AN ANALYSIS OF LABOUR AND CAPITAL PRODUCTIVITY IN SOUTH AFRICA, WITH SPECIAL REFERENCE TO THEIR IMPACT ON THE INTERNATIONAL COMPETITIVENESS OF THE LOCAL MANUFACTURING INDUSTRY

BY
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Gabriele Woratz
Johannesburg, May 1997
SUMMARY

Title: An analysis of labour and capital productivity in South Africa, with special reference to their impact on the international competitiveness of the local Manufacturing Industry.

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The aim of this study was to determine the level of capital and labour productivity in the South African manufacturing industry and their impact on the industry's level of competitiveness on the international markets.

It was established at the outset that there is an important link between productivity and competitiveness. Before a quantitative analysis of South African manufacturing and that of some of this country's major international competitors could be done, it was first necessary to examine the theoretical foundations behind the concepts of productivity and competitiveness. It was found that international competitiveness can be judged in terms of the ability of industries to generate wealth more rapidly than their international competitors. It was established that the main driving force for achieving these goals is growth in the productivity of input factors. This, in turn, is determined by growth in human capital, research and development, government policies and economies of scale.

Various macroeconomic measurements of productivity and competitiveness were examined. At the domestic level these included growth in domestic investment as a necessary requirement for increasing the capital stock and capital-labour ratio, as well as measurements of the level of domestic education. In order
to make international comparisons unit labour costs; terms of trade; the real effective exchange rates and growth in exports were examined.

The level of efficiency of the utilisation of input factors, capital and labour, was found to be critical to productivity performance. In the context of the Cobb-Douglas production function marginal productivity and the marginal rate of technical substitution were examined. That the ultimate aim of a production process is the optimal combination of input factors was highlighted and the efficiency criterion as a technique was discussed. The optimal utilization of the budget outlay was established as a test of whether or not economic waste occurs, and the methodology for establishing whether economies of scale exist was examined.

The quantitative analysis of South Africa's international level of competitiveness at the macroeconomic level showed that South Africa's expenditure on research and development compares poorly with those of its competitors. Domestic savings as a percentage of GDP in South Africa is consistently below 20%, compared with 30 - 40% for Korea. In terms of growth in investment, South Africa did not fare too badly since the beginning of the 1990's compared to the industrialised countries. However, South Africa's investment level below 20% of GDP was far below that of Korea which was nearly 40% of GNP. It was found that South Africa's expenditure on education at about 20% of government expenditure was high in comparison to its competitors. However, the education level was shown to be inadequate, indicating that monies are not spent efficiently.

On the export side results were not much better. Numerous external factors lead to wide fluctuation in the rand exchange rate. In addition, the level of international competitiveness of the South African manufacturing was historically undermined by inward-looking economic and trade policies. As a result growth in exports did not compare favourably with those of South
Africa's competitors. Therefore it was not surprising to find that South Africa's market share of manufacturing exports of developing countries declined from almost 12% in 1955 to a meagre 1,5% in 1993.

The quantitative analysis of the South African manufacturing industry at the microeconomic level showed that labour was over-utilized in each of the years from 1972 to 1993. However, statistical tests (by applying the technique of the efficiency criterion) found that the over-utilization of labour could not be confirmed for all years. According to a comparison of the estimated production output with the one of optimal budget outlay it was established that economic waste occurred. However, the magnitude of economic waste fluctuated during the period 1972 to 1993.

The international comparison of labour and capital productivity showed that both input factors were lagging behind those of South Africa's competitors. The disappointing results can be attributed to inappropriate pricing of production factors relative to productivity changes because of low real interest rates and rapid wage increases. The latter resulted in a constant increase of unit labour costs as labour productivity did not keep pace with the rise in wages. This led to a widening gap between the South Africa's unit labour costs and those of South Africa's competitors and a resultant decline in the level of competitiveness.

All these findings confirm the validity of South Africa's low ranking in the Global Competitiveness Report of recent years.
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CHAPTER I

PROBLEM STATEMENT AND STRUCTURE OF RESEARCH

1 PROBLEM STATEMENT

The aim of this study is to determine the level of capital and labour productivity in the South African manufacturing industry and their impact on the industry's level of competitiveness on international markets.

The importance of competitiveness can be explained by the ultimate goal of all economic activity: namely, to create the wealth that will lead to a rise in the standard of living of a nation. It is widely accepted that the prosperity of a nation depends largely on its success in the world economy. This view is borne in the international experience of countries such as Germany and Japan which grew the fastest after the second world war, and more recently the "East Asian Tigers", all of which based their rapid economic growth on exports. In contrast, countries that based their growth on the domestic market - former Soviet Union, India and much of Africa and South America - have generally stagnated economically.

An increase in the level of competitiveness is measured by improvements in the ability to produce goods and services which compete successfully on domestic and international markets. Growth in productivity is in turn, the prerequisite to producing goods and offer services which compete successfully on domestic and international markets.

A wide range of articles and overall opinions constantly express the view that South Africa's manufacturing industry is not internationally competitive and is, in fact, losing the battle.

The growth of the South African economy is lagging behind that of the developing countries as a group, and especially those of South and East Asia. A number of reasons are given the poor economic performance of South Africa. One of these is that the government is not creating the right framework to ensure high and sustainable economic growth. Government is criticised for spending too much (resulting in high budget deficits) and spending it inefficiently; there is not enough scope for markets to allocate resources because of too much government intervention and trade barriers. Another reason for South Africa's poor economic performance is that the savings level is far too low to finance the investment required to support rapid economic growth. In South Africa investment is below 20% of GDP; whereas the average for developing countries is about 30% of GDP. Another point of criticism is that the education level of the South African labour force is far below that of its competitors which is a serious obstacle to improving the level of labour productivity. South Africa's unit labour costs are also far higher than those of its major international competitors. This indicates that wages are too high in comparison to labour's productivity. All these reasons try to explain why South Africa's level of competitiveness is so low and its rate of economic growth so poor.

Given the starting point that exports must form the foundation of future growth and that manufacturing industries are gaining more and more importance world wide and dominate world trade flows, the South African manufacturing industry and productivity levels therein were chosen as a guideline for South Africa's
level of competitiveness on an international basis.

To measure South Africa's performance relative to that of its competitors, a number of measurement techniques were applied.

At the macroeconomic level the appropriateness of the framework created by government to support the level of competitiveness of the business sector is analysed. The significance of research and development on the South Africa economy is examined against the background of the importance of technological advances in making a country become and remain competitive in today's global economy. Levels of investments and capital formation are examined relative to those necessary to raise the level of capital productivity and are compared with those of South Africa's competitors. The importance of education is highlighted as the basis for labour productivity and the level of education compared to those of South Africa's competitors.

Growth in the exports of the South African manufacturing industry provide an important measurement of the level of international competitiveness. As the global market is expanding, a comparison of South Africa's export performance with that of some its major competitors is done to examine South Africa's relative performance internationally.

At the microeconomic level the productivity performance of capital and labour are analysed. As mentioned, growth in productivity is regarded as the prerequisite for growth in competitiveness. Accordingly, whether South Africa's manufacturing industry is making efficient use of its input factors is tested. This is done by applying various techniques, including a calculation comparing the productivity of input factors to their cost to show whether the combination of input factors is efficient. Other technique used, are a calculation of the efficiency criterion; a measurement of whether economic waste occurs; and a calculation of whether economies of scale exist. All these results indicate in what way the productivity of input
factors and their costs will impact on the level of microeconomic competitiveness.

Finally, the level of productivity of South Africa's manufacturing industry is compared with that of some of its international competitors. In particular unit labour costs between South Africa's manufacturing industry and that of its competitors is compared as this is the most commonly used measure for international competitiveness comparisons.

2 STRUCTURE OF RESEARCH

In Chapter II the theoretical basis of the concept of competitiveness and the major factors determining the level of competitiveness are examined. Michael E. Porter's so called "diamond model" is analysed as a basis for competitive advantages. Trade is analysed as an important driving force for international competitiveness. Finally the nature of barriers used to stay ahead of competition in domestic and international markets is discussed.

In Chapter III an extensive analysis of possible measurements of competitiveness at the macroeconomic level is given. Important measurements highlighted include: research and development; government policies; and investment in physical and human capital. On the international side trade policies, terms of trade and the real effective exchange rate are discussed as factors influencing the export performance of industries. Export growth is analysed as a final measurement of the level of international competitiveness.

Chapter IV examines the theoretical basis of measurements of productivity at the microeconomic level. The Cobb-Douglas production function is shown to be a useful measurement of productivity. Concepts such as the optimal combination of input
factors, the efficiency criterion and the optimal utilization of the budget outlay are analysed. Furthermore, the measurement of technical progress at the microeconomic level is examined.

In Chapter V measurements discussed in chapter III at the macroeconomic level are applied to the South African economy and to South Africa's major international competitors. The results indicate how competitive South Africa is compared to its major competitors.

The Chapter VI deals with the actual productivity performance of the South African manufacturing industry at the microeconomic level. Measurements discussed in chapter IV are applied to establish what level of capital and labour productivity prevails. Furthermore, whether the input factors have been combined efficiently and how the cost of the input factors influence their combination is examined. In the second part of this chapter the levels of labour and capital productivity of the South African manufacturing industry are compared with those of South Africa's major competitors.

In Chapter VII the findings of this study are summarised.
CHAPTER II

THE THEORETICAL FOUNDATION OF THE CONCEPT OF ECONOMIC COMPETITIVENESS

1 INTRODUCTION

The aim of this chapter is to provide a sound theoretical basis for the concept of economic competitiveness.

Competitiveness can arise from assets used in production, or from the nature of the production process. These assets may be inherited (natural resources) or created (infrastructure, skills). Production processes transform assets into economic results (manufacturing).

Different sources of competitiveness highlight why industries are more competitive in domestic and international markets. Due to its dynamic nature, the concept and importance of competitiveness has changed dramatically from the days of Ricardo to Michael E. Porter. The concept of comparative advantage is still valid today but in a changed and more sophisticated form. It becomes very clear that productivity plays a major role in the enhancement of competitiveness as determinants of competitiveness are also determinants for productivity.

Four major determinants of competitiveness (human capital, technological advances, research and development and government policies and economies of scale) will be analysed. It will be shown that domestic and international markets are underlying driving forces for competitiveness. Two schools of thoughts will analysed in the economic debate about the importance of domestic and international competitiveness.

Michael Porter's DIAMOND MODEL will be discussed. Emphasis will
be given to the four major driving forces of the model.

It will be shown that trade is the basis for international competitiveness. As the underlying principle for trade the theory of comparative advantage will be analysed. Furthermore, the influence of trade policies on the flow of trade will be discussed. As an underlying factor for free trade the GATT agreements will be discussed.

Finally, the kind of barriers that are used today to keep competitors out and to stay ahead of competition will be discussed.

2 DEFINITION OF COMPETITIVENESS

Competitiveness is characterised by competition amongst participants. In an economic context, competition amongst market participants is rivalry in the strife for a certain market share to sell a certain product or service. Competition represents the interaction of companies, sectors and nations as they battle for market shares in domestic and international markets.

In economic theory perfect competition is characterised by a large number of sellers and buyers who are all price takers in the market. The product is homogenous and only free entry to the market exists. In the real world a competitor must try to be better in the price and the quality of his product. His level of competitiveness will be evaluated in how successful he can compete against his rivals through lower prices or better quality products.

Competitiveness will be measured by the ability to produce goods and services that meet the test of domestic or international competition, while people that are part of the production process enjoy a standard of living that is both rising and sustainable (Krugman, 1994b: 31). The World Competitiveness Report (World Economic Forum, 1995: 36) defines competitiveness as "the ability
of a country or company to, proportionally, generate more wealth than its competitors in world markets".

3 THE GOAL OF COMPETITIVENESS

At a national level one could say that the ultimate goal for competitiveness is to create wealth and hence improve domestic real income which will lead to a rise in the standard of living of a nation. For a company or industry the main reason to improve its level of competitiveness is to ensure an increase in market share and higher profits. The overall purpose of productivity analysis is to improve business operations and the competitive position in order to serve the longer-term goals of improving profitability. Profit changes can be realized through improvements in productivity or price recovery. Efficiency is improved by reducing the quantity of fixed resources and/or by reducing the consumption of variable resources per unit of output (Van Loggerenberg & Cucchiaro, 1981/82: 89-90). This indicates that the main prerequisite for a higher level of competitiveness is the real growth in productivity leading to a decrease in price levels or at least the limitation of their rate of increase. On the other hand growth in productivity will lead to improvement in the quality of products or services which will give a manufacturer an advantage over his competitors and thus increase competitiveness in local and international markets. Without real growth in productivity an improvement in the level of competitiveness is not possible. Krugman states in his article "Competitiveness: A Dangerous Obsession" (Foreign Affairs, March/April 1994: 32) that in an economy with very little trade, competitiveness (thus rise in standard of living) equals domestic productivity growth. However, real growth in productivity alone will not ensure a better level of competitiveness as it is also influenced by the cost of input factors in the domestic market and in the international market by inflation differentials between countries and movements in exchange rates and purchasing power parity of trading partners.
Two major factors determine competitiveness:

\[
\text{Level of competitiveness} = f(\text{real productivity growth, cost differentials})
\]

Since the early 1970's Europe and the United States recorded low productivity growth rates in comparison to Japan and the NIC's. This state of affairs resulted in a decline in their competitiveness. TABLE 1 illustrates the opposing directional trends of output growth as indicator for productivity.

<table>
<thead>
<tr>
<th>TABLE 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>REAL OUTPUT IN MANUFACTURING</td>
</tr>
<tr>
<td>Average Annual Growth Rate</td>
</tr>
<tr>
<td>United States</td>
</tr>
<tr>
<td>France</td>
</tr>
<tr>
<td>Germany</td>
</tr>
<tr>
<td>United Kingdom</td>
</tr>
<tr>
<td>Japan</td>
</tr>
<tr>
<td>Taiwan</td>
</tr>
<tr>
<td>Korea</td>
</tr>
</tbody>
</table>

Source: National Productivity Institute, 1995: 157

Since the beginning of the 1990's output growth in the United States has been increasing. One of the reasons being that the American firms made far better use of their capital stock (hence an increase in capital productivity) than their counterparts in Germany and Japan (The Economist, June 8, 1996: 19 & 90). The improved growth performance in the United States also reflects a rise in labour productivity which coincides with the start of the recovery from 1992. After the effects of Germany's reunification the German economy had lost momentum and even
recorded negative growth by 1993. Japan's low economic growth starting from 1992 effected labour productivity which in turn had a negative impact on output growth. In Taiwan and Korea output growth fell to a lower level than the ones achieved in the 1970's and 1980's. Korea's decline in output growth can be attributed to rising unit labour costs.

4 DETERMINANTS OF THE LEVEL OF COMPETITIVENESS

A wide range of factors determine competitiveness and thus productivity. The World Competitiveness Report (World Economic Forum, 1995: 36) mentions a number of measurements for world competitiveness. This is illustrated in FIGURE 1.

![FIGURE 1 DETERMINANTS OF WORLD COMPETITIVENESS](image)

Determinants which are most relevant for firms and industries are analysed in the following paragraphs.
4.1 HUMAN CAPITAL

Investment in human capital is defined as a saving from current consumption to increase productivity later. High quality labour is more related to capital than labour per se. It is of great importance that education is not viewed as a 'consumption' variable but rather as a 'production' variable (Brown & Hogendorn, 1994: 67). The level of human capital which can only be improved through education and training determines industries' level of competitiveness. Even if an industry has machinery equipped with the simplest technology, the workers must be capable to use this machinery. Therefore it is not only the amount of education available that is important to improve human capital, but also the suitability for industries' needs. Hence, the quality and relevance of the education system is a vital underlying factor for the development of industries. Improved human capital will increase labour productivity, lead to better quality products and decreases in prices. Thus, an improved level of competitiveness on local and world markets will be achieved. The education system should also be selective to create skills which are necessary for certain job activities in the production process. Not only governments but the private sector should also provide education, for example in-house training or learning-by-doing. In-house training is important to enable the usage of technical advanced machinery (Baker, Boraine & Krafchik, 1993: 57).

4.2 RESEARCH AND DEVELOPMENT (R&D) AND TECHNOLOGICAL ADVANCES

Research and development play an important part in the development of a country's industries and products. R&D is very much interlinked with progress in technology which results in innovations, better products and more efficient input of production factors. R&D is implemented through investment. Therefore a faster rate of investment can lead to more R&D which
can be expected to speed up productivity growth. Each new higher level of productivity through learning about new methods of production and new products makes the next advance in technology possible (Scott, 1989: 117). The result will be a higher level of competitiveness in domestic and international markets.

Productivity growth through technological progress, makes it possible to produce more output from a given quantity of labour and capital (Romer, 1996: 96). The benefits of technological progress together with education can be considered as important determinants of the level of competitiveness because of their importance in increasing efficiency and, ceteris paribus, growth in general productivity. The introduction of technological capabilities (skills in technology, management and institutions) that allows the efficient usage of technology and new equipment leads to greater efficiency in the production process and impacts on labour productivity. To implement advances in technology it is important that industries have access to markets which provide these new technologies. Competitive advantages of a nation "arise at the firm levels from deliberate efforts to build capabilities rather from given factor endowments" (Baker, et al. 1993: 52). Not only R&D at home is important but the acquisition of technology from foreign sources should be encouraged. Especially developing countries where R&D is rather limited (because of few funds available) must make use of technology advances from industrialised countries (National Productivity Institute, 1996: 27).

Romer (Forbes ASAP, undated: 67) points out that the trend is towards more investment in research for new products. He claims that ideas have huge costs with respect to the development of the first unit but then essential zero costs for each additional unit (Forbes ASAP, undated: 67). That means that R&D gains more and more in importance. Especially new ideas and innovation become more and more important in today world of fierce competition.
4.3 GOVERNMENT POLICIES

The government of a country is responsible to provide the right framework for economic growth. The development and implementations of its policies (e.g. legal, monetary, fiscal and trade policies) will to a large extent determine the efficient allocation of resources. A firm's performance is influenced to a large extent by the structural characteristics of a country. Therefore, policies (through better allocation of resources) which improve an economy's assets directly improve firms/industries' competitiveness (World Economic Forum, 1995: 352).

For developing countries an important factor is that government creates the basis for and encourages foreign direct investment which cannot be designed without trade and industrial policies (Baker et al., 1993: 79). Foreign direct investment are capital flows undertaken by a firm of an industrialised country to create a subsidiary in a developing country. This features transfers of resources (capital and know-how) as well as the acquisition of control because the subsidiary is part of the foreign organizational structure (Krugman & Obstfeld, 1994: 159). This connection brings new skills, innovation and new equipment/machinery and will enhance the production process of domestic industries.

Government should also support industries which might have good possibilities to compete in international markets successfully.

4.4 ECONOMIES OF SCALE

A significant part of technical progress is related to economies of scale. A part of the average annual growth in income can be attributed to the expanding scale of operation in the economy. As the scale of production of an industry expands, fewer inputs are required per unit of output, presumably because techniques that are economically inefficient at a small-scale level yield
factor savings at a larger scale of production (Dornbusch & Fischer, 1990: 718).

A specific relation exists between returns to scale (a production concept) and the shape of the long-run cost curve. With constant input prices, increasing returns to scale require that the average cost curve declines. This case is referred to as **economies of scale** (Maurice & Smithson, 1988: 289). After adjusting all inputs optimally, the unit cost of production is reduced as the firm produces more output. One reason for this phenomenon is specialization and division of labour. Jobs can be divided and subdivided with increasing numbers of workers; particular operations can be done by workers with special skill. When workers are allowed to concentrate on one task, they might become very efficient (McConnel, 1978: 523-524).

Small firms are not able to utilise the most efficient productive equipment as it is often only available in very large and expensive units. Effective utilization of this equipment demand a high volume of production. This means only large-scale producers are able to afford and operate efficiently the best available equipment. In the automobile industry the most efficient fabrication methods entails the use of extremely elaborate assembly-line equipment. All these technological considerations (greater specialisation in the use of labour and management, the ability to use the most efficient equipment, and the effective utilization of by-products) will contribute to lower unit costs for the producer who is able to expand his scale of operations (ibid: 523-524).

A final technological element is perhaps the most important of all: as the scale of operation expands there is usually a qualitative, as well as a quantitative change in equipment. More technical advanced machinery will be introduced which tend to reduce the unit cost of production (Maurice et al., 1988: 290-291).
5 THE ECONOMIC DEBATE ABOUT THE IMPORTANCE OF DOMESTIC AND INTERNATIONAL COMPETITIVENESS

There are some supporters, like Porter and Krugman who advocate that an improvement in competitiveness in domestic markets is more valuable to improve the standard of living than an improvement in international competitiveness (World Economic Forum, 1995: 352).

5.1 REASONS UNDERLYING THE IMPORTANCE OF DOMESTIC COMPETITIVENESS

Krugman states in his article "Competitiveness: A Dangerous Obsession" (Foreign Affairs, March/April 1994: 30) "that the idea that a country's economic fortunes are largely determined by its success on world markets is a hypothesis, not necessary truth; and as a practical and empirical matter, that hypothesis is flatly wrong." Krugman argues that an increase in the standard of living (through productivity gains) is not necessarily improved through trade. Since the absolute domestic productivity growth in the non-traded sector is sufficient to improve a nation's standard of living (World Economic Forum, 1995: 352).

A similar argument is, that for wealth creation only the domestic economy matters, the importance of the international economy is marginal (World Economic Forum, 1995: 7). This might be the case for countries with large domestic markets like the United States.

