philippines and Zambia (and India) in TFP growth, but records lower TFI and output growth.

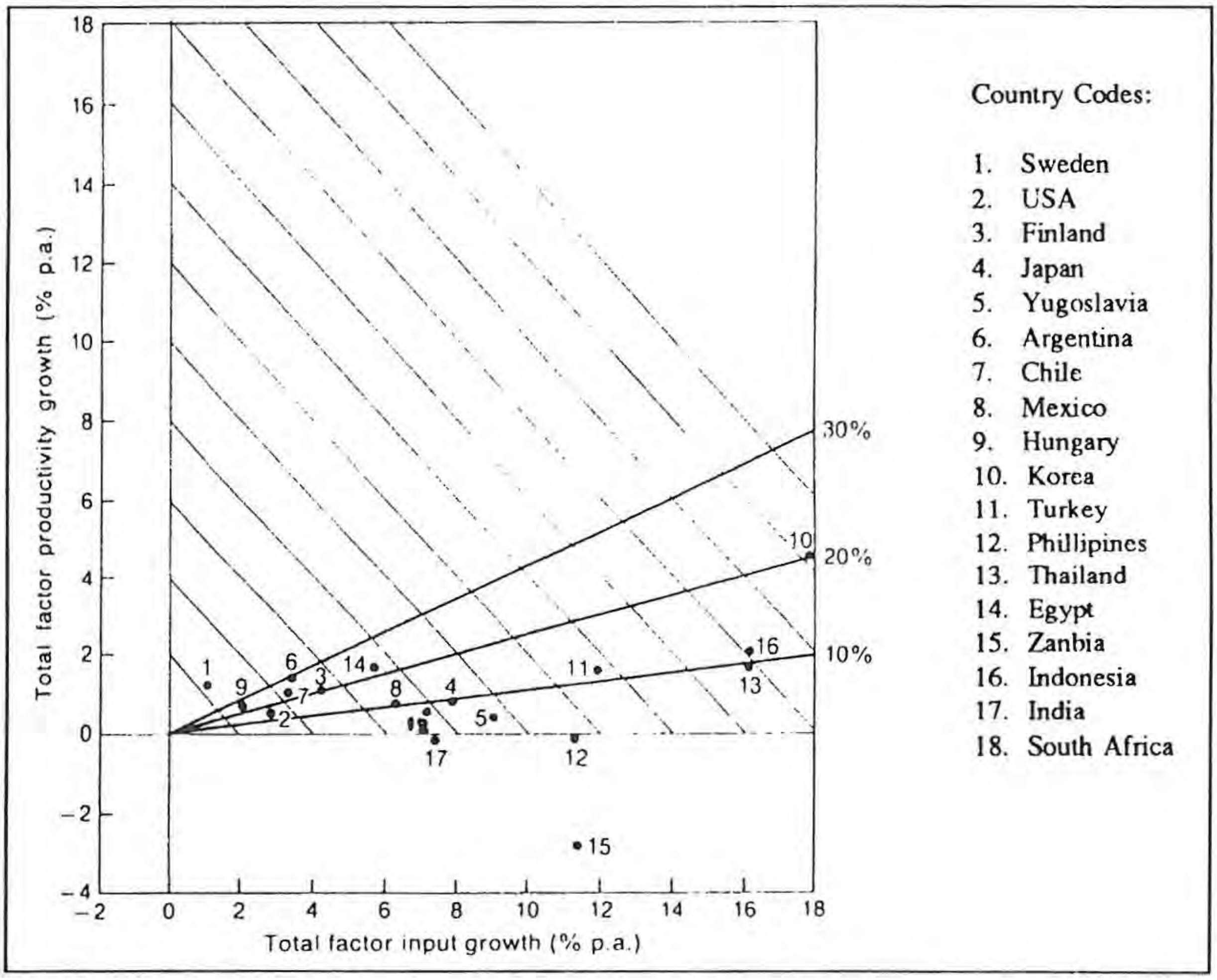
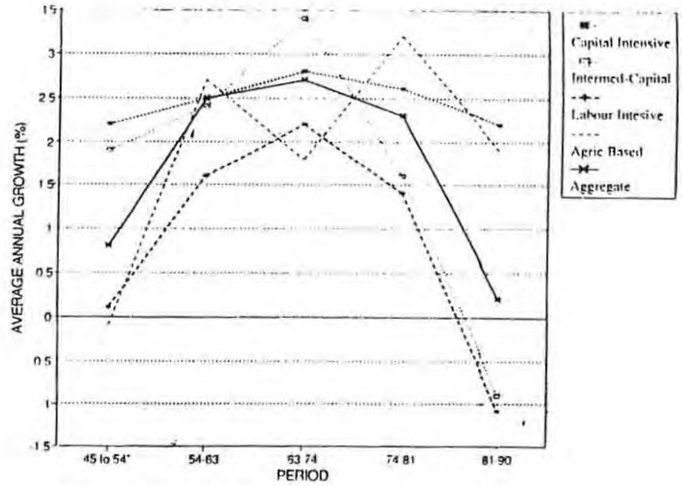


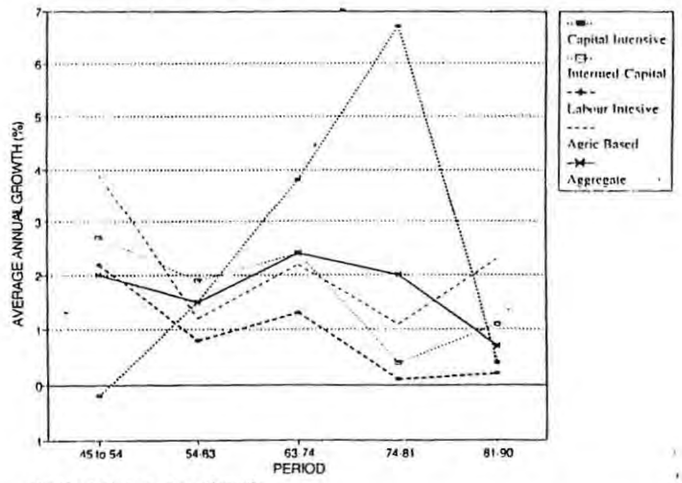
Figure 2.1 : International Manufacturing Comparisons of TFP, TFI and Output Growth.

<u>Sources:</u> For all countries except South Africa: Page (1990), Figure 6.1, p113; for South Africa: Own calculations for the period 1960-75. This period was chosen for its relatively close correspondence to the periods analyzed in other countries.

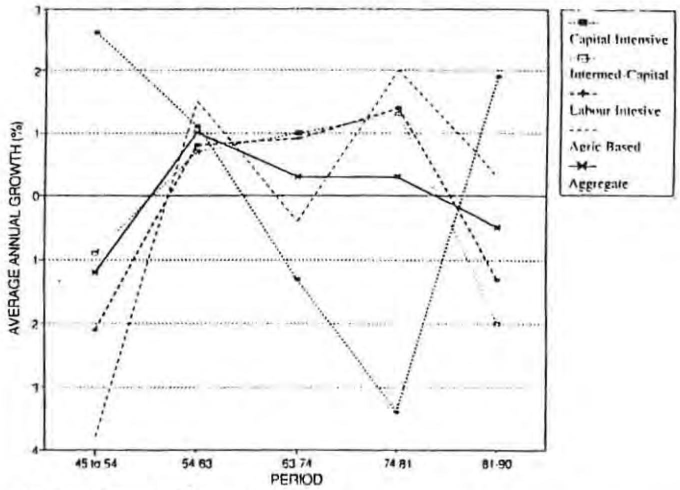
However, the productivity growth estimates for total manufacturing do not tell the whole story. Rather, the productivity performance of manufacturing as a whole should be understood in the light of the productivity growth performance of individual industries (See **Figure 2.2**).



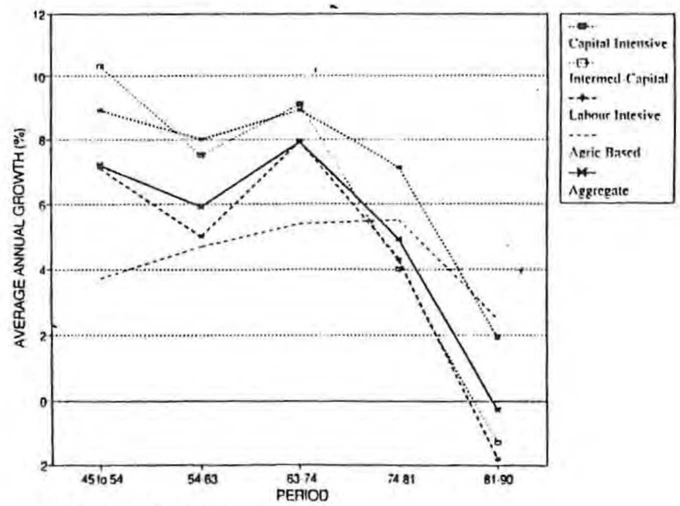
(a) Labour Productivity Growth



(b) Capital Deepening Growth



(c) Total Factor Productivity Growth



(d) Value Added Growth

Figure 2.2 : Average Annual Growth of Manufacturing Industries Categorised by Capital Intensity (%)

Notes and Sources: See Appendix D.

2.3 The Productivity Growth Performance Within Manufacturing

Figure 2.2 shows the productivity growth performance of four categories of industries within the manufacturing sector, distinguished according to capital intensity, for five sub-periods between 1945 and 1990. Industries were ranked in order of capital intensity[11] in 1990 and grouped into capital-intensive, intermediate-capital-intensive, labour-intensive and agriculturally-based industries. Although the dividing line between these groups is somewhat arbitrary, their ranking has remained fairly stable over time and the classification does provide a useful way of analysing the performance of different types of industries[12].

This figure suggests that the intermediate capital-intensive and labour-intensive industries provide the most typical picture of productivity growth trends in manufacturing. Capital-deepening was the dominant source of labour productivity growth for these categories of industries for the three periods between 1945 and 1974. While TFP growth was more significant in the 1963-74 period, it was even more significant in the period 1974-81, where it was virtually the only source of labour productivity growth, as capital-deepening was almost absent in this period. While capital-deepening did pick up a little in the 1981-90 period, substantial declines in TFP, labour productivity and value added were experienced in these categories of industries. For the other industrial categories the picture is not as clearcut. While the TFP growth performance of the agriculturally-based industries was poor in the 1945-54 period, and recorded a lull in growth in the 1963-74 period, the other periods indicate a fairly steady TFP growth performance. The productivity growth performance of the capital-intensive industries however, indicates significant variations between periods. This significant variation

[11] See Appendix C.

[12] Appendix D provides a more detailed picture, showing the performance of individual industries.

across industrial categories makes generalisations from aggregate manufacturing productivity measures misleading as to the productivity performance within manufacturing.

Within industry categories (see **Appendix D**) there are some notable exceptions to general trends of these categories just as there are important differences between the performance of industry categories and manufacturing as a whole (see **Figure 2.2** and **Appendix D**). For example, in the period 1945-54, the relatively poor performance of industrial chemicals (which recorded a TFP decline of 1.3 percent per annum) and non-ferrous metals (TFP decline of 2.4 percent per annum) masked the relatively good performance of iron and steel (TFP growth of 4.4 percent per annum). Another notable feature of this period is the exceptionally poor TFP performance of Motor Vehicles (TFP decline of 3.8 percent per annum) and Electrical Machinery (TFP decline of 5.3 percent per annum) which is largely responsible for the poor TFP performance for the intermediate capital-intensive category as a whole. By contrast, the TFP performance of manufacturing as a whole in the 1954-63 period does provide a good summary of the performance of individual industries and categories of industries, with the notable exception of motor vehicles which continued to register poor TFP performance (declining by 2.7 percent per annum). However, in both the 1963-74 period and the 1974-81 period the intermediate capital-intensive and labour-intensive categories of industries, and most of the industries within them, recorded much better TFP performance than is indicated by the TFP growth measure for manufacturing as a whole in these periods. This is largely due to the poor performance of the capital-intensive category in both periods. However, the individual industries responsible for the poor performance of this category as a whole differ markedly. In the 1963-74 period, even though industrial chemicals recorded a good TFP growth performance of 3.5 percent per annum, this was overshadowed by the poor performance of both iron and steel and non-ferrous metals, which recorded a TFP decline of 2.7 and 3.0 percent per annum respectively. However, these trends were reversed in the 1974-81 period with industrial chemicals experiencing a massive TFP decline of 12.1 percent per annum, which offset the impressive TFP growth performance of iron and steel and non-ferrous metals of 5.3 and 5.5 percent per annum respectively. In the most recent period (1981-90) however, the TFP growth measure for manufacturing as a whole does not show the extent of the poor TFP performance of almost all industries in the intermediate capital-intensive and labour-intensive categories, as the capital-intensive industries all recorded relatively good TFP growth. The deterioration in the productivity growth performance in this period is most alarming in its extent (with both labour productivity and TFP growth slowing down considerably from the 1974-81 period) given the pervasiveness of this deterioration across industries outside of the capital-intensive industry category.

Data availability limits an analysis of South Africa's comparative performance within manufacturing. Nevertheless, Nishimizu and Robinson (1984) provide a useful disaggregated study of TFP growth within manufacturing for Korea, Turkey, Yugoslavia and Japan, while Ahluwahlia (1985) has undertaken a similar study for India. Using these measures, **Table 2.3** presents bilateral comparisons of the productivity measures of each country with those of South Africa, for the period analyzed in each country[13]. This table shows similar trends to those in **Figure 2.1** for manufacturing as a whole but in addition emphasises the comparative performance of individual industries.

[13] Note that it has not always been possible to derive estimates for South Africa that match the period for which the foreign country estimates relate. See notes to Table 2.3 for clarity of actual periods estimated and methods used. Comparability is a problem in so far as the productivity measures for individual South African industries are quite sensitive to the choice of period. Bilateral comparisons are made in an attempt to reduce the severity of this problem.

Table 2.3: Manufacturing TFP growth comparisons: South Africa and other industrialising countries.

	1960-80[a]		1960-77[b]		1963-76		1965-78[d]		1955-73	
	India	SA	Korea	SA	Turkey	SA	Yugoslavia	SA	Japan	SA
Food Processing	-3.6	1.0	5.3	0.8	1.9	-0.2	-0.6	0.8	2.2	1.5
Beverages	-3.1	-0.1		-1.2		-1.7		-2.5		-0.3
Tobacco	-3.6	0.4		1.2		0.0	-1.7	-1.3		3.0
Textiles	1.0	2.2	4.5	0.4	1.4	0.4		0.8	1.7	2.4
Apparel		2.7	1.6	1.3	2.7	1.4	-0.2	1.4	1.9	0.8
Footwear	0.7	1.3		0.5		-0.7		0.0		0.3
Wood products	-3.0	3.0	5.6	1.7	-1.2	1.4	-0.6	1.4	1.1	0.7
Furniture	2.1	2.1	4.9	1.0	3.2	0.6		0.6	-0.1	0.3
Paper	0.1	1.2	4.5	0.7	1.4	-0.3	0.1	0.7	1.6	2.1
Print & Publish	0.5	1.2		1.0		0.8		0.7		2.3
Leather	-2.4	1.1	2.8	-0.1	-1.0	-1.0	-0.1	-0.8	0.9	-1.1
Rubber	-5.5	0.7	5.9	0.2	5.8	-1.4	2.3	-0.5	-1.2	0.1
Chemicals	-1.3	-1.3	4.5	2.1	1.6	1.1	0.1	0.9	2.5	3.4
Petroleum	-5.6		0.7		0.4		0.2		-0.4	
Non-metallic mins	-1.2	1.8		1.7		1.1	1.7	1.0		2.4
Basic metal	-0.9	-0.6	1.9	-1.9	0.9	-2.9	-0.6	-1.9	1.0	-0.6
Metal products	-2.2	0.9	6.0	1.3	1.5	0.7	-0.6	0.5	0.8	2.0
NonElectric mach	-1.1	1.2	5.7	1.1	1.3	0.7		1.0	3.1	1.7
Electrical mach	-0.2	2.3	7.2	2.9	1.8	2.8	-0.3	2.3	4.4	3.1
Transport equip	0.1	0.0	5.1	-0.2	3.3	-0.2		-0.1	2.5	-1.6
Miscellaneous	-4.9	-0.7								
Tot Manufacturing	-0.6	0.7	3.7	0.6	1.3	0.0	0.5	0.2	2.0	1.4

Sources: For Korea, Yugoslavia, Turkey and Japan estimates are drawn from Nishimizu and Robinson (1984) and for India from Ahluwahlia (1985). All these estimates (except for South Africa) are also presented in Bruton (1989). For South Africa see notes to Table 1 and Appendix D.

Notes: Since the South African data series in Kok (1981) only go up to 1975 it was impossible to estimate TFP for periods that precisely matched the periods used in other countries. Hence:
a For the period 1960-80 TFP growth rates were derived from Kok for 1960-75, while TFP growth from 1975-80 was derived from the IDC data. The TFP growth rate shown is the equivalent constant exponential growth rate per annum for the whole period.
b The period 1960-75 was used for South Africa. c The period 1963-75 was used for South Africa.
d The period 1965-75 was used for South Africa.

For South Africa industry categories are as in Appendix D except for: Chemicals which comprises (12) Industrial Chemicals and (13) Other Chemicals; Non metallic minerals which comprises (16) Pottery, China and Earthenware, (17) Glass and Glass Products and (18) Other non metallic mineral products; Basic Metals comprises (19) Iron and Steel and (20) Non Ferrous metals.

In comparison to India, South Africa recorded positive and significantly superior productivity growth performance in virtually every industry in the period 1960-80[14]. Although the TFP growth performance of South African manufacturing, as a whole, is slightly worse than Yugoslavia, most industries in fact performed substantially better than in Yugoslavia. The exceptions were: basic metals, where South Africa recorded poor TFP growth; and rubber, where Yugoslavia's TFP measure was particularly good. However, compared to Korea, South Africa's TFP growth performance is very poor for manufacturing as a whole, as well as for virtually all industries. Compared to Turkey and Japan though, while South Africa's total

[14] See the note to Table 2.3 concerning the method used to estimate TFP growth in South Africa for the whole period 1960-80.

manufacturing performance is relatively poor, at the industry level some industries outperformed or achieved similar TFP growth, to those in Turkey and Japan, while the performance of many other industries was not substantially worse than in Turkey and Japan.

For the agriculturally-based industries of food, beverages and tobacco, for which comparisons can be made, South Africa's TFP measures were not much worse than other countries with the exception of Korea. For most of the labour-intensive industries South Africa's TFP performance was reasonably good. In textiles and apparel, South Africa's TFP growth measures were as good as, if not better than recorded in India, Yugoslavia and Japan, and not significantly worse than measures in Turkey and Korea. Similarly for wood, South Africa's TFP measures compare favourably with almost all countries, with the exception of Korea. The same is true for metal products and electrical machinery. However, the relative TFP performance of the South African basic metals industry was very poor in comparison to all countries shown, except for India where it recorded slightly better performance. In contrast the performance of the other capital-intensive industry, chemicals, appears to have performed relatively favourably in comparison with these countries[15].

In sum then, available international evidence suggests that, for manufacturing as a whole, South Africa's TFP performance has been relatively poor. However, this international evidence does not support such a conclusion for individual industries within manufacturing. Some South African industries have recorded relatively good TFP growth in comparison to other countries, while the TFP performance of other industries has been comparatively very

[15] An anomaly here is the performance of South Africa's chemicals industry compared with India. A closer look at Appendix D (period 1974-81) above should clarify that chemicals as a whole did perform well during most of the periods prior to 1975. In the period 1974-81 however, the TFP performance of the industrial chemicals industry on its own deteriorated substantially, recording a TFP decline of 12.1% per annum.

poor. A more definitive assessment of the TFP growth performance of South African manufacturing is limited by the availability of pertinent international comparisons. The evidence considered in **Table 2.3** only relates to a single period for each country with which South Africa is compared. This prevents an analysis of how South Africa's comparative TFP performance has changed over time and makes it hard to assess the significance of the poor absolute TFP growth performance in 1981-90 period.

2.4. Measuring the Role of Structural Change

An empirical estimate of the importance of resource reallocation can be determined by weighting the productivity growth rates of individual industries according to their shares in total manufacturing value added, summing these weighted TFP measures across industries and comparing them with the TFP growth for total manufacturing[16]. The total reallocation effect (TRE) thus measures the difference (residual) between total TFP growth and the weighted average of the TFP growth rates of individual industries:

$$TFP_t = \Sigma\, TFP_i\, w_i + TRE_A \qquad (2.4)$$

Therefore:

$$TRE_A = TFP_t - \Sigma\, TFP_i\, w_i \qquad (2.5)$$

where the weight, w_i is the share of value added of industry i in total manufacturing value added[17].

Hence, TRE_A will show the total gains/losses resulting from the reallocation of resources between industries with different levels of productivity. As equation 2.4 shows, TFP_t can be

---

[16] See Syrquin (1984) for a more detailed description of the procedure.

[17] See **Appendix E**, where the output (and employment) shares of individual industries and groups of industries are presented. These shares are calculated as the cumulative average over the respective period (ie: $w_i = \Sigma\Sigma V_{it}/\Sigma V_t$). This Appendix also helps to show which industries and industrial groups have been expanding and which have been contracting over time.

decomposed into 'pure' productivity growth generated from increased efficiency within an industry ($\Sigma\ TFP_i\ w_i$) and productivity growth generated from the reallocation of resources between industries (TRE). Hence, a positive TRE indicates the productivity gains that have arisen from the process of resource reallocation where high productivity industries expand and low productivity industries contract. These reallocation effects can be further decomposed into the contribution of the reallocation between industries in a given group and the reallocation between groups, classified according to capital intensity, as follows:

$$TRE_A = \Sigma TRE_j + TRE_B \qquad (2.6)$$[18]

where j = 1 to 4, and refers to the four groupings of industries according to capital intensity.

Hence, TRE_B will show the total gains/losses resulting from the reallocation of resources between high and low level productivity industry categories.

Table 2.4 provides an indicator of the extent to which the reallocation of resources contributed to TFP growth in various periods. The only significant differences between productivity growth within industries (ΣTFP_i) and aggregate TFP for manufacturing as a whole occurred in the 1945-54 period, and to a limited extent in the 1963-74 and 1974-81 periods. In the 1945-54 period, the gains from reallocating resources meant that the sum of productivity growth within industries was worse (-1.7% per annum) than the actual TFP

[18] This follows from :

$$TFP_t = TRE_B + \sum_{j=1}[(TRE_j)\ w_j + \sum_{i=1} TFP_{ij}\ w_{ij}]$$

$$= TRE_B + \Sigma\ w_j\ [(TRE_j)] + \Sigma\ TFP_{i\ wi}]$$

Substituting in equation 6 gives :

$$\Sigma\ TFP_i\ w_i + TRE_A = TRE_B + \Sigma\ w_j\ TRE_j + \Sigma\ TFP_i\ w_i$$

Therefore $TRE_A = TRE_B + \Sigma\ w_i\ TRE_i$

measure for total manufacturing (-1.2% per annum). The fact that the TRE_B of 0.5% per annum is approximately equal to TRE_A means that most of this resource reallocation was between industry categories rather than between industries within these categories[19]. In the 1974-81 period, there were some small gains from resource reallocation, since the weighted sum of individual industry's TFP growth was lower (0.1% per annum) than indicated by the TFP measure for total manufacturing (0.3% per annum). However, in this case, the almost zero TRE_B indicates that most of the reallocation affect was due to the movement of resources among industries within their categories. In contrast, the effect of resource reallocation in the 1963-74 period was to reduce the TFP growth measures for manufacturing as a whole by 0.2% per annum. Most of this resource reallocation was between industrial categories rather than within them.

Table 2.4: The Role of Structural Change in TFP Growth in South African Manufacturing 1945-1990, (%)

	1945-54	1954-63	1963-74	1974-81	1981-90
Total Factor Productivity[a]	-1.20	0.97	0.28	0.31	-0.50
$\Sigma TFP_i w_i$ [b]	-1.73	0.92	0.50	0.08	-0.56
Total Reallocation Effect (TRE_A)[c]	0.53	0.05	-0.22	0.24	0.06
$\Sigma TRE_j w_j$ [d]	0.03	0.07	-0.06	0.21	0.04
Total Reallocation Effect (TRE_B)[e]	0.50	-0.02	0.16	0.04	0.02

Sources:
See **Table** 2.1.
Notes:
[a] TFP Growth for manufacturing as a whole.
[b] The sum of TFP growth rates of individual industries, where each industry (i) is weighted by its value added share in total manufacturing during that period (see Appendix E for shares).
[c] TRE_A is derived as the difference between TFP growth for manufacturing as a whole and the weighted sum of the TFP growth rates of individual industries: Row (1) - Row (2).
[d] The sum of TRE growth rates of individual industries within an industry category, where each industry category (j) is weighted by its value added share in total manufacturing.
[e] TRE_B is derived as the difference between TRE_A growth for manufacturing as a whole and the weighted sum of the TRE growth rates of industry categories: Row (3) - Row (4).

[19] See **Appendix E**, which shows that in the 1945-54 period the capital-intensive and intermediate capital-intensive categories, increased their share in total manufacturing value added between the periods 1945-54 and 1954-63 at the expense of the labour-intensive and agriculturally-based categories. This supports the notion that in general the more capital-intensive industries are likely to be the higher productivity industries.

It appears from these estimates that structural change within manufacturing has not had a significant influence on TFP growth. This appears surprising given the importance economists, such as Chenery (1983) and Syrquin (1984), have attached to structural change in the growth process. However, theory and evidence does suggest that the biggest gains from resource reallocation lie in the movement of resources between major sectors (particularly from agriculture to manufacturing and/or services) rather than from resource reallocations within such sectors. It should also be pointed out that TRE is not a perfect measure of resource reallocation. In the first case, the TRE analysis assumes input homogeneity across industries, so in fact TRE may be partly capturing differences in returns to capital and labour across industries because factors are more productive in some industries as opposed to others and not because of disequilibrium. Secondly, TRE is essentially a static and partial measure. Hence, there is no scope for considering the dynamic effects of resource reallocation. In this respect it is quite possible that resource shifts may in fact facilitate or trigger higher productivity growth, and that at the same time these resource shifts may not be possible without higher investment and income growth rates.

2.5 Summary

For manufacturing as a whole, the clearest trends that emerge are that while total factor productivity growth was fairly steady over the three sub-periods from 1954-81, a substantial TFP and labour productivity growth decline was experienced between 1974-81 and 1981-90. The extent of this recent slowdown and its pervasiveness across industries outside of the capital intensive category, is a striking feature of the productivity growth performance of South African manufacturing. In most industries it has been accompanied by an absolute decline in output, value added and employment, while the growth of capital stock slowed considerably (to 1.1% per annum in the 1981-90 period for manufacturing as a whole in comparison to the 8.1% per annum growth in the 1974-81 period).

However, before an adequate interpretation of these measures can be made, differences across industries, over time, and in comparison with other countries need consideration.

The intermediate capital-intensive and labour-intensive industries provide the most typical picture of productivity growth trends in manufacturing. In these groups capital-deepening was the dominant source of labour productivity growth for the three periods between 1945 and 1974. While TFP growth was more significant in the 1963-74 period, it was even more significant in the period 1974-81, where it was virtually the only source of labour productivity growth, as capital-deepening was almost absent in this period. While capital-deepening did pick up a bit in the 1981-90 period, substantial declines in TFP, labour productivity and value added were experienced in these categories of industries. For the other industrial categories the picture is not as clearcut. While the TFP growth performance of the agriculturally-based industries was poor in the 1945-54 period, and recorded a lull in growth in the 1963-74 period, the other periods indicate a fairly steady TFP growth performance. The productivity growth performance of the capital-intensive industries indicate significant variations between periods. This significant variation across industrial categories makes generalisations from aggregate manufacturing productivity measures of the productivity performance within manufacturing misleading. For example, the extremely poor TFP measure for industrial chemicals in the 1974-81 period disguises the significant TFP growth improvements of other capital-intensive industries, the agriculturally-based industries and many of the intermediate-capital-intensive and labour-intensive industries. Similarly, in the most recent period of 1981-

90, the aggregate TFP growth measure for total manufacturing does not show the extent of the poor TFP performance of almost all industries in the intermediate capital-intensive and labour-intensive categories since the capital-intensive industries recorded relatively good TFP growth. The reallocation of resources between high and low productivity industries does not appear to have played an important role in the growth process except in the earlier period 1945-54.