Advocates for improvement in competitiveness in domestic markets are of the opinion that firms are more successful internationally if they operate on more competitive domestic markets (World Economic Forum, 1995: 353). In FIGURE 2 a close relationship between competitiveness ranking and domestic market dominance is shown.
Carney, as mentioned in the World Competitiveness Report of 1995, (World Economic Forum, 1995: 353) decomposes the effect of domestic competition (proxied by market dominance) and foreign competition (proxied by imports as a percentage of GDP) on national total factor productivity (TFP) growth. In a series of cross section regression tests, domestic competition is found to be positively associated with TFP growth while foreign competition has an insignificant impact. The major component of TFP growth is technological advance (World Economic Forum, 1995: 353).

Porter advocates the importance of domestic competition because a loss of domestic rivalry will undermine competitive advantages, because less domestic rivalry will slow the pace of innovation and dynamism (Porter, 1990a: 170).
5.2 ARGUMENTS UNDERLYING THE IMPORTANCE OF INTERNATIONAL COMPETITIVENESS

Competitiveness proponents have never denied the importance of domestic competition because virtually all descriptions of competitiveness emphasize the importance of domestic savings and investment rates, education, cost of capital and research and development. Trade is typically a secondary issue and more a symptom than a cause of competitiveness (v. Prestowitz, 1994: 187). However, by losing competitiveness on international markets, can mean, losing potential gains in living standards. In the extreme, a loss of international competitiveness can weaken the national security because of a possible decline in economic growth and can cause greater vulnerability to political regimes and international cartels that may lead to constraints of a country's economic potential (ibid: 188).

International competitiveness is important because foreign competition forces a faster pace of economic change in the domestic economy and affords the opportunity to learn new technologies and new and better management practices. Those industries which do not compete abroad will not be productive at home. In the real world a perpetual state of dynamic disequilibrium exits where differentials in wages and rates of return of capital by industries are large and persistent (Thurow, 1994: 190). Competitive manufacturers will take advantage of the differentials, if an industry (like the US car industry) has lost market shares, the remedy is not to keep foreign competitors out, but to take the lead in producing more advanced products. Today's world is one of much more dynamic brain power industries and synthesized competitive advantage which is not limited to a specific country. Industries such as microelectronics, biotechnology, telecommunications and computers have no natural geographic home. With man-made comparative advantage one seeks to create the new products and processes that generate above-average wages and rates of return in the global economy (ibid: 191-192).
The importance of export for smaller economies is illustrated in TABLE 2. The international economy, hence international markets are important for industries with small domestic markets especially with regard to developing economies of scale.

<table>
<thead>
<tr>
<th>TABLE 2</th>
<th>EXPORTS OF GOODS &amp; NON-FACTOR SERVICES AS A PERCENTAGE OF GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>1993</td>
</tr>
<tr>
<td>United States</td>
<td>6</td>
</tr>
<tr>
<td>Japan</td>
<td>11</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>23</td>
</tr>
<tr>
<td>Germany</td>
<td>21</td>
</tr>
<tr>
<td>France</td>
<td>16</td>
</tr>
<tr>
<td>Netherlands</td>
<td>43</td>
</tr>
<tr>
<td>Ireland</td>
<td>35</td>
</tr>
<tr>
<td>Canada</td>
<td>23</td>
</tr>
<tr>
<td>Malaysia</td>
<td>42</td>
</tr>
<tr>
<td>Korea, Rep.</td>
<td>14</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>92</td>
</tr>
<tr>
<td>Singapore</td>
<td>102</td>
</tr>
</tbody>
</table>

Source: World Bank, 1994

Two thirds of countries mentioned in the World Competitiveness Report of 1995 have a population under 50 million. For countries like the Netherlands or Belgium exports make up the largest portion of their GDP. Especially the growth in developing economies is largely determined by their export growth. This is influenced by the country's level of international competitiveness. Good examples are the successful economies of
the NIC's which was based on export-led growth.

5.3 IS WORLD COMPETITIVENESS A ZERO-SUM GAME OR NOT?

The school of thoughts which argues that greater global market penetration of one industry can only be achieved by the contraction in another industry say that world competitiveness is a zero-sum game, because if some win others must loose.

In contrast to Krugman, supporters of the importance of international competitiveness, like Thurow, argue that an open world economy creates wealth for everybody through the international exchange of goods and services. Comparative advantage will lead to an improvement of living standards in countries. The reason for differences in wealth is the speed at which different countries make use of their comparative advantage and the rise in their international competitiveness (World Economic Forum, 1995: 7). Firms sell products that compete with each other. They are each others export markets and each others main suppliers of useful imports. Therefore, international trade, then cannot be considered to be a zero-sum game. A country and its trading partners can both be winners through the dynamics of comparative advantage (v. Prestowitz, 1994: 186).

Much has been written on bridging the gap between the theory and the application of global competitiveness. Both, domestic and international competitiveness drive the productivity performance of industries. Domestic competitiveness can be considered as the underlying driving force of international competitiveness.

6 MEASURING THE LEVEL OF COMPETITIVENESS IN DOMESTIC AND INTERNATIONAL MARKETS

Reasons for competitiveness which can be found in the literature and read about in today's debates differ widely from each other. Advocates of the comparative advantage based on Ricardo's
analysis in the classical theory stand in contrast to Michael E. Porter's Diamond structure.

6.1 COMPETITIVENESS IN THE DOMESTIC MARKET AS AN UNDERLYING FORCE FOR INTERNATIONAL COMPETITIVENESS

Competitiveness in local markets can be regarded as the prerequisite for international competitiveness. If competition in domestic markets does not exist firms and industries as a whole will be ill prepared to enter international markets with their fierce competition.

Domestic competition is of importance if it promotes innovation and technological advancement, especially if domestic markets are large. This makes it possible for industries to develop substantial economies of scale (World Bank, 1991: 91).

Most conceptions of national competitiveness recognise that the structural characteristics of any economy have a strong influence on a firm's performance. Thus, policies which improve an economy's assets and institutions directly improve its competitiveness (which is also determined by structural competitiveness) (World Economic Forum, 1995: 352).

The best known and widely discussed work about the importance of domestic competitiveness as a basis for international competitiveness is MICHAEL E. PORTER'S DIAMOND MODEL.

6.1.1 THE DIAMOND MODEL OF PORTER

Michael E. Porter developed an approach in his book "Competitive Advantage of Nations" to go beyond idiosyncratic reasons for the success of a nation. He established that the success of a nation is based on underlying forces which can be understood and managed. These forces are the national determinants of competitive advantage and are shown in the famous 'DIAMOND'
developed by Michael E. Porter. He points out that ultimately firms compete and not nations. The focus is on specific industries or industry segments. Only at this level can the process by which specialised skills and technology are created, be fully understood (Monitor Company, 1995: 1).

A very powerful statement which can be regarded as the basis of Porter's approach is:

"National prosperity is created, not inherited. It does not grow out of a country's natural endowments, its labour pool, its interest rates, or its currency's value, as classical economics insists." (Porter, 1990b: 73)

Therefore his argument as the basis for competitiveness is as follows:

"A nation's competitiveness depends on the capacity of its industry to innovate and upgrade. Companies gain advantage against the world's best competitors because of pressure and challenge." (Porter, 1990b: 73).

Michael E. Porter (Porter, 1990a: 71) established that to achieve international success four broad driving forces constitute the DIAMOND OF NATIONAL ADVANTAGE to create the environment in which local firm compete. They are illustrated in FIGURE 3 below which shows the famous DIAMOND.

Some of the driving forces which will be discussed in the following paragraphs have already been analysed in the paragraph 'determinants of competitiveness'. However, it seems important to analyse them again as Porter incorporates them in his model in a different way.

These four driving forces, individually and as a system, constitute the framework in which the private sector competes. These driving forces make resources and skills available which
are necessary to create competitive advantages for an industry. Through these driving forces information is given about opportunities that are perceived. Information also shows the direction in which resources and skills should be employed. The driving forces lead to goals of all involved in or carry out competition. The most important feature is pressures on firms to invest and innovate (ibid: 71).

In a national environment that allows rapid accumulation of specialized assets and skills firms will be able to achieve a competitive advantage. If the national environment puts pressure on firms to invest and introduce innovation then firms will apart from gaining competitive advantage also upgrade those advantage over time. (Porter, 1990b: 77).

In the following four paragraphs the four determinants of competitive advantage will be explained in more detail.
6.1.2 FACTOR CONDITIONS

According to Porter (Porter, 1990b: 77-78) the doctrine of factor endowments in the theory of classical economics (Smith and Ricardo) is "at best incomplete and at worst incorrect". Factor endowment of each nation differs and plays a vital role in the competitive advantage of a nation's industries. However, the amount and kind of factors available are less important than the rate at which they are developed, upgraded and specialised with regard to certain industries. Not only the value of factors but also their combination with technology is vital to achieve the highest possible productivity growth (Porter, 1990a: 77). Nations with sophisticated industries do not inherit but create the most vital production factors, skilled labour or a scientific base. The rate at and the efficiency with which these factors are created, constantly upgraded and their employment to serve the needs of particular industries is of great importance. Production factors with sustained and extensive investment and great specialisation play a major role.

Successful industries proved to be particularly good at factor creation (Porter, 1990b: 78). An abundance in certain factors (e.g. abundance of natural resources like gold and coal in South Africa) does not necessarily enhance an advantage. On the contrary, the absence of factors (e.g. natural resources) have led to innovation and strategies to overcome disadvantages in factor endowment as was the case in some Asian countries (Porter, 1990a: 74-75).

Porter in his theory distinguishes between basic and advanced factors where basic factors, such as unskilled labour, need relatively modest investment. Normally they are available in great numbers and have low-cost advantage. Advanced factors on the other hand require more investment in human and physical capital. Advanced factors are significant to build competitive advantages for firms/industries. Another distinction is made between generalised factors including infrastructure, capital and
a well-educated labour force and *specialised* factors, involving narrowly skilled employees, infrastructure with specific properties and other factors with relevance to a single industry. The latter category is more important for the creation of competitive advantage for firms (ibid: 77-78).

Broad categories of factors listed by Porter (Porter, 1990a: 74-75) are *human resources* which include the level of managerial skills, skilled and unskilled labour and their numbers as well as labour costs involved. Closely linked to this category is the one of *knowledge resources*. This entails the availability of scientific, technical and market knowledge concerning goods and services. *Capital resources* are the amount of capital available and its costs to finance industries. This is determined by savings and interest rates. *Physical resources* include land, water, climate, location and geographical size. Under *infrastructure* falls transportation and communication systems and also housing availability and cultural institutions (ibid: 74-75).

---

**FIGURE 4**

**FACTOR CONDITIONS DETERMINED BY OTHER DRIVING FORCES**

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Source: Porter, 1990a: 133
The constant upgrading of factors is vital, otherwise firms or industries run the risk of having their created advantages nullified.

The creation of factor conditions is also to a large extent determined by the other main driving forces within the 'DIAMOND'. This is illustrated in FIGURE 4.

It is questionable whether the theory of comparative advantage by Ricardo can be considered as incorrect; perhaps incomplete. The creation of production factors must be based to some extent on the available work force and its level of training. Through constantly upgrading the level of training industries can create more or highly skilled labour. The theory of comparative advantage is based on productivity differences between industries. Increased productivity will be achieved through better skilled labour or higher education together with more technical advanced machinery. Therefore Porter's arguments for factor conditions are based on improved productivity leading to the theory of comparative advantage. Porter underlined in his book (Porter, 1990a: 6), the importance of improvement in the standard of living of a nation. Highly specialised industries will not necessarily lead to improvement in the standard of living of a nation, unless they represent a big proportion of the nation's GDP or have are spill-over effect to the benefit of less specialised industries.

In South Africa it is important to create employment through broad as well as highly specialised industries with the prospect of developing economies of scale.

6.1.3 DEMAND CONDITIONS

Local consumers' needs and demands will determine how firms respond to these needs. They can put pressure on firms to innovate faster and hence produce more sophisticated goods compared to competitors. The result is an advantage towards other
manufacturers locally and internationally. Three characteristics of local demand are of importance to achieve competitive advantage.

The first characteristic is the **structure** of local demand which is for most industries segmented which is the distribution of demand for particular varieties of goods. Larger segments receive more attention by firms because there might be the possibility to develop economies of scale which are more profitable. Economies of scale are also valuable for the entrance into global markets. A very important characteristic is the **nature** of local consumers. The more demanding and sophisticated they are, the more they will put pressure on firms to upgrade and innovate their products. This will create or sustain an advantage towards other competitors locally and internationally and penetrate these markets. Demanding consumers will stimulate innovation and lead to cut costs. The last of the three characteristics of the composition of local demand is the **anticipation** of consumers needs. This can provide an early indicator of future consumer needs that might spread widely. This will stimulate an ongoing process of upgrading products or developing new products (ibid: 86-92).

The **size** of local demand plays an important role in the development of competitiveness. Opinions about its importance are divided. Some advocate that big consumer demand is important because of possible economies of scale. The size of local demand is an advantage if it encourages investment, innovation and dynamism. In the case where international sales are neglected, a large size local demand can become a disadvantage (ibid: 94). Another important factor apart from the size of local demand is the **rate of growth** of local demand. Rapid domestic growth can force firms to adopt new technologies faster and the building-up of economies of scale. Saturation forces firms to continuous innovation and upgrading or replacements of new versions of their products and cost cutting (ibid: 96).
As was the case for the driving force 'factor conditions', the other driving forces influence the behaviour and development of demand conditions. This is illustrated in FIGURE 5.

**FIGURE 5**

DEMAND CONDITIONS DETERMINED BY OTHER DRIVING FORCES

Source: Porter, 1990a: 136

6.1.4 RELATED AND SUPPORTING INDUSTRIES

Supplier industries are industry which supply another industry with inputs for the production process (e.g. leather footwear industry need machinery, leather and design services). These industries can confer advantages to their customers, if the supplier industries produce inputs which are important to innovation or to internationalization (ibid: 100).

If supplier industries (e.g. leather manufacturers) are internationally competitive they can create advantages in downstream industries (e.g. the leather footwear industry) through the supply of the most cost-effective inputs. Another advantage is the ongoing coordination provided by home-based
suppliers. Perhaps the most important benefit is quick access to information, new ideas and innovations of suppliers. The joint effort to solve problems and the exchange of information can lead to faster and more efficient solutions. To have short communication lines through the location of suppliers in near proximity will be beneficial (ibid: 103). Short communication lines will be created if suppliers and buyers are located in the same area and this will cut down on costs such as transportation costs and the ability to communicate quickly.

The benefits of home-based suppliers and related industries are also influenced by the other driving forces within the DIAMOND MODEL. This is illustrated in FIGURE 6.

The presence of related industries which are competitive themselves will enhance competition. "Related industries are those in which firms can coordinate or share activities in the value chain when competing or those which involve products that are complementary" (ibid: 105). Success of one industry on international markets can pull through the demand for
complementary products and services through recommendation of other firms from their home nation (ibid: 106-107).

Related and supporting industries do not necessarily have to be home-based. In the modern economic environment of fast communication and connections through a vast system of immediate communication between countries, the possibilities of constant exchange of information between industries are immense. Moreover constant exchange of international information is more valuable to create advantages to compete on world markets.

6.1.5 FIRM STRATEGY, STRUCTURE AND RIVALRY

The last driving force of national competitive advantage is the way firms are created, organized and managed. The extent of home rivalry plays an important role with regard to innovation and ultimately international success (ibid: 107).

The framework for competition that is provided by a nation will influence strategies, management practices and forms of organisation. Companies' decisions to invest, take risks and to upgrade are influenced by the structure of capital markets, taxes and social attitudes and perceived national challenges or priorities (Monitor Company, 1995: 7).

National circumstances affect the managing of firms and their choice to compete. Therefore, industries tend to succeed with management practices and modes of organization which are favoured by the national environment and are well suited to the industries' sources of competitive advantages (Porter, 1990a: 108). Firms' goals and motivation of managers and employees differ widely within and amongst nations. Successful industries will combine these goals and motivations with sources of competitive advantages where sustained investment plays a major role. Porter (Porter, 1990a: 110-113) distinguishes between company goals and goals of individuals to develop their skills and maintain an effort to create and sustain competitive
advantage. This will be influenced to a large extent by the reward system under which employees operate (ibid: 113). Aspects of the reward system are social values (e.g. recognition, status) and financial gains.

Through innovation, the productivity of resources employed in an industry can grow faster than through reallocation of these resources. The reason for this is that the knowledge and expertise built-up in an industry, is maintained and therefore the competitive advantage can be upgraded and remains sustainable. Of course, some mobility of resources is necessary to avoid that they stay locked in unproductive situations through deployment by management lethargy or restrictive union agreements. The ideal is the recombination and re-configuration of committed resources to boost productivity (ibid: 115-117).

How firm strategy, structure and rivalry is influenced by the other driving forces is illustrated in FIGURE 7.
The existence of domestic rivalry will create an important stimulus to innovate and upgrade products and/or the production process in an industry. Domestic rivalry will lead to investment and risk-taking which are necessary conditions for competitive advantages. Foreign competitors can also play an important role in upgrading products or production processes, but they cannot be regarded as a substitute for domestic rivalry. The proximity of rivals will speed up the information flow. Closely located rivals will create the need to compete. The presence of actual rivalry provides incentives to upgrade and through spillovers lead to an improvement in the entire DIAMOND. New business formation through new entrants can discover new segments, new processes or other innovations (Monitor Company, 1995: 7).

6.1.6 THE ROLE OF GOVERNMENT

Apart from the four driving forces discussed so far, government also has a vital role to play. It can influence the competitive advantage of a nation through investment in factor creation (e.g. formal education to create the basis for highly skilled labour), its competition policy; through its role as a buyer and in supporting industries; just to mention a few. Government's role can only be successful if it is combined with the other underlying conditions in the DIAMOND MODEL. Government is also responsible for an environment in which firms can achieve competitive advantage rather than be directly involved in the process (Monitor Company, 1995: 8).

The complete picture of Porter's DIAMOND is shown in FIGURE 8. It also includes chance events like shifts in world financial markets, surges of demands, political decisions and discontinuities in input costs, to mention some. They are mainly exogenous factors outside the MODEL and allow shifts in competitive advantages which may lead to the development of new advantages.
6.2 INTERNATIONAL MARKETS AS A DRIVING FORCE FOR COMPETITIVENESS

The economy of globality assumes that production factors do not have to be close to end-users. Therefore the economy of globality makes use of the different advantages of nations world-wide, and integrates them into a global management of the value chain. Through the opening of markets smaller companies also have access to the global economy. The access to the global economy is facilitated through the development of telecommunications and the information technology and the improvement in transportation (World Economic Forum, 1995: 8). The characteristics of the global economy are shown through the effort of cost efficiency and value added.

Internationalisation, which tests the ability to perform on international markets can constitute a vital influence on the production process of domestic industries. It is possible for a country to be wealthy and not be competitive, e.g. by relying
exclusively on existing assets (natural resources or established industries), or because of high prices for production factors in relation to their productivity. This is the case in Germany where expensive labour causes losses in competitiveness. However, poor countries with few accumulated assets can achieve competitiveness through producing efficiently (Japan and Singapore) and raising productivity growth. Over time the latter countries can become more competitive than rich countries. A rise in wages does not imply a loss in competitiveness when it is accompanied by a rise in productivity. A loss in competitiveness will occur if there is an increase in real wages. To compare the level of international competitiveness between two trading partners, producer costs (labour and capital costs) must also be taken into account. An international comparison of costs should always be done in a common currency in order to eliminate currency fluctuations. This can be an over- or undervaluation of currency.

Many policy makers advocate domestic collaboration in the pursuit of international dominance. Strategies for achieving national competitiveness emphasise the importance of a joint effort of national institutions and ultimately the creation of national champions, arguing that only through co-operation can a region win the "coming economic battle among Japan, Europe and America" (World Economic Forum, 1995: 352).

6.2.1 TRADE AS THE BASIS FOR INTERNATIONAL COMPETITIVENESS

The subject of "globalisation" of world economies gains more and more importance. Evidence for this are numerous articles and discussions on this topic. The industries of all nations are increasingly interlinked through trade; not only through trade in products but also through exchange of information. Through openness to trade and the integration into the global economy, competition will be enhanced and the demand for new technology will be widened and increased. This integration process can be achieved through imports as well through exports. Companies or whole industries make use of new or advanced technology through
imports of capital goods. This affects the nature of factor inputs and the production process in general. The access to higher quality production factors will improve productivity and accelerate the growth of output (World Bank, 1991: 98).

Exporters will also benefit from openness to trade through exposure to international markets. This contact will keep them informed about new products and new technology. It will also force exporters to adapt new technological developments and raise their efficiency to cut costs. This will be necessary to remain competitive in international markets (ibid: 90).

6.2.2 RICARDO'S ANALYSIS OF COMPARATIVE ADVANTAGE

The possibilities of a country's industries to compete successfully in international markets must be developed to increase export growth. The underlying principle for all trade in the classical theory is called comparative advantage. Ricardo (Samuelson & Nordhaus, 1989: 901) proved that a country will benefit from international specialisation.

"The principle of comparative advantage holds that each country will specialise in the production and export of those goods that it can produce at relatively low costs (in which it is relatively more efficient than other countries)" (Samuelson et al., 1989: 901).