Available international evidence suggests that, for manufacturing as a whole, South Africa's TFP performance has been relatively poor. However, this international evidence does not support such a conclusion for individual industries within manufacturing. Some South African industries have recorded relatively good TFP growth in comparison to other countries, while the TFP performance of other industries have been comparatively very poor. This variation across industries in comparative productivity growth performance suggests the need for care in attributing too much importance to those factors that have an economy wide effect on productivity growth. In other words it appears that industry specific factors have been important determinants of productivity growth within manufacturing. It should be emphasised though, that a more definitive assessment of the TFP growth performance of South African manufacturing is limited by the availability of pertinent international comparisons.

Having evaluated the TFP growth record of South African manufacturing it is necessary to consider what these TFP measures actually indicate. This is important for facilitating an evaluation of the long term growth prospects of South African manufacturing.

Chapter 3

Interpreting Neoclassical TFP Growth Measures

3.1 Introduction : A closer look at the "Proximate Sources" of Growth

Having evaluated the TFP growth record of South African manufacturing it is necessary to consider how these TFP measures should be interpreted. In essence, the last chapter considered the "proximate sources" of labour productivity growth, over time, across industries and in comparison with other countries. This chapter looks at these proximate sources more closely and argues that various adjustments need to be made to the measures before they can be usefully interpreted as indicating production efficiency trends.

In theory, productivity growth should record the process whereby resources are combined in increasingly more effective ways. The crucial question is how well this TFP residual records such a process? In order to answer this question it is necessary to consider the many analytical problems that emerge when an attempt is made to measure (or value) inputs and relate them to output measures. Consider the functional form assumed by the neoclassical model[1], as shown above by equation 2.2 ($G_{TFP} = G_V - [\alpha G_K - \beta G_L]$). The magnitude and nature of the residual growth (G_{TFP}) will depend upon:

(i) The production function governing the relationship between the inputs and output.

(ii) The importance of variables omitted from the production function.

(iii) The proper measurement of output, including adjustments for changes in its quality.

(iv) The way labour and capital are measured, and the extent to which adjustments are made for changes in their quality and degree of utilization.

---

[1] This section draws upon Nadiri (1970) who provides a succinct discussion of the main theoretical aspects of the conventional neoclassical model. See also Maddison (1987).

Hence, if the assumed functional form relating inputs to output is mis-specified the resulting errors will be captured by the TFP measure. Likewise TFP growth will record any errors that arise in measurement of the inputs capital and labour.

Many economists[2] have tried to "squeeze down" the residual, by making more precise measures of the inputs, capital and labour, in order to "explain" more of output growth . This is regarded as providing a better indicator of the "proximate sources" of growth, and implies that the remaining "unexplained" residual is much smaller. Broadly, most of these adjustments are for changes in the utilisation and quality of the factors. The purpose of this chapter is to understand changes in production efficiency, hence, only adjustments for utilisation changes will be made in arriving at better indicators of the "proximate sources" of growth. However, in chapter five an assessment will be made of the qualitative changes to these inputs, but these will be regarded as part of TFP growth itself, since they provide a more direct indicator of the "underlying sources" of growth. To the extent that quantitative adjustments are possible for qualitative changes to the inputs this will mean that not all of TFP growth will be an "unexplained" residual. The distinction between utilisation adjustments and qualitative adjustments to the inputs is conceptually useful, since qualitative improvements to the factors of production are an important source of improved production efficiency, while fuller utilisation is not. Hence, the impact of qualitative changes to the factors will serve as a useful starting point when an attempt is made to understand the fundamental causes of production efficiency changes.

[2] See Denison, E (1984) and Jorgenson, D (1988); and for South Africa, Döckel and Fourie (1978).

In practical terms, since individual factors vary considerably in terms of utilisation and quality, aggregating them into one factor index is a significant problem, not only in respect of capital:

> **"Most of the controversy on aggregation has emerged from the problem of aggregating the different types of capital goods; however, the issues are equally applicable to the aggregation of heterogenous units of labour and output." (Nadiri, 1970 : 144)**

Partly, this problem is due to the difference between stocks and flows. Usually it is stocks of inputs that are aggregated. The problem of valuing heterogeneous units of labour and capital to form aggregate stocks is that their true value really depends on the present and future flows of services, provided by these stocks, that generate output[3]. It would be preferable to measure the flow of capital and labour services as it is these which really enter the production function. However, it is particularly difficult to value the services provided (the work actually done) by labour or capital independently of the provider of the services (the machine or employee doing the work). This would not be a problem if the value of stocks was closely related to the value of the flow of services from these stocks. However, often they are not.

3.2 Assessing the Impact of Changes in Capacity Utilisation on Recorded TFP Growth

If there have been no changes in the quality of capital and labour, and no factors have been omitted from the production function, then the residual will be solely comprised of changes in the degree of utilisation of capital and labour:

$$G_{TFP} = \alpha G_{MK} + \beta G_{ML} \qquad (3.1)$$

where MK and ML denote the utilisation changes of capital and labour respectively.

---

[3] The asset's true value is really the present value of the flow of services it generates in its economic lifetime, which may be very different from what it costs.

It is difficult to conceive of a sudden deterioration in the quality of inputs, given rising educational levels and the nature of technological change. Hence, a deterioration in TFP growth in the short run seems more adequately explained by a slowdown in the utilisation of factors, as factors are 'sticky' downwards in the short run[4].

There are important short run relations between output growth and the productivity measures, as Bernt (1984 : 325) points out:

> **"One of the most robust findings of empirical analysis is that both labour and multifactor productivity growth tend to be procyclical. As the economy reaches peak performance and full capacity, labour and multifactor productivity growth all grow at relatively rapid growth rates, whereas when the economy experiences a recession productivity growth tends to decline."**

Bernt (1984) argues that the most compelling reason for this is that in the short run stocks of capital and labour (especially skilled labour) are to some extent fixed and not instantaneously adjustable. Hence, when rapid output growth occurs, measured productivity growth improves as capacity slack is reduced. Similarly, when output growth is sluggish, measured productivity growth will decline because of excess capacity. In response to business cycle influences, the flows of capital and labour services adjust much more quickly than the stocks of capital and labour, so that short run TFP measures will be biased[5]. Given that the periods analyzed in chapter two are fairly short, the actual productivity measures may be recording trends in capacity utilisation in periods when output growth fluctuates substantially.

---

[4] See Bruton (1967) who argues that most of the growth of TFP (the residual) during the period 1945-63 for 5 Latin American Countries was due to changes in the utilisation rates of the factors so that 'pure productivity' growth appeared to be almost zero.

[5] Hence, poor short run TFP growth measures are more likely to reflect the undesirable consequence that a business slowdown has on excess capacity, rather than indicating a decline in production efficiency.

Since the aim of productivity analysis is to assess the efficiency of firms and industries, these short run cyclical variations in capacity utilisation clearly undermine the usefulness of the above productivity measures. Comparing growth patterns between peaks, when capacity utilisation rates are perceived as being high, is supposed to reduce the role of cyclical effects. This method of attempting to draw out long term productivity growth trends is dependent on the assumption that all peaks represent equal rates of recovery to full capacity. Unfortunately, this assumption may be extremely questionable in certain periods.

One way to assess the importance of capacity utilisation is to examine the short term relation between output growth and TFP growth. For this purpose regression analysis was used with TFP growth being specified as the dependent variable and value added growth as the independent variable[6]. Since the regression was run across the 26 industries within manufacturing the null hypothesis is that there should be no relationship between value added growth and TFP growth - ie: if a particular industry experienced above average value added growth, a priori there should be no reason to expect this industry to either record better TFP growth or worse TFP growth. **Table 3.1** presents these regression results which show clear evidence of a highly significant positive relation between the variation in output (value added) growth and the variation in TFP growth across industries for virtually every single short run period analysed[7]. However, the strength and significance of this relationship is much greater in more recent periods. In this respect, for example, in the 1981-90 period for all industries, regression analysis suggests that 76% (R^2) of the variation in TFP growth across industries

[6] While the neoclassical model does specify that output growth is dependent on TFP growth, the latter is assumed to occur exogenously and the relationship is essentially a long term one with technology having a parametric effect on output. Short term variability in the relationship is more adequately explained by variations in capacity utilisation.

[7] The only short term period where this positive relationship is not significant is the 1945-54 period for the labour-intensive and intermediate capital-intensive industries.

can be explained by variations in value-added growth across industries, and the t-statistic indicates that the null hypothesis of no relationship between TFP growth and value-added growth can be rejected with a 99.9% level of confidence (ie: at the 0.1% level of significance). Furthermore, this regression equation suggests that if industry X experienced a 1% faster growth in value-added per annum than industry Y in the 1981-90 period then industry X will have experienced a 0.66% faster growth in TFP per annum than industry Y. In contrast, the relationship in the 1963-74 period is less significant (the t-stat indicates that the null hypothesis can only be rejected at the 99% level of confidence), but more importantly it is not as strong. The R^2 value of 0.21 suggests that variations in value-added growth across industries can only explain 21% of the variation in TFP growth across industries. Furthermore, this regression analysis suggests that for a 1% difference in annual value-added growth between industries their annual growth in TFP will only differ by 0.22%.

Hence, although the relationship appears significant in all short term periods its much greater strength in the two most recent periods suggests that variations in capacity utilisation had a much greater effect on recorded TFP growth in these periods than in earlier periods. To some extent then, the 'peak' to 'peak' method of calculating growth rates may have provided an adequate compensation for the effect of capacity utilisation in periods prior to 1974, but not for the two most recent periods[8].

Also shown in **Table 3.1** are the regression results of the more direct relationship between official capacity utilisation measures and TFP growth. However, there are two problems with

[8] However, see below where adjusting TFP growth measures for capacity utilisation improves them in the 1981-90 period, but actually slightly worsens them in the 1974-81 period. This anomaly is explained below.

this data. Firstly, the nature of these capacity utilisation measures appears fairly subjective.

Table 3.1: The regression of TFP growth on Value Added growth and Capacity-Utilisation

Year	All Industries		Labour-Intensive & Intermediate Capital-Intensive Industries	
Short Term Periods				
1945-54	$G_{TFP} = -4.19 + 0.31G_V$ $(2.12)^{**}$	$R^2 = 0.16$	$G_{TFP} = -3.64 + 0.23G_V$ (1.42)	$R^2 = 0.10$
1954-63	$G_{TFP} = 0.08 + 0.14G_V$ $(2.38)^{**}$	$R^2 = 0.19$	$G_{TFP} = -0.14 + 0.14G_V$ $(2.19)^{**}$	$R^2 = 0.21$
1963-74	$G_{TFP} = -1.39 + 0.22G_V$ $(2.53)^{***}$	$R^2 = 0.21$	$G_{TFP} = -0.97 + 0.20G_V$ $(2.52)^{**}$	$R^2 = 0.26$
1974-81	$G_{TFP} = -2.35 + 0.81G_V$ $(2.65)^{***}$	$R^2 = 0.23$	$G_{TFP} = -2.38 + 0.99G_V$ $(6.21)^{****}$	$R^2 = 0.68$
1981-90	$G_{TFP} = -0.68 + 0.66G_V$ $(8.76)^{****}$	$R^2 = 0.76$	$G_{TFP} = -0.74 + 0.67G_V$ $(9.18)^{****}$	$R^2 = 0.82$
Medium and Long Term Periods				
1945-60	$G_{TFP} = -1.91 + 0.13G_V$ (1.30)	$R^2 = 0.07$	$G_{TFP} = -1.72 + 0.09G_V$ (0.86)	$R^2 = 0.04$
1955-73	$G_{TFP} = 0.35 + 0.12G_V$ (1.57)	$R^2 = 0.09$	$G_{TFP} = 0.09 + 0.16G_V$ $(1.90)^{*}$	$R^2 = 0.17$
1945-75	$G_{TFP} = -0.44 + 0.04G_V$ (0.63)	$R^2 = 0.02$	$G_{TFP} = -0.34 + 0.04G_V$ (0.44)	$R^2 = 0.01$
1972-90	$G_{TFP} = -1.06 + 0.56G_V$ $(4.41)^{****}$	$R^2 = 0.45$	$G_{TFP} = -1.09 + 0.67G_V$ $(6.08)^{****}$	$R^2 = 0.67$
Using Capacity Utilisation as the independent/explanatory variable				
1974-81	$G_{TFP} = 21.16 - 0.23\ CU$ (1.00)	$R^2 = 0.04$	$G_{TFP} = -4.09 + 0.07\ CU$ (0.39)	$R^2 = 0.01$
1981-90	$G_{TFP} = -22.34 + 0.25\ CU$ $(2.43)^{***}$	$R^2 = 0.20$	$G_{TFP} = -19.50 + 0.21\ CU$ $(2.03)^{*}$	$R^2 = 0.19$
1972-90	$G_{TFP} = -13.03 + 0.16\ CU$ $(1.78)^{*}$	$R^2 = 0.12$	$G_{TFP} = -16.60 + 0.20\ CU$ $(2.71)^{**}$	$R^2 = 0.29$

Source: Data from Table 1.3.
Note: These regression results show the relationship between TFP growth and Value Added Growth and the relationship between TFP growth and the average Capacity Utilisation rate for the period across industries. The t-statistics for the coefficients of the independent variables are shown in parenthesis below these coefficients, and where significant are indicated by asterisks: Level of Significance: * 90%, ** 95%, *** 99%, **** 99.9%.

Secondly, the measures are only available from 1972 onwards[9]. Generally the regression results of the relationship between average capacity utilisation and TFP growth do support the findings of the other regression analysis, but the evidence is much weaker and less significant.

[9] Fortunately, it is the periods since 1974 that capacity utilisation seems to have had its greatest effect.

One important difference however, is the fact that there is no significant relationship between average capacity utilisation and TFP growth (the relationship is actually negative) in the 1974-81 period even though the relationship between value-added growth and TFP growth across industries was fairly strong and highly significant. This discrepancy does present a problem since if an adjustment is made for capacity utilisation changes on the basis of these official measures then little allowance will be made for the effect of excess capacity that is indicated by the TFP/Value-added regression results[10].

In summary then, the regression results provide strong evidence of a positive correlation between value-added growth and TFP growth in the short term. However, this evidence needs careful interpretation. While correlation implies causality, it does not prove it or exclude the possibility that the causality may actually be the reverse. Hence, it is quite plausible that the correlation may run from TFP growth to value-added growth. Indeed, neoclassical theory, embodiment theories and other theories of technological change suggest that the causation is from TFP growth to output growth. However, there is almost universal recognition that this is a long term relationship with efficiency improvements facilitating output growth. Hence, a more adequate interpretation of a positive correlation between TFP growth and value-added growth (in the short term) is that depressed demand means slower value-added growth which results in excess capacity and so reduces measured TFP growth. This interpretation implies that those industries worst effected by slow value added growth record the worst TFP growth. This interpretation seems highly plausible in the two most recent periods where there is highly significant evidence of a strong positive relationship between TFP growth and value added

[10] Alternatively, it could be argued that while excess capacity was an important factor undermining recorded TFP growth in the 1974-81 period this excess capacity was largely soaked up in the boom of 1981. This illustrates a weakness with the 'peak-to-peak' method even when full capacity is almost attained at the end of the period.

growth. Thus, it appears that the effect of variations in capacity utilisation have clearly undermined the usefulness of the TFP growth measure as an indicator of trends in production efficiency, particularly in the two most recent periods, 1974-81 and 1981-90. However, the usefulness of these TFP growth measures as indicators of production efficiency can be improved if an adjustment is made for capacity utilisation.

3.3 Adjusting for the Effect of Changes in Utilisation on TFP Growth

3.3.1 Capital

The flow of capital services may not correspond very well with the growth in capital stock:

> **"What enters the production function is not the stock of capital, but the flow of capital services, and substantial changes can take place in the flow of services from a given plant. A plant can operate three shifts seven days a week, or eight hours a day for five days." (Baily, 1981 : 17)**

One way to get a more accurate indication of the flow of capital services from capital stock is to multiply the capital stock by the rate of capacity utilisation. This should provide a better indication of capital actually used in production. Since capacity utilisation data is only available for the period 1972 to 1990 this method of adjustment is only applied to the two most recent periods. As discussed above, these happen to be the periods where the effect of capacity utilisation appears strongest. **Table 3.2** shows the effect that such an adjustment makes to TFP growth measures for manufacturing as a whole. For the 1981-90 period the effect is clear and practically all-pervasive across industries (see **Appendix F**), with TFP improving by 0.44% per annum for manufacturing as a whole when an adjustment is made for capacity utilisation. What this means is that excess capacity accounts for almost all of the measured decline in TFP for this period.

This period (1981-90) provides a clear illustration of the failure of the peak to peak method of calculating growth rates to adjust for capacity utilisation. This is borne out by the fact that capacity is unlikely to have recovered to the level attained at the previous peak (1981) by 1990 since value-added actually declined (G_v = -0.3% per annum) in the 1981-90 period.

Table 3.2: Total Manufacturing TFP Growth Measures, Adjusted for changes to capacity utilisation and work hours (% per annum).

	1963-74	1974-81	1981-90
TFP - Unadjusted	**0.28**	**0.32**	**-0.50**
Effect of capacity utilisation changes	-	-0.04	0.44
TFP - Adjusted for capacity utilisation	**0.28**	**0.28**	**-0.06**
Effect of work hour changes	0.01	-0.05	0.08
TFP - Adjusted for both	**0.29**	**0.23**	**0.02**

Sources: TFP measures from Appendix D; Capacity Utilisation measures from South African Statistics; data on work hours from South African Statistics 1976, 1992.
Note : Hours worked refer only to ordinary hours worked by production and related workers.

However, with regard to the 1974-81 period the adjustment for capacity utilisation is small and actually reduces TFP growth. In this respect, capacity utilisation measures were higher in the boom year of 1981 than in the upswing of 1974, despite the fact that regression evidence suggests that variations in value added growth, across industries, had an important influence on TFP growth in this period. This discrepancy was discussed above and seems most likely due to the fact that although there was much excess capacity during the period, it was largely soaked up in the 1981 upswing[11].

3.3.2 Labour

The best way to measure the effective flow of labour services provided by the stock of employed workers is to make an adjustment for hours worked. **Table 3.2** above also shows the effect of an adjustment to work hours on TFP growth for manufacturing as a whole. Work

[11] Alternatively the discrepancy may be due to inaccurate capacity utilisation measures.

hours decreased only marginally in the 1963-1974 period, meaning that labour's effective contribution to output is slightly smaller and the contribution by TFP growth is slightly greater. However, in the 1974-81 period working hours rose moderately, so that the unadjusted TFP measures tend to overstate productivity growth. In the 1981-90 period working hours declined again, but this time more significantly, so that the adjusted TFP growth measures suggest that the TFP decline was not quite as severe as indicated by the unadjusted TFP growth measure[12].

In addition to the fairly small measured decrease in ordinary hours worked between 1963 and 1990 there are other factors which are likely to have led to fewer hours being spent actually working (ie a gap arising between hours ordinarily paid for and hours actually worked).

Longer vacations and sick leave are likely to have caused this gap to widen over time in South Africa - as they appear to have done in the U.S. and elsewhere (see Denison, 1984). Hence, such effects should reduce the effective contributions of labour growth and increase the contribution by TFP growth to output growth (ie TFP growth measures should be better than the adjusted measures in **Table 3.2** indicate). Denison (1984) does make an adjustment for these factors, and the evidence for the U.S. indicates that overall work hours have fallen over time. Denison argues that shorter work hours may to a certain extent reflect the benefits of progress (technical and organisational), enabling more work to be accomplished in less time. Hence, although a fall in work hours may directly reduce output growth, there is likely to be an offsetting effect which raises the productivity of those hours worked and so raises

---

[12] Note that this data refers only to hours worked by production workers and not all manufacturing workers.

output growth[13]. In this respect, it does seem plausible that if more time was spent at work more work might not actually be accomplished[14].

Another factor that is likely to have influenced the gap between hours ordinarily paid for and hours worked is the effect of strikes and stay-aways. Data on work hours are for ordinary working hours and so do not take into account hours lost through strikes and stay-aways.

The figures on work stoppages in **Table 3.3** clearly indicate a rising trend with the exception of the 1954-63 period. This rising trend in work stoppages would have meant that using employment numbers, adjusted for normal working hours, to measure labour input will have provided an increasingly biased estimate of labour's effective contribution to output. One should not exaggerate the importance of this effect however. While businesses may have suffered from the strikes and stay-aways of the 1980s, the slow demand that characterised this period may have meant that some firms experienced excess capacity and so partly benefitted from not having to pay absent workers.

Overall then, normal work hours and other factors, such as vacation and sick leave and the effect of strikes and stay-aways serve to reduce labour's effective contribution to output growth and increase TFP growth in almost all periods. Hence, these adjustments suggest that the actual (unadjusted) TFP measures are understated.

---

[13] In the light of this, Denison (1984) argues that an allowance should be made for this offsetting effect in arriving at the true contribution of labour. However, following Maddison (1987), no allowance is made since the true source of this offset is technological improvement which facilitates more being accomplished in less time.

[14] As in one of Parkinson's laws that claims that work expands to fill the time available.

Table 3.3: The effect of strikes and stay-aways (work stoppages) on hours worked, 1945 to 1990.

Period	Stoppages	Persons	Man Days Lost
1945 to 1954	47	17 484	176 323
1954 to 1963	75	7 456	17 303
1963 to 1974	179	23 008	44 732
1974 to 1981	211	38 168	83 503
1981 to 1990	664	241 656	1 398 134

Source: South African Statistics, 1964, 1970, 1980, 1990, Table 7.3.3: Industrial Disputes.
Note: These figures are not just for the manufacturing sector. All columns show average annual numbers for the period. Man days lost refer only to persons involved.

3.3.3 Conclusions

Overall then, it appears that, for all the periods, in which quantitative data was available or where trends were apparent from a more qualitative perspective, adjustments to both labour and capital for changes in the utilisation of factors increased the contribution of TFP growth to labour productivity growth and correspondingly decreased the contribution of capital deepening. Nevertheless, these adjustments do not appear to have been substantial, except in the most recent period (1981-90)[15]. Hence, it seems that capital-deepening has been the major "proximate" source of labour productivity growth, with TFP growth playing a minor role in almost all periods except the 1981-90 period where the unadjusted TFP measure is understated and capital deepening is overstated because of the effect of capacity utilisation.

[15] While there also seems to be evidence of excess capacity in the 1974-81 period the official capacity utilisation measures present a different picture making the situation less clear and less amenable to adjustment.

Chapter 4

Recent Growth Theories and The Causes of Productivity Growth

4.1 Introduction - The Need For A Theoretical Chapter

We have just seen in chapter 3 that with careful interpretation, the neoclassical approach can provide a useful methodology for measuring the proximate sources of growth in addition to providing a useful indicator of production efficiency trends. Unfortunately, neoclassical theory has little to say about the fundamental determinants of productivity growth. It is for this reason that this chapter examines some more recent theories of growth. These theories largely arose to overcome deficiencies with the neoclassical model.

Readers may prefer to move on directly to chapter five. However, it should become apparent in chapter five, that the analysis there, of the fundamental determinants of South Africa's industrial productivity growth, does not rely entirely on the neoclassical model, but in fact incorporates a number of important insights from some of the more recent theories of growth. As such, this chapter aims to highlight the essence of these theories for those who are not familiar with them.

The newer theories of growth try to overcome the problems that arise because of the way neoclassical theory models technological change and the relationship between technological change and investment. In essence, the neoclassical model treats technical change either as an allocative decision, or as an 'exogenous' technological advance. As a technological advance occurs, the production function is shifted by some fixed and known amount. The model determines the 'new' equilibrium growth path that arises as a consequence of this 'exogenous' advance, but provides no explanation for the causes of this technological change, or any basis with which to analyze the process by which technology is diffused. Technological change is essentially viewed as a "black box". The problem with this is that the quality of labour and existing machinery, as well as the nature of work organisation methods, are highly relevant to how effectively new technology is diffused and implemented into production. Furthermore, the neoclassical model takes no account of the market's role in transmitting stimuli to change. This role may be very different from, even conflict with, the market's role of allocating resources according to present scarcity values.

Thus, the neoclassical model appears of little use as a theory that purports to explain. Basically, the model provides little insight into how social, institutional, political or economic structures, the education system or labour relations might influence an economy's growth, efficiency and welfare. As Nelson (1981 : 1029) emphasises:

> **"the theoretical model underlying most research by economists on productivity growth is superficial and to some degree misleading regarding the following matters: the determinants of productivity at the level of the firm and of inter firm differences; the processes that generate, screen, and spread new technologies; the influences of macroeconomic conditions and economic institutions on productivity growth."**

It is these deficiencies in the neoclassical theory of growth that the newer theories have been developed to overcome. Three "new" theories of growth are outlined in this chapter: Romer's "endogenous" growth theory, Scott's "new view" of growth and the evolutionary theory of economic growth. The examination of these theories will highlight the insights they provide into the underlying causes of productivity growth. The last section of this chapter will try to use these insights to build a coherent framework within which the fundamental causes of productivity growth can be assessed. This framework will then be used in chapter five to supplement the neoclassical framework in the analysis of the fundamental causes of South

Africa's industrial productivity growth. Furthermore, this framework, together with the analysis in chapter five, will prove useful in chapter six, where policy implications are drawn and the policy proposals of other South African authors are assessed.

4.2 Romer's "Endogenous" Growth Model

The model of long run growth that Romer (1990) specifies is an attempt to account for important empirical regularities. In this regard, he notes that empirical data show a positive correlation between the investment share and the growth rate, but that in addition increased investment appears to exhibit diminishing returns, as increases in the rate of investment do not cause a one for one increase in the rate of technological change. The neoclassical model argues that there should be no relationship between investment and productivity, as technological change is exogenous, so that an increase in the rate of investment should simply result in a decrease in the marginal product of capital. In Romer's (1990) view, the precision of the estimates does not warrant such a conclusion. Rather, Romer (1990) argues that the estimates could be interpreted as showing that increased investment does not seem to induce enough technological change to completely offset the diminishing returns associated with increased capital accumulation.

In the light of this evidence, Romer (1990) argues that there is something else (which does not vary one for one with investment) that is decisive for long run productivity growth. Romer (1990) argues that this 'missing factor' is the stock of knowledge possessed by a firm or society. Hence, although investment may be a necessary condition for growth it may be insufficient without an adequate stock of knowledge. This contrasts with models that rely exclusively on capital accumulation to generate long run growth.

Staying within the neoclassical framework, Romer (1990) utilises the notion of a production function. However he makes a significant improvement in terms of the way he incorporates technological change into the model. Technological change is no longer an exogenous parameter occurring as an unexplained residual. Rather, explicit attention can be focused on the process by which technological progress is generated, as it is the stock of knowledge that determines technical progress. By admitting knowledge as an endogenous input into the production function it is recognised that knowledge is not costless, but entails an opportunity cost in terms of forgone current consumption. This allows for the possibility of increasing returns in the traditional sense, since if all inputs (including knowledge) are increased by a certain proportion then output will increase more than proportionately.

The specification in Romer's (1990) model is:

$$\mathbf{Y = g(H_Y,L) \int x(i)^{\gamma}di \; = \; g(H_Y,L)A(K/\eta A)^{\gamma}} \tag{4.1}$$

Here H_Y is human capital, L is labour, K is capital stock valued in terms of the materials that go into making each capital good x_i, and A is the stock of new designs (technology). It seems that there is little difference between this and the simple neoclassical formulation of $\mathbf{Y = f(K,L,A)}$. Indeed $\mathbf{H_Y}$ and **L** grouped together could be thought of as quality adjusted labour (as is often done in empirical applications of the neoclassical model). The way capital is treated is slightly different from the usual neoclassical approach, and essentially entails allowing different types (vintages) of capital goods to have different marginal products. However, the major improvement involves the treatment of technological change (**A**). In the orthodox model, technological changes occur exogenously (and, as such are seen as public: costless, automatic and passive). In Romer's (1990) model however, technological change is endogenous, being dependent on how quickly the firm expands its stock of new designs (**A**). Hence, the set of capital goods available at any point in time is determined endogenously by the current stock of new designs (**A**). To further clarify his model, Romer (1990) distinguishes between three sectors[1]:

[1] The final output production sector

[2] The capital goods production sector

[3] The R&D technology generating sector

Within this framework, the final output sector is treated as in the orthodox neoclassical model, but the capital goods sector no longer produces new goods according to the whims of science. Rather, new goods are produced in the capital goods sector as a result of new technology that is developed by firms in the R&D sector. The R&D sector in this model differs substantially from the orthodox depiction since monopoly rents provide the incentive to innovate. Hence, monopoly barriers are seen as being crucial for generating technological change.