To express this principle in another way one can state that trade will be beneficial if marginal opportunity costs are different between countries. Under the basic assumption of competitive analysis: the price equals marginal costs, different marginal (opportunity) costs will be reflected in different prices. This will lead to trade (Gowland, 1983: 8). If industries concentrate on products in which they have comparative advantage, these industries will try to widen their advantage. This will be achieved by being more productive and saving costs; hence the income will rise and they can consume more (Samuelson et al.,
This implies the potential pareto improvement which represents actions that lead to improvements in the standard of living (Gowland, 1983: 8). "The classical theory of comparative advantage retains its social relevance only when exchange rates, prices and wages are at appropriate levels and when macroeconomic policies banish major business cycles or trade disallocations from the economic scene" (Samuelson et al., 1989: 910).

**6.2.3 DIFFERENCE BETWEEN COMPARATIVE AND ABSOLUTE ADVANTAGE**

According to Adam Smith (Salvatore, 1983: 17) international trade is based on absolute advantage, where industries of a country are more efficient in producing all goods than industries of another country are. The concept of absolute advantage reflects on the overall productivity differences between countries. Not only an industry's productivity level relative to foreign competitors determines the competitive advantage, but also the domestic wage rate relative to the foreign wage rate. However, the overall level of a country's wage rate is also determined by the level of productivity in the non-traded industries (Krugman & Obstfeld, 1994: 22). A country with low wages and low productivity is not necessarily more internationally competitive than a country with higher wages and higher productivity. In competitive factor markets, wages are determined by the marginal productivity of labour. If the unit labour costs in a domestic industry are below that of foreign industries, an increased demand for the domestic goods on world markets will lead to a rising demand for labour in the domestic industry. Therefore, rising productivity will be either matched by higher wages or a stronger exchange rate. If industries which specialise in the production of goods where their productivity is relatively higher than the same industries in other countries (comparative advantage) these industries will gain on world markets (The Economist, November 5 1995: 92).

The "sweatshop labour" argument is based on the argument that foreign competition based on low wages is unfair. Important is the fact that it is profitable for one country to produce the
goods with less labour and import the ones with more labour if
labour is relatively expensive. The same applies to the argument
of unequal exchange. One should compare the amount of labour
needed to produce exports with the amount of labour required for
imports substitution (Krugman et al., 1994: 23).

6.2.4 TRADE POLICIES AS DETERMINANTS OF INTERNATIONAL
COMPETITIVENESS

1) TRADE RESTRICTION

Nearly all nations impose some kinds of restriction on the free
flow of trade. In the Marrakesh Agreement in April 1995 signed
by 111 nations the relaxation of these restriction was agreed to.
One of the most commonly used restriction is that of import
tariffs to protect domestic industries from foreign competition.
Another trade barrier is the quota system. This is a direct
restriction on quantities allowed to be imported or exported
(Salvatore, 1983: 208). In the case of voluntary export
restraints, the importing country will induce a country to reduce
its exports voluntarily. This is the reason for recent trade
negotiations between the United States and Japan. The United
States import a great number of cars from Japan because Japanese
cars of high quality are cheaper than American cars. This makes
the American car industry less competitive with the consequence
of a decline in production and a loss of jobs. Another trade
restriction concerns export subsidies like the General Export
Incentive Scheme (GEIS) in South Africa to promote exports. GEIS
can be considered as a form of dumping as export subsidies lead
to lower export prices compared to domestic prices. Through
protection, relative prices can be distorted and this might lead
to a misallocation of production factors in a way that costly
capital-intensive techniques are employed in economies with

All the above mentioned trade barriers undermine the growth in
productivity and hence the level of international competitiveness.

2) OPENNESS TO TRADE AS DETERMINANT FOR INTERNATIONAL COMPETITIVENESS

The best trade policy is that of a free market without any restrictions, like trade barriers or export subsidies. The more open international trade is, the greater is the opportunity of a high exchange of goods, capital, people and knowledge. Openness to international trade will encourage industries to introduce new production methods to minimize costs through the import of more developed capital goods. Through exposure in international markets exporters are informed of new products and foreign consumers can be a valuable information source for advanced or new technology (ibid: 89). It can also force exporter to adopt new technologies because of increased returns from innovation that can translate into expanded market opportunities (ibid: 90).

6.2.5 GATT AGREEMENTS AS A SOURCE FOR INTERNATIONAL COMPETITIVENESS

As discussed in a previous paragraph, tariffs have a negative influence on trade and reduce competition. International trade agreements aim at tariff reductions to facilitate international trade which is beneficial to freer competition. Since 1945 eight major multilateral trade agreements have been signed. The "Uruguay Round" was finalised in Marakkesch in April 1995. The umbrella framework of multilateral tariff reductions was the General Agreement on Tariffs and Trade (GATT) established in 1947 (Krugman et al., 1994 :227). A set of rules of conduct for international trade policy is embodied in GATT. In 1995 GATT was replaced by the World Trade Organization (WTO). The trade agreements place certain constraints on trade policy. Except for agricultural products signatories to GATT are not allowed to use export subsidies. Import quotas are only allowed in the case of
"market disruption"; e.g. imports that are a threat to a domestic industry. To compensate exporting industries from introduction of new tariffs or an increase in existing tariffs cuts in other tariffs must take place. (ibid: 228; Brown et al., 1994: 198).

The reduction of tariffs, quotas and other non-tariff barriers will allow a freer entry of competitors. The incentive of GATT, now WTO, is to achieve trade liberalization, thus increasing international competitiveness which forces producers to be more productive. This will lead to a more efficient use of production factors. It also underlines the fact that trade is the most promising engine for growth especially for industries in developing economies.

7 GLOBALISATION AND COMPETITIVENESS

Globalisation of economies, fast advancing technologies, convergence of computers, telecommunication and greater emphasis on the improvement of white collar productivity created a new framework within today's economies (World Bank, 1994: 9). The globalisation of economies has also changed the rules of competitiveness in local as well as in international markets. In general, firms will strive to develop one or another form of competitive advantage. A firm must try to assess its competitive advantages and how sustainable they are before making any decisions. The assessment of competitors reactions or strategies and the possibility of new entrants is very important.

Mistakes which are made are for example that low-end competitors are ignored. These competitors were not seen as an immediate threat. Another mistake is to allow a once durable advantage to vanish. This can happen if a market leader is caught unprepared by unexpected competitive moves. A third mistake is to launch a new product without first assessing competitive responses. Established competitors will change their existing products to nullify the advantage of a new entry (Day & Reibstein, 1996: 2).
In today's world of intensified competition, success will depend on actions and reactions of competitors, customers and other stakeholder. The ability to anticipate the moves of competitors and take action accordingly gains more and more importance. The deciding factor is not how good the product or service being offered is, but how good the value is relative to the offer of competitors (ibid: 2). In mature markets achievements that lead to sudden shifts in competitive positions are rare. Competition is then at best a zero-sum game. However, the greater the rivalry, the greater is the chance that competition will deteriorate into a negative-sum game. Then the process of competition will impose costs an all players. For example, if one manufacturer raises its advertising expenditure and competitors follow, there will be no net gain for anyone and costs will have increased (ibid: 2). "Successful companies view the thrust of competition as opportunities to learn and systematically adapt to new situations. They routinely commit substantial resources to this learning process" (ibid: 4).

Most large-scale expenditures which are designed to create competitive advantage will not realise a return unless that advantage can be sustained (Geroski, 1996: 11). To sustain competitive advantage firms will create barriers to entry or mobility barriers.

Barriers to entry can be created through product differentiation where consumers are prepared to pay a price premium to get the product of their choice. Mobility barriers protect firms who operate in one part of the market from established firms who operate in other parts of the same market (ibid: 11). Almost all sources of entry or mobility barriers fall into one of the following categories:

1) **Product differentiation** arises when consumers distinguish the product of one firm from that of another firm and are prepared to pay a price premium to get the product of their choice (ibid: 11).

2) **Absolute cost advantage** can arise when companies undercut the
prices of their rivals. Sources for these advantages are investment in research and development and learning-by-doing in the production process which leads to higher productivity. The privileged access to scarce resources for one company alone can bring advantages against competitors. Governments can also create cost advantages in the form of tariffs, subsidies or trade quotas (ibid: 11-12).

3) The most subtle form of entry and mobility barriers are scale-related advantages; through increased volume of production and sales accompanied by falling unit costs. This will impede the entrance of small-scale companies (ibid: 12).

Apart from the above mentioned entry and mobility barriers there are other entry barriers which are used in the battle to keep competitors out. One is sunk costs. This is used to avoid a new entrant displacing a firm in the market. An incumbent will make investments whose capital value is hard to recover in the event of exit. Therefore, sunk costs make it much harder for an entrant to force an incumbent out (ibid: 12). Another barrier is a strategy of squeezing entrants by a limited access of competitors to customers. This can be achieved by making a larger scale of entry more difficult and expensive than a more modest market penetrations plan. A third possibility could be to raise competitors' costs; for example an incumbent starts an advertising war by raising the total market advertising with a relatively constant advertising share of companies. This can constitute a barrier for new entries as their costs are raised without an increase in revenue (ibid: 12).

The above explains how much is done to keep new entrants out of the market and how much incumbents are prepared to defend their market share.

8 SUMMARY

The aim of this chapter was to provide a sound theoretical basis for the concept of economic competitiveness.
It was stated that competition in an economic context represents the interaction of companies and industries in the battle for shares in domestic and international markets. Competitiveness was defined as the ability of firms or industries to, proportionately, generate more wealth than their competitors.

The ultimate goal of competitiveness was analysed as the creation of wealth, hence a rise in the standard of living. For a company or industry the main reason for an improvement in the level of competitiveness was seen as increase in market shares and higher profits. It was highlighted that a strong correlation exists between productivity and the level of competitiveness. Krugman argues that in a country with little trade, competitiveness equals productivity growth. It was explained that a rise in productivity alone does not ensure higher level of competitiveness. Cost factors such as wages, cost of capital, movements in exchange rates and inflation differentials influence the level of competitiveness.

Four major macroeconomic determinants for the level of competitiveness were discussed. As the first one the investment in human capital was highlighted. Its importance was seen in the fact that human capital builds the basis for labour productivity. It was analysed that the level of human capital can only be improved through education (which is the responsibility of government) and training (which is also the responsibility of the private sector).

The second macroeconomic determinant for the level of competitiveness identified was research and development (R&D) and its relationship to technological advances. It was shown that R&D results in innovations, better products and more efficient production processes. Therefore, R&D can be expected to speed up productivity growth. A new higher level of productivity through learning about new methods of production and new products makes the next advance in technology possible and hence, further
productivity growth will be the case.

R&D's relationship to technological advances was explained by the fact that R&D creates technological advances. The latter then will be introduced through new machinery and the improvement of skills. This will increase efficiency of the production process and, ceteris paribus, growth in general productivity.

Government policies were identified as the third macroeconomic determinant for the level of competitiveness. It was analysed that correct government policies will build the basis for efficient allocation of resources. Governments of developing countries, through trade and industrial policies, should provide the basis for foreign direct investment. The benefits of foreign direct investment are skills, capital and know-how from advanced foreign companies.

The fourth major macroeconomic determinant of the level of competitiveness discussed was economies of scale. They are largely influenced by the other three determinants. As the scale of production of an industry expands, fewer inputs are required per unit of output. It was explained that a specific relationship exists between returns to scale (a production concept) and the shape of the long-run cost curve. With constant input prices, increasing returns to scale will lead to declines in the average cost curve. In large scale operations specialization and division of labour is possible and this will imply a more efficient workforce, hence an increase in labour productivity. A valuable technological element of large scale operations is with their expansion there is usually a qualitative and quantitative change in the equipment. More technical advanced machinery will be introduced which tend to reduce the unit cost of production.

The economic debate about the importance of domestic competitiveness versus the importance of international competitiveness were discussed. Krugman argues that the hypothesis that an economy's fortunes are largely determined by
its success in world markets is wrong. The absolute domestic productivity growth in the non-traded sector is sufficient to increase a nation's standard of living. Another opinion is that the importance of the international economy is marginal since only the domestic economy matters. Other advocates for the importance of domestic competitiveness are of the opinion that firms which operate more competitive domestically are more successful internationally. Furthermore, it was stated that Porter stressed the importance of domestic rivalry because less domestic rivalry will undermine the pace of innovation.

Supporters of international competitiveness argue that foreign competition forces a faster pace of economic change in the domestic economy and gives access to new technology and new management practices developed by foreign competitors. It was highlighted that especially for economies with small domestic markets, international markets are important for the development of economies of scale.

Furthermore, it was explained that world competitiveness is not a zero-sum game. An open world economy through comparative advantage will make the exchange of goods and services possible and everybody can benefit from it. This implies that some are not loosing because others are winning.

Another school of thoughts argues the degree of competition in domestic markets is important in determining an industry's level of international competitiveness. As the best known and widely discussed work about the importance of domestic competitiveness Porter's Diamond Model was analysed. Porter's argument is that a nation's competitiveness depends on the capacity of its industries to innovate and upgrade. He states that national prosperity is created and not inherited. He established that four broad driving forces create the environment in which local firms compete.

The first driving force which was analysed was factor conditions.
Porter emphasises that the rate at which factors are developed, upgraded and specialised to serve the needs of certain industries is of vital importance. Porter points out that not only the value of factors, but also their combination with technology, is important to achieve the highest possible productivity growth. Production factors with sustained and extensive investment and great specialisation play a major role. Porter, in his theory, distinguishes between basic factors, like unskilled labour, and advanced factors, which require more investment in human and physical capital. Another differentiation was made between generalised factors, like infrastructure and capital, and specialised factors, like skilled employees. It was stated that a constant upgrading of factors was necessary for firms to keep their created advantage.

Demand conditions was the second driving force which was analysed. It was stated that the needs and demands of consumers can put pressure on firms to innovate and to produce more sophisticated goods compared with a firm's competitors. This will result in an advantage on local and international markets. Three characteristics of local demand were listed. The structure of local demand is the distribution of local demand for a variety of goods. The nature of local demand was explained how demanding and sophisticated consumers are. As the third characteristic anticipation of consumer needs was mentioned. This can provide an early indication of future consumer needs which will stimulate the process to develop new products. The size of local demand is an advantage if it encourages investment and innovation.

As the third driving force related and supporting industries were analysed. Supplier industries which are internationally competitive can create advantages through the supply of the most cost-effective factor inputs for a manufacturer. The presence of related industries which are competitive themselves will enhance competition. Internationally successful industries are beneficial for complementary industries by recommending the products of these industries on international markets.
The last of the four driving forces which was discussed was firm strategy, structure and rivalry. It was pointed out that the way firms are created, organised and managed is important to create advantages. The motivation of managers and employees play a major role. Goals of individuals to develop their skills and maintain efforts to create competitive advantage is influenced by the reward system under which employees operate. Furthermore, it was explained that the existence of domestic rivalry will stimulate the innovation and upgrading of products or the production process. Domestic rivalry will lead to investment and risk-taking which are necessary conditions for competitive advantage. Like domestic competitors, foreign competition will also lead to innovation and upgrading of products and the production process.

Finally the role of government within the diamond model was discussed. It was stated that government can influence the competitive advantage of a nation through its investments and policies. Government is also responsible for creating the right framework in which firms can achieve a competitive advantage.

Apart from domestic markets, international markets are a driving force for competitiveness. The economy of globality makes use of the different advantages of nations world-wide, and integrates them into a global management of the value chain. International markets will influence the production process of domestic industries through the exchange of information. It was stated that a comparison of the level of international competitiveness must also take cost of production factors into account.

In the global economy trade was analysed as the tool to compete on international markets. The integration process through trade can be achieved through exports as well as through imports. The nature of factor inputs and the production process will be improved through imports of advanced technology which is implemented in capital goods. Exporters will benefit through openness of trade because they will be informed about new products and new technology developed in other countries.
It was shown that the underlying principle for trade is the comparative advantage developed by Ricardo. The principle states that each country will specialise in the production and export of those goods in which it is relatively more efficient than other countries. It was stated that under the assumption that the price of a good equals its marginal cost, the different marginal costs will be reflected in different prices. This will lead to trade.

Furthermore the difference between the concept of absolute advantage and comparative advantage was discussed. The concept of absolute advantage reflects the overall productivity difference between countries. Industries of a country are more efficient in producing all goods compared to other countries. The concept of comparative advantage states that industries will specialise in the production of goods with relative higher productivity than the same industries in other countries.

Apart from trade itself it was shown that trade policies determine the level of international competitiveness. Negative influences are trade restrictions. Three kinds of commonly used trade restrictions were mentioned. The most used restriction is import tariffs to protect domestic industry from foreign competition. Other restrictions are quota system, voluntary export restraints and export subsidies. Trade restriction in general reduce the flow of exports and imports and hence international competition.

To achieve the highest possible international competition free trade is necessary. Openness to international trade will encourage the introduction of new production methods through the import of machinery which will minimize costs. Exporters will have the opportunity to learn about new technology which can lead to more efficient production processes.

International trade agreements aim at tariff reductions to facilitate international trade. The umbrella framework of
multilateral tariffs reduction was the General Agreement on Tariffs and Trade (GATT) established in 1947. In 1995 GATT was replace by the World Trade Organization (WTO). The importance of trade agreements is that they place certain constraints on trade policy. The incentives of GATT, now WTO, is to achieve trade liberalization, thus increasing international competitiveness. This in turn will force producers world wide to be more productive.

The globalisation of economies through fast advancing technologies created a new framework for today's economies and intensified competition. Therefore, the success of industries will depend on actions and reactions of competitors, customers and other stakeholders. The deciding factor is not only the quality of a product or a service, but how it compares to the competitor's offer. It was stated that companies are creating barriers to sustain comparative advantages. These barriers can be barriers to entry or mobility barriers. Almost all sources of entry of mobility barriers are either product differentiation, absolute cost advantages or scale related advantages. Sunk costs is another kind of barrier. An incumbent will make investments where capital value is hard to recover in the event of exit. The strategy of squeezing entrant through a limited access of competitors to customers is also used as barrier. Another barrier mentioned is to raise competitors' costs; for example through an advertising war. All these barriers show very clearly how much is done to defend market shares.
CHAPTER III

MACROECONOMIC ASPECTS OF MEASURING
THE CONCEPT OF ECONOMIC COMPETITIVENESS

1 INTRODUCTION

The aim of this chapter is to discuss the applicable macroeconomic measurements of competitiveness. These techniques will be applied to the manufacturing industry in South Africa in order to draw conclusion about its level of competitiveness in the domestic and international markets.

At the macroeconomic level measurements will analyse how government can influence the level of competitiveness of an industry and how it can create the right framework to enhance competitiveness.

It will be shown that research and development are necessary for the development of new technologies and innovations. This will influence the efficiency of physical capital through new investments. The capital-output ratio will be discussed as a technique to measure the efficiency of capital. The vintage approach will be analysed as another technique to give an indication of the efficiency of capital. Furthermore, factors determining the cost of capital will be mentioned. They too influence decisions about investments.

Apart from capital, labour is the other important production factor which will be analysed in this study. Expenditure in education will be analysed as a measure of investment in human capital. At the microeconomic level production per capita or the labour-output ratio will be discussed as an indicator for the efficiency of labour. Another indicator which will be analysed is unit labour cost. The advantage of this measurement is that
it takes cost of labour as well as labour productivity into account. Unit labour costs is commonly used for comparison on an international basis.

Apart from investment in physical and human capital and government policies, the level of international competitiveness is also determined by movements in export and import prices. As a technique the calculation of terms of trade will be analysed. It will be shown that an increase in terms of trade will lead to a loss of international competitiveness. Not only differences in export and import prices will affect international competitiveness but also movements in exchange rates. A commonly used assessment is the real effective exchange rate. This calculated by adjusting the nominal effective exchange rate by purchasing power parity.

Finally, as a good measurement for the level of international competitiveness growth in exports will be evaluated. However, it will be shown that growth in export market shares is more suitable indicator for international competitiveness.

It will be explained why export growth is a good measure for international competitiveness. Furthermore, the importance of growth in export market shares will be highlighted as the most valid measure for international competitiveness.

2 MEASUREMENTS WITHIN THE MACROECONOMIC FRAMEWORK

Conducive government policies are important ingredients to achieve a high level of competitiveness and therefore higher economic growth. The macroeconomic framework influences the pace and choice of introducing to and making use of technology through its effect on interest rates, exchange rates and the availability of foreign exchange. Among numerous policy factors at the macroeconomic level, which are important for increasing and sustaining economic growth, one of the most important factor is price stability. The best measure for price stability is the
inflation rate. A high inflation rate can impede long ranges of planning and indicates that costs of production factors are rising faster than their productivity. Government consumption as a percentage to GDP is another important measure for government policy regarding economic growth. High government consumption acts as a brake on growth as savings are diminishing. It can lead to the crowding-out effect in so far that funds, like tax incomes, are used for consumption instead of investment (Union Bank of Switzerland, 1996: 5). Another indicator for a desirable macro economic framework is government investment in infrastructure. A good network of roads and a sufficient supply of electricity can complement private investment which is important to raise the productivity level of an industry, hence the level of competitiveness (National Productivity Institute, 1996: 22). A measurement for this is the ratio of government investment to GDP or the proportion of government expenditure for infrastructure.

Measurements of competitiveness in the domestic market involve measurements at the macro- as well as at the microeconomic level. In some cases these measurements can be applied at both levels and they can overlap each other. It is very often the case that macro economic measurements feed through to the micro economic level like investments in education will influence labour productivity at the plant level.