4.2.1 The Research Sector

In the research sector the production of new designs is assumed to be a deterministic function of the inputs used in research:

$$\mathring{A} = \delta H_A A \tag{4.2}$$

$\mathring{A}$ is the rate of increase in new designs, H_A is human capital in research, and **A** is the stock of new designs possessed by the firm. The main features of this model are that:

[1] Although conceptually useful to make the distinction between capabilities in these different activities, in practice it may be very difficult to do so (especially in the LDC context where most technological change may be of the evolutionary type which makes it even more difficult to distinguish what activities should be classified under R&D).

(1) The growth rate of production of new designs ($\mathring{A}/A$) is increasing in the amount of human capital in research ($\mathring{A}/A = \delta H_A$). This makes technical change depend positively on the amount of human capital in research. This is a fundamental assumption of Romer's model. Clearly then, technological change is endogenous to the model because increased research effort is assumed to have a positive effect on the rate of production of new designs.

(2) The productivity of a unit of human capital ($\mathring{A}/H_A$) is increasing in the total number of designs that currently exist ($\mathring{A}/H_A = \delta A$). By specifying the productivity of human capital in research as an increasing function of **A**, the model also captures the cumulative nature of knowledge and takes cognisance of important complementarities.

Like orthodox neoclassical theory, Romer (1990) treats designs as idealized goods which are not tied to any physical good. It is this disembodied assumption which basically gives them their non-rival characteristic. Romer (1990) is correct in emphasising that it is this aspect of technology that is the key to the understanding of how to model change. Once the cost of creating a new design has been incurred, its non-rival characteristic means that it can be used over and over again at no extra cost. Given this public good characteristic, there are clear externalities which in theory will be socially optimised with the widest possible dispersion of the design. To ensure this, the neoclassical model relies on perfectly competitive behaviour in all markets, so that for profit maximisation all firms would be forced to adopt the best technology. This latest technology in perfectly competitive markets is deemed to be costless, since its non-rival nature means that the marginal cost of dispersion of the design is zero. With orthodoxy's commitment to the assumption of perfect competition in all markets, there is no other possibility than to assume that technological change arises exogenously to the model. There is no way to explain why rational agents would incur the fixed cost of developing new and better designs if they had to give away the designs afterwards.

In contrast, Romer (1990) starts from the premise that technological change arises largely because of intentional actions by people who respond to market incentives. A questioning of orthodox assumptions is clearly required if this premise and the non-rival nature of technology is accepted. Romer (1990) argues that what cannot be supported in an endogenous modelling of technological change is price taking behaviour on the part of the research sector. Rather, it is partial excludability that is required to enable firms to capture rents for incurring the fixed cost of developing new and better designs. Hence, unlike the orthodox framework where knowledge is viewed as a non-rival, non-excludable good, Romer (1990) views knowledge as a non-rival, partially excludable good.

In Romer's (1990) model, the degree to which new knowledge is excludable will determine the extent of the rents the research sector is able to extract, and this in turn will determine the allocation of human capital between the research sector and the final output sector. This allocation of human capital is crucial in Romer's theory, as the level of human capital in research determines technological progress ($\mathring{A}/A$), and thus the growth of the economy. In Romer's (1990) model, designs are only partially excludable. Designs are patentable, and if a firm does not own the design for a durable good it cannot produce it. However, new designs also contribute to the general stock of design knowledge which researchers can make use of for creating newer designs. While the former benefits are excludable, the latter are not.

4.2.2 The production of intermediate producer durables

Romer (1990) maintains the perfectly competitive market assumption for all other markets besides the market for new designs. It is in modelling the capital goods sector that the separability (disembodiment) of technological change from investment becomes apparent. Once a durable already has a design, units of the durable can be produced at a constant unit cost in terms of forgone output. Hence, capital goods are valued in terms of the cost of materials (apart from the rental accruing to a new design) that go into making them. A firm that owns a design and sells a new durable thus charges a price for the good that is higher than the constant price of producing that good. This is how the firm recoups the investment in the research that is necessary to create the design. Thus, the firm basically earns a rent over and above the market price of producing the good.

Departing slightly from orthodox treatments of capital stock, Romer (1990) argues for the need to distinguish between all the different possible types of capital inputs: $\mathbf{x} = \{x_i\}_{i=1}$. Each good is measured in common units of production cost. In this conceptualisation, different types of capital goods have additively separable effects on output. This avoids having to assume that all the different types of capital goods are perfect substitutes for each other. Despite this novelty, the way Romer (1990) treats capital essentially stays within the neoclassical fold, since he argues for distinguishing growth in total capital that arises from adding units of the existing set of capital goods and the growth in capital that arises from bringing new types of capital goods into use. As is usual, the former type of capital accumulation is associated with diminishing returns to capital accumulation, whereas the latter is not. Romer argues that capital goods should be valued according to the value of the inputs used to produce these goods. Hence, Romer wishes to make the distinction where the former is merely an expansion of capital stock, while the latter involves the payment of a rent. Hence, despite making technological change endogenous, Romer (1990) still essentially maintains the distinction between movements along a unit isoquant and shifts of that unit isoquant. However, this distinction is conceptually more plausible in Romer's (1990) scheme of things than in the simple neoclassical model. This is because the knowledge and human capital in the research sector influences the return on investment. Hence, investment can lead to productivity growth, so long as this investment is applied to research, rather than involving an expansion of the firm's productive capacity. Romer's (1990) model suggests that investment is necessary for growth, but that its return will depend on the complementary stock of knowledge and capabilities possessed by a firm, industry or country. However, it seems that problems have been encountered in making the model empirically operational as Scott (1993) points out that he is not aware of any empirical studies that have used Romer's model. A likely reason for this is that in reality there is no neat distinction between the research and production sectors. New technology actually often evolves through the interaction between production and research[2] in accordance with the particular production context. Furthermore, it is innovation and minor adaption (applied research) rather than invention (basic research) that is most important to developing countries that are not at the cutting edge of new technology. As such, the sharp distinction between the research sector and other sectors is particularly limiting in the developing country context. Having said this though, Romer's (1990) model does provide a useful way of analyzing the process by which technological change is generated and so makes the causes of productivity growth more easily understood, even if not quantifiable.

---

[2] This process may even be vital in facilitating learning and technological capabilities of the firm and its workforce through the complementarities of multiskilling and the coordination and interaction of different divisions.

4.3 Scott's "New View of Growth" ?

In contrast to Romer (1990), Scott (1989) argues that the neoclassical model should be discarded because the model's attempt to separate investment from technological change and productivity growth is unrealistic and serves no practical analytical purpose. He argues that even with vintage models it does not seem possible to separate that portion of investment spent on generating new assets from that portion spent on replicating existing assets.

In Scott's (1989) view then, there is no room for the neoclassical distinction between the elasticity of substitution within a given technology and the bias of technological change, since he argues that there is a significant interaction between relative price changes and technological changes[3]. Instead, Scott (1989) advances an investment-led growth model. He argues that any attempt to improve performance requires some change to economic arrangements, which can only be achieved through investment. Scott's (1989) basic model is:

$$\mathbf{g} = \mathbf{a}\varrho\sigma + \mu\mathbf{g}_l \tag{4.3}$$

This model essentially decomposes output growth (**g**) into two proximate sources: the rate of investment (σ) adjusted for its efficiency (ϱ), and the rate of growth of quality adjusted employment ($\mathbf{g}_l$). So, rather than TFP, the efficiency of investment (ϱ) becomes the criterion for evaluating production efficiency. In this equation **a** and μ are, respectively, the output elasticity of efficiency adjusted investment growth and the output elasticity of quality adjusted employment.

---

[3] The chicken and the egg story (whether technological change causes, or is caused by relative price changes) is essentially assumed away by the neoclassical model. It assumes that it is changes in factor endowments that cause changes in relative factor scarcity values (prices); while technological change is assumed to be neutral or of a constant (predictable) bias.

Scott (1989) avoids the problems inherent in the artificial neoclassical distinction between investment and technological change by treating all investment as involving some technological change. Scott (1990) therefore specifies the causality as running from investment to technological change and then to growth, in contrast with the orthodox specification where, although technological change drives growth, it is essentially independent of investment.

In Scott's (1989) view, all past investment is relevant to determining the total sacrifice that has been made by an economy to bring it to its present state. In effect then, what one is assessing is how well the countries/industries/firms have performed for a given level of sacrifice in terms of forgone consumption. Hence, it is not just the rate of investment that is important for growth, but also the efficiency of this investment.

However, as is the case with the TFP measure, Scott (1989) emphasises that the isolation and measurement of $\mathbf{g_l}$ and $\boldsymbol{\varrho}$ is only the start of an explanation of economic growth. The underlying determinants of these still need to be explained, and in Scott's (1989 : 177) view they are likely to depend upon:

> **"The knowledge, intelligence, originality, commonsense, and effort of businessmen, inventors, and scientists are all highly relevant, as are the economic institutions that influence their perceptions and choices, including the degree of competition, taxes and subsidies, the credit systems, and product and factor markets generally. .... Decision makers' motives are obviously important."**

4.4 Evolutionary Theories of Growth

The evolutionary theorists have been the most critical of orthodoxy's disregard of the importance of complementarities between inputs and technological change:

"The spirit of evolutionary theory is that inputs come in complementary packages associated with the use of particular techniques and that it is not meaningful to parcel out credit for output or output changes among the different inputs." (Nelson, 1989 : 329)

The sources of growth approach ignores the crucial role of complementarities. Nelson (1981) emphasises the inaccuracy of this neoclassical growth decomposition by drawing an analogy with a cake recipe. To make the cake, all ingredients in the recipe may be necessary, and in order to try and make a better cake it may be useful to analyze the effect of altering each ingredient a little at the margin while keeping other ingredients constant, but it makes no sense to divide up the credit for a good cake among its various ingredients. In the presence of important complementarities between the three factors (capital, labour and technological progress) Nelson (1991) argues that it makes little sense to divide up the credit among them. For example, the value of specifically trained employees is undermined if these employees are not complemented with appropriate equipment. In the light of such complementarities, Nelson (1981) questions the usefulness of the neoclassical distinction between movements along a production function and movements between production functions. Hence, it has been suggested by Nelson (1981) that the growth of labour and capital should merely be viewed as descriptive of the characteristics of output growth, rather than explaining it. It is underlying factors that are regarded as simultaneously affecting the rate of growth of labour, capital and technological progress[4].

The advantage of evolutionary theories is that they focus on the process by which technological change arises and diffuses and thus generates productivity growth. As such, it

[4] For this reason qualitative changes to the factors are analysed as "underlying" sources of productivity growth (in chapter 5), rather than as "proximate" sources of productivity growth as is normally done in conventional neoclassical analyses.

is the only theory among the ones analysed here, which specifically tries to relate the micro workings of firms to their overall performance and the performance of the industry and the whole economy. However, the main weakness of the evolutionary theories is that they provide no formal alternative to the neoclassical model. Despite this, their approach proves useful for understanding what causes technological change and productivity growth.

In particular, evolutionary theory focuses on the process by which firms, industries and the economy evolves. As such, they reject the orthodox assumption of a representative firm and regard it as hazardous to assume that all firms are in a system of competitive equilibrium. Rather, they stress the importance of the idiosyncrasies of individual firms, and point out that the fact that some firms have high costs and others low costs, with some expanding and others contracting, illustrates the dynamics of the evolution of particular industries.

Evolutionary theorists argue that individual and organisational behaviours are selected, penalised or rewarded. Organisations (and individuals) are selected **ex ante** on the basis of their capabilities: in terms of the competence of employees, the organisational structure within which these employees interact and establish work norms, and the quality of managerial decisions about the future. However, organisations are also selected **ex post** through mechanisms which cannot always be predicted or controlled for.

Lall (1992), amongst others[5], extends the mainstream evolutionary theory to the developing country context. Lall (1992) argues that what is important for productivity growth is the

[5] Also see Fransman and King (1984), Dosi et al. (1988) for two collections of articles by evolutionary economists who have focused on the developing country context.

indigenous technological capabilities (ITCs) possessed by firms in LDCs. Along these lines, an instructive growth model in the evolutionary spirit, is Fagerberg's (1988). He emphasises the importance of technological capabilities for a nation's productivity:

$$Q = ZD^{\alpha}N^{\beta}C^{\tau} \tag{4.4}$$

Here, **Q** is the productivity of a country (as proxied by GDP per capita), **D** is the level of knowledge (stock of designs) diffused from abroad, **N** is the level of knowledge created in the country (its technological activity) and **C** is the country's capacity for exploiting the benefits of knowledge. Fagerberg (1988) uses this specification as a basis to undertake a cross-country empirical investigation of the relationship between a nation's technological activity (N) and its productivity (Q). He uses patents and/or R&D expenditures as a proxy for a nation's technological activity. His regression results confirm the existence of a positive and significant relationship between productivity (Q) and national technological activity (N). Fagerberg's framework helps to highlight crucial technological determinants of a firm's or nation's productivity performance. These are the nation's (or firm's) existing capabilities (C), the extent to which deliberate efforts are undertaken to enhance technological capabilities (N), and the extent to which knowledge is diffused from abroad (D).

However, Lall (1992) argues that these capabilities do not arise in a vacuum. Rather, the development of a nation's technological capabilities should be analysed in terms of the interplay of *incentives*, *capabilities* and *institutions*. Institutions are seen as setting the rules of the game, which can alter capabilities and affect incentives by influencing attitudes and expectations. Capabilities are seen as defining the best that can be achieved with given resources, while incentives influence the use of capabilities and stimulate their expansion, renewal or disappearance. This helps to emphasise the interaction between demand and supply factors:- capabilities constrain a firm or country's ability to grasp opportunities confronting it, while these same opportunities act as incentives to improve capabilities.

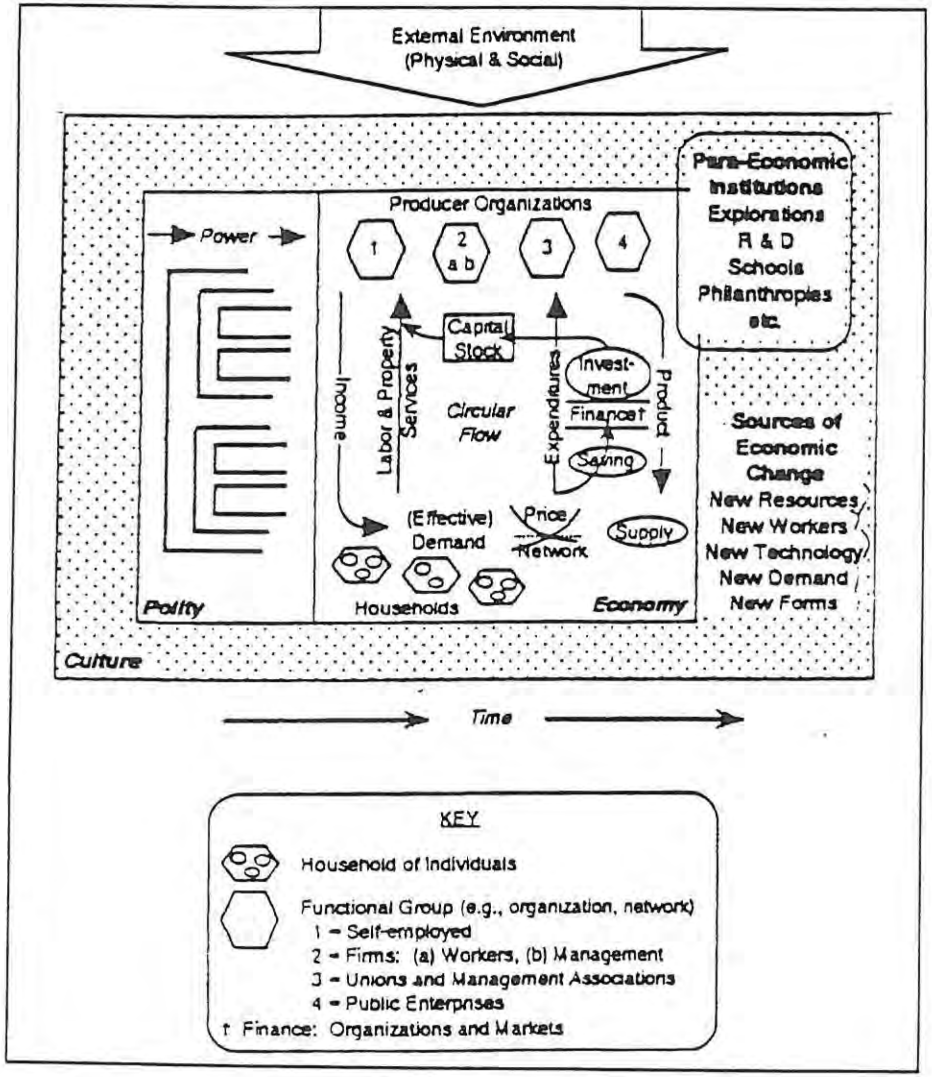
Parker (1990), an evolutionary economic historian, provides two useful schematic diagrams (see **Figure 4.1**) which help emphasise Lall's (1992) point about the interplay of incentives, capabilities and institutions. **Figure 4.1 (a)** illustrates that firms do not simply follow the static dictates of the price network. Rather, the dynamics of the system requires firms to respond to stimuli from various institutions and a changing external environment. **Figure 4.1 (b)** illustrates the historical evolution of individuals, institutions and organisations. Individuals are "culturally matured" into society by various institutions which have an important influence on the attitudes and skills of individuals. This figure also emphasises the internal dynamics of organisations whose behaviour is dependent on the response of economic agents to the incentives and penalties generated by institutional and other environmental influences.

On the demand side, Lall (1992) regards the following factors as the most crucial incentives influencing firms to enhance their technological capabilities:

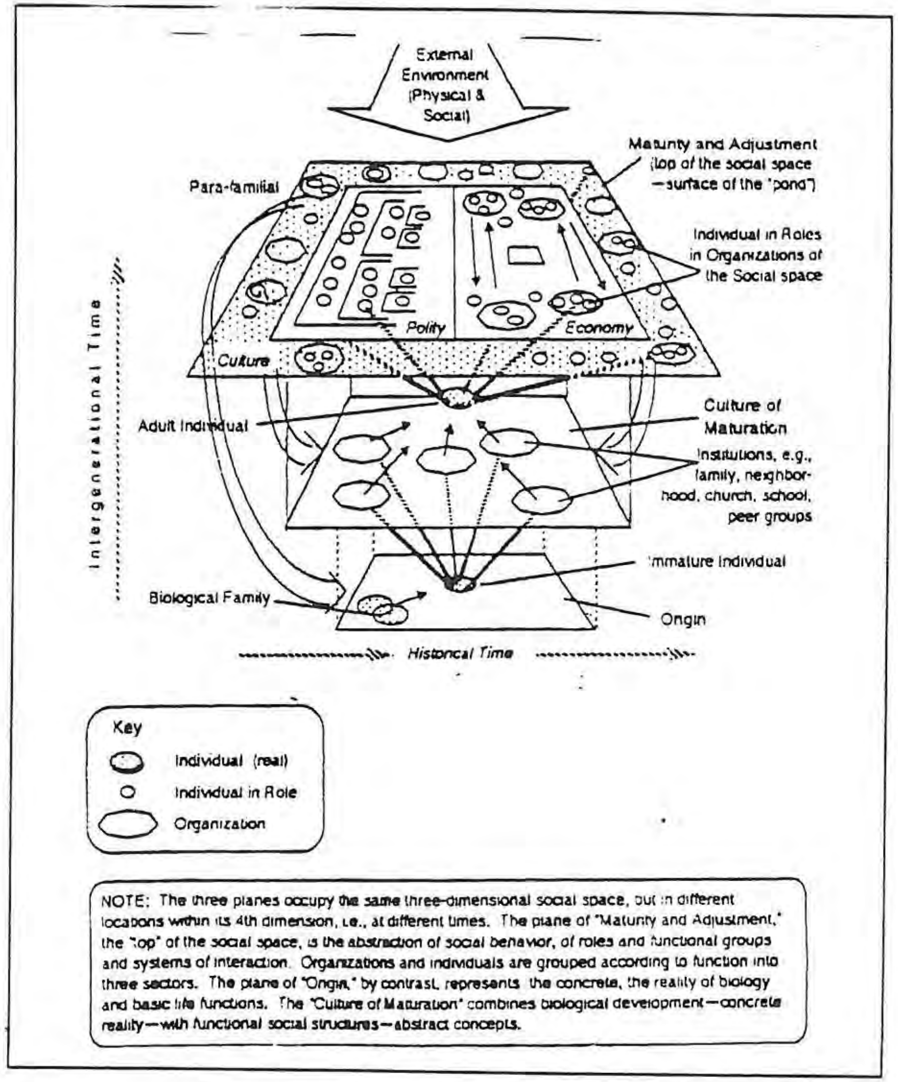
(1) An inherent need by firms for sufficient development of new skills and information as a prerequisite to the adoption of new technology.

(2) External factors such as the macroeconomic environment, competitive pressures, and the trade regime influence firm's perceptions regarding the benefits of efforts to develop their capabilities. In this respect though, Lall (1992 : 169) notes that:

> **" ... international competition [is] probably the most potent inducement to skill and technology upgrading. Competition is, however, a double edged sword, and given the necessary costs of learning, can stifle capability building in newcomers when certain markets failures exist."**



(a) *A National Economy in its Operation within the Culture*



(b) *A Social Space: Individuals in Connection with Organisations within a Culture showing Intergenerational Reproduction*

Figure 4.1

(3) Technological change at the world frontier is seen by Lall as stimulating developing countries to catch up. Although competition is seen to mediate the incentive for firms to improve technological capabilities, recognition of the potential gains from the adoption of more efficient available technology may also induce firms to invest in improving their technological capabilities.

On the supply side, the extent to which firms can improve their technological capabilities are regarded as depending on:

(1) The firm's size - which will constrain (or facilitate) their ability to utilize complex technologies or highly skilled or specialised labour, where these inputs may only be justified on a large scale.

(2) The local market for skilled labour, both technical and managerial. Here the nature of a nation's education and training systems are clearly important as are a nation's ability to keep or attract such personnel.

(3) The flexibility of firms, in so much as they are able to restructure and absorb new methods and technologies.

(4) Access to external technical information and support.

(5) Access to appropriate "embodied" technology.

Lall (1992) emphasises that one can conceive of national differences in technological capabilities, since such factors will mean that countries will differ in their ability to assimilate technologies, which will show up in their long run productivity and trade performance.

However, an important insight of evolutionary theory needs to be stressed: the idiosyncrasies of firms. Evolutionary theory rejects the orthodox micro-economic notion of a representative firm, which is based on an identical response by firms to the macro-institutional environment they face. All firms do face the same policies, markets and institutions, and so have the incentive to respond in similar ways. However, they are unlikely to respond in identical ways, given uncertainty, imperfect information and the reality of their peculiar internal structures, which reflect the evolutionary outcome of past idiosyncratic behaviour.

> **"Thus, there are factors which are firm specific (leading to micro level differences in FTC [firm-level technological capabilities] development and to "idiosyncratic" results) and those that are common to given countries (depending on their policy regimes, skill endowments and institutional structures.)" (Lall, 1992 : 169)**

In the evolutionary theory, firms are seen as using technological change, by improving products and/or processes, as a major weapon in their competitive struggle - either offensively through innovating or defensively through imitating their rivals. Hence, the outcome of such behaviour is a continual disequilibrium situation as change and adjustment to change occurs. Contrary to orthodox theory, individual and firm behaviour diversity is central. It arises largely from idiosyncratic responses to the uncertainty of technological changes. Micro-level analysis of technology in LDCs has drawn inspiration from the evolutionary theories. The central theme of this approach is firm idiosyncrasies:

> **"Technological knowledge is not shared equally among firms, nor is it easily imitated by or transferred across firms. Transfer necessarily requires learning because technologies are tacit, and their underlying principles are not always clearly understood. Thus, simply to gain mastery of a new technology requires skills, effort and investment by the receiving firm, and the extent of mastery achieved is uncertain and necessarily varies by firms across these inputs. Furthermore, firms have more knowledge of their 'own' technology, less about similar technologies of other firms and very little about dissimilar alternatives, even in the same**

industry. They operate, in other words, not on a production function but at a point, and their technical progress, building upon their own efforts, experience and skills, is (to varying degrees) 'localised' around that point (Atkinson and Stiglitz, 1969). The extent to which firm-level differences in technological effort and mastery occur may vary by industry, by size of firm or market, by level of development or by trade/industrial strategies pursued. There is little doubt that as a description of reality, in developed or less developed countries, the evolutionary approach is far more plausible than the production function approach." (Lall, 1992 : 166)

4.5 A Framework for Analysing the Fundamental Causes of Productivity Growth

The National Productivity Institute (NPI, 1990 : 9) emphasises that productivity measures merely demonstrate an association between various factors and not a causal relationship[6]:

> **"The act of measuring productivity can be compared to taking a patient's temperature. Having established that the patient is running a temperature, the doctor only knows that the person is ill and that the effect of the illness is manifested in a high temperature. He then has to find the cause of the illness"**

These causal determinants of productivity growth are critical because they are of fundamental importance to a nation's long run growth and welfare prospects and therefore should not be ignored simply because the neoclassical model fails to deal with them adequately. However, the task of quantifying productivity determinants should not be underestimated. Indeed, the fact that no simple prescriptions exist for improving productivity is precisely because many of its fundamental determinants are intangible. Hence, claims that the causes of productivity can be quantified and explained in a simple way should be treated with considerable scepticism. As Denison (1984 : 23) notes with regard to the productivity growth slowdown that occurred in the U.S. and elsewhere in the early 1970s:

[6] The problem with the analogy in this quote is that it implies that measuring productivity is just as easy and accurate as measuring temperature on a thermometer. However, it has been emphasised that there are many problems with productivity estimates, which suggests the need for greater scepticism in interpreting derived productivity measures as definitive indicators of efficiency.

"The causes of the slowdown in the residual remains a mystery to me, although others do not hesitate to state it."

While it may not be possible to quantify the causes of productivity growth, and so explain the "mystery", this does not mean that no attempt should be made to understand these fundamental determinants. In this respect, it should be recognised that our lack of knowledge regarding the fundamental determinants of productivity growth is partly due to the way productivity has been conceptualised by the neoclassical model, which essentially treats technological change as a black box.

In this respect though, as was seen above, recent alternative theories have arisen largely in response to the defects of the simple neoclassical model and their theorising is facilitating a greater understanding of the underlying causes of productivity growth. Evolutionary theory[7], Scott (1989) and Romer (1990) all stress the overriding importance of viewing increased production efficiency as the result of deliberate efforts to improve technology. While the specifics of these theories are different, they share a common framework which recognises that new technology does not arise passively, automatically or costlessly (as is the case in the neoclassical model). This suggests that to understand the fundamental determinants of productivity growth, what is needed is an analysis of the processes by which new technology is generated, diffused and implemented in production.

While the quantification of the underlying causes of productivity growth appears to remain elusive, a coherent conceptual framework can improve our understanding of some of the

[7] See Nelson and Winter (1982), Nelson (1981) and, as applied to the development context, Fransman and King (eds) (1984), Fransman (1985), Fagerberg (1988) and Lall (1992).

processes that generate productivity growth. Such a framework can benefit from the insights of the three theories discussed above, particularly evolutionary theory. This framework will focus on the processes involved in technological change. Romer's model stresses the importance of disembodied knowledge and the human capital that complements this knowledge. Evolutionary theory stresses the importance of firm idiosyncrasies in their acquisition of technological capabilities, but argues that it is not possible to separate the knowledge and capabilities of a firm from the employees who possess or control this knowledge. Scott's model argues that while investment is crucial for growth, the efficiency of this investment is dependent on deliberate actions to improve technology. While these models differ, there is much common ground and they do provide important insights with which to construct a conceptual framework for understanding the fundamental causes of productivity growth.