3 MEASUREMENTS OF DOMESTIC COMPETITIVENESS

3.1 RESEARCH AND DEVELOPMENT (R & D)

In order to enhance productivity at the plant level the adaption of new technologies and innovations are important. This can be implemented through investment in new machinery or the production of new goods. A broad measurement for the importance given to R&D is its expenditure as the percentage of GDP or as the percentage of total government expenditure. A more appropriate indicator is the expenditure of business on R&D.
At the moment most of the R & D expenditure takes place in the industrial economies. This indicates that they can afford to spend more on innovation which will create future wealth. However, some Asian economies are catching up and becoming innovators (The Economist, May 18, 1996: 80). This is illustrated in FIGURE 9.

**FIGURE 9**
COMPARISON OF R&D SPENDING AND REAL GROWTH IN R&D SPENDING IN VARIOUS COUNTRIES.

Another possible measure is the ratio of imported capital goods to total production. This can give a rough indication of applications of new technology, especially in developing countries. Export success in the manufacturing sector, can point to a successful application of competitive technologies. The export growth in the manufacturing sector can be used as an indication for the application of technical advanced machinery (Union Bank of Switzerland, 1996: 4).

Source: The Economist, May 18th, 1996: 80
3.2 INVESTMENT IN PHYSICAL CAPITAL

The potential of the real growth in the manufacturing sector is determined to a large extent by the real growth in its stock of productive physical capital. It can be calculated by the increase in capital stock in real terms which is the new capital minus capital scrapped. A distinct acceleration in the accumulation of capital can either indicate an increased growth rate in the industry or a build-up in over-capacity, if new capital is not employed efficiently. The latter can lead to misallocations of resources. The link between accumulation of capital and the increase in output growth is not necessarily linear because it is also influenced by other factors for example movements in interest rates and in particular by labour (Banque Indosuez, 1996a: 6).

A broad measure of investments in connection with its contribution to growth is its growth rate compared with the one of total production.

Additional investment in capital will lead up to a certain point in the production process to a rise in output per unit, and hence an increase in capital productivity. PAUL KRUGMAN states in his article 'THE MYTH OF ASIA'S MIRACLE' (Foreign Affairs, 73, Nov. 1994: 70) that "the newly industrializing countries of Asia, like the Soviet Union of the 1950's, have achieved rapid growth in large part through astonishing mobilization of resources....Asian growth, like that of the Soviet Union in its high growth aria, seem to be driven by extraordinary growth in inputs like labour and capital."

Therefore, not only the fact that investments are taking place but that they are of a high quality is of great importance. The quality of new investments depends on factors that predominantly affect the productivity of the production process. These factors are the incorporation of innovation and technological progress in new machinery and equipment which will lead to higher
3.3 MEASUREMENTS OF FIXED CAPITAL STOCK

Fixed capital stock reflects the physical capacity that is available for the repeated use in the production process. It can be calculated as gross or net capital stock in real terms. The calculation of gross capital stock uses weights of which the values remain fixed until the capital good is not used any more. It represents costs of total investment over time that is used in the production process. No differentiation of age is made (Prinsloo & Smith, 1996: 31-32).

Estimates of net capital stock are based on a straight line retirement function. Net capital stock can be calculated according to the perpetual inventory method which is essential to estimate the economic lifetimes of assets. The perpetual inventory method makes it possible to calculate the average age of capital stock for assets with the same lifetime. The average age of capital stock evaluates the necessity for replacement demand (ibid: 33). Over the lifetime of an assets the capital expenditure in each period is multiplied by the period of investment and the sum of weighted investment is divided by the capital stock to reflect the average age of capital stock (ibid: 33). The general aging of capital equipment carries an obvious risk of technological obsolescence and backwardness and potentially, a loss of competitiveness of products in domestic and international markets (ibid: 33).

The calculated net capital stock is a weighted average of past real investment spending. The weights assigned to real investment spending in past periods decline with an increase in the age of assets. Over a longer period of time, the capacity of stock measured by its unexpired life expectation is more relevant, because the regularity in the depreciation of capital stock is in keeping with the declining productivity of assets as time moves on (ibid: 33).
The perpetual-inventory method is also used by the South African Reserve Bank to calculate fixed capital stock. This method calculates the accumulation of net fixed investment in real terms which is the gross fixed investment less the depreciation. Mathematically, the productive stock $K_t^n$, at the end of period $t$ is given by:

$$K_t^n = K_{t-1}^n + l_t - W_t$$

where

- $K_t^n = \text{net capital stock in period } t$
- $K_{t-1}^n = \text{net capital stock for the previous year}$
- $l_t = \text{gross fixed investment in period } t$
- $W_t = \text{provision for depreciation in period } t$
  (usually a straight-line basis of depreciation)

This formula implies that there is a direct relationship between the age of an asset and the efficiency of that asset (National Productivity Institute, 1995: 168).

### 3.4 Efficiency of Fixed Capital

Commonly used measurements for the efficiency of fixed investment at the plant level are measurements in capital-output ratio, their size and changes. This ratio is the amount of capital divided by the amount of output and gives an indication of how much capital is used per unit of output. It can also be used to measure the marginal efficiency of fixed capital when it measures the ratio of additional capital to additional output (Lipsey, 1983: 644-645). Another way to measure the efficiency of capital is the incremental capital-output ratio (ICOR), which is the average change in real fixed capital stock relative to the increase in real output. An increase in ICOR indicates a decline in the efficiency of capital as the growth rate in capital is greater than the growth rate in real output. (Prinsloo et al., 1996: 40-42).
TABLE 3 demonstrates the increase in capital-output ratio in the South African manufacturing industry since the 1960's.

<table>
<thead>
<tr>
<th>TABLE 3</th>
<th>CAPITAL-OUTPUT RATIO OF THE MANUFACTURING INDUSTRY</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>average annual growth</td>
</tr>
<tr>
<td>0.94</td>
<td>1.06</td>
</tr>
<tr>
<td>Source: Prinsloo &amp; Smith, 1996: 41</td>
<td></td>
</tr>
</tbody>
</table>

One can conclude according to TABLE 3 that the capital used in the South African manufacturing sector did not embody enough technical progress, as the amount of capital utilised per unit of output increased. Low capital productivity will be a hinderance to achieve higher competitiveness in domestic and international markets.

3.5 PRODUCTIVITY OF PHYSICAL CAPITAL

Productivity of capital at the plant level can be measured as the amount of output per unit of capital employed. The marginal productivity of capital is the rise in output resulting from an additional unit of capital. However, capital productivity increases through additional capital input will be limited and will lead to diminishing returns if it is not supported by increases in efficiency and technical progress (Dornbusch, et al., 1990: 309; Sachs & Larrain, 1993: 122). Therefore, the productivity of capital is determined to a large extent by the advancement in technical knowledge or technical progress. It is also influenced or varied by the quality and quantity of the other production factors; the most important factor being labour which must be available to operate machines equipped with advanced technology.
3.5.1 INCREASED CAPITAL PRODUCTIVITY THROUGH TECHNICAL PROGRESS

The implementation of technical progress through new machinery can be broadly measured through the investment ratio to real output. It would be better to measure technical progress, which is embodied in new machinery, separately to see the direct impact on capital productivity. This would explain better why an additional unit of capital will lead to more additional units of output, and avoid diminishing returns. The latter will occur if there is no embodied technical progress.

Capital stock series can be adjusted to reflect changes in its composition and to allow for the fact that new additions to capital stock are likely to be more productive than the existing capital stock as a result of technical advance. This is the idea of embodied or endogenous technical change as opposed to exogenous technical change, an assumption of the original Cobb-Douglas production function which supposes that all vintages of capital share equally in technical progress. Embodied (endogenous) technical progress refers to technical improvements that can only be introduced into the productive system by new investment. In contrast disembodied technical change (exogenous) is not dependent on capital accumulation (Thirlwall, 1989: 73).

It would be important to disaggregate the benefits of technical progress from total factor productivity and add the embodied technical progress to capital productivity, as the ultimate goal to adjust the capital stock for embodied technical change is to raise the sensitivity of the growth rate of output to changes in the rate of capital accumulation (ibid :74). This can be incorporated in a later chapter of this study into the Cobb-Douglas production function of the South African manufacturing industry according to the calculation of the vintage approach which will be dealt with in the following paragraph.
3.5.2 THE VINTAGE APPROACH AS A MEASUREMENT OF CAPITAL EFFICIENCY

The vintage approach which takes the embodied technical progress into consideration is associated with Professor Solow. He was one of the first who modified the basic Cobb-Douglas function to include technical change and to estimate its growth. The most recent and presumably the more productive additions receive a higher weight. The deciding of weights poses a problem. R. Nelson (ibid: 74) explained 'effective' capital stock as a function of gross capital stock, its average age and the rate of productivity improvements of new capital goods (ibid: 74). The quality weighted sum of capital goods can be written as follows:

\[ \tau_t = \sum K_{vt}(1+\lambda_k)^v \]

where

- \( \lambda_k = \) constant rate of quality improvements of new machines through technical progress, which is an assumption
- \( K_{vt} = \) amount of capital built in year \( V \) which is still in use in time \( t \) (ibid:75-75).

With changes in the rate of growth of capital the age distribution of capital will be altered. It will affect the productivity of capital in so far as the gap between the average technology and the best-practice techniques will be changing. If the average age of capital is decreasing the productivity of capital will improve by an amount equal to \(-\lambda_k \Delta A\) (\( \Delta A \) = change in average age of capital).

The rate of growth of the 'effective' capital stock may be written as follows:

\[ \frac{\Delta \tau}{\tau} = \frac{\Delta K}{K} + \lambda_k - \lambda_k \Delta A \]

where

- \( \frac{\Delta K}{K} = \) rate of growth in actual capital stock
- \( \lambda_k = \) rate of growth of improvements in capital stock
\[ \lambda_k \Delta A = \text{effect of changes in the average age of capital stock which is a function of the investment ratio (ibid: 75).} \]

The embodied technical progress integrated into the Cobb-Douglas production function can be expressed in its estimated form as follows:

\[ r_a = r_T + \alpha r_K + \alpha \lambda_k - \alpha \lambda_k \Delta A + \beta r_l \]

where \( r = \text{rate of growth of variables over time} \)

If one knows the rate of growth of total productivity and the age distribution of capital under the assumption that all technical progress is embodied, then \( \lambda_k \) and the effects of changing age distribution can be calculated.

\[ r_0 - r_T - \alpha r_k - \beta r_l = \alpha (\lambda_k - \lambda_k \Delta A) \]

\[ (r_0 - r_T - \alpha r_k - \beta r_l) / \alpha (1 - \Delta A) = \lambda_k \]

However, it is not realistic to assume that all technical progress is embodied. To estimate the embodied technical progress by the vintage approach is to experiment with different rates of embodied technical progress on a trial-and-error basis. And then choose that rate which gives the best statistical fit when the function is estimated using empirical data for the other variables. This technique is arbitrary, but given values for \( \lambda_k \) and \( \lambda_k \Delta A \), the sensitivity of output with respect to capital is increased (ibid: 74-75).

### 3.6 COST OF CAPITAL

Not only the efficiency of capital but also the cost of capital influences the level of competitiveness in domestic and international markets. As mentioned in chapter II competitiveness is a combination of productivity and costs. The user cost of capital comprises the price of an investment, depreciation allowances, level of interest rates (especially long-term) and
taxes or tax concessions. All these factors will influence the purchase of new capital goods. The relative user cost of capital can be calculated by dividing user cost of capital by the general level of manufacturing output prices (Prinsloo et al., 1996: 36). User costs of capital are to large extent determined by monetary policies through movements in interest rates and influencing movements in inflation.

3.7 INVESTMENT IN HUMAN CAPITAL

Apart from physical capital as a determinant of real growth in the manufacturing sector, human capital is another determinant. Investment in human capital takes many different forms like expenditure on education or health. Investment in human capital can overcome characteristics of the labour force that act as impediments to greater productivity, like poor health and illiteracy. One of two most important factors affecting the quality of labour are work force experience, which primarily improves the average quality of labour. The other factor is formal education and training, which may exert their effect through changes in the average quality of labour. The 'age' distribution of the work force will primarily affect, if education and training expand, new workers (Thirlwall, 1989: 77). Efficiency and productivity can be raised gradually through the process of 'learning-by-doing'. This refers to experience in the course of production which enables productive efficiency to be improved in the future (ibid: 124). The importance of education and training was outlined in chapter II under the factor conditions of Porter's diamond model.

3.7.1 MEASUREMENTS OF INVESTMENTS IN HUMAN CAPITAL

An often used measurement as an indicator for an improvement in human capital is government expenditure for education as a percentage of total government expenditure. However, this might give a rather distorted picture as monies might not be spent in an efficient way. A better measure is years of school enrolment
or the ratio of skilled to unskilled workers. Low human capital stocks limit the competition to relatively low skill, mass production and labour-intensive manufactured goods markets.

A more appropriate indicator of the development in labour is to measure the productivity level of workers in the manufacturing sector before and after an on-the-job training program. However, this exercise might not be possible because of the non-availability of data.

3.7.2 ESTIMATING THE CONTRIBUTION OF EDUCATION TO LABOUR PRODUCTIVITY

The contribution of education to labour productivity can be measured either at the macroeconomic level or at the microeconomic level with regard to a specific industry or firm.

A possible method to calculate the effect of education on labour productivity involves the differences in the amount of schooling and income. Two steps necessary:

1. gathering information on the distribution of the labour force by amounts of schooling at different dates.

2. Collecting information on income differences between education cohorts with different amounts of schooling embodied in them, which are used as weights to derive at an index of the improvement in the quality of labour due to education. This is based on the assumption that a certain percentage of differences in earnings is due to differences in the amount of education (ibid: 125).

The calculation of an index could be done as follows: the earnings differential between 8-year and 10-year education is 20%. If one assumes that 1/2 of the 20% of higher income is due to higher education and one puts 8-year education as 1 unit then the 10-year education is calculated as

\[ 10\text{-year} = 1 + (0.5 \times 0.2) = 1.1 \text{ units} \]
According to the growth in units the contribution of education to the quality of labour can be estimated (ibid: 125).

An alternative way for estimating the contribution of education to growth and the rate of return on education expenditure is to use the production function approach. A measure of education expansion (education deepening) is to be included in the production function. The contribution of education to measured growth is then the rate of growth of the education variable multiplied by the elasticity of output with respect to the education variable. The rate of return to education is then

$$\frac{\Delta Q}{\Delta E} = \gamma \frac{Q}{E}$$

where

- $Q = \text{mean level of output}$
- $E = \text{mean level of education}$
- $\gamma = \text{elasticity of output with respect to education}$ (ibid: 127).

### 3.7.3 PRODUCTIVITY OF LABOUR

The broadest measurement of labour productivity at the manufacturing level is the average output per unit of labour. A rise in labour productivity means less labour is needed to produce the same amount of goods. As mentioned earlier labour productivity is a prerequisite for competitiveness. Variations in labour productivity are determined by changes in labour's marginal productivity which is the ratio of additional output to additional labour input (Samuelson, et al., 1989: 671). This depends on the quality of labour which is determined by factors like education and training as mentioned in previous paragraphs. It gives an indication of wealth created by people employed in the manufacturing sector on average. This measure it influenced by the vibrancy of entrepreneurial spirit.
3.7.4 EFFICIENCY OF LABOUR

The efficiency of labour at the plant level can be measured by the labour-output ratio, their size and changes. The incremental labour-output ratio can be applied as a measurement of efficiency. An increase in the incremental labour-output ratio indicates a decline in the efficiency of labour because the rate of growth in labour input exceeds the rate of growth in real output.

3.7.5 UNIT LABOUR COSTS

Another measurement that impacts on competitiveness at the plant level is unit labour costs. These are calculated by dividing an index of total salaries and wages by the index of real output (National Productivity Institute, 1994: 110). A change in unit labour costs results from changes in labour productivity combined with changes in remuneration per employee. If unit labour costs rise faster than labour productivity, prices of produced goods become more expensive which indicates a loss in competitiveness and vice versa.

The relationship between productivity and prices can be illustrated by examining the connection between profits, productivity and prices. An entrepreneur will increase prices to raise his profit margin; i.e. the difference between income (I) and costs (C). Income is determined by the quantity of units (Q₀) produced and the price (P₀) received, that yields

\[ I = Q₀ \times P₀ \]

The cost for total input (C) is determined by the quantity of inputs (Q₁) and the price for each unit of input (P₁) that yields

\[ C = Q₁ \times P₁ \]
Therefore, profits are determined by the ratio of income to costs

\[ \frac{I}{C} = \frac{Q_0/Q_1}{(P_0/P_1)} \]

where

- \( Q_0/Q_1 \) measures productivity performance
- \( P_0/P_1 \) measures the price recovery

The above equation indicates that any increase in input prices will lead to an increase in output prices if there is no concurrent increase in productivity at the same time to keep the profit ratio constant (Du Plooy, 1988: 85-86).

4 MEASUREMENTS OF INTERNATIONAL COMPETITIVENESS

Apart from measurements of physical and human capital as well as government policies which determine the level of competitiveness, there are other factors which impact especially on the level of international competitiveness. The most valuable measurements will be examined in the following paragraphs.

4.1 TERMS OF TRADE

Terms of trade are the ratio of export prices to import prices as expressed in indices. An increase in terms of trade reflects a rise in export prices or decline in import prices and vice versa. To express it in an equation, it follows:

\[ N = \left( \frac{P_X}{P_M} \right) 100 \]

where

- \( P_X \) = price index for exports
- \( P_M \) = price index for imports

The income terms of trade (I) can be expressed as follows:

\[ I = \left( \frac{P_X}{P_M} \right) Q_X \]

where

- \( Q_X \) = index of volumes of exports

This measures the export based capacity to import (Salvatore,
Even if terms of trade decline it does not mean that total export earnings decline, as long as the volume of exports increases proportionately. Change in productivity along with the terms of trade will influence the export growth of an industry. To put this into an equation, it yields

\[ D = \left( \frac{P_x}{P_m} \right) \times \left( \frac{Z_x}{Z_m} \right) \times 100 \]

where

- \( P_x \) = export price index,
- \( P_m \) = import price index,
- \( Z_x \) = productivity index of exports,
- \( Z_m \) = productivity index of imports

This implies that export can grow even with a decline in terms of trade as long as the productivity index of exports rises faster than the productivity index of imports (ibid: 257).

It could be the case that productivity is rising but exports do not grow proportionately. Only through devaluation of the currency, a proportionate rise in exports is possible. The reason for this is that productivity growth is outweighed by the terms of trade (Krugman, 1994a: 32-33). The devaluation of the currency would relate to an unsustainable gain in competitiveness on international markets thus being undesirable for a nation's well being. The consequence would be that the standard of living in this country, which depends on its purchasing power over imports and domestically produced goods, would eventually decline.

4.2 PURCHASING POWER PARITY AND THE REAL EFFECTIVE EXCHANGE RATE AS A MEASUREMENT FOR COMPETITIVENESS

As discussed earlier competitiveness is not only explained by productivity but is also influenced by prices. Therefore, a common approach to analyze international competitiveness involves a comparison of movements in exchange rates influenced by different price levels between countries based on the concept of Purchasing Power Parity (PPP).

Purchasing power parity exists when the exchange rate between two
currencies can buy the same amount of goods and services in both countries. It represents the true equilibrium of exchanges (Kenen, 1995: 417). Therefore, changes in price levels of one nation compared with changes in price levels of another nation is one of the determinants of fluctuations in relative exchange rates (Brown et al., 1994: 534-535).

Transportation costs and institutional impediments to trade like tariffs and quotas, makes it not possible to equalize absolute price levels internationally. A more visible but not necessarily better comparison is the real effective exchange rate which predicts that changes in nominal exchange rates should vary according to differences between domestic and foreign inflation (Bartolini, 1995: 46).

The real effective exchange rate is calculated by adjusting its nominal effective exchange rate for differences in inflation at home and abroad and is expressed as an trade-weighted index. This provides a measure for the export competitiveness of a country or industry. A rise in the real trade-weighted index implies a decrease in competitiveness since a country's or industry's exports become more expensive on international markets and vice versa (The Economist, September 7, 1996: 111). Changes in the real trade-weighted exchange rate can be caused by changes in the nominal trade-weighted exchange rate or by inflation differentials between trading partners. The latter can be influenced by productivity changes. However, measurements of trends in real effective exchange rates are in general only broad and imprecise and can be based on terms of trade, consumer or producer price index, an export-based index or unit labour cost to mention a few (Bartolini, 1995: 48).

Competitiveness means something different from productivity if and only if purchasing power grows significantly more slowly than output (Krugman, 1994b: 33). If a country has a high level of inflation it will surely experience a deterioration in the purchasing power. It means that productivity and hence output
grow more slowly than prices. In this case growth in productivity is not necessarily equal to growth in competitiveness.

4.3 EXPORT GROWTH AS AN INDICATOR OF INTERNATIONAL COMPETITIVENESS

The broad proposition that orientation towards exports encourages productivity and economic growth is widely accepted. Increases in productivity arise by the more efficient use of production factors in response to international competition. This is an important connection for the development of skills and adaptation of new production techniques and innovations.

FIGURE 10
AVERAGE GROWTH IN REAL MANUFACTURING WAGES COMPARED WITH AVERAGE ANNUAL CHANGE IN EXPORT-GNP RATIO

In addition to this, the size of international markets could make previously unfeasible economies of scale attainable. It could also lead to reallocation of production factors to more efficient sectors to become more productive and hence more competitive. Numerous empirical studies support the phenomenon of a correlation between export growth and economic growth. The NICs are the best example for countries that experienced export-led growth (Fallon & Pereira de Silva, 1994: 74-75). A good illustration is FIGURE 10.