Overall then, these theories suggest that it is the knowledge and capabilities possessed by a firm that govern the firm's scope for productivity growth. Furthermore, these theories all recognise that to a large degree these capabilities do not arise passively, automatically or costlessly - rather they require active and deliberate efforts which can be extremely costly.

The rest of this chapter will de devoted to outlining a framework within which the causes of productivity growth can be assessed, while the next chapter will apply it to South Africa in order to assess the relative importance of various fundamental determinants of productivity growth in the manufacturing sector.

The neoclassical model provides a point of departure for addressing the "underlying sources" of growth. In this respect, it was argued in the previous chapter that it seems conceptually useful to view qualitative improvements to the factors (a better educated and trained workforce and technologically more sophisticated machinery) as "explaining" part of TFP growth because they clearly improve production efficiency[8]. Hence, although recognising neoclassical weaknesses, its familiar structure (which distinguishes between the different inputs capital and labour) provides a useful starting point for building a framework with which to begin to assess the underlying causes of growth[9]. As such, a useful conceptual framework can be built around the following questions:

* What compositional changes have taken place to the quality (skills and experience) of the workforce ?;
* What changes have occurred in the technological sophistication of machinery ?;
* What organisational changes have been implemented in production ?;

However, in order to gain a comprehensive assessment of the causes of productivity growth an analysis of the forces behind these changes is required in each case, as well as the extent to which these changes have been complementary.

Before providing a deeper conceptual framework that draws on the insights from these new growth theories, a case study will be considered. This case study analyses the technological development of an archetypical successful firm (USIMINAS) which is an integrated steel producer in an LDC (Brazil). This case study helps to emphasise some of the critical issues

[8] This would leave only part of TFP growth "unexplained" (exogenous), and what remains will (apart from measurement error) be due to disembodied technological progress such as work organisational changes.

[9] It can only serve as a start since the model has no theory of how inputs are qualitatively improved and how this affects production efficiency. The model also ignores the fact that in reality the process by which TFP growth is generated is crucially dependent on the complementary nature of skilled labour and technology.

discussed by Romer, Scott, and, in particular, the evolutionary theorists. The authors conclude from the case study that:

> **"This description shows that successful technological development depends on a long term effort to build systematically on foreign technological inputs and on accumulated experience." (Dahlman, Ross Larson, Westphal, 1987 : 8)**

Initially the firm had to rely entirely on foreign practice and advice in designing and operating the plant. However, from the start of designing and establishing the plant, locals worked closely with foreigners and received extensive training prior to operation, so that locals accumulated knowledge on many aspects of the design, equipment selection, installation, start up and operation of the plant. This helped facilitate improvements in the understanding of the technological package so that as production proceeded the firm's personnel proceeded from the stage of knowing how to operate the plant to analysing the contents of the package. Hence the firm was able to 'unbundle' the package by studying and understanding different elements of its technology, so that it was able to uncover its deficiencies and correct for them.

Hence, the firm did not lock itself into a reliance on foreign technological assistance, but rather emphasised the need for an understanding and assimilation of foreign technology as it was purchased. Through a gradual learning process the firm developed technological proficiency over its technological purchases so that the type and nature of foreign assistance moved to higher and more specific levels.

As this case study elucidates, the transfer of technology is not simply a usual product exchange transaction, but there is an element of tacitness involved in the transfer that needs to be carefully managed if the purchaser of the technology is to realise the full benefits from it. Given this, the authors argue for a more insightful conceptualisation of technology, where technology is seen as being characterised by its key elements:

(1) The technological means to undertake the transformation

(2) Technological information about the method

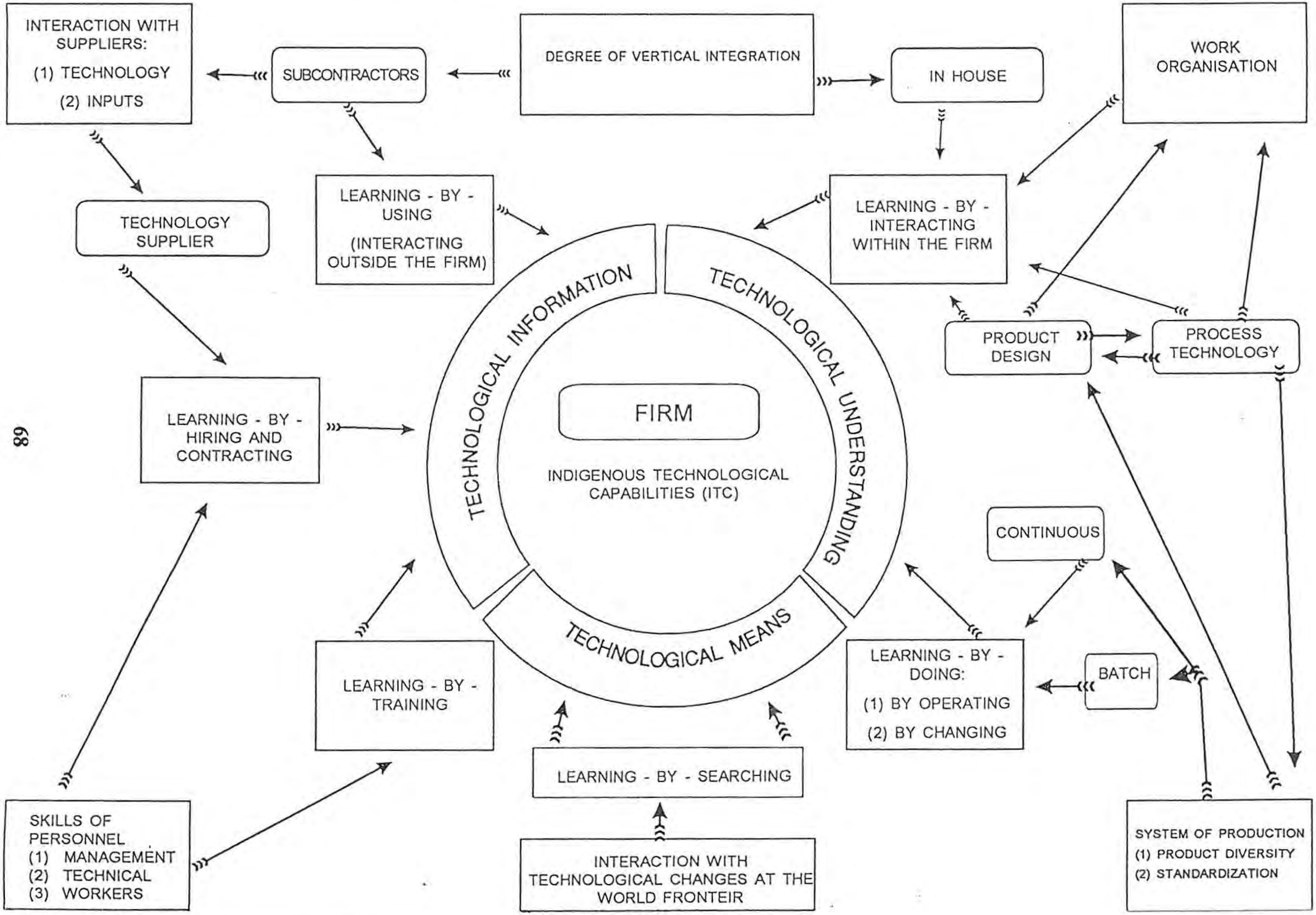
(3) Understanding how and why the method works

The first element simply relates to the fact that a particular machine has a particular technology embodied in it. This element of technology is most readily assimilated as it just requires an operating knowledge of the machine. Such operating knowledge merely indicates that the technology embodied in the machine has simply provided a means to undertake a specific transformation. The second element relates to the technical details of the design (the blueprint) of technology that comprises this machine. Hence, this element provides a technical description of the technology involved, but since most technology is tacit these details often do not aid an understanding of the processes involved or why these processes work. This understanding is the third element of technology and is the least easily articulated.

An appropriate technological means to undertake the transformation and understanding how it operates is necessary. However, acquiring technological information about the method, and understanding how and why the method works, are clearly more crucial to the enhancement of a firm's technological capabilities.

Using these key concepts as building blocks **Figure 4.2** attempts to provide a framework for analysing how a firm manages technological change and improves its technological capabilities. It seems that the neoclassical assumption that technology is public has obscured

Figure 4.2 : Learning Mechanisms in a Firm's Management of Technological Change



a recognition of the fact that technology is not simply a means to undertake a transformation, but that the other elements: technological information about the method and understanding how and why the method works, are also crucial to the effectiveness of technological choice and use.

Figure 4.2 emphasises the importance of the various learning mechanisms in the build up of a firm's technological capabilities and illustrates the importance of managing technological change to realise its benefits. This figure should help to provide the basis of a conceptual framework for analysing the fundamental causes of technological change and productivity growth. To make the figure more easily understood and to clarify this framework it is necessary to discuss the nature of the learning processes that underscore improvements in a firm's technological capabilities.

Martin Bell (1984) points out that some economists terminologically link productivity growth and 'learning'. Performance trends are supposed to be the observable 'effects' of 'learning'. Hence the efficiency of task performance rises because additional skills and knowledge have been acquired ('learning' has taken place). However, Bell (1984) emphasises that this terminological identification of cause and effect is potentially quite misleading, since it provides no framework for analysing how this skill and knowledge is acquired (thus no way of assessing the nature of the learning process itself).

Bell (1984) argues that it needs to be recognised that there are many different learning mechanisms, and some are more effective than others. Hence, this means that productivity growth improvements may be caused by very different learning mechanisms. This suggests that to understand the underlying causes of productivity growth performance requires an examination of the various different learning processes by which technological capabilities are built up.

From this perspective, Bell (1984) usefully distinguishes the process where ITC is acquired simply through 'learning by doing' as opposed to other learning mechanisms which require more deliberate attention to improve ITC. This distinction is conceptually useful because the two kinds of learning processes function in quite different ways and the relative importance of the two has important implications for explaining productivity growth and suggesting policy measures. The USIMINAS case study highlighted the important role of such deliberate learning mechanisms for improving the technological information and understanding aspects of a firm's ITC.

Dosi, G and Orsenigo, L (1988) argue that orthodox economics treats doing-based learning as being characterized by the following elements :

[1] **Passiveness:** no explicit effort or resources are required to capture the benefits.

[2] The learning process is **automatic** since after a given period of doing (level of cumulative output) a certain amount of learning will have taken place.

[3] **Costless :** since learning is acquired as a free by-product from carrying on with production.

If all learning was doing-based, improved technological capabilities would simply require increased doing, with fairly obvious implications regarding returns to scale and policy. However, other learning mechanisms do not have these passive, automatic and costless properties and so to the extent that they are important sources of improved technological capabilities (and productivity growth) conceptualising all learning as being doing-based will provide an inaccurate depiction of the learning processes that caused productivity growth. Hence, Bell (1984) emphasises the importance of identifying the extent to which doing-based learning, as oppose to other kinds of learning, has contributed to the improved technological capacity of firms. Therefore, in order to clarify the sources of improved ITC he suggests further subdividing these learning processes into:

Doing Based Mechanisms:	**Other (Deliberate) Mechanisms:**
LEARNING BY OPERATING	SYSTEMS PERFORMANCE FEEDBACK
LEARNING BY CHANGING	LEARNING BY TRAINING
	LEARNING BY HIRING
	LEARNING BY SEARCHING

These are relatively self explanatory, but do serve to emphasise the processes by which indigenous technological capabilities can be effectively built up. **Figure 4.2** tries to indicate the importance of the various learning mechanisms for a firm's indigenous technological capabilities. The reason why most of the focus has been on learning-by-doing is that other learning mechanisms are regarded as largely a matter of management discretion which is supposed to be overcome in a sufficiently competitive environment. However, as Lall (1992) emphasises, in reality there are many other incentives and institutions influencing the learning undertaken by firms. As such, there may be important market failures undermining the effectiveness of these learning mechanisms. Specific skill shortages and inadequate training institutions may undermine the effectiveness of learning-by-hiring and learning-by-training mechanisms; poorly developed subcontracting markets may limit the scope for learning-by-using; poor international relations, limited access to the latest technological information and the weak bargaining power of local firms may undermine the effectiveness of learning-by-searching processes; and cultural and/or institutional factors that affect industrial relations may undermine what can be achieved through learning-by-interacting within the firm.

The USIMINAS study helps clarify the distinction between these different types of learning mechanisms. Initially USIMINAS relied on learning-by-hiring and learning-by-training in addition to doing-based learning mechanisms. Later USIMINAS was able to deepen its capabilities through other deliberate learning mechanisms such as systems performance feedback and learning-by-searching. Further, this case study illustrates that the advancement of LDCs or firms is not a simple matter of technology transfer. Rather technological capabilities are built up in a slow process that follows a sequence of building on strengths, so that normally a firm in an LDC will develop by proceeding from accumulating capabilities in production to investment and innovation capabilities[10].

From the distinction made by the case study it seems apparent that although doing-based learning processes may be sufficient to build up capabilities in production, they may be insufficient to serve as a base upon which capabilities in investment and innovation are built up (these requiring more deliberate learning mechanisms to improve the quality of their capabilities). Here, learning-by-doing may improve a firm's ability to use a given technological means (*'Know How'*) such that task level performance improves as employees

---

[10] In Katz's (1984) discussion of the sequential nature of the learning process he argues that from the firms (in Latin American metalworking industries) surveyed, typically product design capabilities develop at an earlier stage than process engineering capabilities. This suggests that the former are easier to acquire than the latter because changes to the process are likely to involve more 'know why' than 'know how'.

gain experience. However, total reliance on this type of learning process is unlikely to assist the firm in understanding why what is being done works (*'Know Why'*) and whether what is being done is the most effective way of doing it. Hence, as Bell's (1984) distinction highlights, more deliberate learning mechanisms (which are costly and entail effort) are possibly the only way a firm will be able to find out more about how and why things are done and how and why they work and whether better ways of doing things exist; and, in this way enhance their investment and innovation capabilities.

This framework suggests that depicting the learning process as simply doing-based is most unrealistic. In reality the technological capabilities acquired by individuals - and through them, firms - are the result of sequential learning processes that begin in schools and continue in the workplace. The effectiveness of schools significantly influences an individual's skills and their foundations for subsequent learning. Furthermore, the technological capabilities acquired in the workplace will depend to a large extent on the many deliberate learning processes a worker undergoes, or is exposed to. The technology and information, as well as the skills and experience of other employees are all highly relevant to what an individual learns and the technological capabilities they acquire and contribute to the firm.

What is important though, is that these deliberate learning processes are not always simply a matter of management discretion. Managers can make a substantial difference to the productivity performance of individual firms through deliberate efforts to improve technological capabilities. However, they may encounter various environmental constraints in the form of market failures which will limit what they can achieve.

In terms of delineating the scope for policy it seems useful to distinguish between three categories of national environmental factors:

(i) Exogenous factors such as the weather and natural resources of a country.

(ii) Economic and institutional factors which the government can influence.

(iii) Cultural and institutional factors peculiar to a particular nation's social system and which the government has only limited influence over.

While there is not much that government policy can do about the first or third category of factors, the government can play an important role in overcoming market failures arising from the second category of factors which may undermine the efforts of firms to improve technological capabilities. However, it is important that the state does not, in attempting to correct market failures, undermine the competitive environment that provides a powerful incentive for firms to deliberately engage in efforts to enhance their technological capabilities.

At the start of chapter five, the neoclassical framework will be used as a basis for outlining trends that have taken place to the quality of inputs in South African industry. However, the framework that has been developed here, will also be used to gain a deeper insight into the institutional and other environmental factors that have been responsible for these trends. Hence, an attempt will be made to analyse institutional and other factors that have impinged on the effectiveness of the various learning mechanisms of South African firms. An important part of this analysis will be to examine the role played by the state - assessing in what cases it has helped to overcome market failures and in what cases its actions have militated against the enhancement of technological capabilities.

Chapter 5

The Underlying Causes Of Productivity Growth in SA Manufacturing

5.1 Introduction

Having built up a framework that improves our understanding of the fundamental causes of productivity growth we are in a much better position to assess and understand the past productivity growth performance of the South African manufacturing sector. Overall, it seems that what is required is an analysis of how South Africa's capabilities have changed over time in terms of what qualitative changes have taken place to labour, machinery and work organisational practices as well as the incentive mechanisms and institutional factors that have had an important impact on these developments.

5.2 Qualitative Improvements to Labour

Typically labour quality adjustments are made for compositional changes in the level of education and age of the workforce. These are regarded as a good proxies, the former for the skills and the latter for the experience of the workforce. Data availability limits our ability to assess the effect of education and training on the quality of manufacturing employment[1]. Nevertheless, it is possible to gauge the impact of changes in the education profile of the workforce in a fairly qualitative way by considering broad trends in the education system itself as well as changes to the educational attainment of the economically active population.

The human capital model argues that the function of education is to impart knowledge and skills which improve the productivity of workers. Hence, increased educational attainment of

[1] Similarly, lack of data prevents an assessment of the impact of age compositional changes on the quality of the workforce over time.

the labour force should improve the production efficiency of firms, thus making an important contribution to TFP growth. In South Africa there has been rapid educational expansion in recent years, particularly for blacks[2]. Fallon (1992) points out that there has been a substantial improvement in black educational attainment, while Pillay (1992 : 1) emphasises that :

> **"Although educational inequality is still pervasive, education since the mid 1970s has been characterised by a rapid quantitative expansion of resources for black, particularly African, education. Consequently, there has been a dramatic increase in the number of black students emerging from the school system with a matriculation certificate."**

Unfortunately, there is no official data available on changes in the education profile of the manufacturing workforce. However, **Table 5.1** shows data on the education level of the whole economically active population. This indicates that there has been a general rise in the educational level of the workforce since 1970. In 1970 only 33.7% of the workforce had attended school up until at least standard 6, and only 10.2% had completed secondary school (attended school up until at least standard 10). In 1980 however, 44.2% of the workforce had attended school up until at least standard 6, and 15.4% had completed secondary school. By 1985 these percentages had increased to 48.6% and 18.6% respectively. The data also suggests that the education level of the workforce grew slightly faster between 1970 and 1980 than between 1980 and 1985, since the proportion of the workforce that had attended school until at least standard 6 (standard 10) grew at an average exponential rate of 2.8% per annum (4.2%) between 1970 and 1980, but only at a rate of 1.9% per annum (3.8%) between 1980 and 1985[3].

---

[2] See Appendix G.

[3] However, see Pillay (1992) who notes that the **mean** years of schooling of the workforce grew faster between 1980 to 1985 then from 1970 to 1980.

Table 5.1: Education Levels of the Economically-Active Population, 1970, 1980 and 1985

Year	1970		1980		1985	
Level of Education	Number ('000)	Share (%)	Number ('000)	Share (%)	Number ('000)	Share (%)
None - Std 1	2 894	35.7	2 577	29.7	2 420	23.7
Std 2 - Std 5	2 478	30.6	2 206	25.4	2 784	27.3
Std 6 - Std 9	1 913	23.6	2 504	28.8	3 066	30.0
Std 10	514	6.3	748	8.6	1 013	9.9
Diplomas & Degrees	312	2.9	591	6.8	885	8.7
Unspecified	-	-	65	0.7	42	0.4
Total	8 111	100.0	8 691	100.0	10 210	100.0

Sources: South Africa, Population Censuses, 1970, 1985 and South African Labour Statistics, 1980.

To the extent that these trends hold for manufacturing[4], qualitative changes to labour, in the form of increased educational attainment, have made a positive contribution to increased productivity growth, with the effect being greater in the 1970s than the early 1980s[5].

In the above analysis, labour quality has only been adjusted for years of education which takes no account of the quality of education received during these years. This issue is particularly important in South Africa since cognisance needs to be taken of the deficiencies of the apartheid education system. Apartheid education and labour market policies adversely effected the skills of the workforce and thus the productivity growth of firms. Essentially, these policies will have reduced the effectiveness of any deliberate learning initiatives undertaken by firms. In particular, these policies will have affected learning-by-hiring, learning-by-training and learning-by-interacting within the firm. Restricted access to, and poor quality of, black education in earlier periods, coupled with job reservation and influx controls undermined the skill enhancement of black workers and their prospects for geographical and

[4] However, since manufacturing employment usually comprises under 15% of the economically active population, it is quite a strong presumption to assume that the same trends hold for manufacturing on its own.

[5] See footnote 3 above, which implies that if instead education is adjusted by mean years of schooling then the contribution to productivity growth would rather be greater in the early 1980s than in the 1970s.

occupational mobility. Rather than leading to any changes in productivity growth over time, these policies are likely to have had an adverse effect on productivity growth up until the mid 1980s when the effects of expanded educational opportunities began to be felt in the workplace, and job reservation policies increasingly became a thing of the past. With respect to these issues Fallon (1992 : 5) argues that:

> **"The main era of job reservation was between 1967 and 1974... Virtually all forms of job reservation had disappeared by 1984... Although controls of this kind never affected more than 2 percent of wage employees, it has been argued that, even in establishments in which reservations were not applied, the perception of the legislation among employers was that administrative and supervisory positions were reserved for whites. The dismantling of job reservation and other regulations helped open up access of qualified blacks to higher jobs."**

While the rapid expansion of government expenditure on black education in the 1970s has led to an increase in the number of years of schooling of the workforce, it appears that, to some extent, this expansion has been accompanied by a deterioration in the quality of education[6]. While there is little direct evidence on the quality of education in South Africa, the following qualitative problems with the black education system have been emphasised:

> **"Black education ... is characterised by an inequitable allocation of resources, overcrowded classrooms, high drop out rates and insufficient and poorly qualified teachers" (Pillay, 1992 : 2)**

> **"Curriculum differences between black and white schools on paper are minor and concern mainly the language of instruction. In general it appears that in black education the same knowledge and skills are imparted as in the white system, but in a severely watered down form with lower examination standards and expectations and far fewer material inputs." (Archer and Moll, 1992 : 23)**

[6] See Moll (1991).

Fallon (1992) argues that the consequence of this seperate provision of education to racial groups and the limitations on the provision of training to Africans was to create very large gaps in racial skill levels.

While the current educational expansion is a positive feature stimulating productivity growth, the quality of education and training is equally vital for improved production efficiency. In this respect, an assessment of the effectiveness of a nation's education and training system requires an analysis of the nature of the learning process by which skills are acquired and deepened[7]. Although this is difficult to assess, it appears that the performance and capabilities of school leavers are crucial if subsequent learning processes in the workplace and in training institutes are to be effective. From the perspective of industrial achievement, the main function of schooling should be to ensure that pupils learn to learn[8]. In the context of rapidly changing technology, the general skills and basic mathematical and scientific proficiency of workers are important attributes for ensuring their flexibility in learning new skills. In this respect though, there is little evidence on the average mathematical attainments of South African pupils, apart from those who allege that very few students study maths or science for very long, with the result that most students are not very proficient in these areas.

Prais (1987 : 210) summarises the lessons that can be drawn from the comparative analysis of Britain's and Japan's schooling systems as follows[9]:

---

[7] See Wright (1992) for a more detailed discussion of these education quality issues as well as the effect of labour market influences on skill deepening. Also see Archer (1992).

[8] From the training perspective see Archer (1992), who argues that this same function is crucial, both to learning on the job and in training institutes, for ensuring the suitability of worker's skills and their flexibility.

[9] This article is the last in a series of comparative assessments of schooling, training systems and industrial capabilities of matched plants. Mostly Germany and the UK are compared, but some articles do compare the UK to Japan (as in this article) and France. The aim of Prais's studies was to examine the extent to which the UK's recent poor relative industrial performance was due to the structure of her education and training systems.

> **"from the present comparisons we see that Japan's extraordinary industrial success is strongly based on (a) foundations laid during compulsory schooling, till the age of 15, by way of substantially higher attainments in mathematics by average pupils than in Britain...; and (b) these standards make possible more advanced vocational preparation - up to Technician level - at full-time Secondary Technical and Commercial Schools, at ages 16-18, for at least three times as many as attain that level here. Virtually all aged 16-18 in Japan continue to study mathematics and sciences, as part of non-compulsory full-time schooling, even if not on technical or scientific courses. Any training given subsequently in the course of employment in Japan is able to build on those foundations laid during full time schooling; training within industry can thus be more specialised, more effective and more worthwhile to the employer."**

The quotation emphasises that it is the effectiveness of learning processes in schools, training institutes and on the job that are crucial for enhancing learning capabilities. Furthermore, these learning processes should not be considered in isolation, but as a sequence:

> **"It is crucial to see the achievement of educational capacity not just as a school or college product, but rather as a school or college product affected by informal learning in family or group, altered by post school training, and altered by learning on the job." (King, 1984 : 59)**

It could be argued that the black education system under apartheid was not a central constraint on productivity growth because whites were afforded access to a high quality education and training system which enabled them to become highly skilled workers. However, this was more a weakness than a strength, since a few highly qualified professional and technical experts is not sufficient for continual production efficiency improvements. Prais (1987 : 199) emphasises this point strongly in his comparative assessment of Japanese and English learning systems:

> **"Yet there remains a need to examine closely how attainments in schooling and the vocational preparation of their workforce compares with this country - particularly in relation to the *average* member of the workforce, rather than the university trained elite."** Emphasis Added.

This issue is even more important in a developing country context like South Africa, which has to rely more on the effective assimilation and adaption of foreign technology than on its own inventions. As such, the whole workforce needs to be well educated and trained, not just a few professionals and technical experts who would rather invent and create. In terms of the framework discussed in chapter four, it seems that the South African education system and various apartheid labour market policies constrained productivity growth. The nature of the education and training system reduced the effectiveness of learning-by-hiring and learning-by-training mechanisms, while apartheid labour market policies also discouraged such processes in addition to imposing a significant constraint on learning-by-interacting within the firm.

Overall, there seems a fair degree of consensus among South African analysts that education and training deficiencies in South Africa have had adverse consequences for industrial productivity growth. Indeed, from the evidence available, Joffe et al. (1993 : 37) conclude[10]:

> **"We thus observe a relatively uneducated population, a problematic schooling system, underinvestment in relevant training within the productive sector ... This suggests considerable market failure in the education and training systems."**

5.3 Qualitative Improvements to Capital

5.3.1 Introduction

Capital stock is defined as gross investment less depreciation, where conventional depreciation methods estimate an asset's lifetime in terms of how fast it deteriorates physically. The question is whether or not this provides an accurate valuation of the "true" capital stock. In the absence of technological change the measure of capital stock derived will be accurate if

[10] Also see Archer (1992), Archer and Moll (1992) and Lall (1993).

the asset does in fact deteriorate at the assumed rate. However, as was seen above, Scott (1989) argues that an asset's true value is affected more by obsolescence in the face of technological change. Hence, to arrive at a "true" capital stock requires adjusting capital stock according to the technological sophistication of different assets. Scott (1989) argues that cumulative gross investment (rather than investment less depreciation) provides a better measure of "true" capital stock[11]. Baily (1981 : 17) concurs with Scott (1989) on this issue:

> **"A factory that is scrapped, extensively modified, or is put on reduced hours of operation has probably not worn out, it has become uneconomic. Individual components need replacement, and certainly maintenance costs rise over time. But obsolescence is usually more important in determining economic value. The standard [U.S.] data on capital stock takes no account of variations in scrapping rates, utilization rates, or the extent to which capital spending is used to modify old plants because of changes in factor price or product mix."**

The real problem then, is that providing an accurate value of an asset requires anticipating the asset's future worth, which may be both uncertain and unpredictable, since it will depend on how quickly superior new technologies appear to render the asset obsolete. This highlights the practical difficulty of separating technological change from capital accumulation. It may be impossible to distinguish between that portion of investment spent on replicating existing assets (maintaining them in the face of physical deterioration) from that spent on new and better technology[12]. According to the neoclassical model, technological change occurs exogenously according to the whims of science and will be adopted automatically and at no cost by rational firms seeking to maximise profits. However, these assumptions effectively

---

[11] Scott (1989) recognises that assets will require maintenance to offset physical deterioration, but argues that this effect on an asset's value will be minor compared to obsolescence. However, Scott argues that this devaluation of an asset's value through obsolescence should not reduce the value of total capital stock. In his view, a firm will only invest in a new asset if this performs at least as well as the asset it replaces. Hence, a new asset should bring about an appreciation in the capital stock which will at least offset the depreciation in the capital stock from the obsolescence of the old asset.

[12] More importantly though, Scott (1989) argues that there may be little point in doing so since investment is often necessary for the generation and diffusion of technological change.

deny any role for investment, either as a generator or diffusor of technological change. In other words, the neoclassical theory essentially postulates that there will be no relationship between investment and productivity growth. However, even Solow (1988) recognises the fact that most new technology makes its way into production through investment in new machines[13]. This "embodiment effect" implies that slow investment may undermine technological change and so slow down productivity growth.

The rapid capital accumulation that characterised most industries in South African manufacturing in the first three periods, 1945-54, 1954-63 and 1963-74 (see **Figure 2.2** and **Appendix D**) suggest that slow investment cannot be held responsible for the relatively slow TFP growth in these periods. However, in the two most recent periods, 1974-81 and 1981-90 it is quite possible that slow investment - as indicated by the minimal capital-deepening occurring in almost all industries in each period - may have been responsible for the poor absolute TFP performance in these periods[14]. The continued slow investment in almost all manufacturing industries since the 1970s is a particularly disturbing feature, in terms of the embodiment hypothesis, and can be expected to have fairly long lasting adverse consequences for TFP growth[15]. Learning-by-using, learning-by-searching and learning-by-doing processes tend to be undermined in period of slow investment.

---

[13] Solow (1988) argues though, that vintage models should provide a more accurate value of capital stock by facilitating a more precise distinction between technological change and capital accumulation. However, the age classification used by most of these models may not correspond very well with the timing and extent of technological change, so that they do not overcome the capital valuation problem noted by Scott (1989).

[14] A significant exception is the Industrial Chemicals industry in the 1974-81 period where massive capital-deepening was undertaken (12.7% per annum), but was matched by an equally significant decline in productivity (12.1% per annum).

[15] See capital deepening trends in **Appendix D**.

5.3.2 Investment Efficiency, Technological Trends and Foreign Investment

It is commonly asserted that the manufacturing sector has become excessively capital intensive to the detriment of efficiency[16]. The simple neoclassical model specifies no relationship between TFP and investment, but suggests that as investment increases diminishing returns set in and an inefficient capital intensification process occurs. While capital-deepening has been the major source of labour productivity growth in all periods prior to 1974, it is not clear from a casual inspection what effect this characteristic feature of labour productivity growth has had on TFP growth. Regression results provide some support for the conjectures regarding the adverse efficiency effects of increased capital intensity. **Table 5.2** summarises these results. They show a negative and significant relationship between TFP growth and capital-deepening across industries in all periods except the most recent period (1981-90), where the relationship was positive but not significant.

This suggests that those industries in which capital-deepening was greatest tended to experience the worst TFP growth. While the most obvious interpretation of these results is that excessive capital-deepening has had an adverse effect on production efficiency, a number of qualifications need to be made to such an interpretation. Although correlation implies causality, it does not exclude the possibility of reverse causality or the effect of a third factor. Also, there is a need to assess the extent to which this relationship holds for all industries, and, for those that it does hold, there is a need for careful interpretation. With regard to this latter point, the capital-intensive industrial chemicals and basic metals industries are often singled out as prime examples of excessive and inefficient investment. The TFP growth

[16] See Levy, B (1981) who argues that by suitable international comparisons South Africa's manufacturing sector is heavily orientated towards capital intensive sectors. He argues that this orientation partly reflects government policy.

performance of basic metals in the 1963-74 period and industrial chemicals in the 1974-81 period do tend to support these notions. However, the improved TFP growth performance of industrial chemicals in the 1981-90 period does not support the following conclusion of Joffe et al. (1993 : 11), even if it may be applicable to the 1974-81 period:

> **" ..investment in the chemicals sector was driven by strategic factors. Obtaining petrol from coal is a high-cost operation. Moreover, the attempt to tap offshore deposits has proved to be extremely costly. The strategic investments in the 1980s were estimated to have cost R13-R14bn in 1990 prices, equivalent to half of total investment during the 1980s... The consequence of these strategic investments has been to severely dampen capital and total factor productivity, particularly during the 1980s."**

Table 5.2: The relation between TFP growth and Capital-Deepening

Year	All Industries		Labour-Intensive & Intermediate Capital-Intensive Industries	
Short Term Periods				
1945-54	$G_{TFP} = 0.00 - 0.67(\alpha G_{K/L})$ (2.29)**	$R^2 = 0.16$	$G_{TFP} = -0.97 - 0.28(\alpha G_{K/L})$ (0.49)	$R^2 = 0.01$
1954-63	$G_{TFP} = 1.41 - 0.36(\alpha G_{K/L})$ (1.73)*	$R^2 = 0.11$	$G_{TFP} = 1.13 - 0.32(\alpha G_{K/L})$ (1.04)	$R^2 = 0.06$
1963-74	$G_{TFP} = 1.37 - 0.49(\alpha G_{K/L})$ (2.06)**	$R^2 = 0.15$	$G_{TFP} = 0.06 + 0.36(\alpha G_{K/L})$ (1.12)	$R^2 = 0.06$
1974-81	$G_{TFP} = 2.17 - 1.11(\alpha G_{K/L})$ (7.19)****	$R^2 = 0.68$	$G_{TFP} = 1.81 - 0.99(\alpha G_{K/L})$ (2.31)**	$R^2 = 0.23$
1981-90	$G_{TFP} = -1.14 + 0.21(\alpha G_{K/L})$ (0.51)	$R^2 = 0.01$	$G_{TFP} = -2.19 + 1.01(\alpha G_{K/L})$ (1.47)	$R^2 = 0.11$
Very Short, Medium and Long Term Periods				
1985-90	$G_{TFP} = 1.18 - 0.83(\alpha G_{K/L})$ (2.06)**	$R^2 = 0.15$	$G_{TFP} = -0.08 - 1.52(\alpha G_{K/L})$ (2.80)**	$R^2 = 0.31$
1945-60	$G_{TFP} = 0.23 - 0.57(\alpha G_{K/L})$ (2.46)***	$R^2 = 0.20$	$G_{TFP} = -0.36 - 0.34(\alpha G_{K/L})$ (0.89)	$R^2 = 0.04$
1955-73	$G_{TFP} = 1.20 + 0.05(\alpha G_{K/L})$ (0.13)	$R^2 = 0.00$	$G_{TFP} = 0.78 + 0.35(\alpha G_{K/L})$ (0.69)	$R^2 = 0.03$
1945-75	$G_{TFP} = -0.15 + 0.01(\alpha G_{K/L})$ (0.05)	$R^2 = 0.00$	$G_{TFP} = -0.54 + 0.28(\alpha G_{K/L})$ (0.74)	$R^2 = 0.03$
1972-90	$G_{TFP} = 0.60 - 0.43(\alpha G_{K/L})$ (1.53)	$R^2 = 0.09$	$G_{TFP} = 0.23 - 0.28(\alpha G_{K/L})$ (0.63)	$R^2 = 0.02$

Source: Data from Table 1.3.

Note: These regressions results show the relationship between TFP growth and Capital deepening across industries. The t-statistics for the coefficients of capital deepening are shown in parenthesis below these coefficients, and where significant are indicated by asterisks: Level of Significance: * 90%, ** 95%, *** 99%, **** 99.9%.

However, it should be borne in mind that past investments in the capital-intensive industries have tended to be long term and lumpy in nature. Hence, the consequences of these investments will extend far beyond the period lengths of the short term regressions. And, as such, for longer term regressions the strength and significance of this relationship disappears.

Hence, while there appears to be some support for the contention that the increased capital intensity of manufacturing has adversely affected TFP growth, the evidence is generally weak once it is carefully interpreted. It is possible that the seemingly heavy reliance on capital deepening by South African manufacturing is indicative of a serious malaise. However, it should be pointed out that heavy reliance on capital deepening is not unique to South Africa. International studies indicate that larger contributions from capital accumulation are a common feature of the growth pattern experienced by developing countries in contrast to developed countries[17]. Hence, for developing countries in particular, capital-deepening may be an important source of output and productivity growth to the extent that technological progress is facilitated through the embodiment effect.

Besides the embodiment effect there are other factors that are likely to influence the quality of capital (the efficiency of investment). In this respect, as was discussed above, Romer (1990) addresses evidence from the U.S. and claims that it appears to show no systematic relationship between capital accumulation and TFP growth. He argues that this evidence is best explained by the fact that other factors (particularly knowledge) have a crucial influence on the relationship between capital accumulation and TFP growth. This does not deny the

[17] See Chapter 2, where international TFP comparisons are made and comments by Pack (1988) amongst others are noted. See also Bruton (1967), Chenery (1983) and Havrylysyn (1990).

importance of the embodiment effect, but emphasises that capital deepening can be excessive (inefficient) if it there is not an adequate, complementary stock of knowledge. The embodiment hypothesis, like the simple neoclassical model, suggests that technological change occurs exogenously (although slow investment can hamper the diffusion of technological change). In contrast, Romer's (1990) model suggests that there is scope for deliberate efforts to improve knowledge and technology. Following this view, while slow investment does have adverse consequences for TFP growth, rapid investment/capital-deepening need not be inefficient (leading to diminishing returns) so long as it is accompanied by deliberate efforts to improve knowledge. Where it appears that knowledge improvements are slow, implying a lack of deliberate learning efforts, there is a need to assess whether this is simply due to management slack, or, if in fact there are important institutional or other environmental factors restraining such learning efforts.

An alternative interpretation (following Romer (1990)) of the rapid growth in capital-deepening, and the negative short run correlations between capital-deepening and TFP growth in South African manufacturing prior to the 1970s, is that efforts to improve knowledge did not match the rate of capital accumulation, and it is because of this that diminishing returns set in[18]. What needs to be considered is the extent to which institutional and environmental factors present in the South African economy limited the ability of South African firms to learn-by-searching and learn-by-using. In this respect, Joffe et al (1993) analyse data on R&D expenditures and argue that, at the national and sectoral level, investment in enhancing technological capabilities is low by international standards and currently declining.

---

[18] In support of Romer's hypothesis, note that in the long run (see **Table 5.2**) there is no systematic relation between capital-deepening and TFP growth.

Since South Africa, like most developing countries, relies to a large extent on foreign technology, this interpretation might mean that the technology embodied in new technology from abroad is inappropriate for South Africa. Or, more importantly, it could mean that local firms are not devoting enough effort and resources to ensuring that foreign technology is effectively assimilated and adapted in this country. In other words, firms may be deriving few net benefits or rents from this technology given the terms of the technology transfer. It is quite possible that South African firms do not have the technical expertise to conduct effective searches, or that the nature of international relations may serve to thwart the effectiveness of such searches.

As the earlier discussion of recent theories emphasises, production efficiency improvements require deliberate efforts to enhance technological capabilities:

> **"Trained labour and physical capital are only fully productive when combined with efforts by productive enterprises to assimilate and improve upon the relevant technology... it is evident that different countries devote different levels of effort to technology. Apart from domestic technological effort, the extent and nature of a country's reliance on foreign technology is also directly relevant to NTC [National Technological Capabilities]. All countries need to import technology, but different modes of import have different impacts on local technological development." (Lall, 1992 : 170)**

Hence, there is a need to be sceptical of arguments that South Africa's productivity will improve so long as foreign investment is forthcoming. While foreign investment is crucial, the benefits of such investment needs to be evaluated in terms of the extent to which firm and national capabilities are enhanced. However, this does not imply that the other extreme of self sufficiency be adopted. As Dore (1984 : 76) says:

> **"The brave posture of scorning any help from foreigners (from the foreign multinationals who have the rights in a lot of technology) is appealing. In reality it takes more patriotism and self confidence to grit your teeth in all humility, negotiate with the multinationals, drive an intelligent bargain and be damned to those who impugn your integrity."**

This argues for a pragmatic approach, along the lines pursued by USIMINAS. Foreign and local capabilities should be combined in ways that progressively develop local capabilities in areas where they can be more efficient. In this regard the knowledge and bargaining skills of the purchasers are most important. Manòeuvrability in bargaining with multinationals should be sought in the dynamic elements of technological information and understanding rather than in the technological means as it is the former two that are most crucial for facilitating a firm's technological maturity[19].

The fact that LDC firms can capture technological rents in this way is emphasised by the reluctance of multinationals to transfer these elements of technology for fear, that in so doing, they will undermine their ability to appropriate the full rents from their innovation:

> **"there is evidence that these firms are more hesitant to send overseas their process technology than their product technology because they perceive that the diffusion of process technology once it goes abroad, it is harder to control." (Mansfield, 1985 : 223 fn10)**

In purchasing from multinationals it may be difficult or prohibitively expensive to acquire the technological understanding and information with the means. Hence, in certain cases the best option may be for firms to create their own technology. However, the costs and constraints to achieving technological maturity in this way also need to be borne in mind.

In this respect, India is noted for its strategy of technological self-sufficiency and Bruton (1989) argues that there is evidence of genuine '*know-why*' being achieved, and technological maturing occurring. However, the dismal TFP performance by India (see **Table 2.3**) suggests

---

[19] See Chapter 4 and Figure 4.2 in particular as well as the discussion of the USIMINAS case study.

that the short run costs of such a strategy have been high. However, potential dynamic long term productivity returns to such a strategy may to some extent justify the costs. In contrast, while there is evidence that Korea lags far behind India in technological maturity it has clearly recorded impressive TFP growth performance.

By all accounts, the South African manufacturing sector has undergone significant growth and structural change so that it is now both diversified and fairly large in comparison with other sectors and countries[20]. However, the extent to which it has technologically matured is less clear. Trends in the size, nature and performance of a country's capital goods sector is sometimes taken as an indicator of the country's technological maturity. **Table 5.3** helps put some of these issues in context. What is most disconcerting is the relatively small contribution made by machinery and transport equipment to value added in the manufacturing sector in South Africa compared to other countries, in addition to its comparative export and import propensities in these industries.

These trends may reflect a dependence on foreign technology. If a country possesses a high degree of knowledge and understanding about technology, then the decision to import technology, in preference to creating it, may not indicate a dependency relationship. As argued above, this is especially important from the dynamic perspective of possessing the capabilities to capture technological rents by assimilating and adapting foreign technology. However, in a situation where a host nation's technological capabilities are weak, the decision to import technology is likely to indicate a dependency relationship. While South Africa's technological capabilities remain to be clarified, in comparisons to other countries, the nature

[20] See Archer (1987), McCarthy (1988)

and significance of South Africa's machinery and transport equipment industries does not present a reassuring picture of the technological maturity of manufacturing.

Overall then, in South Africa there is little evidence on either domestic technological efforts or the impact that foreign technology has had on ITC. Without much supporting evidence, the Kleu study group (1983) merely notes that most technology is transferred to South Africa in a packaged form. Similarly, Fransman (1982 : 254) emphasises the paucity of information on technology transfer, but notes that what information there is indicates:

> **"... a manufacturing sector that undertakes little research and development expenditure and imports foreign technology through licensing and other know-how agreements."**

Joffe et al. (1993) also argue that local firms tend to rely upon the acquisition of technology from abroad. Additionally, Joffe et al. (1993 : 45) emphasise that licence agreements:

> **"..are characterised by high levels of royalties and frequent and wide ranging restrictive clauses, including typically on exporting."**

The penetration of foreign direct investment into South Africa appears to be of a similar magnitude to other developing countries (see **Appendix H**). However, the extent to which a country is dependent on foreign technology is not easily resolved by recourse to indicators of foreign direct investment. Given the evidence just considered it is quite plausible that the nature of technological transfer has been a dependent one in which South African firms have failed to enhance their own technological capabilities in the process, with the result that production efficiency gains have been small. Hence, the nature of this technology relationship may have undermined the effectiveness of learning mechanisms in South African firms.

Table 5.3: The Manufacturing and Capital Goods Sector in Selected Countries.

		South Korea	South Africa	Brazil	India	UK	West Germany
1.	Manufacturing as % of GDP, **1960**	12	23	26	14	32	40
	Manufacturing as % of GDP, **1977**	25	22	-	16	25	38
	Manufacturing as % of GDP, **1985**	28	23	-	17	22	31
2.	Machinery & transport equip as a % of manufacturing value added, **1975**	23	17	30	12	32	33
	Machinery & transport equip as a % of manufacturing value added, **1984**	29	20	18	19	33	41
3.	Machinery and transport equip as a % of merchandise exports, **1960**	-	4	-	1	44	44
	Machinery and transport equip as a % of merchandise exports, **1976**	17	5	10	6	40	48
	Machinery and transport equip as a % of merchandise exports, **1985**	36	2	14	4	32	47
4.	Machinery and transport equip as a % of merchandise imports, **1960**	12	37	36	30	8	10
	Machinery and transport equip as a % of merchandise imports, **1976**	27	55	29	19	21	18
	Machinery and transport equip as a % of merchandise imports, **1985**	34	55	15	25	32	23

Sources: Fransman, 1982, p245, Table 12.7 and World Development Report, 1987.

5.3.3 The Impact of Trade Policies on the Quality of Capital

Much theoretical and empirical work has focused on the relationship between trade orientation and productivity growth[21]. The practice of making development aid conditional on trade liberalisation exemplifies the prevailing, though widely disputed, wisdom that nations who adopt neutral, or outward orientated trade regimes will outperform those who pursue more endemic policies which protect domestic producers from foreign competition.

At the theoretical level, few dispute the orthodox conclusion that free trade is optimal for static efficiency. The fundamental question however, is whether this result has any

[21] It should be emphasised that this focus by economists on the trade regime has tended to detract from the importance of other national characteristics important to industrialisation and productivity, especially issues of technological capabilities on the supply side.

implications for a particular nation's long term growth and welfare.

The relation between degree of openness and efficiency is at the centre of the case for trade liberalisation. The main arguments used to justify this notion can basically be broken down into two categories. Firstly, the benefits of a larger market and secondly, the incentives that foreign competition brings[22]:

1a) Openness leads to specialization in internationally competitive goods which allows for greater economies of scale.

b) Specialization and the opportunities for export growth helps contribute to greater capacity utilization.

c) Access to larger markets that openness ensures is supposed to facilitate 'learning by doing' as is postulated by Verdoorn's law of a positive relation between productivity growth and cumulative output.

Hence larger scale and a greater intensity of input use are seen as being major efficiency benefits of an open trade policy. While the benefits of a larger market offered by the international market are obvious, it is not at all obvious how easy it is to penetrate these markets. With regard to emerging industries, the argument about the benefits of increased capacity utilization, economies of scale and the scope for learning by doing could just as easily apply to the benefits that protection affords to import competing industries, in terms of assuring them of a larger share of the domestic market. In fact, one of the main justifications for promoting infant industries was the belief that with time and a larger market they would be able to learn by doing

[22] See Pack (1988:349) and Havrylysyn (1990).

and so become internationally competitive.

2a) The pressure of international competition should ensure the elimination of X inefficiency which is argued to characterize local firms who exist behind trade barriers and are able to pursue the quiet life.

b) Similarly, the pressure of international competition should force firms to stay up to date with technological advances and incorporate them as and when they occur.

c) Interaction in foreign markets is regarded as exposing firms to information about new technological products and processes[23].

The pressure of international competition can certainly have a positive effect on productivity by eliminating unnecessary slack within the firm. However, it may also have the negative effect of preventing firms from investing in the technological capabilities necessary to compete successfully in the future. In other words it may force the allocation of resources in accordance with static rather than dynamic considerations. Given linkages and public good attributes (such as partial excludability) of technology, competition may act as a disincentive on firms to commit resources to the enhancement of technological capabilities. This criticism applies also to the notion of the role of 'learning by doing'. As was emphasised earlier, it is insufficient to rely on this passive, costless and automatic learning mechanism to generate the capabilities needed to compete successfully in the future. Also, the assumption that the *mere* interaction in foreign markets is somehow sufficient to

[23] Edwards (1991 : 5), specifies a Romer type model where he postulates a:
" 'learning-by-looking' type of process where the mere contact with newer commodities and technologies increases the efficiency with which innovations are absorbed."

ensure the diffusion of appropriate technology is highly questionable. The nature of interactions and the technological capabilities of those interacting in foreign markets are pertinent to the costs and benefits of the technology that is transferred.

At the most general level, all these arguments require significant qualification. Nishimizu and Robinson (1984) argue that it is quite plausible that the causation runs from productivity performance to output and export growth rather than the reverse that is suggested by this analysis. Furthermore, most of the arguments ignore the crucial role played by technological capabilities. As Lall (1992 : 171) argues:

> **"Most of the conventional arguments are not couched in terms of the impact of trade strategies on technological capabilities, but the implicit assumptions made about technological capability (TC) development are very relevant to the issue."**

This point is just as applicable to the arguments used to justify protectionist trade strategies. As was noted earlier, the passive learning-by-doing justification for infant industries is likely to be of little importance to technological capability. At the heart of the impact of trade strategies on technological capabilities is the fact that international competition can be either a stimulant or a retardant. International competition can provide a powerful incentive for firms to deliberately enhance their technological capabilities. Lall emphasises that it is because of this that many of the barriers which governments erect to such competition may retard technological development, efficiency, export growth and structural change, precisely because they are made in a sweeping, irrational and prolonged way.

That many countries which adopted import substitution policies have experienced many problems is by now fairly well established. In these cases though it is not always clear that the policy of import substitution was responsible for the problems. In this respect, in a study of the objectives and achievements of import substitution, Bruton (1989) argues that much of the lambasting of the strategy is unwarranted and frequently focused on the wrong issues. He argues further that protection should be viewed as an investment in the economy's future - a future in which the economy is more independent and productive:

> **"More specifically, the objective is to establish a flexible, responsive economy that can take advantage of opportunities generated in the world at large and, more importantly, that can generate its own opportunities. Behind this protection, new activities are created that modify the structure of the economy and induce learning. The achievement of both these objectives is necessary if import substitution is to accomplish the intended objectives. Learning is reflected most clearly in total factor productivity growth and in the emergence of an indigenous technological capacity. This latter notion is admittedly fuzzy and TFPG is also open to severe measurement and conceptual problems." (Bruton, 1989 : 1637).**

Hence, it seems more appropriate to assess the merits of various trade regimes on the basis of their impact on technological capabilities[24]. The incentive structure of a particular trade regime will have an important influence on the deliberate efforts of firms to enhance their technological capabilities. It should also be emphasised that protection and export promotion need not be mutually exclusive. In fact, it is quite possible that protection may be a necessary phase in which technological capabilities are built up so that cost reductions and quality improvements facilitate the achievement of international competitiveness and ensure the successful penetration of foreign markets by exports.

The above analysis has examined some of the causal connections used to justify the link between trade orientation, output and productivity growth and technological capabilities. Is there any evidence to support these arguments and how strong is it ? Havrylyshyn (1990 : 7) examines the evidence regarding the link between productivity growth and trade policy and

---

[24] The merits of various trade regimes should also be considered from the perspective of the state's ability and willingness to implement these strategies in accordance with their aims.

concludes that empirical studies of productivity that do make a reference to trade policy:

> **"generally support the hypothesis of a positive relation between degree of openness and efficiency gains. The conclusions are generally weak, however, and based as much on qualitative as quantitative evidence."**

Edwards (1991) emphasises that the major problem encountered in attempting to test the hypothesised link between trade orientation and productivity growth is the difficulty in constructing adequate indicators of trade orientation. There are basically two approaches that have been adopted to deal with this problem. Neither of them fully resolve the problem however. The one approach[25] constructs a subjective index of trade orientation, but as Edwards (1991 : 3) emphasises the results of these studies depend:

> **"upon whether Korea and a few other countries are classified as 'liberalised' or 'unliberalised' economies."**

The second approach essentially uses exports[26] as an indicator of trade orientation[27]. The weakness of this approach is that strong assumptions are required if the results are to be interpreted conclusively. Interpreting a positive relationship between exports and TFP growth as indicative of the benefits of an outward orientated trade policy requires assuming that liberal trade regimes do facilitate export expansion. However, the association between exports and productivity can be interpreted in a number of ways. It is just as plausible that productivity growth from other sources facilitates export growth[28]. Nishimizu and Robinson

---

[25] See World Development report, 1987.

[26] Edwards (1991) approach uses Leamer's index of trade orientation, but it appears that this index is constructed from trade flows and intensity and so may not be significantly different from using exports.

[27] See Feder (1983) and Nishimizu and Robinson (1984).

[28] It is also quite possible that a bias against exports arises because slow productivity leads domestic producers to pressurize the state to implement protectionist measures. In this case protectionist measures do not stem from a coherent strategy based on economic rationality.

(1984 : 191) note:

> **"One must be very cautious ... in implying the direction of causality in the relationship. For example, it is just as plausible that higher rates of exogenous TFP change lead to rapid growth in demand through lower costs and prices."**

Hence, while there is little doubt that a country that is experiencing rapid productivity, output and export growth is in an extremely fortunate situation, it is not at all clear that the fundamental cause of this association is due to the trade regime per se. It is simplistic to assume that the mere adoption of an outward orientated trade regime is sufficient to ensure either rapid productivity growth or rapid export growth.

In a review of alternative trade strategies Pack (1988 : 372) concludes that:

> **"Export orientation ... does not appear to yield higher total factor productivity than does import substitution. Comparisons of total factor productivity growth among countries pursuing different international trade orientations do not reveal systematic differences in productivity growth in manufacturing, nor do the time series studies of individual countries that have experienced alternating trade regimes allow strong conclusions in this dimension. ...it seems unlikely that the absence of the expected pattern stems primarily from deficiencies in the data."**

This lack of conclusive evidence regarding the link between the trade regime and productivity growth leads Pack (1988) to conclude that there may be no short cuts to industrial proficiency. It may in fact be technological capabilities that are the missing explanation of productivity growth differences rather than data deficiencies that account for the poor explanatory power of conventional models. It might easily be the case that there is no systematic relationship between the broad characterizations of nations' trade orientations and their technological capabilities. However, technological capabilities are not easily quantified satisfactorily, so empirical evidence on the fundamental determinants of productivity is likely to remain inconclusive. In this regard, Pack's conclusion may be partly correct insofar as technological capabilities are not easily acquired, and do require lengthy deliberate learning.

What implications does this analysis have for the link between South Africa's trade orientation and its productivity performance? To answer this question it is first necessary to provide a brief description of the structure and trade orientation of the South African manufacturing sector.

The present structure of the South African economy owes its foundations to the discovery and exploitation of gold and diamonds in the late nineteenth century. A manufacturing sector emerged to satisfy the needs of the mines and the mining communities. Mining interests were closely tied to British commercial interests and the power of their opposition to protection for local manufacturing is evident in the Customs Tariff Act (no 26) of 1914 which clearly comes out in favour of a policy of free trade. It is apparent that up until the end of world war one the structure of the manufacturing sector evolved mainly from the natural protection that transport costs and wartime disruptions afforded, rather than from any explicit attempt to shape its evolution. However, the Nationalist-Labour PACT government ushered in a new phase for industrialisation in South Africa. This coalition was essentially an alliance of white labour interests, nationalist white farmers and manufacturing capital (against mining and commercial interests). The strategy of active economic industrialization was viewed by the government as necessary to ensure greater economic independence, and also partly a reflection of the desire to develop a solid industrial base to replace the wasting gold mining industry. Since then South Africa has pursued a fairly active protection policy to promote industrialisation. The state has also actively participated in the establishment of large industries. Officially this has been viewed as a way to advance the process of import substitution, given the reluctance of private local or foreign investors to commit themselves to such large undertakings. Despite the recommendations of government commissions, since the Reynder's commission (1972), for South Africa to pursue a more neutral or outward orientated trade strategy, in practice trade policy has continued to focus on import replacement. Nevertheless, Belli et al. (1993 : 1) point out that:

> **"since the early 1970s .. the trade regime has undergone substantial modifications that have made exports more profitable and the trade regime less protective."**

Bell (1992) argues that important import-liberalisation steps in this period included the replacement of quantitative restrictions with tariffs and the switching from a positive to a negative list of goods requiring import permits. However, it is only as recently as 1990, when the General Export Incentive Support Scheme (GEISS) was implemented, that the move in official thinking began to be put seriously into practice. The scheme does not attempt to discriminate, as it entitles all exporters to a subsidy. In this regard, apart from state intervention and subsidised interest rates, which favour more capital intensive industries, there is little evidence of a coherent attempt by the state to target industries for (import or export) promotion[29]. Nor has there been any attempt to draw out the implications of these policies for the technological capabilities of firms or industries. This is not surprising as the government does not really have a technology policy, as finance minister Keys makes clear:

> **"The last thing we could claim is that we are in any position to be arbiters of what kind of development should go on, or that we are able to develop some kind of master plan which would result in an optimal development of technology in South Africa." (Financial Mail, 1992 : 41)**

[29] This is even though official documents claim that the principle of customs tariffs in South Africa is to provide *moderate* and *selective* protection. See McCarthy (1988:9)

Import substitution has clearly played an important role in the growth and diversification of the South African manufacturing sector. However, given the productivity performance of the South African manufacturing sector many have questioned the efficacy of the import substitution policy pursued in South Africa. Despite inconclusive theoretical and empirical evidence regarding the link between the trade regime and productivity growth, the dominant view in South Africa still comes out in favour of a more liberal trade regime. Against this background various authors have argued that the state's policy of import substitution is an important part of the explanation for the poor productivity performance of the South African manufacturing sector. Becker and Pollard (1990 : 9) argue:

> **".. it is apparent that the mere threat of sanctions has already forced South Africa to take costly evasive action that reduces its dependence on the outside world. The consequence has been to greatly curtail South Africa's productivity growth .."**

Similarly, Moll (1990) argues that the Nationalist governments adoption of import substitution was one of the most important factors responsible for the poor productivity performance of the South African economy. Moll's "opportunities missed hypothesis" claims that South Africa missed out on a golden opportunity to penetrate export markets in the 1950s and 60s phase of worldwide prosperity[30], with the result that it under-achieved in respect of its productivity growth potential. However, the measures in Chapter 2 indicate that while South Africa's productivity performance was not exceptionally good - in comparison to other countries - in the 1950s and 1960s, it was not exceptionally bad either. More importantly though, it is not at all clear that South Africa possessed the capabilities, especially

---

[30] Joffe et al. (1993) reach similar conclusions after comparing South Africa's industrial export record with the records of various Newly industrialised countries:

> **"There is little doubt that by comparison with many LDCs, South Africa has missed out on significant export opportunities."**

technological, necessary to successfully penetrate export markets. In this respect, Moll (1990) uses catch up theory to argue that by the start of the 1950s South Africa had acquired substantial infrastructural and social capabilities and so had the potential to realise its "advantages of backwardness". His conclusions regarding this potential were reached despite quoting Abramovitz regarding the difficulty of describing social capabilities. In addition, Moll (1990) does not adequately assess the technological capabilities that South Africa possessed at the time. As the framework in this thesis emphasises, these issues are vital, and any account which attempts to explain without a careful consideration of them is likely arrive at unwarranted conclusions.