This shows very clearly a strong correlation between export growth and growth in wages hence an increase in the standard of living, the main goal of competitiveness.

Mechanisms leading to higher growth via export-led growth vary. They can be economies of scale, increased capacity utilisation and improvement in productivity and technology (ibid: 74-75).

| TABLE 4 |
| GROWTH IN MANUFACTURING AND EXPORTS |

<table>
<thead>
<tr>
<th>MANUFACTURING</th>
<th>EXPORT GROWTH</th>
<th>MANUFACTURING EXPORTS AS % OF TOTAL EXPORTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philippines</td>
<td>6.1</td>
<td>0.8</td>
</tr>
<tr>
<td>South Africa</td>
<td>4.7</td>
<td>-0.4</td>
</tr>
<tr>
<td>Argentina</td>
<td>1.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Korea</td>
<td>17.7</td>
<td>12.3</td>
</tr>
</tbody>
</table>

Source: Data from World Bank, 1995
An example for the link between manufacturing growth and export growth is given in TABLE 4. This shows that a growth/decline in manufacturing leads to an increase/decrease in exports. It underlines the growing importance of manufacturing exports within total exports.

An adequate measure of how well the South African manufacturing industry is competing on international markets is export performance. If a decrease in productivity leads to higher unit costs a loss in competitiveness will be shown through a decline in exports. As FIGURE 11 illustrates there is a relatively good relationship between productivity performance and export developments.

As discussed before productivity together with movements in the exchange rate and changes in domestic and world demand influence the export performance of an industry. The high growth in exports in 1984 can be attributed to the rapid fall in the rand during this time as it was the case in 1988.

**FIGURE 11**

GROWTH IN EXPORTS COMPARED WITH CAPITAL AND LABOUR PRODUCTIVITY OF THE SOUTH AFRICAN MANUFACTURING INDUSTRY

Source: Data from Industrial Development Corporation
TABLE 5 compares average growth rates in production, export performance and productivity of capital and labour in the manufacturing sector of South Africa. During the period from 1972 to 1983 growth in production outperformed growth in exports. This can be explained by the inward looking policy during this time. The decline in the average productivity of capital can be largely contributed to over-investment in capital because of low real interest rates during this period. This made capital investment cheaper in relation to labour costs which increased during the later part of this period.

<table>
<thead>
<tr>
<th></th>
<th>1972-83</th>
<th>1983-90</th>
<th>1990-93</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>4.1</td>
<td>1.6</td>
<td>-1.4</td>
</tr>
<tr>
<td>Export</td>
<td>2.8</td>
<td>7.5</td>
<td>1.9</td>
</tr>
<tr>
<td>Aveg capital productivity</td>
<td>-3.4</td>
<td>2.0</td>
<td>-2.4</td>
</tr>
<tr>
<td>Aveg labour productivity</td>
<td>1.3</td>
<td>1.3</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Source: Data from Industrial Development Corporation

4.4 EXPORT MARKET SHARE AS AN INDICATOR OF INTERNATIONAL COMPETITIVENESS

Not only the growth in exports of an industry as such is an indication of the level of competitiveness but its growth in export market share is important. Even if there is a substantial growth in exports it does not mean that the share on world markets is increasing proportionately. The growth in export market shares is also determined by the growth in world trade. In today world with constantly growing international trade through openness of economies an improvement in international
competitiveness is better indicated through an increase in international market share. The development in the market share is calculated as the difference between export growth and the growth in demand in export markets which is the average of imports of the country's trading partners weighted by the respective shares in the country's foreign trade (Banque Indosuez, 1996a: 3).

The fact that exports have become an important contributor towards overall economic growth is always stressed in the debate about the importance of exports. To achieve a growth in exports, industries must be competitive on world markets.

TABLE 6
EXPORT PENETRATION, SELECTED ASIAN ECONOMIES, 1965-90

<table>
<thead>
<tr>
<th>Economy</th>
<th>Share in world exports</th>
<th>Share in developing-economy exports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total exports</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>5.0</td>
<td>7.0</td>
</tr>
<tr>
<td>Four Tigers</td>
<td>1.5</td>
<td>3.8</td>
</tr>
<tr>
<td>Southeast Asian NIEs</td>
<td>1.5</td>
<td>2.2</td>
</tr>
<tr>
<td>HPAE subtotal</td>
<td>7.9</td>
<td>13.1</td>
</tr>
<tr>
<td>All developing economies</td>
<td>24.2</td>
<td>28.7</td>
</tr>
<tr>
<td>World</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Exports of manufactures

<table>
<thead>
<tr>
<th>Economy</th>
<th>Share in world exports</th>
<th>Share in developing-economy exports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>7.8</td>
<td>11.6</td>
</tr>
<tr>
<td>Four Tigers</td>
<td>1.5</td>
<td>5.3</td>
</tr>
<tr>
<td>Southeast Asian NIEs</td>
<td>0.1</td>
<td>0.4</td>
</tr>
<tr>
<td>HPAE subtotal</td>
<td>9.4</td>
<td>17.3</td>
</tr>
<tr>
<td>All developing economies</td>
<td>11.1</td>
<td>11.8</td>
</tr>
<tr>
<td>World</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

—Not available.
N.A. Not applicable.
a. Republic of Korea, Hong Kong, Singapore, and Taiwan, China.
b. Indonesia, Malaysia, and Thailand.

Source: World Bank, 1993: 38

TABLE 6 underlines that an increase in export market share is a good indicator of better competitiveness on international markets.
5 SUMMARY

The aim of this chapter was to discuss the applicable macroeconomic measurements of competitiveness.

It became clear that government policies are responsible for building the right macroeconomic framework to achieve a rise in competitiveness. One of the most important policy factors is price stability. High government consumption will limit savings which are essential for investment. Government's investment in infrastructure was analysed as another important indicator for the right macroeconomic framework to complement private investment.

To have a good basis for growth in competitiveness, research and development was analysed as an indicator for the adaption of new techniques and innovations. The results of research and development are introduced at the plant level through more technical advanced machinery. The more advanced equipment will enhance productivity. The ratio of imported capital goods to the total production can also give an indication of the introduction of new technologies. Apart from imported technologies, successful exports can be used as a broad measure for applications of new techniques at plant level.

Physical capital, one of the two major production factors, is created through investment. Therefore, growth in investment is a good indicator for the build-up of capital stock. It was stressed that not only the amount of investment is of importance. A high quality of investments which incorporates technology progress is also necessary to enhance higher productivity of physical capital.

A technique used to measure the efficiency of capital is the capital-output ratio. Where the incremental capital-output ratio (ICOR) takes into account, changes in real fixed capital stock relative to the increase in real output. An increase in ICOR
points to a decline in the efficiency of capital.

Furthermore, the perpetual inventory method was explained. This method is used by the South African Reserve Bank to calculate the net fixed capital stock. This is a useful measurement for changes in fixed capital stock which influence the efficiency of capital. The perpetual inventory method also allows calculation of the average age of capital stock. This gives a good indication, if a general aging of capital stock prevails. High average age in capital stock carries the risk of technological backwardness and hence a loss of competitiveness in domestic and international markets.

As a broad measure of capital productivity the amount of output per unit of capital was discussed. It was stated that a rise in capital productivity through additional capital inputs will lead to diminishing returns, if they are not supported by technical progress.

The importance of technical progress was stressed before. One can differentiate between embodied or disembodied technical change. Embodied technical progress refers to new investment. Capital stock can be adjusted in a way to reflect that new investments are likely to be more productive than the existing capital stock. The vintage approach was discussed as a method to calculate the effect of new investment and separate it in the Cobb-Douglas production function from the variable of technical change. This method gives new investments higher weights. It emphasises the importance of the average age of capital stock. Under the assumption that all technical progress is embodied the constant rate of quality improvement of new machinery can be calculated.

Apart from measurements of investments and of the efficiency of capital, the cost of capital determines decision about investment. The calculation of user cost of capital takes into account the price of investments, depreciation and the level of interest rates.
Labour is the other major production factor. Its productivity level is determined to large extent by investment in human capital. As an indicator for investment in human capital, government expenditure on education was analysed. Another and better measurement is the level of education which can be established through school enrolment and the number of years of schooling.

A method to calculate the impact of education on labour productivity is to compare the level of schooling with the level of earnings. It is also possible to include the contribution of growth into the production function. The rate of growth of the education variable is then multiplied by the elasticity of output with respect to the education variable.

As it was discussed for capital a broad measure for labour productivity is the average output per unit of labour. A very similar measurement is the labour-output ratio and its changes.

A commonly used application for international comparison of competitiveness is unit labour costs. Its importance can be seen in the way that it combines labour productivity with labour costs. Unit labour costs can change through changes in productivity and/or changes in labour costs.

In order to determine the level of international competitiveness, factors at the macroeconomic level which impact on the export performance were discussed. Terms of trade measure the ratio of export prices to import prices. Prices as such are influenced by productivity and costs. Therefore, terms of trade give a good indication of developments between exporters and importers and hence the competitiveness position of trading partners.

Another important factor that determines the international competitiveness level is the real effective exchange rate. This is calculated by adjusting the nominal effective exchange rate by price differentials between trading partners. This is based
on the concept of purchasing power parity and represents the true equilibrium of exchanges. Two countries are at purchasing power parity when the exchange rate is at a level that the two currencies can buy the basket of goods and services in both countries. A rise in the real effective exchange rate indicates a loss in competitiveness. The price differentials can be based on terms of trade, consumer or producer price indices, an index based on export prices or unit labour costs.

Export growth is a good indicator to show how well industries perform in international markets. An increase in export growth points to a rise in international competitiveness. It was analysed that growth in productivity arises through better allocation of production factors in response to foreign competition. As it was discussed before a rise in productivity leads to an increase in competitiveness.

Finally a better measurement for international competitiveness is the growth in export market shares. Even a substantial growth in exports does not show if an industry competes more efficiently on international markets. The development in market shares is calculated as the difference between export growth and the growth in import demand of a country's trading partners. The difference between export growth and a rise in export market shares is that the latter takes import demand into account. When the import demand grows proportionately faster than exports, this indicates a loss in international competitiveness.
CHAPTER IV

MICROECONOMIC ASPECTS OF MEASURING
THE CONCEPT OF ECONOMIC COMPETITIVENESS

1 INTRODUCTION

The aim of this chapter is to discuss the microeconomic measurement of economic competitiveness.

As discussed in chapter II productivity can be considered as the most important prerequisite for competitiveness. At the microeconomic level it has its starting point at the manufacturing base. Various measurements of productivity at the manufacturing level analysed in this chapter will lead to a conclusion about the level of competitiveness of the South African manufacturing industry.

The importance of productivity at the input base will be highlighted and its influence on the long-term growth of an industry will be explained.

As the basis to measure productivity at the input base, the Cobb-Douglas production function will be discussed. Within the context of the Cobb-Douglas production function marginal productivity will be explained. Calculations for the elasticity of substitution will be shown as a measure of how easily input factors are substituted for each other. Furthermore, the importance of factor intensity with regard to production efficiency will be explained. This can be measured by the capital-labour ratio. In the context of the Cobb-Douglas production function the factor intensity is calculated by the ratio of output elasticities.
Apart from labour and capital productivity, the cost of production factors influences the efficiency of a production process. It will be shown how the cost of production factors are included in the Cobb-Douglas production function. This is needed to determine the optimal combination of inputs. The maximum output with a given level of inputs will be analysed as a tool to determine the efficiency of input combination. As an alternative to determine the optimal input combination, the efficiency criterion will be discussed. Furthermore, the technique to establish the optimal utilization of the budget outlay will be explained. This can be used to ascertain if economic waste occurs.

Furthermore, returns to scale will be analysed. The calculation of returns to scale will lead to conclusions about how input growth affects output growth. It will be shown that there is a specific relationship between returns to scale and the long-run average cost curves. This relationship will be used to determine if economies or diseconomies of scale exist.

Technical progress plays a major role in output growth. Different kinds of technical progress (like neutral, capital-deepening and labour-deepening) will be discussed. A method which is often applied to explain technical progress is the calculation of total factor productivity. The method used by the National Productivity Institute will be analysed.

2 THE CONCEPT OF PRODUCTIVITY

The most important aspect of productivity is its close relationship to an industry's long-term growth performance. Changes in the growth rate of productivity can cause declines or increases in the growth rate of output and profits. If this results in improvements of efficiency then one speaks of productivity increases (Dornbusch et al., 1990: 11).

The OECD put the essence of the productivity issue as follows:
"Above all, productivity is a state of mind. It is the spirit of progress, of continuous improvement on what exists today. It is the determination to improve on yesterday's performance, and to do even better tomorrow. It is the will to improve on the current situation, regardless of how good it may seem or how good it may be. It is the sustained effort to apply new techniques and methods. It is faith in progress" (ABSA Bank, 1995: 5).

The concept of productivity in the framework of the production process is the efficiency with which input factors, capital and labour, will lead to changes in output (which can be measured by total output divided by total input). Of greater importance is the change in average productivity compared to the change in inputs. This will give an indication if additional production factors are used more efficiently than the existing ones.

Productivity increases occur if the same output is produced with less input or more output is produced with the same amount of inputs, or the change in output is greater than the change in inputs. Not only the quantity of products but also the quality of products are of great importance.

2.1 IMPORTANCE OF PRODUCTIVITY

Without a steady growth in productivity an increasing and sustainable growth of an industry's output will not translate into a rise of the standard of living or higher profits. If sustainable long-term growth of an industry can be achieved through higher productivity, then this will influence savings and thus lead to higher investments. Improved investment will have a positive influence on employment. Increase in productivity through higher output with a given amount of input of production factors, will create scope for increases in the real compensation of production factors. This has a direct impact on the standard of living of employees (Central Economic Advisory Service, 1995: 77).
65). On the other hand, higher real income through rising productivity will have a positive impact on consumer demand which in turn will have a positive impact on investment spending and thus employment.

The link between productivity, growth in turnover and profits, exports and international competitiveness can be best illustrated through a flow chart.

![Flow Chart](flowchart.png)

Manufacturers will strive constantly to improve their earnings, achieve higher profits and to expand their production. FIGURE 12 illustrates why productivity is important for profits.

FIGURE 12 illustrates that a change in productivity influences profits directly. It also has an indirect impact on profits through a change in costs. In the case of economies of scale an
increase in productivity leads to a decrease in costs.

2.2 DIFFERENT WAYS OF PRODUCTIVITY COMPARISONS

The rate in changes of productivity is not constant over time. It is a well-know fact that business cycles tend to influence productivity. It has been observed that before the start of a recession productivity begins to decline and then start to recover towards the end of a recession or at the beginning of a recovery, as the recent upswing in the South African economy demonstrates. In the long-run it is desirable that productivity shows steady growth.

Productivity levels can be compared in three different ways:

1) Time comparison
   The performance during different time periods are compared to show the extent of changes in productivity that have occurred. This kind of comparison will indicate whether a firm or industry is becoming more or less productive.

2) Comparison with the norm
   Actual results are compared with performance norms for a specific period. Variances obtained will represent the difference between the normal and the actual. The variances can be favourable, unfavourable or zero. Norms used can be hard, engineered standards or softer norms, such as experience from previous years or industries. This type of comparison addresses the question of whether a company or industry is indeed productive or not.

3) Cross-sectional comparison
   Cross-sectional analysis represents the typical inter-firm comparison where the reference data comprise the industry averages and the review data comprise information for the firm. This type of comparison will show whether the firm is more or less productive than its peers. This kind of
analysis is very important in order to compare South African industries with the same industries on international markets (Parson & Moller, 1986:17).

3 THE COBB-DOUGLAS PRODUCTION FUNCTION

The production process combines production factors to produce goods and services which are necessary to satisfy the needs of people in an economy. The production function links production factors, (the inputs), with the manufactured goods, (the output). It is the relationship between input and output where output is proportional to input (Dornbusch et al., 1990: 486).

Economic theory defines as the main production factors land, capital, labour and technical knowledge. However, entrepreneurial knowledge or management plays an important role in today's business world and is part of the production process. Land is included in the production factor of capital and entrepreneurial knowledge is included in labour. One arrives at a simplified mathematical equation for the production process where output \( Q \) is a function of inputs, labour \( L \), capital \( C \) and technical knowledge \( T \).

\[
Q = f(L,K,T)
\]

(Sachs et al., 1993: 49).

In the theory of production, a widely used mathematical form for a production function is a power function like

\[
Y = ax^b z^c
\]

The coefficient 'b' and 'c' are called the exponent or power to which \( X \) and \( Z \) are raised. The power function is used to express a relationship between output and inputs (James & Thorsby, 1980: 51). The production theory uses a power function which is a non-linear function because there are specific problems using a linear function.
AN ANALYSIS OF LABOUR AND CAPITAL PRODUCTIVITY IN SOUTH AFRICA, WITH SPECIAL REFERENCE TO THEIR IMPACT ON THE INTERNATIONAL COMPETITIVENESS OF THE LOCAL MANUFACTURING INDUSTRY

BY
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If one expresses the long-run production function as

\[ Q = aK + bL \]

one can see that it is not necessary to use positive amounts of \( K \) and \( L \) to produce an output which is greater than zero. It does not make sense that goods can be produced with for example only labour input. Another problem that arises is that the isoquants would not be convex to the origin thus the marginal rate of substitution would not be diminishing with a constant slope of \(-\frac{b}{a}\). In the short-run production function capital is constant and one can express the short-run production function as

\[ Q = aK + bL \quad \text{or} \quad Q = 0 + bL \]

When \( K = 0 \) then the output would be determined by a constant \((c)\) thus no increase in output would take place. Another shortcoming is that the marginal product of labour in this form is

\[ MP_L = \frac{\Delta Q}{\Delta L} = b \]

thus constant. Therefore the law of diminishing marginal product is violated (Maurice & Thomas, 1995: 401).

If one comes across measurements of productivity one finds most of the times that these calculations are based on the Cobb-Douglas production function. It has been used by the World Bank in their discussion paper "South Africa - Economic Performance and Policies", their publication "The East Asian Miracle" and it has been used by Thirlwall in his book "Growth & Development with special reference to developing countries" in his method to calculate capital and labour productivity. The Cobb-Douglas production function is expressed as

\[ Q = AK^\alpha L^\beta \]

The constants in this function are \( A, \alpha \) and \( \beta \) and the variables are \( Q, K \) and \( L \). \( Q \) as an explicit function of \( K \) and \( L \) can be varied.
by changing the input of K and L alone or together. Another characteristic is that both inputs must be used to obtain a positive output, because Q will be zero if either K or L are zero. Furthermore it is possible to substitute the inputs with each other through different combinations but maintain the same level of output (James et al., 1980: 136-137; Heathfield, 1971: 34).

To establish, if the estimated values for $\alpha$ and $\beta$ are statically significant their estimated t-values must be compared with the critical value of t. If the calculated value of $t_\alpha$ and the one of $t_\beta$ are greater than the critical value of t, one can reject the null hypothesis at a certain significance level and can conclude that $\alpha$ and $\beta$ are greater than zero.

### 3.1 AVERAGE PRODUCTIVITY OF INPUTS

The average productivity (AP) is the ratio of output to input at each level of input usage. Therefore the average productivity of capital and labour can be defined as follows:

$$AP_K = \frac{Q}{K} \quad \text{and} \quad AP_L = \frac{Q}{L}$$

It will change with variations in capital and labour.

In the context of the Cobb-Douglas production function it can be expressed as

$$AP_K = \alpha \left(\frac{Q}{K}\right) \quad \text{and} \quad AP_L = \beta \left(\frac{Q}{L}\right)$$

### 3.2 MARGINAL PRODUCTIVITY OF INPUTS

Apart from changes in the average product of output per unit of inputs as a measure for productivity, changes in the marginal productivity (MP) of L and K are a better measure.

In the production theory MP is derived as the partial derivative of the production function with respect to K and L. It concentrates on the area of output where MP of inputs is positive but decreases. That can be expressed as follows:
MP_L > 0 but d(MP_L)/dL < 0

and

MP_K > 0 but d(MP_K)/dK < 0

(Koutsoyiannis, 1979: 71).

The fact that in the production process the MP is still positive but the rate of growth becomes negative is called the law of diminishing returns. As the employment of the variable production factor increases (assuming that the others are held constant) the additional output will reduce progressively (Dornbusch et al., 1990: 505).

Translated into the Cobb-Douglas production function

\[ Q = AK^a L^b \]

it becomes

\[ MP_K = aAK^{a-1}L^b = \alpha Q/K \]

and

\[ MP_L = bAK^aL^{b-1} = \beta Q/L \]

From the above expression one can see that

\[ MP_K = \alpha AP_K \]

and

\[ MP_L = \beta AP_L \]

this yields that

\[ MP_K/\alpha P_K = \alpha \quad \text{and} \quad MP_L/\beta P_L = \beta \]

(Sher & Pinola, 1981: 96).

Because of the specific relationship of the Cobb-Douglas production function where \( \alpha \) and \( \beta \) are constants, the ratio of MP to AP is constant regardless of the level of output and input ratio. In general \( \alpha \) and \( \beta \) do not equal 1. If \( \alpha, \beta > 1 \) for \( K \) and \( L \), MP is always greater than AP which then increases. In the case of \( \alpha, \beta < 1 \) MP is always less than AP which is then decreasing. In the case that MP and AP are equal values of \( K \) and \( L \), \( \alpha + \beta = 1 \) (ibid: 96-97). The coefficient \( \alpha \) measures the output elasticity of capital and \( \beta \) the one of labour. Changes in \( \alpha \) and \( \beta \) indicate what effects changes in capital and labour input will have on
total output.