Belli et al. (1993) suggest that the modifications to the trade regime seem to have had some effect. Although manufacturing export growth remained slow in the 1972-83 period, it was moderately high in the 1983-90 period. Belli et al. (1993) estimate that TFP growth, for manufacturing as a whole, increased from 0.05% in the period 1972-83 to 0.55% in the period 1983-90. In contrast, estimates in this thesis and those of Moll (1990)[31] suggest that TFP growth worsened between 1974-81 and 1981-90, even though all estimates suggest that it appears low in absolute terms in both periods. While Belli et al. (1993) argue that they find this poor TFP growth performance a puzzle, they do suggest that the import substituting industrialising policies pursued in South Africa are partly responsible. They try to address this issue by examining the relationship between TFP growth and the sources of output growth in South African manufacturing in the periods 1972-83 and 1983-90. They conclude from their analysis that there was a positive and significant association between export expansion and TFP growth in both periods. However, Joffe et al. (1993) are reluctant to accept Belli et

[31] See **Appendix A** for a comparison of the different estimates.

al's (1993) argument that export expansion can cause productivity growth improvements given international evidence which finds no significant relationship between export expansion and productivity growth. Furthermore, from their detailed sector analysis, Joffe et al. (1993) find little evidence of production efficiency improvements by firms who expanded exports. However, they did find that export expansion enabled many firms to operate at higher capacity levels. This may provide an alternative explanation for Belli et al's (1993) finding of a positive association between TFP growth and export expansion. While the benefits of higher capacity utilisation are clear, what it is not encouraging is the tendency of firms to only pursue export markets in times of sluggish domestic demand[32]. However, if firms that were previously geared to the domestic market are able to sustain export volumes, this may suggest that their export success is partly due to past import protection measures that facilitated their technological maturity.

It should also be emphasised that Belli et al's (1993) analysis provides little support for their other conjecture about the association between import substitution and productivity growth. While the relationship between import substitution and TFP growth was negative in the 1972-83 period, the relationship was not statistically significant. Furthermore, in the 1983-90 period, the relationship between import substitution and TFP growth is positive and statistically significant. Hence, their overall empirical analysis does not provide strong support for their argument that the import liberalisation and export expansion trends, in the 1970s and 1980s, helped improve TFP growth in South African manufacturing.

[32] See Bell (1992), Holden (1992) and Lall (1993).

It needs to be emphasised that trade policy is only one factor, among many, which influences productivity growth and so should not be regarded as *the* simple panacea for improving productivity growth.

5.4 Other Factors

5.4.1 Work Organisational Influences

This section essentially takes cognisance of the human dimension of production. **Figure 4.1 (b)** emphasised that individuals are role players in organisations. How individuals behave and interact in an organisation has important implications for the effectiveness of the organisation. Like technology the neoclassical model treats the internal workings of a firm as a black box. The essential assumption is that management has full control and adopts the cost minimising solution in the face of perfect competition. In reality, a firm is not a unitary actor, and its performance does depend on the actions, decisions and efforts of its personnel. Behavioural and evolutionary[33] theorists emphasise that in reality there is no simple global function to be optimised as rationality is bounded. Rather, firms satisfice in an attempt to satisfy the divergent interests of the different groups that comprise a firm.

Hence, the structure of an organisation is vital to a firm's performance. A particular structure entails a particular combination of penalty and reward mechanisms which influences the discretionary behaviour of individuals. The structure of a firm's organisation also determines how individuals interact within the firm and so will also influence the degree to which knowledge and capabilities are transmitted through the organisation. Hence, the particular structure of a firm will have an important impact on the extent to which learning-by-

[33] Nelson and Winter (1982), Simon (1955), Cyert and March (1963).

interacting takes place within a firm. However, it should be emphasised that the particular structure of a firm is not simply a matter of management design, but will be influenced by worker-manager relations as well as external institutional and other environmental factors.

Recent literature[34] suggests that fundamental technological changes are taking place, in the form of radically new products and production processes. They emphasise that the benefits of this new technological paradigm require radical changes to institutions and the social relations of production. They argue that the Taylorist era has become obsolete. In this era work was organised to mass produce a standardised product with an extreme division of labour which made workers highly specialised at very routine tasks. The new technological paradigm has facilitated a work organisation system based on the standardised production of differentiated products (flexible specialisation) which require more skilled and flexible workers. In terms of the work extraction function this technological paradigm shift has orchestrated a change in the social relations of production away from surveillance and divide-and-rule strategies (the stick) and in favour of improving the skills, control and participation of workers. This relies more on organisational aspects and monetary rewards (the carrot)[35]. Japanese work practices such as lifetime employment, job rotation, quality circles and participative management are all highly reliant on worker cooperation[36]. In the context of these organisational forms for the present technological paradigm it suggests that worker unity, in the form of peer group determination of worker norms, may be more effective than owner control via divisive divide and rule strategies.

[34] Piori and Sabel (1984), Perez (1983), Perez and Freeman (1988) and Boyer (1988)

[35] For a discussion of some of the training implications of these organisational forms see the next section (3.4) and Archer (1992).

[36] Cooperative worker-management relations may also be necessary, though not sufficient, for the effectiveness of such practices as Just in time (JIT) management and subcontracting.

In South Africa the increasing power and militancy of national trade unions, such as COSATU and NACTU may undermine the efforts of individual firms to improve productivity through work organisational change. Job reservation, which characterised apartheid labour market policy militated against the formation of work organisation systems based on a cooperative management labour relationship. Since social and institutional structures lack inertia, the effect of these policies is likely to be felt for some time. In addition, this policy together with other aspects of apartheid is likely to have reinforced the strength of trade unions, especially at the national level. However, Joffe et al. (1993) argue that with the dismantling of apartheid and the introduction of new forms of work organisation in production, unions are likely to moderate industrial action. If this materialises it could generate significant improvements to productivity.

Some argue that businessmen cannot be relied upon to make the substantively rational decisions that are required for the improvement of technological capabilities necessary for international competitiveness[37]. As a result, apart from the pursuit of wage restraint by a strong state, the only way substantive rationality will dominate is if a national union takes the lead in designing and pursuing an industrial strategy[38]. However, on the basis of the conceptual framework used in this thesis, it is rather argued that the nature of emerging technology requires a cooperative relationship between labour and management if technological capabilities are to be improved. Such a cooperative relationship seems unlikely in a situation where a strong national union is perceived as telling management its job. Joffe et al. (1993) also advocate the active involvement of organised labour in industrial strategy.

---

[37] See Higgens (1993).

[38] Even if a national union-led initiative is fairly successful in forcing substantial rationality on business, it is highly likely that the unemployment situation will worsen.

However, they seem to argue that the state should be able to broker the cooperation of management and organised labour.

5.4.2 Cultural and Institutional Factors

As with technology, conventional economics prefers to treat cultural and institutional factors as exogenous, to be explained by other disciplines. However, institutional economics is a growing subject[39] that has arisen from a number of different lines of analysis and schools of thought.

Figure 4.1 emphasises the importance of cultural and institutional factors for regulating the way individuals, firms and the state behave and interact. The nature of this environment is likely to be different in different countries with implications for productivity performance.

Institutions have been taken to mean a number of things to different people. Nabli and Nugent (1989 : 1334) argue that institutions can best be understood either from:

> **"a behavioural perspective, in which 'institutions are complexes of norms of behaviour that persist over time by serving collectively valued purposes' (Uphoff, 1986 : 9), or from a rules perspective where institutions are the rules of a society or of organisations that facilitate coordination among people by helping them form expectations which each person can reasonably hold in dealing with others."**

The former can be regarded as entailing the cultural values of a society that governs the relationship among its individual and group members. A society's culture involves a high degree of permanence that essentially has to be taken as given, for the purposes of designing

---

[39] See amongst others: Doeringer and Streeten (1989), Nabli and Nugent (1989), Ranis (1989), Perez (1983) and Boyer (1988).

a development strategy. However, the rules perspective indicates that, within a given culture, the set of rules a society adopts are not inimical to change. While institutions can be changed, their ability to regulate coordination is largely achieved by the understanding of permanence and predictability. This ability is also dependent on the perception that the rules (whether legislative, cultural norms or private market contracts) will actually be enforced. Government's do have an important role to play in the formation and operation of institutions, but there are many other rules outside the realm of government that characterise a nation's institutions. In this respect institutions should be regarded as contracts governing the relations between parties to a contract. The parties to a contract may be the state and its citizens, but they can just as easily be a union and its members, a firm and its employees or two persons.

There is no doubt that institutions play a fundamental role in a nation's performance. How institutions are formed[40] is clearly important, but beyond the scope of this analysis.

In contrast to other commentators, Ranis (1989 : 1443) regards the success of the East Asian NICs, in their transition to modern growth, as being due to:

> **"the role of institutional/organisational changes orchestrated by a government which was both sensitive to these systems initial conditions and to the importance of setting the stage for the fullest participation, through markets, of a large number of dispersed private actors."**

[40] It could be argued that (government) institutions merely reflect the most powerful parties - or interest groups - to a contract. From this perspective the formation of the institution of apartheid by the Nationalist government in 1948 may be better understood as reflecting the enormous power of white workers rather than being a simple unilateral decision by the government as Moll (1990) appears to argue.

He sees this success as being comprised of three ingredients: secularism, egalitarianism and nationalism[41]. Ranis regards secularism as entailing the attachment of a high priority to economic attainment rather than political, ideological or religious notions. He sees egalitarianism in terms of a society that is committed to equality of access and opportunity rather than equality of outcome. Lastly, organic nationalism is seen as a common purpose and allegiance of individuals and groups of a society that is based on a common heritage:

> **"While economists are understandably loathe to put too much weight on cultural factors, there can be little doubt that the felt need to create a synthetic type of nationalism when facing marked regional, ethnic or religious disparities among groups pulling in different directions all too frequently lead new LDC governments to overpromise and overcommit and, as a consequence, to be both unable to carry out the major development functions and in danger of losing their credibility early in the game." (Ranis, 1989 : 1445)**

Drawing on Olson's (1982) analysis, Pack (1988) argues that the East Asian success stems from the willingness and ability of the state to pursue institutional change in spite of the power of interest groups opposing such change. This ability and willingness may not simply reflect the power of a strong state, but may also reflect the degree of consensus between the state and its citizens which recognises a mutual obligation to pursue national rather than group interests. Institutions can help to restore confidence in a government by limiting its discretion to satisfy the rights of powerful interest groups before the national interest. In South Africa, this can partly be achieved through greater equality of opportunity and access - especially in the education and training system and in the workplace.

[41] Authors such as Perez (1983), Freeman and Perez (1988) or Boyer (1988) focus on the applicability of a given social structure for the emerging technological paradigm. While Ranis abstracts from this technological dimension his analysis does help emphasise the importance of cooperation and consensus which many see as vital to the latest technological paradigm where flexible specialisation is an important component of work organisation and requires a greater degree of skills, flexibility and participation by workers, which can only be achieved through labour-management cooperation and trust.

Moll (1990) argues that apartheid had an 'ossifying' effect on economic growth in South Africa. He argues that an important part of this is that black education and job reservation policies constrained the occupational mobility of blacks which ultimately resulted in a skills shortage. This skills shortage, together with the higher price for the "skilled" whites are seen to have had an adverse effect on productivity performance. Fallon (1992 : 2) also supports this interpretation:

> **".. as strong labour market discrimination accompanied by enabling legislation effectively reserved middle and upper-level jobs for whites, the supply of whites may have acted as an effective constraint on the productive capacity of the economy. Declining growth in white labour supply during the 1970s and early 1980s may then have had the effect of reducing .. economic growth."**

In the long run the removal of these inequalities should overcome this productivity growth restraint. However, the time that these apartheid policies have been in operation[42] does not bode well for encouraging a more cooperative relationship between workers and management. Such a relationship appears to be important for the future performance of the manufacturing sector where the emerging technological paradigm suggests the optimality of a work organisation system based on flexible specialisation.

Ranis's (1989) analysis helps add a note of scepticism to those attempting to emulate the success of the East Asian NICs. He argues that for cultural reasons the possibilities are remote that the NIC strategies can be successfully adopted in deeply divided societies such as South Africa. However, his analysis does point to areas of institutional change that can help to restore confidence in the government's ability to act for the common good.

---

[42] It is of course recognised that firms did not always comply with job reservation regulations.

Chapter 6

Conclusions and Policy Implications

6.1 Theory and Policy

It has been stressed in earlier chapters that the neoclassical model is of limited use for assessing the fundamental causes of productivity growth. Most of the current proposals for enhancing the productivity growth of the South African manufacturing sector are mainly based on neoclassical principles. Hence, the relevance of these proposals is limited. These proposals espouse free markets, locally and internationally on the basis of a static theory of comparative advantage. It is far from clear whether such a recommendation is relevant to, let alone optimal for dynamic, long run growth. In the light of the problems with the neoclassical proposals, some recent alternative theories have been considered. As was discussed earlier, these theories provide a useful basis for the construction of a coherent framework with which the fundamental determinants of the productivity performance of the South African manufacturing sector can be analysed.

Following Denison (1984), it is argued that to a certain extent the fundamental causes of productivity growth will remain a mystery, as they cannot be quantified. The inconclusiveness of the evidence on the link between productivity growth and trade policy supports this general conclusion of Denison's. It is clear then, that any attempt to provide a definitive explanation of the performance of South African manufacturing should be treated with a certain amount of scepticism. Accepting this, a framework has been constructed for analyzing the processes by which technological capabilities are built up that facilitate improvements in production efficiency in the long term. Rather than trying to provide a definitive explanation of productivity trends then, such an analysis seeks to examine the processes involved in the generation of productivity growth.

This conceptual framework suggests a very different interpretation of the fundamental determinants of South Africa's industrial performance than is currently in vogue. The policy implications of this analysis are also markedly different in certain respects.

6.2 The South African Debate on Policies to Improve Industrial Productivity Growth

It is apparent from chapter five that there have been various interpretations of the fundamental causes of South Africa's industrial productivity growth performance to date. In this section, the various policy proposals that have been advanced to improve this performance are outlined. In the next section, the specific proposals advanced by these different approaches will be discussed and contrasted with the policy implications drawn from the analysis in this thesis.

6.2.1 The World Bank And Other Liberal Reformers

The World Bank's position has been made clear in two recent documents. Belli et al. (1993) is concerned with the trade regime, while Fallon (1992) is concerned with the labour market.

In general, Belli et al. (1993) identify the past trade regime as an important factor underlying South Africa's poor productivity growth performance and advocate a greater emphasis on export promotion and import liberalisation. They argue that immediate measures should be taken to encourage exports and remove the anti-export bias, but suggest that tariff reductions should be phased in more gradually. Others have also argued for the need for more liberal trade policies. In this respect, as was discussed in chapter five, Moll (1990) regards the policy of import substituting industrialisation as partly to blame for South Africa's poor industrial productivity growth performance and advocates a policy of export promotion. The state's "Normative Economic Model" (1993 : 261) also favours a more liberal trade regime:

> **"Low productivity in South Africa's manufacturing sector presents a major problem. An outward orientated development plan could make a significant contribution towards increasing efficiency..."**

The main distinguishing feature of Belli et al's (1993) policy proposals to improve productivity growth is the reliance placed on a reformed trade regime.

Fallon (1992) focuses on the South African labour market and education system and mainly argues for inequalities to be redressed. Fallon's (1992 : 31) general policy proposals would have fairly obvious stimulator effects on industrial productivity growth:

> **"In the immediate future, encouraging the acquisition of job-related skills by blacks could be of immediate benefit, while a closing of interracial educational standards would be beneficial over the longer term."**

At the general level, these sorts of policy proposals are not very controversial. Indeed, although the government's Normative Economic Model does not mention the need to overcome inequalities, they do propose that school leavers should be made better prepared for work, and that training should be designed so as to make employees more mobile. However, when it comes to formulating the best specific education and training policies to meet these general objectives consensus is absent. In this respect, neither Fallon (1992) nor the government's Normative Economic Model really consider these specific policy issues.

6.2.2 A Technological Capabilities Framework: Lall and The Industrial Strategy Project

In general Lall (1993) is in broad agreement with Belli et al's (1993) assessment of the need for trade reform. In particular, Lall (1993 : 21) stresses that:

> **"the complexity, ad hoc nature and unpredictability of the protective regime are clear disincentives to firms in terms of long-term investments in capability development and restructuring."**

Likewise, the Industrial Strategy Project (Joffe et al. (1993)) also agree with most of the World Bank's proposals for trade reform. However, in contrast to Belli et al. (1993) who advocates a uniform tariff schedule, Lall (1993) and Joffe et al. (1993) favour a certain degree of selective intervention.

Furthermore, Lall (1993) and Joffe et al. (1993) emphasise the need for policy measures to address various supply side factors influencing the development of technological capabilities. Joffe et al. (1993) are adamant that the strengthening of South Africa's international competitiveness is not simply a matter trade reform as Belli et al. (1993) seem to imply. Hence, Joffe et al. (1993 : 35) argue:

> **"...we have identified four major areas in which we feel that policy attention should focus - building human resources for production; strengthening small, medium and microenterprises; and the more effective organisation of production, work and inter-institutional linkages."**

Similarly, Lall (1993) identifies skills deficiencies and the paucity of research and development as two factors undermining the development of technological capabilities in South Africa.

6.2.3 The Policy Proposals of this Thesis

It is argued here that the overall purpose of industrial policy should be to encourage the development of a more independent, flexible and technologically mature industrial base. In this respect, the state has an important role to play in designing education and training policies, labour market policies as well as technology policies that promote the development of technological capabilities in South African firms.

It seems that often policies are advanced with narrow objectives, such as the promotion of exports or expanding education access. What is emphasised here is that the various policies should recognise their shared purpose of enhancing technological capabilities. Hence, policies should rather be designed with this specific aim in mind.

There are several advantages to this general approach. Firstly, it should help highlight policies which lack any rational objective. Secondly, it should help point to areas where different policies are having conflicting impacts. Thirdly, it helps to emphasise that the central objective of industrial policy should be to improve overall industrial productivity growth. This last point is often lost with the focus on achieving "international competitiveness". It is possible to assess the international competitiveness of a particular firm, given ruling wage rates and the exchange rate. However, it makes little sense to talk of a nation as a whole being "internationally competitive", since it should be recognised that nations trade on the basis of comparative and not absolute advantages. In reality, although any industry can be made internationally competitive if the exchange rate is low enough, it is not possible to maintain an artificially low exchange rate for any prolonged length of time. Also, although firms can also be made internationally competitive through wage repression, this really involves a decline in living standards and is also not sustainable in the long term. It is productivity growth that generates rising living standards for a nation, and thus it is only productivity growth that can really ensure that individual firms maintain their competitiveness. Hence, the focus of industrial policy must be predominantly concerned with productivity growth and not "international competitiveness".

South Africa is fortunate to be endowed with large deposits of gold. However, this is not as advantageous as it may seem since this tends to make for a fairly strong currency by developing country standards, which means that the productivity levels of firms need to be correspondingly high if they are to be internationally competitive. Hence, the only way for South Africa to reduce its reliance on gold is to pursue the fundamental task of improving its industrial productivity growth.

What is of fundamental importance is that this task cannot be achieved by simply implementing trade policy reforms. Trade policies can provide useful incentives that encourage the development of technological capabilities. However, a reliance on trade policy initiatives disregards the substantive issues. As was discussed in chapter four, firms need to undergo difficult and complex learning processes in managing their technological development. The effectiveness of these learning processes in turn depend on the education and training system, the market for knowledge and new technology as well as other institutional effects. In many of these areas significant market failures may undermine such learning processes and it is these that are in most need of policy attention.

6.3 Specific Policy Implications for South African Manufacturing

From the perspective of the framework used in this thesis, the performance of the South African manufacturing sector should be explained in terms of those factors that have enhanced technological capabilities and those factors that have undermined them.

While it seems that there is a large degree of consensus at the general level between the various approaches, important specific differences remain (even between Lall (1993) and Joffe et al. (1993)). Obviously there are also important differences between these approaches and the policies advocated in this thesis. All these differences should become apparent from the examination of policy proposals on specific issues.

The specific avenues in which policy can play a role and are worth further investigation include the structure of the education and training system, trade policy, regulations governing technological transfer in addition to technology and competition policies. However, it should be emphasised that specific policies need to be pursued in a coordinated way for overall policy to be effective.

6.3.1 International Competitiveness and Trade Policy

There are two parts to Belli et al's (1993) policy proposals: exchange rate management and trade reform. With regard to exchange rate management, Belli et al. (1993) recognise that the dominance of gold exports means that the gold price can, under a flexible exchange rate, have a major influence on the value of the rand to the possible detriment of other exports. Hence, Belli et al. (1993 : 50) argue that:

> **"Appropriate incentives for manufactured exports would entail: (i) fixing the value of the rand at a level that is probably lower than the market-clearing rand, and (ii) keeping it at a level that maintains the competitiveness of South Africa's manufacturing exports."**

Joffe et al. (1993) also argue for an exchange rate devaluation to help make South African industry more competitive. However, the problem with this approach is that it assumes that the adverse effects of the gold price can be effectively overcome by making the exchange rate a policy variable. In reality it will prove impossible to maintain the exchange rate at an artificially low level for any prolonged length of time.

With regard to South Africa's current trade regime Belli et al. (1993 : 1) conclude that it:

> **".. is not overly protective, but too fluid and complex, and also biased against exports... (and) the dispersion of the tariff schedule is far greater than in most countries."**

Given this, they advocate a strategy of export-led growth that should provide exporters with free access to inputs at world prices and that removes the anti-export bias that is associated with continued import protection. They also argue that the tariff schedule needs to be rationalised and protection eventually reduced.

Lall (1993) also emphasises the advantages to the rationalisation of the tariff schedule. Such a rationalisation should make it more transparent and predictable and thus provide firms with much clearer signals on which they can formulate long term strategies.

Belli et al. (1993) only advocate a gradual reduction in tariffs. They do however argue that the highest tariffs should be dropped immediately to a maximum of 150% or so. Joffe et al.

(1993) interpret this proposal of gradual import liberalisation as an acknowledgement by the World Bank that import liberalisation may be neither a necessary or sufficient condition for export expansion.

Overall, Belli et al. (1993) are advocating a concerted strategy of export promotion coupled with a degree of import liberalisation. The justifications for these prescriptions are however weak. Basically, the proposals seem to stem only from a belief that this is the only way to reap the benefits of international competition. As such, Belli et al. (1993 : 50) argue that:

> **"Countries that attempted to follow a more classic infant industry strategy - achieved first the lax standards of the protected domestic market, then move on to export promotion from that base - were much less successful. Having installed capacity and technology that met only the local standards of competition, the owners of this capacity and technology - along with their workers - became an entrenched interest against adjusting to the more rigorous international standard."**

Belli et al. (1993) provide little evidence that changes in South Africa's trade regime have had any effect on industrial productivity growth performance (see chapter five). Hence, it seems that their policy of export promotion is, in fact, mainly based on the standard liberal position that poor productivity growth is largely due to slack managers who have been sheltered from international competition.

Despite noting their scepticism for the causal link between export orientation and productivity growth, Joffe et al. (1993 : 12) seem to believe in this challenge-response theory:

> **"It is neither desirable or practical to continue insulating domestic producers from these international competitive pressures if productivity growth is to reach the levels which are required ... to achieve sustained income growth. A more effective outward orientation of the industrial sector is thus an important component of the strategy to increase productivity growth within the industrial sector."**

This challenge-response mechanism is the second part of Belli et al.'s (1993) prescription for improving the international competitiveness of firms. If the exchange rate devaluation does not make firms competitive then these firms are required to eliminate their slack under the pressure of international competition. Viewed in this light, what makes this challenge-response mechanism so questionable is that it is difficult to envisage how the extent of managerial slack can possibly be related to the gap between the actual exchange rate and an exchange rate at which a particular firm would be internationally competitive. It is largely for this reason that the focus needs to be on productivity growth and not international competitiveness. The fallacy of the international competitiveness approach is that it avoids the substantive issues and presumes that growth and development are natural and automatic processes. If the focus is on productivity growth, an analysis of the learning processes by which technological capabilities are developed provides a more useful indicator of the actual factors influencing a firm's performance.

A credible threat of exposure to international competition can provide a powerful incentive for firms to engage in costly and difficult learning processes. However, there may be important market failures that undermine such efforts by firms. In some cases state intervention in the form of protection or export promotion may provide the necessary time for firms to overcome various impediments, as in the case of infant industries. However, there are many other spheres in which market failures may undermine the learning efforts of firms. Hence in the case of skill deficiencies or poorly functioning technology markets trade policies will be of little help and policy really needs to address the source of these market failure directly. Lall (1993 : 36) emphasises this point:

"Most developing countries, possibly including SA, have granted protection without ensuring that their enterprises had access to the new skills and information they needed to become competitive."

With regard to the debate between uniform versus selective protection, Belli et al. (1993) seem to favour uniformity, while Lall (1993) and Joffe et al. (1993) view a degree of selectivity as desirable. The reason for favouring selective intervention is that some industries, activities or firms are likely to possess superior growth potentials, linkages or other externalities. However, the ability of the South African state to identify such activities and to pursue a policy that keeps protection temporary and without favouritism needs to be questioned. In this regard, Lall (1993 : 36) argues that:

" .. there are some governments today that are capable of mounting effective selective interventions at a fairly complex level. .. many .. are at best confined to functional policies, or the most general levels of selectivity."

An important point that Archer (1987 : 44) emphasises with regard to selective intervention concerns the fact that while the NICs have tended to take a proactive approach the South African approach has been more reactive:

"It appears that in Japan, Korea and Taiwan .. once an industry was selected and accorded assistance, .. this was provided thoroughly and generously on the plausible grounds that a minimum 'critical mass' was required to initiate sustained development. ... the policy attitude in South Africa, by contrast, appears as one of minimal and tardy provision of help consonant with survival of the industry, and then allowing such low-level assistance to continue indefinitely."

Taking all this into consideration then, although selective intervention seems appealing, the practicalities suggest that it is not feasible except if there are very strong grounds for believing that a particular industry should receive support. If an activity, such as mineral beneficiation, is considered for targeting, then a detailed analysis of the activity's long term fundamentals should be conducted in addition to analysing the nature of linkages, externalities and other market failures which may be discouraging private initiatives. Where such protection measures are instituted, care should be taken to ensure that they are perceived as temporary and that they do not act as a serious disincentive to the development of technological capabilities by firms.

The last point to note is that there do not seem to be any particularly convincing arguments for favouring export promotion over protection and, in fact it is not clear that they are necessarily mutually exclusive policies.

6.3.2 Regulation of Foreign Technology and Investment

Lall (1993) acknowledges the fact that South African industry has relied heavily on foreign technology and argues that as a result sanctions and disinvestment are likely to have retarded the assimilation and development of new technologies. This suggests that with the removal of sanctions and the return of foreign investment this obstacle to technological development will be removed.

Foreign investment is often regarded as the panacea to South Africa's problems, and that it will be forthcoming once a democratically elected government is in place. While foreign investors may be encouraged by the prospects of stability that a future government holds, most foreign investors are likely to be guided more by the economic fundamentals of this country. In South Africa's present economic and political circumstances there is a need to question the terms under which foreign investment will be forthcoming. In this respect, foreign investment should not be regarded as unequivocally a good thing. Similarly, as was seen in chapter five, there may be many hidden costs and contingencies associated with the purchase of foreign technology.

In addition to improving capital accumulation, foreign investment may facilitate the diffusion of new technology. However, consideration is needed of the real price of technology transfer and its benefits. Technology transfer between the parent and subsidiary of a multinational corporation is not an "arms-length" transaction. As such, the price of the technology may be artificially high. More importantly though, little technological information and knowledge may be transferred with the means, and the local subsidiary may be restricted from capturing the rents from local innovations. While this type of technology transfer is possibly the most difficult to regulate (especially without being accused of discouraging foreign investment) it is probably the most important from the perspective of its impact on the development of local technological capabilities. However, the state's control over technology transfer that occurs through market transactions should prove more effective.

The main issue is that the regulation of technology transfer may improve a domestic firm's bargaining power and so enable it to capture more of the rents of a particular technology and so enhance the firm's scope for creating subsequent rents.

Joffe et al. (1993) support this general proposal that the state should try to regulate the terms of technology transfer. They argue that this can best be achieved by policy designed to strengthen the power of local licensees through limiting restrictive clauses and requiring training on the part of the licensor in an effort to provide local firms with access to the "core technology" (the technological information and understanding). Overall though, Joffe et al. (1993 : 49) emphasise that the regulation of technology transfer:

> **"..should be less concerned with the cost of transfer and more directed to ensuring technological assimilation and learning"**

In conclusion then, although sight should not be lost of the importance of foreign technology, the question should not be whether or not South Africa is getting enough of it, but what South Africa is getting for what it pays. It is not simply a matter of utilising appropriate technology effectively. Rather the underlying principle should concern the extent to which foreign technology enhances South Africa's indigenous technological capabilities and at what cost.

6.3.3 Competition and Domestic Technology Policy

While competition in factor markets may be desirable for efficient resource allocation, given the public attributes (non-rival, partially excludable) of technology, private investors may underinvest in technology when competition is too severe. This clearly illustrates that public support may be needed to encourage innovation, adaption and capability building. To this end, Joffe et al. (1993) propose that there should be a greater direct commitment from the state to support research and development (R&D) and that the state should also strengthen incentives for firms to invest in their own R&D by tax incentives.

Dore (1989) emphasises that the main purpose of government R&D funding is to enhance the international competitiveness of local firms. Dore (1989 : 1667) also argues that:

> **"Yet, for all the retreat of western governments from providing consumer goods and services, when it comes to providing research and development ... the movement is all the other way."**

These governments clearly recognise the benefits of government support for R&D - especially for large projects which do make long term sense to a country. Since South Africa is a follower country the assimilation of foreign technology is more important than attempts to create new technology. Hence, more attention should be given to facilitating the adaptation of foreign technology by local firms.

Hence, care should be taken to avoid R&D projects, undertaken by scientists and politicians, for prestige rather than economic reasons. More attention should be focused on making important adaptations of foreign technology. The international competitiveness of firms is more likely to be enhanced by directing the R&D energies of South African scientists towards these more mundane matters that involve learning from others. Furthermore, technology policy needs to be well formulated and coordinated with other policies.

With regard to competition policy, Joffe et al. (1993) argue that the highly concentrated market structure of the manufacturing sector promotes collusion rather than competition. Hence, Joffe et al. (1993 : 21) recommend the promotion of competition by:

> **"the strengthening of the authorities responsible for regulating market structure and conduct."**

However, an important point that needs to be emphasised is that, as with international competition, if competition in the domestic market is too severe it can just as easily stifle innovative, imitative or technological capability building efforts as promote them.

6.3.4 Education and Training Policy

Lall (1993), Joffe et al. (1993) and others have pointed to the education and training deficiencies in South Africa. Archer (1987 : 44) helps to emphasise these issues:

> **"Of all the factors that distinguish South Africa from the more successful industrialisers, this one promises to be the most vital. The right mixture of industrial policies is obviously critical, but if the right inputs of labour are lacking because of deficiencies in basic education, skills, aptitudes and the capacity and opportunity to learn-by-doing, then the potential for growth may simply be negated. So the absence of widespread good quality schooling, .. may yet prove the major deficiency in South Africa's industrial conundrum"**

From the perspective of improving the flexibility and learning capabilities of the South African workforce, education and training policy needs to focus more on qualitative aspects. It will not be easy for a future government to disregard the pressure for educational expansion. However, in the face of limited resources, this is likely to involve a trade-off between quality and quantity. Hence, cost effective ways of responding to educational expansion need to be sought in areas which are least likely to jeopardise quality. Joffe et al. (1993 : 37) also emphasise that:

> **"..an unfocused increase in educational investment will be an insufficient response to the challenges of international competitiveness."**

Fallon (1992) advocates a narrowing of interracial educational standards. However, it should be recognised that the real problem with this objective lies in the trade-off between increased educational access and improved educational quality that arises from a limited budget.

Technically, at the microlevel, it is the ability of individual schools to provide the sort of teaching that allows pupils to "learn how to learn" that is important to South Africa's future industrial achievement. Socially and politically however, the most important role for the state is to structure institutional mechanisms that foster equality of opportunity. Not just in schools and training institutes, but most crucially in the workplace. Only in such an environment, where achievement is valued and seen to be rewarded, can a culture of learning develop.

With regard to training and job related learning, the state can play a crucial role. As with technology there are many externalities to training. Since private firms will be unable to appropriate the benefits/externalities of training they will tend to underinvest in training. Firms will also tend to train employees in job specific skills to undermine employee mobility and so capture the skill benefits of these employees. The state can overcome some of these market failures by subsidising and coordinating training initiatives at an industry level. Further, they can help to establish generally recognised qualifications by encouraging the interaction between firms, industry associations and themselves.

Joffe et al. (1993) also emphasise the need for greater vocational training. Specifically, they argue that there is particularly a need for intra-firm training, supplementary adult education and industry-wide training. They also argue for a nationally integrated system of training which links different levels of the training and education system and which provides for accreditation. The general proposals of Joffe et al. (1993) are not controversial since the government's Normative Economic Model (1993 : 164) proposes similar policies[1]:

> **"A more co-ordinated system is necessary under which all qualifications will be nationally recognised and comparable ... consideration should be given to developing a national occupational qualification structure, supplementary to the existing qualification structure for formal education."**

---

[1] However, in reality it is the specifics of education and training policies where most of the controversial pertinent issues lie.

In general, it is argued here that education and training policies should be designed with the aim of promoting a culture of learning in schools, training institutes and in the workplace. Further, given the importance of deliberate learning mechanisms for industrial achievement, and the sequential nature of these learning processes the state should place the most emphasis on building strong learning foundations in the lower levels of schooling.

6.3.5 Labour Market Policy

Some[2] see wage repression as an essential component of the NICs industrial success. In this respect, Archer (1987) argues that the tight control of the labour movement by the state in the NICs facilitated a close relationship between the state and business and ensured that wage rates were kept in line with productivity.

The union movement in South Africa is well organised, national and politically powerful. Joffe et al. (1993) correctly emphasise that the current pattern of industrial relations is a significant obstacle to the competitiveness of South African manufacturing. Under these circumstances then, there is little hope for wage restraint on behalf of the unions unless a social contract can be reached between the unions and business. Joffe et al. (1993) do seem to envisage a situation where the government brokers a contract between the unions and business in which institutions and mechanisms are put in place for the formulation of a co-ordinated and carefully designed industrial policy. This point is quite important from the perspective of those who strongly advocate a policy of selective intervention, since such a policy may require some form of wage restraint if the purpose of subsidies or protection is not short circuited.

[2] See Fields and Wan (1989) for a consideration of this view.

In contrast to those who view wage repression as an important component of the NIC industrial success, Fields and Wan (1989 : 1477) rather argue that:

> **"A number of analysts ... have commented favourably on the efficiency of the Korean labour market, the responsiveness of Korean workers to job opportunities in other locations and in other sectors, and the absence of wage distortions owing to trade unions, public sector pay policy, or minimum wages."**

While many reasons have been advanced to explain these circumstances, they do not suggest the outcome of a wage repressive strong state, and it is quite plausible that a fundamentally cooperative relationship between management and labour may have a lot to do with it.

With regards to labour market policy then, the state should attempt to provide an institutional environment in which equality of opportunity is highly respected. This will provide citizens with greater confidence in the state and the social structure, and create greater consensus in national objectives and cooperative effort. Specifically though, the state should avoid succumbing to sectionalist interests. In this respect, minimum wage legislation should be avoided as should inflated public sector pay. Pay and employment practices in the public sector should be carefully formulated, as they provide important signals to the private sector. Fallon (1992) supports these general points:

> **"There are two forms of labour market interventions that should be avoided, given prevailing labour market circumstances in South Africa, these are: (a) aggressive national minimum wage policies; and (b) job security regulations."**

6.4 Final Conclusions

South Africa's productivity growth performance, for manufacturing as a whole, has been poor, particularly in the 1980s. Even after an adjustment is made for excess capacity the performance still appears poor in this period, and, given the embodiment effect, the slow rates of investment in this period seem to be a cause for concern. However, one positive feature is that the somewhat comparatively poor aggregate productivity growth performance of manufacturing in earlier periods does not appear to be pervasive across industries, since in some industries performance compared relatively favourably with achievements in other developing countries.

It must be accepted that the key determinants of production efficiency trends will remain something of a mystery. Nevertheless, there is scope for a greater understanding of these underlying causes. In this regard however, there is a need to question the presumption that "growth is natural"[3], which suggests that our poor productivity growth performance merely reflect the things we have done wrong.

It is true that certain policies have had adverse consequences for growth and efficiency. Apartheid, an obvious candidate, is certainly to blame, particularly for its effect on education, training and skills enhancement in the workplace, and, to a much lesser degree, for the adverse consequences of sanctions and disinvestment. Trade policy, a common culprit, may have had some adverse effects on production efficiency, but may also have aided technological maturity, however, evidence about either is weak.

It seems unrealistic to blame the government for all our woes. As such, institutional and cultural factors are important underlying influences that have a degree of permanence and so are not easily modified in ways that encourages growth. Also, resource endowments are not

[3] See Landes (1990) for an insightful discussion of these issues.

always a good thing from the perspective of trying to build an industrial base. Of utmost importance however, there is little reason to believe that growth and development are processes that occur naturally and automatically. As the earlier discussion of some of the recent growth theories suggests, growth is actually quite a difficult process and requires deliberate and costly efforts to improve technological capabilities. As such, in attempting to understand the fundamental causes of improvements in production efficiency more attention needs to be paid to those factors that have influenced technological capabilities.

In conclusion then, in developing countries, like South Africa, policy is of great importance as it can assist to surmount structural constraints and market failures which can be immense. However, the possibility of government failure should not be taken lightly. Policy can just as easily involve excessive and unwarranted interventions or be poorly implemented. While industrial policy can be very important in a developing country such as South Africa, a prerequisite for the success of such a policy is a government's commitment to the pursuit of macroeconomic stability. An environment of stable expectations is vital to giving private agents the incentive to make the long term investments in technological capabilities that industrial achievement requires. Of overriding importance however, is that specific policies should not be formulated in isolation, but in a coordinated way, with a common purpose - the improvement of technological capabilities in South African industry.

APPENDICIES

Appendix A : Comparison of Productivity Growth Estimates for South African Manufacturing 1945-1990, (%)

	1945-54	1954-63	1963-74	1974-81	1981-90	1972-90
As derived in Table 1.1	-1.2	1.0	0.3	0.3	-0.5	-0.1
Moll (1990)	-0.8[a]	1.9	1.0	0.7	-1.9[b]	-
Belli et al. (1993)	-	-	-	0.1[c]	0.6[d]	?
NPI (1990)	-	-	-	-	-	0.1[e]
Dockel & Fourie (1976)	-	-	1.6[f]	-	-	-
Joffe et al. (1993)	-	-	-	-	1.4	-1.0

Notes: For various periods the years compared are not exactly the same as are used in Table 2.1:
[a] 1948-54 [b] 1981-88 [c] 1972-83 [d] 1983-90 [e] 1970-89 [f] 1960-72
Apart from the different periods used, the different estimates partly reflect different primary data sources and partly reflect different methods. For example the method of weighting factor contributions by their factor shares in value added is used here (and by Moll (1990)) is recommended by Denison (1984). In contrast, Belli et al (1993) estimate output-input elasticities using regression analysis. Belli et al (1993) also seperate out the contribution of intermediate inputs to gross output growth and adjust capital stock for capacity utilisation.

Appendix B : Average Annual International Productivity Growth Comparisons in the Business Sector, 1960-90

	Total Factor Productivity			**Labour Productivity**		
Country	1960-73	1973-79	1979-90[a]	1960-73	1973-79	1979-90[a]
U.S.A	1.6	-0.4	0.1	2.2	0.0	0.5
Japan	5.9	1.3	2.0	8.6	2.9	3.0
W.Germany	2.6	1.8	0.9	4.5	3.1	1.6
France	4.0	1.7	1.5	5.4	3.0	2.4
Italy	4.4	2.1	1.3	6.3	3.0	1.9
U.K.	2.3	0.6	1.3	3.6	1.6	2.0
Canada	2.0	0.8	-0.1	2.8	1.5	1.1
Austria	3.3	1.2	0.9	5.8	3.2	1.9
Belgium	3.9	1.4	1.5	5.2	2.8	2.3
Denmark	2.8	1.1	1.4	4.3	2.6	2.3
Finland	3.2	1.5	2.5	4.9	3.2	3.6
Greece	5.7	1.5	-0.2	8.8	3.3	0.7
Netherlands	3.1	1.5	0.9	4.8	2.8	1.5
Spain	3.3	0.9	1.8	6.0	3.3	2.8
Sweden	2.6	0.3	0.7	4.1	1.4	1.5
Switzerland	2.0	-0.4	0.5	3.2	0.8	1.1
Australia	1.6	0.8	0.3	2.7	2.2	0.9
New Zealand	0.9	-1.9	0.5	1.7	-1.3	1.5
OECD	2.8	0.5	0.7	4.1	1.4	1.4
South Africa[b]	n a	-0.2	-0.1	n a	1.9	1.7
South Africa[c]	1.2	0.2	-0.5	3.2	2.1	0.2

Sources and Notes: OECD (1992), Table 55 for all countries except South Africa.
[a] 1979-81 for the United States, France, United Kingdom, Canada and New Zealand, 1979-89 for Greece and Switzerland.
[b] These South African productivity measures are from the NPI (1990), Tables 35 and 37, p54, and relate to the periods 1973-79 and 1979-88 only (na means no data available for the 1960-73 period), but are estimated for the whole private economy, thus being relatively comparable to other countries shown here.
[c] For South Africa the periods used are 1960-73, 1973-81 and 1981-90. However, these estimates, which are from Table 2.1 and 2.2, relate only to the manufacturing sector not the whole business sector and so are not strictly comparable.

Appendix C : Categorisation of Industries on the basis of Capital intensity, 1990

	(1) Index of Capital Intensity (K/L)$_i$ Mfg=100	(2) Index of Value Added per worker (V/L)$_i$ Mfg=100	(3) Index of Capital Stock per Rand of Value Added (K/V)$_i$ Mfg=100
CAPITAL-INTENSIVE[a]	501	256	195
12 Industrial Chemicals	721	323	223
19 Iron and Steel	341	175	199
20 Non Ferrous Metals	158	259	62
INTERMEDIATE-CAPITAL-INTENSIVE[a]	85	126	76
17 Glass and Glass products	138	167	96
10 Paper and Paper products	136	227	61
18 Other Non Metal products	95	65	150
13 Other Chemicals	83	114	75
25 Transport Equipment	68	87	81
24 Motor Vehicles	64	118	56
14 Rubber Products	56	106	54
23 Electrical Machinery	55	91	62
LABOUR-INTENSIVE[a]	30	73	42
11 Printing and Publishing	40	100	41
15 Other Plastic Products	39	93	44
22 Machinery	38	96	40
4 Textiles	38	54	72
16 Pottery, China, Earthenware	31	59	55
21 Metal Products	30	74	42
8 Wood	29	36	82
26 Jewellery and Other n.e.c.	22	84	26
6 Leather Products	17	52	33
7 Footwear	10	49	22
9 Furniture	10	48	20
5 Clothing	6	36	12
AGRICULTURALLY-BASED[a]	115	102	112
2 Beverages	217	183	122
3 Tobacco	86	98	90
1 Food	72	66	109
TOTAL MANUFACTURING	100	100	100

Notes: Data is from the IDC data base (January 1992). The first column shows the ranking of industries according to capital intensity except for the agriculturally-based industries. The latter two columns present some alternative characteristics which distinguish the different industries.

[a] These are weighted averages using value added shares from Appendix E.

Appendix D : Average Annual Rates of Growth of Productivity within Manufacturing [illegible] - 1990, (%)

	1945 - 54					1954 - 63				
	(1) $G_{V/L}$	(2) $\alpha G_{K/L}$	(3) G_{TFP}	(4) G_V	(5) $G_{TFP}/G_{V/L}$	(1) $G_{V/L}$	(2) $\alpha G_{K/L}$	(3) G_{TFP}	(4) G_V	(5) $G_{TFP}/G_{V/L}$
CAPITAL-INTENSIVE[a]	2.2	(0.2)	2.6	8.9	118%	2.5	1.5	1.1	8.0	44%
12 Industrial Chemicals	2.5	3.8	(1.3)	6.3	-	4.3	4.4	(0.2)	7.7	-
19 Iron and Steel	2.7	(1.7)	4.4	10.1	163%	2.3	1.7	0.7	6.0	30%
20 Non Ferrous Metals	(1.7)	0.8	(2.4)	6.7	-	1.0	(3.2)	4.2	16.1	420%
INTERMEDIATE-CAPITAL-INTENSIVE[a]	1.9	2.7	(0.9)	10.3	-	2.4	1.9	0.7	7.5	29%
17 Glass and Glass products	3.4	4.2	(0.8)	10.7	-	3.5	(0.3)	3.8	7.1	109%
10 Paper and Paper products	1.2	1.4	(0.2)	15.0	-	5.2	1.9	3.4	11.8	65%
18 Other Non Metal products	4.1	3.2	0.9	9.6	22%	2.5	1.2	1.3	4.0	52%
13 Other Chemicals	3.4	3.3	0.1	8.0	3%	4.3	5.0	(0.7)	8.8	-
25 Transport Equipment	2.5	1.3	1.2	17.3	48%	1.2	0.8	0.4	3.4	33%
24 Motor Vehicles	(1.4)	2.4	(3.8)	9.3	-	(2.2)	0.5	(2.7)	6.8	-
14 Rubber Products	3.9	2.6	1.3	12.4	33%	0.8	1.2	(0.4)	3.2	-
23 Electrical Machinery	(2.9)	2.4	(5.3)	10.0	-	2.0	(1.0)	3.0	10.3	150%
LABOUR-INTENSIVE[a]	0.1	2.2	(2.1)	7.1	-	1.6	0.8	0.8	5.0	50%
11 Printing and Publishing	(1.6)	2.0	(3.6)	3.6	-	1.7	0.2	1.5	5.1	88%
15 Other Plastic Products	(4.2)	(0.2)	(4.0)	6.7	-	4.9	2.6	2.4	26.2	49%
22 Machinery	0.8	3.9	(3.1)	9.2	-	2.6	0.7	2.0	7.4	77%
4 Textiles	(5.8)	3.8	(9.6)	9.7	-	2.2	1.2	1.0	8.5	45%
16 Pottery, China, Earthenware	4.6	3.1	1.4	10.1	30%	2.2	2.1	0.1	3.7	5%
21 Metal Products	0.3	1.1	(0.9)	9.3	-	2.7	0.5	2.3	5.6	85%
8 Wood	2.9	3.2	(0.3)	6.0	-	(1.2)	(0.1)	(1.0)	1.3	-
26 Jewellery and Other n.e.c.	(1.7)	0.7	(2.5)	6.4	-	1.4	1.9	(0.4)	6.7	-
6 Leather Products	(0.5)	3.0	(3.4)	(1.1)	-	1.3	1.0	0.4	1.7	31%
7 Footwear	3.5	1.3	2.2	9.1	63%	2.4	1.8	0.6	2.1	25%
9 Furniture	(0.2)	1.4	(1.6)	6.2	-	1.0	1.1	(0.1)	2.1	-
5 Clothing	1.7	2.1	(0.4)	6.9	-	(0.5)	1.0	(1.5)	0.9	-
AGRICULTURALLY-BASED[a]	(0.1)	3.9	(3.8)	3.7	-	2.7	1.2	1.5	4.7	56%
2 Beverages	2.0	8.1	(6.2)	3.9	-	0.1	(1.0)	1.1	5.8	1100%
3 Tobacco	3.0	4.8	(1.8)	5.5	-	6.4	2.5	3.9	2.4	61%
1 Food	(0.9)	2.8	(3.7)	3.4	-	2.9	1.5	1.4	4.7	48%
TOTAL MANUFACTURING	0.8	2.0	(1.2)	7.2	-	2.5	1.5	1.0	5.9	40%

Appendix D : Continued

	1963 - 74					1974-81				
	(1) $G_{V/L}$	(2) $\alpha G_{K/L}$	(3) G_{TFP}	(4) G_V	(5) $G_{TFP}/G_{V/L}$	(1) $G_{V/L}$	(2) $\alpha G_{K/L}$	(3) G_{TFP}	(4) G_V	(5) $G_{TFP}/G_{V/L}$
CAPITAL-INTENSIVE[a]	2.8	3.8	(1.3)	8.9	-	2.6	6.7	(3.4)	7.1	-
12 Industrial Chemicals	4.6	1.0	3.5	11.9	76%	0.7	12.7	(12.1)	6.1	-
19 Iron and Steel	2.1	4.8	(2.7)	7.8	-	5.3	0.1	5.3	8.4	100%
20 Non Ferrous Metals	2.6	5.6	(3.0)	7.2	-	3.2	(2.3)	5.5	7.8	172%
INTERMEDIATE-CAPITAL-INTENSIVE[a]	3.4	2.4	1.0	9.1	29%	1.6	0.4	1.3	4.0	81%
17 Glass and Glass products	4.8	3.1	1.8	7.2	38%	(0.5)	3.4	(3.9)	(0.2)	-
10 Paper and Paper products	2.7	2.6	0.2	6.4	7%	0.5	0.2	0.3	1.7	60%
18 Other Non Metal products	4.5	2.7	1.8	8.7	40%	3.1	2.6	0.5	3.3	16%
13 Other Chemicals	4.0	2.7	1.3	6.7	33%	2.3	0.7	1.6	5.3	70%
25 Transport Equipment	3.7	2.5	1.3	14.0	35%	1.7	0.1	1.7	1.8	100%
24 Motor Vehicles	1.8	2.1	(0.4)	11.8	-	1.2	(0.2)	1.4	5.7	117%
14 Rubber Products	1.3	2.8	(1.5)	6.1	-	2.9	(1.8)	4.6	4.1	159%
23 Electrical Machinery	4.2	1.6	2.6	12.5	62%	1.3	0.1	1.2	4.6	92%
LABOUR-INTENSIVE[a]	2.2	1.3	0.9	7.9	41%	1.4	0.1	1.4	4.3	100%
11 Printing and Publishing	3.3	1.6	1.7	7.8	52%	0.1	(0.5)	0.5	2.0	500%
15 Other Plastic Products	2.8	2.5	0.3	15.6	11%	(1.7)	(1.6)	(0.1)	3.5	-
22 Machinery	2.2	1.1	1.1	9.8	50%	0.1	0.3	(0.1)	4.3	-
4 Textiles	1.7	1.4	0.3	7.9	18%	6.2	0.6	5.6	6.6	90%
16 Pottery, China, Earthenware	3.6	1.5	2.2	11.5	61%	0.5	0.2	0.3	3.1	60%
21 Metal Products	3.5	1.9	1.5	8.3	43%	(0.5)	0.5	(1.1)	2.2	-
8 Wood	4.2	2.4	1.9	6.7	45%	4.5	0.5	4.0	5.6	89%
26 Jewellery and Other n.e.c.	(0.5)	0.2	(0.8)	6.6	-	2.0	0.0	1.9	3.7	95%
6 Leather Products	(1.9)	0.7	(2.5)	1.3	-	4.5	0.1	4.4	6.1	98%
7 Footwear	(0.1)	0.9	(1.0)	3.4	-	(0.2)	(0.5)	0.3	3.1	-
9 Furniture	0.3	0.4	0.0	5.5	0%	3.8	(0.2)	4.0	6.2	105%
5 Clothing	1.1	(0.3)	1.4	6.2	127	4.6	(1.0)	5.6	8.0	122
AGRICULTURALLY-BASED[a]	1.8	2.2	(0.4)	5.4	-	3.2	1.1	2.0	5.5	63%
2 Beverages	2.2	3.7	(1.4)	7.6	-	5.3	1.0	4.3	7.3	81%
3 Tobacco	1.7	1.7	0.0	1.2	0	0.6	3.4	(2.8)	2.7	-
1 Food	1.7	1.9	(0.2)	5.2	-	2.7	1.0	1.7	5.2	63%
TOTAL MANUFACTURING	2.7	2.4	0.3	7.9	11%	2.3	2.0	0.3	4.9	13%

Appendix D : Continued

	1981 - 90				
	(1) $G_{V/L}$	(2) $\alpha G_{K/L}$	(3) G_{TFP}	(4) G_V	(5) $G_{TFP}/G_{V/L}$
CAPITAL-INTENSIVE[a]	2.2	0.4	1.9	1.9	86%
12 Industrial Chemicals	1.8	0.2	1.6	2.2	89%
19 Iron and Steel	1.9	0.1	1.8	0.7	95%
20 Non Ferrous Metals	4.7	2.0	2.7	3.5	57%
INTERMEDIATE-CAPITAL-INTENSIVE[a]	(0.9)	1.1	(2.0)	(1.3)	-
17 Glass and Glass products	2.3	1.7	0.7	0.7	30%
10 Paper and Paper products	3.2	2.4	0.8	4.2	25%
18 Other Non Metal products	(1.1)	0.9	(2.0)	(1.0)	-
13 Other Chemicals	(2.2)	0.2	(2.5)	(1.7)	-
25 Transport Equipment	(5.6)	0.2	(5.8)	(7.7)	-
24 Motor Vehicles	(4.3)	0.8	(5.1)	(5.3)	-
14 Rubber Products	(0.4)	0.6	(1.1)	0.4	-
23 Electrical Machinery	1.9	1.4	0.5	0.3	26%
LABOUR-INTENSIVE[a]	(1.1)	0.2	(1.3)	(1.8)	-
11 Printing and Publishing	(0.1)	0.2	(0.2)	1.0	-
15 Other Plastic Products	1.2	1.5	(0.3)	2.4	-
22 Machinery	(2.0)	0.5	(2.4)	(4.1)	-
4 Textiles	(1.7)	0.4	(2.1)	(3.4)	-
16 Pottery, China, Earthenware	(5.2)	0.2	(5.4)	(4.9)	-
21 Metal Products	(0.5)	0.0	(0.5)	(1.9)	-
8 Wood	(2.9)	0.2	(3.1)	(2.5)	-
26 Jewellery and Other n.e.c.	2.1	(0.1)	2.2	3.0	106%
6 Leather Products	(0.9)	0.0	(0.9)	(0.4)	-
7 Footwear	(0.3)	0.1	(0.4)	(0.4)	-
9 Furniture	(4.8)	(0.3)	(4.5)	(4.4)	-
5 Clothing	(1.4)	(0.5)	(0.9)	(1.9)	-
AGRICULTURALLY-BASED[a]	1.9	2.3	0.3	2.5	16
2 Beverages	3.8	4.8	(1.0)	4.0	-
3 Tobacco	1.2	(1.4)	2.6	2.8	217%
1 Food	1.2	1.6	(0.4)	1.9	-
TOTAL MANUFACTURING	0.2	0.7	(0.5)	(0.3)	-

Notes and Sources

See notes to Table 2.1. The accounting framework on which this analysis is based is presented in equation 2.3 above.