The slope of MP product curves is negative and can be expressed as the second partial derivative with respect to each factor.

\[ \frac{d^2Q}{dK^2} < 0 \] which is the slope of \( MP_K \)

and

\[ \frac{d^2Q}{dL^2} < 0 \] which is the slope of \( MP_L \)

(Koutsoyiannis, 1979: 71-72)

which is the law of diminishing returns. In order for the properties of the Cobb-Douglas production function to conform to the law of diminishing returns, it requires that \( \alpha \) and \( \beta \) are less than one. Through the second partial derivative one arrives at

\[ OMP_K = \alpha(\alpha-1) A K^{\alpha-2} L^{\beta} \]

and

\[ OMP_L = \beta(\beta-1) A K^{\alpha} L^{\beta-2} \]

If \( OMP_K \) and \( OMP_L \) are diminishing it means they are less than one, then \( \alpha \) and \( \beta \) must be less than one (Maurice et al., 1988: 340). If the value of \( \alpha \) is \( 0 < \alpha < 1 \) and \( \beta \) is \( 0 < \beta < 1 \) the Cobb-Douglas production function conforms to the theoretical properties of the production theory (ibid: 308).

To determine if decreasing returns exist it must be statistically tested that \( \alpha \) and \( \beta \) are significantly less than one.

\[ t_\alpha = (\alpha-1)/s_\alpha \quad \text{and} \quad t_\beta = (\beta-1)/s_\beta \]

(Kleynhans, 1994: 34).

If the estimated values for \( \alpha \) and \( \beta \) are greater than the critical value for \( \text{t} \) at certain significance level, one can reject the null hypothesis and can conclude that \( \alpha \) and \( \beta \) are greater than zero. Therefore it can be assumed that the \( OMP_K \) and \( OMP_L \) are diminishing.
3.3 ELASTICITY OF SUBSTITUTION

In a highly competitive world it is important that production factors are used in an optimal way. It was pointed out in chapter II that to be competitive, it is important to increase productivity. One possibility is to substitute one production factor for another one; e.g. capital for labour. The introduction of new machinery often means that labour is substituted for capital. One of the concepts to measure this is the elasticity of substitution.

If a production process indicates a fall in the productivity of labour and an increase in the productivity for capital, the result will be that more and more labour will be substituted for capital to obtain an optimal input mix. The relationship of possible substitution of capital for labour or vice versa is called the marginal rate of technical substitution. It is defined as

$$\text{MRTS}_{L,K} = -\frac{\partial K}{\partial L} = \frac{MP_L}{MP_K}$$

substituting $K$ for $L$. Since the slope of the isoquant is negative a minus sign is added to keep MRTS as a positive number. (Maurice et al., 1988: 242; Koutsoyiannis, 1979: 74). In the context of the Cobb-Douglas production function one arrives at

$$\text{MRTS}_{L,K} = \frac{\beta A P_L}{\alpha A P_K} = \frac{(\beta(Q/L))}{(\alpha(Q/K))}$$

$$\text{MRTS}_{L,K} = - (\frac{\beta}{\alpha})(K/L)$$

To see how easy input factors are substituted with each other the measurement of the elasticity of substitution ($\sigma$) is used, under the assumption of given technology. It relates changes in relative factor inputs to a proportional change in MRTS between labour and capital or the proportional change in the relative factor-price ratio on the basis of marginal productivity theory (Koutsoyiannis, 1979: 75).
It is defined as follows:

\[ \sigma = \frac{\% \text{change in } K/L}{\% \text{change in MRTS}} \]

It is a pure number independent of the units of the measurement of capital and labour, since both the numerator and denominator are measured in the same units (ibid: 74).

If \( \sigma < 1 \) the ratio of capital's share to labour's share will decrease; if \( \sigma = 1 \) it will stay the same and if \( \sigma > 1 \) the ratio of capital's share to labour's share will increase.

### 3.4 FACTOR INTENSITY

Factor intensity can be measured by input ratios. One can show the production function as output per labour input or as a function of capital per labour input. The latter is known as the capital-labour ratio. If one writes a production function as \( q = f(k) \) where \( q = Q/L \) and \( k = K/L \) then this version of a production function is expressed in per capita units in comparison to previous production functions where totals of output and inputs were considered.

**FIGURE 13**

CAPITAL-LABOUR RATIO

Source: Dornbusch & Fischer, 1990: 728
As it can be seen from FIGURE 13 the higher the capital-labour ratio, the higher the output per labour input. The additional output that results from increased capital-labour ratio grows progressively smaller (Dornbusch et al., 1990: 728). The reason is that the slope of the function $q=f(k)$ is the marginal productivity of capital. According to the law of diminishing productivity the slope will become flatter with increased capital input.

Factor intensity in the Cobb-Douglas production function, where $\alpha$ and $\beta$ are the output elasticities for capital and labour respectively is measured as the ratio of $\beta$ to $\alpha$.

A decrease in $\beta/\alpha$ indicates a deepening of capital. An increase in $\beta/\alpha$ indicates labour deepening (Koutsoyiannis, 1979: 76).

In contrast to capital deepening one speaks of capital widening when the quantity of capital is increased and additional labour is employed while the proportions of factor inputs remain unchanged (Lipsey, 1983: 394).

The capital/labour ratio of the South African manufacturing industry over the period 1972 to 1993 is illustrated in the FIGURE 14.

The rise in capital-labour ratio point to a capital deepening. From 1972 to 1984 the capital-labour ratio increased constantly because of low interest rates during this period and declined during 1984 to 1987. The later period was marked by high interest rates and a sharp decline in the rand causing imports to become very expensive. From then to 1993 it changed to an increase again.
Diminishing productivity of capital with an increase in labour productivity could indicate that capital is over-utilized. Over-utilization of capital and under-utilization of labour implies that production factors are not used efficiently. It implies that this situation leads to a loss in competitiveness because of diminishing marginal productivity. As it has been pointed out in chapter II an increase in productivity is a vital prerequisite for competitiveness.

In cases of capital or labour deepening as mentioned above one can assume that there is no technical progress, e.g. no innovation of new machinery which will shift up the isoquant. The reason for capital deepening leading to over-utilization of capital can be a low level of interest rates in the markets. Another reason is relatively high labour costs in comparison to the costs for capital. This makes it also more attractive to employ more machinery in relation to labour. In the case of labour deepening wages will be lower than the cost of capital which will then be profitable to employ more labour. Also the nature of the production process of some industries in the manufacturing sector is more labour intensive than others.
However, it will only remain profitable to be more labour intensive as long as wages are in line with productivity level of labour. Otherwise a loss in competitiveness will result.

3.5 COST OF PRODUCTION FACTORS

Not only the productivity level of production factors (which has been discussed so far) but also the relevant prices for the production factors will determine the production level in the South African manufacturing industry.

Factor combinations of capital and labour, which can be bought with a fixed amount of total costs, is determined by the isocost curve. If the amount of total costs changes, one arrives at a different isocost curve (Koutsoyiannis, 1979: 87).

Prices for production factors, capital and labour, are determined by demand and supply in their markets. Therefore total costs \( C \) are determined by the price for capital \( r \) and the price for labour \( w \) and the amount of units of factors employed. One arrives at the total cost equation:

\[
C = rK + wL \tag{1}
\]

where \( r = \) price for capital and \( w = \) price for labour

The price for labour \( w \) can be calculated by dividing total remuneration by the number of employees. To express \( w \) in real terms it must be deflated by either the CPI or the PPI. The price for capital \( r \) is defined as \( r = q_K (i + \delta) \) where \( q_K \) is the acquisition cost of capital, \( i \) the real interest rate and \( \delta \) the rate of depreciation (Maurice et al., 1988: 344).

One can rearrange equation (1) and arrives at the linear equation for the isocost curve

\[
L = C/w - (r/w)K \tag{2}
\]
The slope of the isocost curve will vary with changes in input prices. A relative rise of w to r will steepen the isocost curve and vice versa a decline of w to r will flatten the curve (ibid: 247).

The slope of the isocost line can be arrived at as the first derivative of equation (2)

\[ dL = \frac{dC}{w} - \frac{(r/w)dK}{\ldots (3)} \]

since the amount of C is fixed, \( dC = 0 \). Hence the slope is

\[ \frac{dL}{dK} = - \frac{r}{w} \ldots (4) \]

(James et al., 1980: 117).

Equation (2) can be substituted in the Cobb-Douglas production function

\[ Q = AL^\alpha B \ldots (5) \]

one obtains

\[ Q = AK^\theta (C/w - (r/w)K)^\theta \ldots (6) \]

Thus Q is only a function of K. To arrive at the slope of the isocost line one takes the first derivative which is

\[ \frac{dQ}{dK} = \alpha A(C/w - (r/w)K)^{\alpha - 1} - \frac{Br/\omega A(C/w - r/wK)^{\alpha - 1}K^\alpha}{B(\beta - 1)K^2 + \beta (\beta - 1)K^2} = 0 \ldots (7) \]

The second derivative is

\[ \frac{d^2Q}{dK^2} = ((\alpha(\alpha - 1))/K^2 - (2\alpha r)/\omega L \ldots (8) \]

Substituting (2) into (7) the first derivative can be written as

\[ \beta AL^\theta \cdot K^{\alpha/w} = \alpha AL^{\theta - 1} \ldots (9) \]

This can be written also as
awL - βrK = 0 .................................(10)

This equation defines the tangency between an isoquant and an isocost curve (Sher et al., 1981: 101-102).

After having looked at possible combinations of inputs (isoquant) and possible combinations of inputs with regard to their prices (isocost), the next step will be to look at the optimal combination of inputs when quantities of inputs and their relevant prices are combined.

3.6 OPTIMAL COMBINATION OF INPUTS

In order to solve a problem one has to trade one objective off against another. For example a firm cannot achieve a maximum output with a minimum of costs. To solve the tradeoff problem one can specify a given acceptable level for one objective that only one objective is left for which an optimum level can be found. The acceptance of a given level for one objective is called a constraint (James et al., 1980: 109).

Therefore, a company has two choices regarding their output. They can choose a combination of production factors which will yield a maximum output with a given level of expenditure, or they can choose a given level of output which is produced by an input combination of factors with the lowest total cost possible.

3.6.1 MAXIMUM OUTPUT WITH GIVEN LEVEL OF INPUTS

A firm will try to work as efficiently as possible to achieve a maximum profit. This can be done by achieving a maximum output with a given level of costs which determines the amount of inputs possible. Under the assumption that input prices for the production factors, labour and capital, are given one can arrive at various combinations of inputs along the isocost curve as discussed in a previous paragraph. If one superimposes the isocost line on the isoququant map, one can find the maximum output
possible under the constrain of given costs.

The maximum is point P where the isocost curve is the tangent to the isoquant.

![Figure 15: Optimal Output Under Cost Constraint](image)

Source: Mansfield, 1985: 186

The slope of the isoquant is the negative MRTS which is also $\frac{MP_L}{MP_K}$. The slope of an isocost is $-\frac{w}{r}$. Hence the optimal point of the input combination under the cost constrain is where $\frac{MP_L}{MP_K} = \frac{w}{r}$ or $\frac{MP_L}{w} = \frac{MP_K}{r}$ (Mansfield, 1985: 185). Higher levels of output are desirable but not possible because of the cost constraint. At point P in FIGURE 15 the slope of the isocost curve ($\frac{w}{r}$) equals the slope of the isoquant ($\frac{MP_L}{MP_K}$). Another condition for the maximisation is that the isoquant must be convex to its origin.

A formal derivation of the equilibrium conditions solving a constrain maximum problem can be demonstrated as follows:

maximise $Q = f(L,K)$ objective function
subject to $C = wL + rK$ cost constraint

$C - wL - rK = 0$ implicit function
Multiply the constraint by a constant $\lambda$ (Lagrangian multiplier)
\[\lambda(C-wL-rK) = 0\]

The Lagrangian multiplier is undefined constants which are used for solving constrain maxima or minima. Their value is determined simultaneously with the values of the other unknowns ($L$ and $K$). "The Lagrangian technique for solving constrained optimization problems is a procedure that calls for optimising a function that combines the original objective function and the constraint conditions" (Pappas, Brigham & Snipley, 1983: 65). The combination of the two equations is called the Lagrangian Function. It ensures that when it has been maximized/minimized the objective function will also be maximized/minimized and that all constraint requirements will have been satisfied (ibid: 65).

From the 'composite' function
\[\phi = Q + \lambda(C-wL-rK)\]

it can be shown that maximisation of the composite function implies maximisation of output. The first condition for the maximisation of composite function is that its partial derivatives equal zero. Partial derivatives of the above function with respect to $L,K,\lambda$ are:

\[
\frac{d\phi}{dL} = \frac{dQ}{dL} + \lambda(-w) = 0 \quad \text{(1)}
\]
\[
\frac{d\phi}{dK} = \frac{dQ}{dK} + \lambda(-r) = 0 \quad \text{(2)}
\]
\[
\frac{d\phi}{d\lambda} = C - wL - rK = 0
\]

Solving (1) and (2) for $\lambda$

\[
\frac{dQ}{dL} = \lambda w = \left(\frac{dQ}{dL}\right)/w = \lambda \quad \text{(3)}
\]
\[
\frac{dQ}{dK} = \lambda r = \left(\frac{dQ}{dK}\right)/r = \lambda \quad \text{(4)}
\]

The two equations must be equal.
Thus \( \frac{dQ}{dL}/w = \frac{dQ}{dK}/r \)
or\[ MP_L/w = MP_K/r \]
or\[ MP_L/MP_K = w/r. \]

A firm is in equilibrium when it equates the ratio of the marginal productivity of factors to ratio of their prices (Koutsoyiannis, 1979: 89-90).

Given the Cobb-Douglas function as
\[ Q = AK^aL^b \]
and the cost equation as
\[ C = wL + rK \]
one will arrive at the total cost function as a function of the output
\[ C = f(Q) \]

Solving the constrained output maximisation problem

Maximise \[ Q = AK^aL^b \]
Subject to \[ C = wL + rK \] which is the cost constraint

The composite function will then be
\[ \phi = Q + \lambda(C - wL - rK) \]
\[ \phi = AK^aL^b + \lambda(C - wL - rK) \]

The first condition for maximisation is that the first derivatives of the function with respect to \( L, K \) and \( \lambda \) are equal to zero.

\[ \frac{d\phi}{dL} = BQ/L - \lambda w = 0 \] \hspace{2cm} (1)
\[ \frac{d\phi}{dK} = aQ/K - \lambda r = 0 \] \hspace{2cm} (2)
\[ \frac{d\phi}{d\lambda} = (C - wL - rK) = 0 \] \hspace{2cm} (3)
from equation (1) one obtains \( BQ/L = \lambda w \)
and from (2) \( \alpha Q/K = \lambda r \)

dividing these expressions: \( (BQ/L)/(\alpha Q/K) = w/r \)
it yields \( (B/\alpha)(K/L) = w/r \) ............................................(4)

Solving (4) for \( K \) it yields
\[ K = (w/r)(\alpha/B)L \] .........................(5)

Solving for \( L \) from (4) it yields
\[ L = (B/\alpha)(r/w)K \] .........................(6)

(Koutsoyannis, 1979: 97-98).

Under the cost constraint, equation (5) can be applied to identify the optimal point for capital utilization. Equation (6) can be used to find the optimal point for labour utilization.

**3.7 THE EFFICIENCY CRITERION**

In the context of the Cobb-Douglas production function the optimal condition for the use of capital and labour is

\[ (B/\alpha)(K/L) = w/r \text{ or } (B/\alpha)(K/L) - w/r = 0 \]

Multiplying by \( \alpha \) the efficiency criterion becomes

\[ B(K/L) - \alpha(w/r) = 0 \]

Therefore if \( B(K/L) - \alpha(w/r) < 0 \) labour is over-utilized
if \( B(K/L) - \alpha(w/r) > 0 \) capital is over-utilized

To apply this relation empirically one can obtain \( \alpha \) and \( B \) from the estimation of the production function and \( K, L, w \) and \( r \) are actual data. Using these values one can calculate the value of the efficiency criterion (\( \psi \)) as
\[ \psi = \beta (K/L) - \alpha (w/r) \]

As the calculated value of \( \psi \) will not be exactly zero, it must be tested if it is significantly different from zero. To establish this a t-test is required (Maurice et al., 1988: 342-344).

3.8 THE OPTIMUM INPUT RATIO

The optimum factor allocation (where MRTS = w/r) can be represented by the equation

\[ (\beta/\alpha)(K/L) = w/r \]

This implies that the optimal input ratio between the factors of production are:

\[ K/L = (aw)/(Br) \]

If \[ Z = (aw)/(Br) \]

it yields \[ K/L = Z \]

When the factors of production are not optimally allocated the capital/labour ratio will differ from the optimal ratio (Z), and K/L is not equal to Z. In this case production factors are not used efficiently. But if \( \psi = 0 \) then K/L = Z.

It was shown that \[ Z = (aw)/(Br) \]

hence it can be said that \[ Z = (a/\beta)(w/r), \]

thus the optimal input ratio is the product of the reciprocal of the intensity factor and the input factor price ratio (Kleynhans, 1994: 49-50).
3.8.1 MINIMUM COST WITH A GIVEN LEVEL OF INPUTS

In the case of a minimum costs with an output constraint the isoquant curve is given. Whatever output level is chosen by a firm the goal will always be to produce a given level of output with minimum of costs. It is assumed that price for labour (w) and price for capital (r) are given in perfect competitive input markets. The given isoquant is superimposed onto a isocost curves map as illustrated in FIGURE 16.

![FIGURE 16](image)

Source: Mansfield, 1985: 187

The equilibrium is attained at point W where the isoquant (the chosen output level) is the tangent to an isocost line. The slope of the isoquant is given by MRTS and the slope of an isocost curve is w/r. Thus at the tangency, the slopes of the two curves are equal. That yields

\[
MRTS = \frac{MP_L}{MP_K} = \frac{w}{r} \quad \text{or} \quad \frac{MP_L}{w} = \frac{MP_K}{r}
\]

The market input-price ratio indicates at which point one input
can be substituted for another. MRTS shows the rate at which inputs can be substituted between each other in the production process (Maurice et al., 1988: 247-248).

As illustrated in FIGURE 16 there will be several isocost curves. Closer to the origin means less costs are involved. The isocost lines are parallel because one assumes w and r are constant. Therefore all isocost lines have the same slope w/r. The minimum of costs with the combination of K and L are determined by the point of tangency of the isoquant with the isocost. The condition for equilibrium (least cost) are the equality of the slopes of the isocost and isoquant curves.

A formal derivation of the equilibrium conditions solving a constrain minimum problem can be demonstrated as follows:

minimise \[ C = wL + rK \]  
subject to \[ Q = f(L,K) \]

If one rewrites the constraint in the form of \[ Q - f(L,K) = 0 \]

and multiplies the constraint by the Lagrangian multiplier \( \lambda \) it yields \( \lambda(Q - f(L,K)) = 0 \)

the composite function yields

\[ \phi = C - \lambda(Q - f(L,K)) \]

or \[ \phi = (wL + rK) - \lambda(Q - f(L,K)) \]

The first condition for the minimization of the composite function is that its partial derivatives equal zero. Partial derivatives of the composite function with respect to L,K and \( \lambda \) are:

\[ \frac{d\phi}{dL} = w - \lambda \frac{df(L,K)}{dL} = 0 \]

\[ = w - \lambda \frac{dQ}{dL} \] ..............................(1)

\[ \frac{d\phi}{dK} = r - \lambda \frac{df(L,K)}{dK} = 0 \]
\[ r = \lambda \frac{dQ}{dK} \]  \hspace{1cm} (2) \\
\[ \frac{d\phi}{d\lambda} = -(Q - f(L,K)) = 0 \]  \hspace{1cm} (3) \\

it yields \[ w = \lambda \frac{dQ}{dL} \]  \hspace{1cm} (4) \\
and \[ r = \lambda \frac{dQ}{dK} \]  \hspace{1cm} (5) \\

Equation (4) and equation (5) must be equal \\
thus \[ \frac{w}{r} = \frac{(dQ/dL)}{(dQ/dK)} = MRTS_{L,K} \]  \hspace{1cm} (6) \\

A firm is in equilibrium when it equates the marginal rate of 
substitution to the ratio of their prices (Koutsoyiannis, 1979: 91-92).

Solving the constrained cost minimization problem in the context 
of the Cobb-Douglas production function:

Minimize cost \[ C = wL + rK \] 
subject to constraint of given output \[ Q = AK^aL^b \] 

the composite function is \[ \phi = wL + rK + \lambda (Q - AK^aL^b) \] 

The first condition for minimizing is that the first derivatives 
of the function with respect to K,L and \( \phi \) equal to zero.

\[ \frac{d\phi}{dL} = w - \lambda AK^aL^{b-1} = 0 \]  \hspace{1cm} (1) \\
\[ \frac{d\phi}{dK} = r - \lambda aAK^{a-1}L^b = 0 \]  \hspace{1cm} (2) \\
\[ \frac{d\phi}{d\lambda} = Q - AK^aL^b = 0 \]  \hspace{1cm} (3) \\

From equation (1) it yields \[ 1/\lambda = (\beta L^{b-1}K^a)/w = (\beta (Q/L))/w \]  \hspace{1cm} (4)
and from equation (2) it yields

\[ \frac{1}{\lambda} = \frac{(aAL^B K^{-1})}{r} = \frac{(a(Q/K))}{r} \quad (5) \]

Then it follows

\[ \frac{(B/Q/L)}{w} = \frac{(a(Q/K))}{r} \quad (6) \]

\[ \frac{(B/Q/L)}{(a(Q/K))} = \frac{w}{r} \quad (7) \]

\[ \frac{(B/a)(K/L)}{w} = \frac{w}{r} \quad (8) \]

Equation (8) is identical to equation (4) to maximise output under the cost constraint. This indicates that the two approaches yield the same results (Sher et al., 1981: 106-107).

3.9 THE OPTIMUM UTILIZATION OF THE BUDGET OUTLAY

When input factors of production are optimally allocated, the production isoquant, which can be expressed as \( Q = A L^{a} K^{B} \), and the isocost curve which is represented by \( C = rK + wL \), are tangent to each other and thus equal. The optimal allocation of the labour input can be determined from the optimal input ratio.

\[ \frac{L}{K} = \frac{(Br)}{(aw)} \quad (1) \]

one arrives at an equation for \( L \)

\[ L = \frac{(BrK)}{(aw)} \quad (2) \]

It can also be derived from the isocost line for a specific cost outlay:

\[ C = rK + wL \quad (3) \]

solving equation (3) for \( L \) it yields

\[ L = \frac{(C-rK)}{w} \quad (4) \]

one can see that equation (2) equals equation (4)

\[ \frac{(Brk)}{(aw)} = \frac{(C-rK)}{w} \quad (5) \]
From equation (5) it follows
\[ BrKw + awrk = Caw \]
\[ K(Brw + arw) = Caw \] ............(6)

Solving equation (6) for K it yields
\[ K = (Caw)/(Brw + arw) \] ............(7)
\[ K = (aC)/(r(a+B)) \] ............(8)

If the sum of \(\alpha\) and \(\beta\) are expressed as \(E\), equation (8) can be written as
\[ K = (aC)/(rE) \] ............(9)
where \(E = \alpha + \beta\)

For a given cost outlay \(C\) the optimal point of capital utilization would be: \(K = (\alpha C)/(rE)\) or \(K = (\alpha w)/(BrL)\) and for labour: \(L = (C-rK)/w\) or \(L = (BrK)/(aw)\).

The optimal factor input amounts are determined by equations (8) and (2) and the cost of such an optimal allocation is determined as \(C_0 = rK_0 + wL_0\). A comparison with the actual cost outlay calculated with equation \(C = rK + wL\) and the cost of optimal allocation will indicate if economic waste occurred and by how much (Kleynhans, 1994: 50-51).

**3.10 ECONOMIES OF SCALE**

**3.10.1 RETURNS TO SCALE**

Economies of scale are based on the concept of returns to scale.

In the long-run production process output can be increased by a rising all factor inputs. Factor inputs can be changed by different proportions or by the same proportions. In the traditional production theory the focus is on an increase of all inputs by the same proportion. The law of returns to scale refers to possible effects that scale increases of inputs will have on the output. Where scale increase means that all inputs are
increased by the same percentage. "The returns to scale reflect the responsiveness to total product when all the inputs are increased proportionately" (Samuelson et al., 1989: 503).

To explain it in a mathematical way you increase all inputs by a constant percentage (k) in a production function \( Q = f(K, L) \), you will arrive at a new production with a change in output by a factor \( z \)

\[ zQ = f(kK, kL) \]

(Kousoyannis, 1979: 77, Maurice et al., 1988: 253-254).

One can distinguish between increasing, constant or decreasing returns to scale. Increasing returns to scale occur when \( z > k \). The increase in all inputs leads to a more-than-proportional growth in output. In this case the large scale of inputs will lead to greater productivity of the production factors. If \( z = k \) one speaks of constant returns to scale. This means the output increases by the same proportion as the increase in inputs. In the case of decreasing returns to scale the output rises less-than-the proportional increase of all inputs and \( z \) would be smaller than \( k \) (Samuelson et al., 1989: 503).

In general a production function will first show increasing returns to scale. As output increases more specialised labour and large-scale machinery can be employed. Beyond a certain point in the production process further gains from specialization become limited and co-ordination problems may increase costs. When co-ordination costs more than offset additional benefits of specialisation the production process will show decreasing returns to scale (Pappas et al., 1983: 222).

Returns to scale concern the behaviour of a production function when all inputs change proportionately. They can be demonstrated by a homogeneous production function. The Cobb-Douglas function is homogeneous of the degree \( \alpha + \beta \). Multiplying \( L \) and \( K \) by a positive number \( t \), the Cobb-Douglas production function can be written as
$Q = A(tK)^\alpha (tL)^\beta = At^\alpha K^\alpha L^\beta$

$= t^{\alpha \beta} AK^\alpha L^\beta = t^{\alpha \beta} Q$

When both inputs are multiplied by $t$, the output is multiplied by $t^{\alpha \beta}$. This means the production function is homogeneous of the degree $\alpha + \beta$ (Sher et al., 1981: 98).

The Cobb-Douglas production function exhibits

- constant returns to scale if $\alpha + \beta = 1$
- increasing returns to scale if $\alpha + \beta > 1$
- decreasing returns to scale if $\alpha + \beta < 1$

However, the constant $t$ must be greater than 1 (Sher et al., 1981: 100-101; James et al., 1980: 144).

If $\alpha + \beta > 1$, increasing returns exist since an increase in $K$ and $L$ would increase $dQ/dK$ and $dQ/dL$ respectively. An increase in $\alpha$ will lead to an increase in $dQ/dK = MP_K = \alpha(\Delta K)$ and an increase in $\beta$ will lead to an increase in $dQ/dL = MP_L = \beta(\Delta L)$.

For any value of $\alpha$ and $\beta$ one can examine the offsets on $Q$ changing $K$ and $L$ thus:

$Q = AK^\alpha L^\beta$

therefore $dQ = A\alpha K^{\alpha - 1}L^\beta dK + AK^\alpha \beta L^{\beta - 1} dL$

$dQ = \alpha Q/KdK + \beta Q/LdL$

$dQ = \alpha AP_K = \beta AP_L dL$

(Heathfield, 1971: 35-38).

Before a final conclusion about economies of scale can be made, it must be tested for statistical significance. It must be determined whether the sum of the parameters is significantly less than one by performing the $t$-test. The calculated $t$-value
(in absolute terms) must be compared with the critical value of \( t \). The calculated t-value is:

\[
\text{t}_{\alpha+B} = \frac{((\alpha + \beta) - 1) / (S_{\alpha+B})}{1}
\]

where the value 1 indicates from which the difference is tested, and \( S_{\alpha+B} \) is the estimated standard error of the sum of the estimated coefficients (parameters). To obtain the standard error of \( \alpha + \beta \) the variances and covariances of the regression coefficients are used.

The estimated variance for \( \alpha \) and \( \beta \) is calculated as

\[
\text{Var}(\alpha+\beta) = \text{Var}(\alpha) + \text{Var}(\beta) + 2 \text{Cov}(\alpha, \beta)
\]

the estimated standard error of \( (\alpha+\beta) \) is:

\[
S_{\alpha+B} = \sqrt{\text{Var}(\alpha) + \text{Var}(\beta) + 2 \text{Cov}(\alpha, \beta)}
\]

If the calculated t-value exceeds the critical value, it can be assumed that \( \alpha+\beta \) is significantly greater than one (Maurice, 1988: 125-129).

### ECONOMIES OF SCALE

In the context of the Cobb-Douglas production function economies of scale exist when \( \alpha+\beta > 1 \). If the sum of \( \alpha \) and \( \beta < \) diseconomies of scale prevail. Therefore the question of economies of scale is reduces to the question of the size of \( \alpha+\beta \) (Southwick, 1985: 234).

A specific relation between returns to scale and the shape of the long-run cost curves exists. Under the assumption of constant input prices the average cost curve will decrease with increasing returns to scale. This is referred to as economies of scale. The opposite, diseconomies of scale occur when the average cost curve rises because of decreasing returns to scale (Maurice et al., 1988: 289). A decrease in the average cost hence decreasing prices together with increasing returns to scale will lead to
improved competitiveness in domestic and international markets. A decrease in average costs can be caused by increasing productivity through specialization, division of labour and technological progress. All these factors via increased productivity will reduce unit costs by expanding the scale operation. Also financial reasons for economies of scale exist, such as purchases of large quantities of material (quantity discounts), and financing of large-scale business easier and cheaper (bank loans at lower interest rates and access to security markets) (ibid: 291).

Porter's diamond theory constantly underlines the importance of specialisation and innovation for creating competitive advantages and also the importance of economies of scale.

So far economies of scale have been analyzed under the aspect of the size of production. However, not only the size of output but the cost of output are important with regard to competitiveness. As mentioned earlier the advantage of economies of scale is to reduce the cost per unit produced. Otherwise economies of scale will not lead to improved competitiveness.

The general form of the long-run cost function can be written as follows:

\[ TC = f(Q,w,r) \] \hspace{1cm} (1)

or \[ TC = wL + rK \] \hspace{1cm} (2)

If it is expressed in a power function like the Cobb-Douglas production function it can be expressed as follows

\[ TC = AQ^\gamma w^\delta r^\delta \] \hspace{1cm} (3)

Under the assumption that \( \gamma + \delta = 1 \) a doubling of input prices will double the total cost to produce a given level of output, which is the required characteristic of a cost function. If this
condition is imposed on equation (3) than $\delta = 1 - \gamma$ and it yields

$$TC = AQ^8 w' r^{1-\gamma}$$
$$= AQ^8 w' r^{-r}$$
$$= AQ^8 (w/r)^{r} \quad \ldots \ldots \ldots \ldots (4)$$

To ensure that the total cost is positive and increase when output and input prices increase, the parameters restrictions are $\alpha > 0, \beta > 0$ and $0 < \gamma < 1$. As was the case for the production function this power function can also be converted into logarithms to express it as a linear function. One arrives at

$$\log TC = \log A + \beta \log Q + \gamma \log (w/r) + \log r$$

This equation requires that $\log r$ must equal one. As this equation will be estimated, such a value cannot be guaranteed. To overcome this problem the equation will can be re-arranged as follows:

$$\log TC - \log r = \log A + \beta \log Q + \gamma \log (w/r)$$
$$\log (TC/r) = \log A + \beta \log Q + \gamma \log (w/r)$$

The coefficients $\alpha, \beta$ and $\gamma$ can be estimated. As was the case in the production function $\beta$ and $\gamma$ are elasticities of output. The coefficient $\beta$ is the elasticity of $TC$ with respect to production. Therefore

$$\% \text{change in } TC = \beta \% \text{change in output}$$

or

$$\beta = \% \Delta TC / \% \Delta Q$$

When $\beta > 1$ it means that $TC$ is increasing more than proportionately to output. This means that the average cost would be increasing and diseconomies of scale would prevail. If $\beta < 1$, then $TC$ are increasing proportionately less than output and economies of scale would prevail. The size of the estimated $\beta$ gives an indication of the strength of economies or diseconomies of scale. (Maurice et al., 1995: 424-425).
If capital stock is not increased with an additional number of workers, the marginal product curve will decline in the long-run and average costs will increase, indicating **diseconomies of scale**. An increase in employment together with additional capital to make specialisation of labour possible will lead in the long-run to higher productivity and average costs will decrease, indicating **economies of scale**. Together with specialisation of labour technical progress applied to new machinery and equipment plays an important role for economies of scale as this will also improve productivity. There is also a cost factor involved concerning the purchase of new machinery. The price of a machine producing ten times as much as a smaller one will not cost ten times as much. With expansion of scale operations there will be qualitative and quantitative improvements in new machinery because of innovation and invention through technical progress. Specialisation through education and learning-by-doing of the labour force and division of labour together with technical advances are the two **main reasons** to reduce average costs through expanding scale operations (ibid: 382-384).

4 TECHNICAL PROGRESS

Technical progress through innovation is one of the main determinants (described in chapter II) to create comparative advantages. 'Rivalry' contains technological advancement because competitors making use of advanced technology in their production process are always ahead of their rivals. In order to be competitive in domestic and international markets it is important for firms and/or industries to apply the latest technology available.

In chapter III some measurements of technical progress at the macroeconomic level have been mentioned. Now the effect of technical progress in the production process as such, therefore its relevance on productivity is analysed.

Technical progress in general is achieved through innovations and
can describe several phenomena. It is used to describe the kind of technical improvements which can be capital-saving, labour-saving or neutral. It can be referred to as advancement in technology itself. Like the development of new techniques or the invention of new machinery which will lead to a better performance of the production process. Research, invention and innovation will lead to technical progress (Thirlwall, 1989: 120). Everything that contributes to additional growth in output without any increase in the production factors can be defined as technical progress.

The classification of technical progress owes its origin primarily to the works of Prof. Hicks. "Hick's classification of technical progress takes the concept of MRTS between factors" (Thirlwall, 1989: 120-121). Technical progress shifts the production function upwards and the isoquant downward to its origin. In the case of neutral technical progress the ratio of marginal productivity of factor inputs remains unchanged. As shown in FIGURE 17 the same output can be produced with fewer inputs of both factors; moving from point P to point Q. Or with the same amount of inputs a greater output can be produced.

Source: Thirlwall, 1989: 122
Capital-deepening technical progress can also be called labour-saving. This kind of technical progress raises the marginal product of capital more than that of labour under the assumption that the K/L ratio remains unchanged. The MRTS (MP\textsubscript{L}/MP\textsubscript{K}) decreases in absolute terms. However, because the slope of the isoquant is negative it will increase MRTS. This is illustrated in FIGURE 18.

If one moves from point P to point Q in FIGURE 18, then there is a shift in the isoquant from Y to Y\textsubscript{1} and a shift in the isocost curve from KL to K\textsubscript{1}L\textsubscript{1}, which means that the costs are reduced and the input factors are combined more efficiently. At the same time labour input is reduced from L\textsubscript{2} to L\textsubscript{3}. The production function indicated by Z is shifted upwards.

Another form of technical progress is labour-deepening. It is capital-saving as it raises the marginal product of labour more than that of capital. With a constant K/L ratio MRTS will increase in absolute terms. Given the fact that the ratio of MP\textsubscript{L}/MP\textsubscript{K} is negative the MRTS will fall. This is illustrated in FIGURE 19 (Koutsoyiannis, 1979: 85; Thirlwall, 1989: 121).
FIGURE 19
THE ILLUSTRATION OF LABOUR-DEEPPENING TECHNICAL PROGRESS

![Diagram of Labour-Deepening Technical Progress]

Source: Thirlwall, 1989: 121

It is difficult to prove through empirical evidence that a change in factor proportions is due to a shift in a production function or that the change in factor proportions is due to a change in relative prices.

Another way to explain technical progress is total factor productivity (TFP). Economic theory includes technical progress in the equation for growth. It is the contribution for growth that cannot be attributed to the growth of factor inputs.

TFP is a residual which measures changes in the quality of factor inputs, labour and capital and how changes are applied. In the long-run TFP takes account of improvement in technical progress, labour and entrepreneurial skills and economies of scale. This could be innovation or an improvement in the production process in a way that production factors are used more efficiently. It will contribute to higher productivity of labour and capital and is a broad measure of growth in efficiency that cannot be measured directly by changes in factor inputs.
The National Productivity Institute defines TFP as follows:

\[
A = \frac{Q}{(WL \times L + WK \times K)}
\]

where

- \(Q\) = real output
- \(L\) = employment
- \(K\) = capital stock
- \(WL\) = labour's income share
  = remuneration of employees/total income
- \(WK\) = capital's income share
  = gross operating surplus/total income

therefore \(WK + WL = 1\).

This is the concept of a homogenous production function where the elasticities sum up to 1 (National Productivity Institute, 1995: 168-169). Constant returns to scale are assumed.

5 SUMMARY

The aim of this chapter was to discuss the microeconomic measurement of economic competitiveness.

Productivity was analysed as a major prerequisite of competitiveness, which has its starting point at the manufacturing base. Productivity performance has a major influence on industries' long-term growth performances and indicates the efficiency of input factors, like capital and labour.

A steady rise in productivity that leads to a higher output with a given amount of production factors will create scope for rising compensation of the production factors. This will have a direct impact on the standard of living of employees. Growth in productivity will also lead to higher profits.

Different ways of productivity comparison were discussed. One being the time comparison which indicates if an industry has changed its productivity level. Another comparison is the one of
norm. It addresses the question whether an industry is productive. The third comparison mentioned was the cross-sectional comparison. This analyse whether a firm is more or less productive than its counterparts.

It was explained why the production theory uses a power function, a non-linear function, instead of a linear function. One problem with a linear function, it is not necessary to have two input factors to produce an output. Another problem is that the law of diminishing marginal product is violated. The most frequently used power function for empirical studies is the Cobb-Douglas production function. It can be easily applied to empirical data.

The marginal productivity of capital and labour was analysed in the context of the Cobb-Douglas production function. It was found that the output elasticities for capital (\(\alpha\)) and labour (\(\beta\)) equal the ratio of marginal productivity (MP) to average productivity (AP). This yielded for capital \(\alpha = \frac{MP_K}{AP_K}\) and for labour \(\beta = \frac{MP_L}{AP_L}\). It was established that the Cobb-Douglas production function conforms to the theoretical properties of the production theory.

The marginal rate of technical substitution (MRTS) was analysed as a measurement to determine to what degree the production factors are substituted with each other. In the context of the Cobb-Douglas production function it was defined as 

\[
MRTS = \frac{\beta}{\alpha} \cdot \frac{K}{L}.
\]

The size of the elasticity of substitution (\(\sigma\)) indicates if capital's share to labour's share will change or remain constant.

Factor intensity was analysed as a measure for input ratios. Changes in the factor intensity indicate changes in the capital-labour ratio. In context of the Cobb-Douglas production function factor intensity is measured as the ratio of \(\beta\) to \(\alpha\), namely \(\beta/\alpha\). An increase in the ratio indicates a deepening of capital and a decrease indicates a deepening of labour.

It was shown that apart from the productivity of the production
factors their relevant prices too determine the production level of an industry. The total cost function was stated as \( C = rK + wL \). It was found that in the context of the Cobb-Douglas production function the tangency between an isoquant and isocost curve was defined as \( \alpha wL - \beta rK = 0 \).

As it was stated before the optimal combination of input factors is the ultimate aim for an efficient production process. A firm has two possibilities to achieve this aim. One possibility is to maximise output with a given level of inputs. Under the assumption of given prices for capital and labour the isocost curve is fixed. To solve the cost constraint the Lagrangian multiplier \((\lambda)\) was used. It was found that in the context of the Cobb-Douglas production function the maximum output was achieved when \( (\beta/\alpha)(K/L) = w/r \). The same result was yielded in the approach to minimize cost with a given level of output.

The efficiency criterion \((\psi)\) was discussed as another measurement to establish if optimal combination of inputs exits. The value of the efficiency criterion is calculated as \( \psi = \beta(K/L) - \alpha(w/r) \). It was stated that inputs are combined efficiently when \( \psi = 0 \). In the case of \( \psi<0 \) labour is over-utilized and \( \psi>0 \) capital is over-utilized. This is an important measurement which will be applied to establish if labour and capital in the South African manufacturing industry are combined efficiently.

Another way to measure the optimal factor allocation is the application of input ratios. It was found that production factors are combined efficiently when \( K/L = (\alpha w)/(\beta r) \).

It was found that with a specific budget outlay that the optimal point for capital utilization was \( K = (\alpha C)/(rE) \) with \( E \) being defined as the sum of \( \alpha \) and \( \beta \). The optimal point for labour utilization was found to be \( L = (\beta r K)/(\alpha w) \). A comparison of the actual cost outlay with the cost of optimal allocation will indicate if economic waste occurred.
Returns to scale were analysed as a tool to measure what impact changes in inputs have on the output. In the context of the Cobb-Douglas production function returns to scale are expressed as the sum of $\alpha$ and $\beta$. Increasing returns to scale occur when $\alpha + \beta > 1$. This means that the increase in capital and labour leads to a more-than-proportional growth in output. If $\alpha + \beta = 1$ constant returns to scale prevail; the output increases by the same proportion as the increase in $\alpha$ and $\beta$. Decreasing returns to scale occur when $\alpha + \beta < 1$; meaning that the output rises less-than-the proportional increase in capital and labour.

It was demonstrated that a specific relationship between returns to scale and the long-run cost curves exists. Economies of scale prevail when with increasing returns to scale the average cost curve decreases. Diseconomies of scale occur when the average cost curve rises because of decreasing returns to scale. This is an important measurement with regard to competitiveness as economies of scale indicate a gain in competitiveness because of declining average costs. It was shown that in the long-run cost function expressed as a power function the coefficient $\beta$ is the elasticity of total cost with respect to the production. If $\beta < 1$ TC are increasing proportionately less than output and economies of scale prevail. It was found that $\beta = \%^{\Delta TC}/\%^{\Delta Q}$. This technique will be applied to establish if the South African manufacturing industry indicates economies of scale.

The importance of technical progress was outlined in the previous chapter on a macroeconomic level. Technical progress is equally important on a microeconomic level and is a measure to establish variations in the efficiency of the production process. Three different kinds of technical progress were discussed. Neutral technical progress achieves a greater output with the same amount of production factors. Capital deepening technical progress will lead to a saving of labour input. Another form of technical progress which was discussed was labour-deepening. This will lead to a saving of capital.
A technique used by the National Productivity Institute to explain technical progress is the calculation of total factor productivity. This is the residual in the calculation for growth which cannot be attributed to the growth of factor inputs. In this calculation the elasticities of capital and labour sum up to 1. This means that constant returns to scale are assumed.
CHAPTER V

QUANTITATIVE ANALYSIS OF THE LEVEL OF ECONOMIC COMPETITIVENESS: A MACROECONOMIC PERSPECTIVE

1 INTRODUCTION

The aim of this chapter is to compare the international competitiveness level of South Africa with its major trading partners at a macroeconomic level.