Value added growth is G_V, Labour productivity is $G_{V/L}$, capital deepening is $\alpha G_{K/L}$ and G_{TFP} is total factor productivity growth. For each period, α, the output elasticity of capital was calculated from data on labour's share in value added.

Constant returns to scale was assumed so that $\alpha = 1-\beta$, where β is labour's share in value added. Thus α is capital's share in value added. For the periods 1945-74, the employment and earnings data is from the South African Statistics (CSS), 1964, 1970 and 1980, while for the periods 1974-90 it is from the IDC (1992).

Using an alternative methodology from Dollor and Sokoloff (1989, p.319), α was derived for the parameters of a modified translog production function estimated over a pooled cross-section of the industry data over the years in the specific period. The production function was of the form :
$Ln(Y/L)_{it} = \tau_i d_i + \beta_1 Ln(K/L)_{it} + \beta_2 [Ln(K/L)_{it}]^2$
Although the intercepts were allowed to vary across industries the parameters β_1 and β_2 hold for all industries. The estimates of α utilised in the decomposition were compiled according to the expression $\alpha = \beta_i + \beta_2 Ln(K/L)_i$ with the average of each industry's capital-labour ratio for each period. Hence the quadratic term specifies the extent to which the output elasticity of capital, α varies according to the capital intensity of industries. These α values are shown in Appendix I. Unfortunately these values appeared most unsatisfactory as they were clearly significantly different from factor shares. Hence, this method was discarded in favour of assuming factor shares.

(a) These industry groupings are weighted averages of individual industry growth rates using industry value added shares for the relevant period from Appendix 1.2.

Appendix E: Industry shares (%) in total manufacturing value added and employment

	1945-54		1954-63		1963-74		1974-81		1981-90	
	V_i/V_t	L_i/L_t	V_i/V_t	L_i/L_t	V_i/V_t	L_i/L_t	V_i/V_t	L_i/L_t	V_i/V_t	L_i/L_t
CAPITAL-INTENSIVE	10.8	8.3	13.1	9.1	13.9	9.8	23.8	12.0	27.1	12.2
12 Industrial Chemicals	2.6	2.0	2.6	1.9	3.8	2.0	12.9	3.7	14.5	4.4
19 Iron and Steel	7.2	5.9	8.4	6.2	8.1	6.5	8.2	7.0	9.1	6.3
20 Non Ferrous Metals	1.1	0.5	2.1	1.0	2.0	1.3	2.7	1.4	3.6	1.5
INTERMEDIATE-CAPITAL-INTENSIVE	24.1	22.3	28.7	25.0	31.7	26.2	30.3	25.1	28.3	24.9
17 Glass and Glass Products	0.8	0.9	0.9	0.9	0.9	0.9	0.8	0.7	0.8	0.6
10 Paper and Paper Products	2.2	1.9	3.8	2.8	4.0	2.9	4.1	2.5	4.8	2.7
18 Other Non Metal Products	4.9	8.3	4.7	7.3	4.7	6.1	4.0	5.1	3.8	4.9
13 Other Chemicals	6.1	5.1	7.8	5.4	8.1	4.4	4.4	3.0	3.9	3.3
25 Transport	1.0	1.1	1.4	1.4	2.0	1.8	2.5	2.0	1.6	1.5
24 Motor Vehicles	4.0	1.9	4.1	2.6	5.0	4.7	7.9	5.5	7.0	5.8
14 Rubber Products	2.3	1.4	2.5	1.5	2.0	1.4	1.5	1.4	1.4	1.3
23 Electrical Machinery	2.7	1.9	3.6	3.0	5.0	4.0	5.0	5.0	5.0	4.8
LABOUR-INTENSIVE	42.1	48.7	38.8	47.2	39.5	49.0	35.4	48.0	32.4	47.6
11 Printing and publishing	5.8	3.7	4.4	3.2	4.3	3.0	3.2	2.9	3.6	3.2
15 Other Plastic Products	0.1	0.1	0.5	0.4	1.5	1.3	1.7	1.7	2.1	2.1
22 Machinery	4.6	4.0	4.9	4.3	6.5	5.9	8.1	6.1	6.5	6.1
4 Textiles	3.2	4.5	4.6	6.9	6.0	8.8	4.3	8.2	4.2	6.9
16 Pottery, China and Earthenware	0.2	0.4	0.2	0.3	0.2	0.3	0.3	0.3	0.2	0.4
21 Metal Products	9.0	10.6	9.0	10.5	9.1	10.3	9.2	10.1	7.6	9.3
8 Wood	3.4	6.1	2.6	5.4	2.0	4.3	1.7	3.8	1.6	3.8
26 Jewellery and Other Manufacturing	1.7	1.1	1.7	1.3	1.4	1.7	1.1	1.7	1.2	1.9
6 Leather Products	1.4	1.4	0.8	1.0	0.5	0.8	0.4	0.7	0.4	0.7
7 Footwear	2.2	3.4	2.0	2.8	1.4	2.3	1.1	2.0	1.0	2.1
9 Furniture	3.3	2.9	2.4	2.5	1.9	2.3	1.4	2.1	1.3	2.5
5 Clothing	7.1	10.4	5.6	8.6	4.3	8.1	2.8	8.3	2.8	8.6
AGRICULTURALLY-BASED	23.1	20.7	19.4	18.7	14.9	15.0	10.6	14.9	12.2	15.3
2 Beverages	3.7	2.2	3.3	2.2	2.9	2.1	2.2	2.3	3.0	2.4
3 Tobacco Products	1.9	1.4	1.5	0.9	1.0	0.4	0.4	0.3	0.5	0.3
1 Food	17.5	17.1	14.6	15.6	11.1	12.5	8.0	12.3	8.7	12.6
TOTAL MANUFACTURING	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

See notes to Table 2.1.
V_i/V_t is the percentage share of industry i in total manufacturing value added, expressed as an average for the period.
L_i/L_t is industry i's share in total manufacturing employment expressed as an average for the period.

Appendix F : TFP Growth Adjusted for Capacity Utilisation, 1974-81 and 1981-90

	1974 - 81			1981 - 90		
	(1) G_{TFP}	(2) G_{TFP}(Adj)	(3) Difference	(1) G_{TFP}	(2) G_{TFP}(Adj)	(3) Difference
CAPITAL-INTENSIVE						
12 Industrial Chemicals	(12.06)	(12.09)	(0.03)	1.57	2.93	1.44
19 Iron and Steel	5.26	5.29	0.03	1.83	2.09	0.26
20 Non Ferrous Metals	5.48	5.93	0.45	2.69	2.39	(0.30)
INTERMEDIATE-CAPITAL-INTENSIVE						
Glass and Glass products	(3.89)	(3.90)	(0.01)	0.65	1.19	0.54
Paper and Paper products	0.27	0.05	(0.22)	0.77	1.11	0.34
18 Other Non Metal products	0.49	0.63	0.14	(2.03)	(1.33)	0.70
13 Other Chemicals	1.62	1.66	0.04	(2.47)	(2.29)	0.18
25 Transport Equipment	1.69	1.69	0.00	(5.83)	(5.65)	0.18
24 Motor Vehicles	1.43	1.42	(0.01)	(5.06)	(5.18)	(0.12)
14 Rubber Products	4.63	4.77	0.14	(1.05)	(0.54)	0.51
23 Electrical Machinery	1.22	1.47	0.25	0.54	1.13	0.59
LABOUR-INTENSIVE						
11 Printing and Publishing	0.54	0.53	(0.01)	(0.24)	0.07	0.31
15 Other Plastic Products	(0.14)	(0.19)	(0.05)	(0.33)	0.14	0.47
22 Machinery	(0.12)	(0.16)	(0.04)	(2.44)	(2.02)	0.42
4 Textiles	5.64	5.43	(0.21)	(2.11)	(1.62)	0.49
16 Pottery, China, Earthenware	0.31	0.21	(0.10)	(5.41)	(4.47)	0.94
21 Metal Products	(1.06)	(1.07)	(0.01)	(0.54)	(0.22)	0.32
8 Wood	4.00	3.86	(0.14)	(3.09)	(2.77)	0.32
26 Jewellery and Other n.e.c.	1.91	1.67	(0.24)	2.23	2.55	0.32
6 Leather Products	4.38	4.17	(0.21)	(0.93)	(0.72)	0.21
7 Footwear	0.32	0.13	(0.19)	(0.43)	(0.08)	0.35
9 Furniture	3.96	3.83	(0.13)	(4.50)	(4.23)	0.27
5 Clothing	5.61	5.59	(0.02)	(0.93)	(0.80)	0.13
AGRICULTURALLY-BASED						
2 Beverages	4.29	4.45	0.16	(1.01)	0.02	1.03
3 Tobacco	(2.83)	(2.34)	0.49	2.59	2.43	(0.16)
1 Food	1.67	1.75	0.08	(0.39)	(0.07)	0.22
TOTAL MANUFACTURING	0.32	0.28	(0.04)	(0.50)	(0.06)	0.44

Source: Appendix D; Capacity Utilisation measures from South African Statistics.
Note: G_{TFP} is as derived in Appendix D, while G_{TFP}(Adj) is TFP growth adjusted for capacity utilisation following the method described in the text.

Appendix G.1: Education Enrolment Ratios (%) for 1960 and 1985

	Primary		Secondary		Tertiary	
	1960	1985	1960	1985	1960	1985
Whites	118	115	69	87	18	44
Coloureds	109	129	15	62	2	7
Asians	125	106	23	88	4	24
Africans	77	109	3	49	1	5
Total	78	111	11	56	4	14

Source: Pillay (1992), p4, Table 2
Note: Primary refers to Sub A - Standard 4 and the age group 6-11. Percentages larger than 100 indicate a number of pupils older than 11 years attended primary school. Secondary refers to standards 5-10 and the age group 12-17. Tertiary refers to the age group 18-22.

Appendix G.2: South African Matriculation Passes by Race for 1970, 1975 and 1987

Year	African	Coloured	Asian	White	Total
1970	2820	1926	1406	36544	42696
1975	6761	3920	3048	42985	56714
1987	84966	11836	12419	62067	171288

Source: Pillay (1992), p4, Table 3
Note: These figures include University entrance passes and school leaving passes.

Appendix H: Share of Foreign Owned or Controlled Firms in Selected LDCs, various years.

Country	Employment		Gross Value of Production or Sales	
	% Share	Year	% Share	Year
Latin America				
Argentina	10-12	1970	31	1972
Brazil	30	1977	44	1977
Chile	-	-	25	1978
Columbia	28	1970	43	1974
Mexico	21	1978	39	1970
Asia				
India	13	1977	13	1975
Malaysia	34	1978	44	1978
South Korea	10	1978	19	1978
Taiwan	28	1976	-	-
Singapore	72	1980	81	1980
Hong Kong	10	1980	16	1980
Africa				
Kenya	30-35	1975	-	-
Ghana	-	-	50	1974
South Africa (a)	28	1978	-	-
South Africa (b)	18	1990	-	-

Note: - means "not available"
Sources: For all countries except South Africa: Weiss, 1988, p45, Table 2.5; for South Africa: Cooper, 1990, p43, Table 2.14.

Appendix I: Alternative estimates of the output-capital elasticity (α) for manufacturing as a whole

	1945-54	1954-63	1963-74	1974-81	1981-90
(1) Values actually used: Factor Shares[a]	0.52	0.54	0.51	0.37	0.42
(2) Values estimated from regression analysis[b]	0.06	0.38	0.09	0.14	-0.06
(3) Moll's estimates: Factor Shares[c]	0.45	0.44	0.38	0.37	0.41

Sources and Notes:
[a] See Table 1.3 for data sources.

[b] The methodology used in Dollar and Sokollof (1989) was used to calculate these regression estimates of the capital-output elasticity. See the notes to table 1.3 for a fuller description of this method.

[c] These are the factor share estimates used by Moll (1990). Note that the periods used differ in the first and last period of Moll's analysis (1948-54, 1981-88).

The differences between (1) and (3) most probably reflect differing underlying sources.

REFERENCES

Abramovitz, M, (1986): "Catching Up, Forging Ahead and Falling Behind" *Journal of Economic History*, Vol 96, No 2.

Archer, S, (1987): "South Africa's Industrial Experience in Perspective" *Social Dynamics*, Vol 13, no 1, pp 31-46.

Archer, S, (1992): "Technological Development and Education and Training of the Labour Force in South Africa" paper orignally prepared for NEPI Human Resources Conference, May.

Archer, S and Moll, P (1992) "Education and Economic Growth." In: Abedian A and Standish, B. (eds) "Economic Growth in South Africa: Selected Issues".

Baily, M, (1981): "Productivity and the Services of Capital and labour", *Brookings Papers on Economic Activity*, Vol 2.

Becker C and Pollard, P, (1990): "The Vulnerability of South Africa to Economic Sanctions: An Input-Output Analysis" in: "The Impact of Sanctions on South Africa - The Economy", Investor Responsibility Research Centre.

Bell, M, (1984):"Learning and the Accumulation of Industrial Technological Capacity in Developing Countries" in Fransman, M and King, K (eds) "Technological Capability in the Third World".

Bell, T, (1992): "Should South Africa Further Liberlise its Foreign Trade ?" Working Paper 16, Economic Trends Research Group, Cape Town; Also in Lipton, M and Simkins, C. (eds) "States and Markets in a Post Apartheid South Africa", Witwatersrand University Press, Johannesburg and Westview Press, Boulder.

Belli, P, Finger, M and Ballivan, A, (1993) "South Africa : Review of Trade Policy Issues", Informal Discussion Paper on Aspects of the South African Economy, Paper no. 4. Southern Africa Department, Washington, World Bank.

Berndt, E, (1984):"Comment" (on Jorgenson) in Kendrick (ed), "International Comparisons of Productivity and Causes of the Slowdown".

Bloch, G, (1991): "The Development of South African Manufacturing Industry" In: Konczacki, Z, Parport, J and Shaw, T (eds): "Studies in Economic History in Southern Africa", Vol 2.

Bowles, S, Gordon, D and Weisskopf, T, (1983): "Hearts and Minds : A Social Model of U.S. Productivity Growth". *Brookings Papers on Economic Activity*, No. 2.

Boyer, R, (1988): "Technological Change and the Theory of Régulation". In G. Dosi et al. (eds), "Technical Change and Economic Theory". London: Pinter Publishers

Bozzoli, B, (1975): "The Origins, Development of Local Manufacturing in South Africa" *Journal of Southern African Studies*, Vol 1, No 2.

Bruton, H, (1967): "Productivity Growth in Latin America", *American Economic Review*, Vol 57, pp 1099-1116.

Bruton, H, (1989): "Import Substitution" in Chenery, H and Srinivasan, T (eds), "The Handbook of Development Economics", Vol II, pp 1601-1644.

Chenery, H, (1983):"Interaction between Theory and Observation in Development" *World Development*, Vol 11.

Chenery, H, Robinson, S and Syrquin M, (1986): "Industrialization and Growth: A Comparative Study". New York: Oxford University Press (1986).

Cooper, H, (1990): "Foreign Direct Investment in South Africa", Seminar held at Department of Economics and Economic History, Rhodes University.

Cyert and March, (1963): "A Behavioural Theory of the Firm" Engelwood Cliffs, New Jersey : Prentice Hall.

Dahlman, C, Ross-Larson, B and Westphal, L (1987):"Managing Technological Development : Lessons from Newly Industrializing Countries" *World Development*, Vol 15 , No. 6.

Denison, E, (1984): "Accounting for Slower Economic Growth: An Update" in Kendrick (ed), "International Comparisons of Productivity and Causes of the Slowdown".

Döckel, J, and Fourie, L, (1978): "The Sources of Growth in the South African Manufacturing Sector" *Studies in Economics and Econometrics*, No.2, pp. 4-18.

Doeringer, P and Streeten, P, (1990): "How Economic Institutions Affect Economic Performance in Industrialised Countries: Lessons for Development" *World Development*, Vol 18, No 9.

Dollar D, and Sokoloff, K, (1990): "Patterns of Productivity growth in South Korean Manufacturing Industries 1963-79" *Journal of Development Economics*, Vol 33.

Donaldson, A and Roux, A, (1992): "Education, Employment and Incomes of Black South Africans", Paper given at 'Economic Growth and Human Development - The Economic Dimensions of Education in South Africa', Conference held at UCT.

Dore, R, (1984): "Technological Self-reliance: Study Ideal or Self Serving Rhetoric" in Fransman, M and King, K (eds) "Technological Capability in the Third World".

Dore, R, (1989): "Technology in a World of National Fronteirs" *World Development*, Vol 17, No 11.

Dornbush, R, (1992): "The Case for Trade Liberalisation in Developing Countries", *Journal of Economic Perspectives*, Vol 6, No. 1.

Dosi, G, Freeman, C, Nelson, R, Silverberg, G and Soete, L (Eds), (1988): "Technical Change and Economic Theory". London: Pinter Publishers.

Dosi, G, and Orsenigo, L, (1988): "Co-ordination and Transformation: An Overview of Structures, Behaviour and Change in Evolutionary Environments". In Dosi et al. (eds), "Technical Change and Economic Theory". London: Pinter Publishers.

Dosi, G, and Soete, L, (1988): "Technical Change and International Trade". In Dosi et al. (eds), "Technical Change and Economic Theory". London: Pinter Publishers.

Du Plooy, R, (1988): "Productivity in South African Industry" in *SAJE*, Vol 56, No 1, pp. 82-93.

Economist, (1992): "Economic Growth - Explaining the Mystery" January 4th.

Economist, (1990): "Japan's Schools: Why Can't little Taro Think ?" April 21st.

Edwards, S, (1991): "Openness, Outward Orientation, Trade Liberalization and Economic Performance in Developing Countries," National Bureau of Economic Research , Working Paper No. 2908 (Cambridge, MA: NBER).

Elias, V, (1970): "Sources of economic growth in Latin American countries" in *Review of Economic Statistics*, Vol 60, No 3, pp. 362-370.

Evans, D, (1989): "Alternative Perspectives on Trade and Development" Ch 24 in Chenery, H and Srinivasan, T (eds): Handbook of Development Economics, Vol 2, North Holland, Amsterdam.

Fagerberg, J, (1988): "Why Growth Rates Differ". In G. Dosi et al. (eds). "Technical Change and Economic Theory". London: Pinter Publishers, pp. 432-457.

Fallon, P , (1992): "An Analysis of Employment and Wage Behaviour in South Africa", Informal Discussion Paper on Aspects of the Economy of South Africa, Paper No. 3, Southern African Department, World Bank, Washington.

Feder,G, (1983): "On Exports and Economic Growth" *Journal of Development Economics*, Vol 12, No 1.

Fields, G and Wan, H, (1989): "Wage Setting Institutions and Economic Growth" *World Development*, Vol 17, No 9.

Fischer, S, (1988): "Symposium on the Slowdown in Productivity Growth" *Journal of Economic Perspectives*, Vol 2, No 4.

Fourie, L, (1978): "Technology and Economic Growth", Paper presented at: The Road Ahead International Futures Conference, July.

Fransman, M, (1982): "Capital Accumulation in South Africa". In Fransman (ed). Industry and Accumulation in Africa, London, Heinemann.

Fransman, M, (1985): "Technology and Economic Development". Brighton: Wheatsheaf.

Fransman, M, and King, K (Eds.), (1984): "Indigenous Technological Capability in the Third World". London: Macmillan.

Freeman, C and Perez, C, (1988) "Structural Crises of Adjustment, Business Cycles and Investment Behaviour". In Dosi et al. "Technical Change and Economic Theory". London: Pinter Publishers.

Havrylyshyn, O,(1990): "Trade Policy and Productivity Gains in Developing Countries - A Survey of the Literature" *The World Bank Research Observer*, Vol 5, No 1, pp. 1-24.

Helleiner, G, (1993): "Introduction : Trade Policy and Industrialisation in Turbulent times". In Helleiner, G (ed) "Trade Policy and Industrialisation in Turbulent times", Claredon Press, Oxford.

Higgens, J, (1993): "Industry Policy", Talk given to Department of Sociology and Industrial Sociology, Rhodes University.

Holden, M, (1992): "Trade Reform : Finding the Right Road", *South African Journal of Economics*, Vol 60, No. 3.

IDC, (1992): Manufacturing Sector Data Series, January.

Joffe, A, Kaplan, D, Kaplinsky, R and Lewis, D, (1993): "A Framework for Industrial Revival in South Africa", Economic Trends Research Group.

Jorgenson, D, (1988): "Productivity and Postwar U.S Economic Growth" *Journal of Economic Perspectives*, Vol 2, No. 4.

Katz, J, (1984) "Domestic Technological Innovation and Dynamic Comparative Advantage: Further Reflections on a Comparative Case Study Program" *Journal of Development Economics*, Vol. 16, No.1, pp. 13-38.

King, K, (1984): "Science, Technology and Education in the Development of Indigenous Technological Capability" in M. Fransman and K. King (eds.): "Indigenous Technological Capability in the Third World". London: Macmillan.

Kleu Study Group, (1983): "Report of the Study Group on Industrial Development Strategy", RSA, Pretoria, Government Printers.

Kok, W, (1981): "Die Kapitaalstructuur van die Suid Afrikaans Fabriekswese, Unpublished Phd dissertion, RAU.

Lall, S (1992):"Technological Capabilities and Industrialisation" *World Development*, Vol 20.

Lall, S (1993):"What will make South Africa Internationally Competitive", ASPEN/IDASA Conference on South Africa's International Economic Relations in the 1990s.

Landes, D, (1990): "Why Are We So Rich And They So Poor?" *American Economic Review*, Vol 80, No. 2.

Levy, B, (1981):"Industrialisation and Inequality in South Africa" in *SALDRU Working Paper*, No.36. University of Cape Town.

Lindbeck, A, (1983): "The Recent Slowdown of Productivity Growth" *The Economic Journal*, Vol 93.

Maddison, A, (1987): "Growth and Slowdown in Advanced Capitalist Economies: Techniques of Quantitative Assessment" *Journal of Economic Literature*, Vol 25, No 2.

Mansfield, E, (1985): "How Rapidly does New Technology Leak Out?" *Journal of Industrial Economics*, Vol 34, No 2.

McCarthy, C, (1988): "Structural Development of South African Manufacturing Industry - A Policy Perspective" *South African Journal of Economics*, Vol 56, No 1.

Mohr, P, (1993): "South Africa's Economic Prospects: Can we Learn From Other Countries?" *Studies in Economics and Econometrics.* Vol 17, No 2.

Moll, T, (1990): "Output and Productivity Trends in South Africa: Apartheid and Economic Growth", Unpublished Phd dissertion, Cambridge.

Moll, P, (1991): "The Equity-Growth tradeoff in South African Education." *Journal for Studies in Economics and Econometrics,* Vol 15, No. 1.

Nabli, N and Nugent, J, (1989): "The New Institutional Economics and its Applicability to Development." *World Development,* Vol 17, No. 9.

Nadiri, M, (1970): "Some Approaches to the Theory and Measurement of Total Factor Productivity : A Survey" *Journal of Economic Literature,* Vol 8.

Nelson, R, (1981): "Research on Productivity Growth and Productivity Differences: Dead Ends and New Departures" *Journal of Economic Literature,* Vol 93, pp. 1029-1064.

Nelson, R, (1989): "Industry Growth Accounts and Production Functions when Techniques are Idiosyncratic" *Journal of Economic Behaviour and Organisation,* Vol 11, No 3.

Nelson, R and Winter, S, (1982): "An Evolutionary Theory of Economic Change." Cambridge, MA: Harvard University Press.

Nishimizu, M, and Robinson, S, (1984): "Trade Policies and Productivity Changes in Semi -Industrialized Countries" *Journal of Development Economics,* Vol 16, No 1.

NPI (National Productivity Institute), *Productivity Focus.* Pretoria NPI (1990).

OECD, (1992): OECD Outlook, Vol 52, December. Paris : OECD

Olson, M, (1982): "The Rise and Decline of Nations", New haven : Yale.

Olson, M, (1988): "The Productivity Slowdown, the Oil Shocks and the Real Cycle" *Journal of Economic Perspectives,* Vol 2, No 4.

Pack, H, (1988): "Industrialization and Trade" in H.B. Chenery and T.N. Srinivasan (eds), "Handbook of Development Economics", Vol 1 Amsterdam: North Holland.

Pack, H, (1993): "Productivity and Industrial Development in Sub-Saharan Africa" *World Development,* Vol 21, No. 1.

Page, J, (1990): "The Pursuit of Industrial Growth" In Scott, M and Lal, D (eds): "Public Policy and Economic Development : Essays in Honour of Ian Little" Claredon Press, Oxford.

Parker, W, (1990): "Understanding Productivity: The Ways of Economics and of History" *Journal of Economic Behaviour and Organisation,* Vol 13.

Perez, C, (1983): "Structural Change and the Assimilation of New Technologies in the Economic and Social System", Futures, Vol 15, No 5.

Pillay, P, (1992): "Education, Occupation and Earnings in South Africa" Paper presented at 'Economic Growth and Human Development - The Economic Dimensions of Education in South Africa', Conference held at UCT, September.

Piore, M and Sabel, C, (1984): "The Second Industrial Divide", New York, Basic Books.

Prais, S, (1987): "Educating For Productivity: Comparisons of Japanese and English Schooling and Vocational Preparation." in National Institute Economic Review.

Ranis, G, (1984): "Determinants and Consequences of Indigenous Technological Activity". In Fransman, M and King, K (eds), "Technological Capability in the Third World".

Ranis, G, (1989): "The Role of Institutions in Transistion Growth: The East Asian Newly Industrialising Countries" *World Development*, Vol 17, No 9.

Rees, A, (1980): "Improving Productivity Measurement" *American Economic Review*, Vol 70, No. 2.

Rodrik, D, (1992): "The Limits of Trade Policy Reform in Developing Countries", *Journal of Economic Perspectives*, Vol 6, No. 1.

Romer, P, (1990): "Capital, Labour, and Productivity" *Brookings Papers on Economics*.

Scerri, M (1990): "R&D and the International Competitiveness of the South African Manufacturing Sector." *South African Journal of Economics*, Vol 58, No 3.

Scott, M, (1989): "A New View of Economic Growth" Oxford, Oxford University Press.

Scott, M, (1993): "Explaining Economic Growth" *American Economic Review*, Vol 83, No. 2, AEA Papers and Proceedings.

Siebert, H, (1991): "A Schumpeterian Model of Growth in the World Economy: Some Notes on a New Paragigm in Economics" *Weltwirtschaftliches Archiv*, Vol 127, No 4.

Simon, H, (1955): "A Behavioural Model of Rational Choice", *Quaterly Journal of Economics*, Vol 69.

Solow R, (1988): "Growth Theory and After" *American Economic Review*, Vol 78, No 3.

South African Statistics, 1964, 1970, 1972, 1976, 1980, 1990, 1992. South Africa, Government Printer, Pretoria.

South African Labour Statistics, 1991. South Africa, Government Printer, Pretoria.

Syrquin, M, (1986): "Productivity Growth and Factor Reallocation" in Chenery, H. et al. (eds), "Industrialization and Growth: A Comparative Study". Oxford: Oxford University Press.

Syrquin, M, (1987): "Growth Accounting with Intermediate Inputs and the Transmission of Technological Change" *Journal of Development Economics*, Vol 26.

World Development Report, (1987): World Bank, Washington D.C.

Wright, A, (1992): "Education and Industrial Achievement : Causations and Policy Implications" Paper presented at 'Economic Growth and Human Development - The Economic Dimensions of Education in South Africa', Conference held at UCT.