The chapter will also explore reasons for the poor performance of the South African manufacturing industry compared with its main competitors. According to the South African Reserve Bank the United States, Japan, Germany and the United Kingdom are South Africa's major trading partners. The total trade in 1995 between South Africa and Japan was 15% of its total, Germany 11% and the United States 6%. South Africa not only competes against these countries, but also East Asian countries such as Taiwan, Malaysia and Korea which are important competitors for South Africa as well as Latin American countries. It was difficult to obtain relevant data for East Asian and South American countries therefore Korea and Chile were chosen. The performances of these countries will be used as a benchmark for the determination of the level of international competitiveness of the South African manufacturing industry.

It will be analysed what significance research and development has in South Africa compared to its competitors. In order to establish a level of comparison several measurements will be applied.

As it was stated before savings are necessary to finance investment. Therefore, the level of savings of the South African economy will be established to see how this matches with the
level of savings of South Africa's competitors. The accumulation of physical capital through investment is one of the major factors of stimulating output growth. Therefore, it will be necessary to compare the investment level of South Africa's manufacturing industry with those of its competitors. The results will indicate whether enough investment is taking place in the South African manufacturing industry in contrast to its competitors. Furthermore, a comparison of the level of the South African manufacturing industry's capital and that of its competitors will be applied.

Apart from physical capital, human capital plays a major role to enhance output growth. In order to make conclusions about the level of South Africa's human capital, differences between South Africa's education level and that of its competitors will be established.

Not only savings, investment in physical and human capital determine the level of international competitiveness but also trade policies, terms of trade and the real effective exchange rate impact on the level of international competitiveness. It will be shown how these determinants influence the level of international competitiveness in South Africa and in the countries of its competitors.

Finally, export growth and growth in export market shares will be applied as measurements for the level of South Africa's manufacturing visa-vie its competitors.

2 RESEARCH AND DEVELOPMENT (R&D)

As discussed in chapter III the outcome of R&D can be either the substitution of old products for new ones or to supplement old ones. Another result of R&D is learning-by-doing which can upgrade existing goods and services (Wefa Group, 1996: 26). This can lead to economies of scale as a result of taking advantage
of higher capital and labour productivity and more efficient ways in managing the production process.

A broad measurement at the macro-economic level is R&D expenditure as a percentage of total GDP. In 1993 the United States spent 2.8% of GDP for R&D, Germany 2.5%, Japan 3.0%, Korea 2.1% and for Chile 0.79%. South Africa spent a mere 0.7% of GDP for R&D (World Economic Forum, 1995: 651). This does not compare well with the other countries except for Chile. An alternative way to view the importance of R&D is the real growth in total expenditure on R&D.

| TABLE 7 |
| REAL GROWTH IN TOTAL EXPENDITURE ON R&D |
| (annual real compound percentage growth) |
|    USA   | Germany | Japan | Korea | Chile | South Africa |
| 1989-93 | 0.2     | 1.0   | 4.2   | 11.5  | 0.8         | -3.3         |


The table above indicates that Korea as a newly industrialised country is trying to catch up with the industrial countries. Japan's growth is substantially higher than those of Germany and the United States. The negative growth rate of -3.3% for South Africa confirms that it is lagging behind. A drawback of this measurement is that in most countries a large part of government financed R&D expenditure is spent on security, defense or health. Therefore it is less stimulative for productivity gains with regard to industries (OECD, United States, 1993: 84). The South African R&D has been directed mainly towards defense and energy. The synfuel technology developed by Sasol has certainly been a substantial technological achievement (Wefa Group, 1996: 26-27). This only benefits the domestic market. However, what is important is the development of products for world markets at competitive prices.
A better indication of R&D importance for industries is the real growth in business R&D expenditure as shown below. R&D done by business itself is more valuable as it is directed specifically to develop new products and production processes for the industry. Its importance can be measured by the intensity ratios which are the ratios of R&D performed by business to the gross output of business.

### TABLE 8

**REAL GROWTH IN BUSINESS R&D EXPENDITURE**  
(annual real compound percentage growth)

<table>
<thead>
<tr>
<th></th>
<th>USA</th>
<th>Germany</th>
<th>Japan</th>
<th>Korea</th>
<th>Chile</th>
<th>South Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989-93</td>
<td>-1,1</td>
<td>-0,2</td>
<td>4,7</td>
<td>9,7</td>
<td>16,7</td>
<td>7,6</td>
</tr>
</tbody>
</table>


Here the trend between Germany, the States and Asia is moving in opposite direction with the former showing negative growth rates and the later showing highly positive growth rates. The extremely high growth rate for Chile is very surprising. Here South Africa shows a better position compared to the other countries and is close to Korea's growth rate. This indicates that business is trying to develop new technology and new products.

The importance of R&D to achieve further technical progress is also highlighted by the fact that leading world companies spend a large portion of their sales for R&D, for example 11% spent by Siemens, 7,4% by Kodak and 6,3% by Xerox (Productivity Focus, 1996: 27). Leading Japanese equipment manufacturers, like Hitachi, Mitsubishi, Sony and Fuji, spent between 5,6% and 7,2% of their sales on R&D. South African corporations spent only 1% of their sales on R&D (Productivity Focus, 1996: 27). This is clearly not enough to develop new products or new technologies to raise the competitiveness level. The South African manufacturing industry should focus in a direction where it can develop a competitive advantage in export markets (Productivity
Together with industrial development structural changes within the manufacturing sector do occur. These are characterised by a shift from labour intensive, low-technology and resource based industries to medium and high-technology and scale based industries (Wefa Group, 1996: 26). FIGURE 20 illustrate the importance of R&D especially for high technology.

**FIGURE 20**
R&D INTENSITY RATIOS OF INDUSTRIALISED COUNTRIES IN THE MANUFACTURING SECTOR

<table>
<thead>
<tr>
<th>Country</th>
<th>Total Manufacturing</th>
<th>High Technology</th>
<th>Medium Technology</th>
<th>Low Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>9%</td>
<td>3%</td>
<td>5%</td>
<td>1%</td>
</tr>
<tr>
<td>Germany</td>
<td>6%</td>
<td>2%</td>
<td>4%</td>
<td>2%</td>
</tr>
<tr>
<td>Japan</td>
<td>4%</td>
<td>1%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>3%</td>
<td>1%</td>
<td>2%</td>
<td>1%</td>
</tr>
</tbody>
</table>

Source: OECD, United States, 1993: 88

Although there is an increase in R&D expenditure in the United States the other countries' expenditure grew at a faster rate. They are catching up with the United States through faster investment growth. As it is indicated in FIGURE 21 the United States is still the world's technological leader even if its leading position has declined in recent decades.

The United States share in R&D for high technology declined from over 60% in 1973 to about 54% in 1990. This was primarily to the benefit of Japan which increased its share from 10% in 1973 to nearly 20% in 1990 (OECD, United States, 1993: 84).
The fact that South Africa is lagging behind its competitors in its R&D expenditure, has a negative impact on the development of productivity and the level of competitiveness of its manufacturing industry. It can be seen as one reason for the low productivity level which will be analysed in another chapter.

3 SAVINGS AS A DETERMINANT OF INVESTMENT

In chapter III the importance of investment was highlighted. This must be financed by savings. Between 1960 and 1990 savings as well as investments in the High-performing Asian economies recorded high growth rates. In 1976 the savings rate in the developing High-performing Asian economies were lower than in Latin America. But by 1990 they exceeded Latin America's savings rate by almost 20%. A similar trend is recorded for investments. In 1965 investment levels were about the same in Latin America and East Asia. By 1990 East Asia's investment rates had nearly doubled the average for Latin America (World Bank, 1993: 41). High savings and high investment have resulted in high economic growth. This has led to high income growth in Asia which in turn has produced further high savings. These high savings were
transformed into further high productive investments creating a virtuous circle (James Capel, 1996: 59). Growth, savings and investment interacted in a virtuous circle as high investment initially spurred growth, which resulted in increased savings to support continued high investment (World Bank, 1993: 221-222).

In the case of Chile gross fixed capital formation has increased from 17% of GDP in 1986 to 26% of GDP in 1994. Domestic savings recorded considerable growth during this period from 11% of GDP in 1986 to 25% of GDP in 1994 (Speech by Roberto Zahler, 1995: 5).

In contrast to high saving rates in East Asia the savings rate in the United States plunged in the 1980's by 3,5% relative to the 1970's average. However, capital investment was sustained through foreign borrowing during this period and fell only by 0,5% to 6,5% of national income (OECD, United States, 1993: 65).

As it has been discussed before investment must be financed by
savings. The gross domestic saving as a percentage of GDP in South Africa is very low as FIGURE 22 shows. The development of South Africa's savings do not compare well with the successful economies in East Asia where domestic savings account for 30% to 40% of GDP.

If a country does not save enough itself to finance its investments it needs to borrow foreign funds or to attract foreign direct investment. In South Africa political uncertainty discouraged foreign investment. Government is responsible for encouraging private savings by creating the right basis. Private sector savings are penalised by high taxes from government to municipal taxes which destroy any savings drive (F&T, weekly, 18.10. 1996: 16). Dissaving of government takes away investment opportunities. In South Africa the consumption level both for government and the private sector is far too high. High savings will lead to high investment and that in turn will create economic growth. This will allow a higher consumption level. For South Africa it is of vital importance that the savings level will rise in order to have a good basis for growth in investments.

4 INVESTMENT IN PHYSICAL CAPITAL AS A DETERMINANT OF CAPITAL STOCK

Accumulation of physical capital through investment is one of the major means of stimulating output growth. Apart from the quantitative growth the qualitative growth of investment gains more and more importance in a world of high technology and constantly rising competition as was discussed in chapter II. The latter is also important for gains in capital productivity as only quantitative growth can lead to diminishing returns, thus a decline in capital productivity at a later stage of industrial development. Investment in physical capital is one way of raising labour productivity. If the workforce is provided with more and better machinery each hour of work will produce more than it previously did (National Productivity Institute, 1996: 22).
According to the above table growth in real investment slowed down dramatically in the United States during the period from 1986 to 1990. One reason could be that there was sufficient unused capacity which was built-up during the previous period of 1980 to 1985.

Investment levels for Japan increased drastically during the period from 1986 to 1990 after the recession from the late 1970's to the early 1980's. This corresponds well with the higher GDP growth during 1986 to 1990. The lower growth rate during 1991 to 1995 is in line with low economic growth during the first half of the 1990's.

In Germany the low growth of investment during the period 1980 to 1985 reflects the effects of the recession during the early 1980's. During the recovery in the 1980's investment growth regained most of the downturn and was still on a firm upward

### TABLE 9

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>3.7</td>
<td>0.6</td>
<td>4.3</td>
</tr>
<tr>
<td>Japan</td>
<td>6.4</td>
<td>10.1</td>
<td>6.2</td>
</tr>
<tr>
<td>Germany</td>
<td>0.6</td>
<td>6.2</td>
<td>-0.1</td>
</tr>
<tr>
<td>South Africa</td>
<td>6.4</td>
<td>-0.2</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Source: For the United States, Japan and Germany it is private non-residential fixed capital formation, OECD Economic Outlook, June 1996.
For South Africa it is real fixed capital stock for the Manufacturing sector, South African Reserve Bank, Quarterly Bulletin, December 1996
trend. The main reason for Germany's high average growth rate in investment during the period 1986 to 1990 was the recovery and the anticipation of reunification. In 1991 the ratio of private non-residential investment to GDP reached its highest level in German post-war history. The negative growth in the period from 1991 to 1995 is in line with the weakening in economic growth which started in 1992 and reached its lowest point in 1993. It has been argued that the low level of business investment in recent years is a correction of the rapid build-up of capital stock which took place immediately after the reunification. This could point to a certain degree of 'over-investment' which is being corrected (OECD, Germany, 1996: 13-14).

FIGURE 23
REAL GROSS NON-RESIDENTIAL FIXED CAPITAL FORMATION

![Graph showing real gross non-residential fixed capital formation for Japan, Germany, and the United States from 1978 to 1995.]

Source: Data from OECD, Economic Outlook, June 1996

The above figure shows constantly increasing investment levels in Japan until 1991. One can conclude that the age of capital decreased significantly from 1987 to 1991 reflecting higher capital efficiency which leads to higher capital productivity since investment and the age of capital have an inverse
correlation. As opposed to Japan's investment levels those of the United States and Germany remained relatively flat which indicates that the overall level of the age of capital stock did not change to a great degree. In the United States the trend changed from 1992 indicating an increase in the efficiency of capital stock. This is in line with the development in R&D share as discussed in a previous paragraph.

Following the 1990-91 recession, the American economy recorded an upswing marked by a very strong investment effort as can be seen in the growth of capital stock illustrated in the graph below. The American investment has been adjusted by information technology investment that has a working life that is much shorter than traditional types of investment. The decision to scrap technology investment is based substantially more on the degree of technical obsolescence than on the physical wear and tear of the equipment (Banque Indosuez, 1996b: 68).
Since the second half of the 1980's Japan has been engaged in a sharp rise in investment which produced a rate of growth in capital stock from 5% to 7% per annum. As FIGURE 24 illustrates the absorption of excess capacity lasted until 1993 reflecting a decline in growth of capital stock. The last two years showed an increase with a gradual return to growth. In Germany the capital stock followed a similar development to that of Japan, but of a much smaller amplitude. German unification failed to prevent a downward adjustment in capital stock continuing until the 1993 recession. The level of productive investment during the brief recovery seen in 1994-1995 was insufficient to produce any real acceleration in the growth of capital stock with rises of only 1% in Germany (Banque Indosuez, 1996b: 68).

FIGURE 25 depicts movements in investment demand of the manufacturing industry over the last twenty-two years.

![FIGURE 25](image)

The overall trend in manufacturing investment is demand driven but has been strongly influenced by strategic considerations and exogenous shocks. During the 1970's investment was buoyant in the South African manufacturing industry. It was encouraged by the gold
boom and acceleration of other commodity prices as well as by generous tax incentives and low (sometimes negative) real interest rates. The sharp decline in investment growth from 1982 to 1985 was due to the end of large minerals-related investments in chemicals and iron and steel industries and external shocks like the slowdown in world trade and a deterioration of the terms of trade. From 1985 financial sanctions dampened investment further and low investment levels continued during the second half of the 1980's and the beginning of the 1990's as political and economic uncertainty increased (Fallon et al., 1994: 274-276). Investment in the manufacturing sector has been too concentrated on mineral commodities and related industries whose performance is influenced by the commodity cycle. It missed investments towards higher technology-intensive industries which are competitive on world markets. A low investment level bodes ill for efficient capital stock leading to low capital productivity where the age of capital was discussed.

The key engine behind Asia's economic expansion was the high investment level. In 1991 to 1995 gross investment rates averaged 35% per annum in Korea (James Capel, 1996: 59). The share of private investment is remarkably high in the High-performing Asian economies (HPAEs). It is about 7% higher than in other middle-income countries. From a level of 15% of GDP in 1970 it rose to nearly 22% in 1974 and remained at about 18% between 1975 and 1984. The contraction to 15% between 1984 to 1986 reflects the impact of the global recession. By 1988 it had recovered to about 19% (World Bank, 1993: 42-43). The investment level in Korea is very high. As a share in GNP investment had reached in 1980 30% and remained at these levels until 1988. From 1989 it increased further and reached nearly 40% in 1991 (OECD, Korea, 1994: 48). This indicates that investment was a strong driving force for the high economic growth rates in Korea. FIGURE 26 below confirms high growth in investment for Korea. Chile shows a similar trend.
5 INVESTMENTS IN HUMAN CAPITAL

A country's industrial performance in an economic sense and its competitiveness is very much dependant on human resources. High technical equipment in machinery and the latest technical advancement do not guarantee a high level of competitiveness without a highly educated workforce.

As mentioned in chapter III a broad measurement for investment in human capital is government expenditure in education as a percentage of total expenditure.
As one can see from the above table the industrialised countries spent more on education in the 1970's which followed a decline of 30% in the United States during the 1980's and stabilised around these levels in the 1990's. The decline in Germany was nearly 50% in the 1980's and also stabilised in the 1990's. Korea shows a high percentage of total government expenditure allocated to education which indicates a catching-up towards a more skilled labour force. In the case of Chile, government expenditure on education was very high but declined quite rapidly in the 1980's and stabilised at a level well below that of Korea.

The World Competitiveness Report of 1995 quotes data in US$ per capita spent on education per capita. In 1992 the United States spent US$ 1172 followed by Japan with US$ 1113, Germany US$ 767, Korea US$ 294 and South Africa US$ 181. The reason for South Africa's low level can be explained by the fast growing school-age population in contrast to a slow or even declining one in the other countries.

Higher shares of government expenditure devoted to education do not necessarily explain the larger accumulation of human capital. A
major policy factor is the allocation of public expenditure between basic and higher education. In East Asia the expenditure allocated to basic education has been constantly higher than elsewhere. In 1985 Korea allocated 83.9% of its education budget to basic education in comparison to 31.0% in Venezuela (World Bank, 1993: 199). This might explain the fact that although Chile's government expenditure was very high, Chile did not perform as well as Korea.

The relatively low expenditure pattern for the United States and Germany could be explained by the declining or slowly growing school-age population. In this case, the same expenditure as a percentage of GDP can give more schooling or better quality. Alternatively, current standards can be maintained with a cut in expenditure as a proportion of GDP (ibid: 194).

A constant share of GDP allocated to education with a smaller school-age population can double the resources available for education (ibid: 193-194).

A better measurement than that of government expenditure on education is the level of school enrolment at different levels over the years. TABLE 11 shows the developments in school enrolments for different countries.

Primary school enrolment data are estimates of the ratio of children of all ages enrolled in primary school to the country's population of school-age children. The reason for exceeding 100% is that some pupils are younger or older than the country's standard primary school age (World Development Report, notes to tables).

All countries in the above table have universal primary education because the ratios are either around 100% or above 100%.
TABLE 11
PRIMARY EDUCATION
number enrolled in school as percentage of age group

<table>
<thead>
<tr>
<th>Country</th>
<th>1965</th>
<th>1984</th>
<th>1992</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>118</td>
<td>101</td>
<td>104</td>
</tr>
<tr>
<td>Germany</td>
<td>133 (1960)</td>
<td>99</td>
<td>107</td>
</tr>
<tr>
<td>Japan</td>
<td>100</td>
<td>100</td>
<td>102</td>
</tr>
<tr>
<td>Korea</td>
<td>101</td>
<td>99</td>
<td>105</td>
</tr>
<tr>
<td>Chile</td>
<td>124</td>
<td>107</td>
<td>96</td>
</tr>
</tbody>
</table>


Compared with the other countries South African education at the primary level reached that of universal education only in 1970. However, it remains a question whether these data published by the World Development Bank also include the black population.

Secondary school enrolment data are calculated in the same way as the primary ones. Secondary education was already very high in the United States during the 1960's and reached nearly a universal education level in the 1980's. The same applies for Japan. The development in Germany started from a much lower level but doubled its ratio from 1965 to 1992, when it reached the universal education level. One explanation could be that pupils who became craftsmen only needed primary education in the 1960's and 1970's. From the 1980's it became more important to have higher education. Korea shows a large increase from relatively low levels in the 1960's to 1980's, which shows the evidence of a superior education system. An imperfect though common measure of educational quality is the expenditure per pupil. In Korea real expenditure per pupil rose by 335% between 1970 and 1989 in comparison to Mexico where expenditures rose by 64% during the same period (World Bank, 1993: 132)
### TABLE 12
SECONDARY EDUCATION

<table>
<thead>
<tr>
<th></th>
<th>1965</th>
<th>1984</th>
<th>1992</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>86 (1960)</td>
<td>95</td>
<td>98 (male in 1993)</td>
</tr>
<tr>
<td>Germany</td>
<td>53 (1960)</td>
<td>74</td>
<td>101 (male in 1993)</td>
</tr>
<tr>
<td>Japan</td>
<td>82</td>
<td>95</td>
<td>95 (male in 1993)</td>
</tr>
<tr>
<td>Korea</td>
<td>35</td>
<td>91</td>
<td>90</td>
</tr>
<tr>
<td>Chile</td>
<td>34</td>
<td>66</td>
<td>72</td>
</tr>
</tbody>
</table>

**Source:** World Development Reports 1987, 1995 and 1996

According to the World Competitiveness Report of 1995 the secondary school enrolment for South Africa in 1991 was 69% which was relatively low compared with the other countries.

### TABLE 13
TERTIARY EDUCATION

<table>
<thead>
<tr>
<th></th>
<th>1965</th>
<th>1984</th>
<th>1992</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>40</td>
<td>57</td>
<td>76</td>
</tr>
<tr>
<td>Germany</td>
<td>9</td>
<td>29</td>
<td>36</td>
</tr>
<tr>
<td>Japan</td>
<td>13</td>
<td>30</td>
<td>32</td>
</tr>
<tr>
<td>Korea</td>
<td>6</td>
<td>26</td>
<td>42</td>
</tr>
<tr>
<td>Chile</td>
<td>6</td>
<td>15</td>
<td>23</td>
</tr>
<tr>
<td>South Africa</td>
<td>4</td>
<td></td>
<td>14</td>
</tr>
</tbody>
</table>

**Source:** World Development Reports 1987, 1995 and 1996
The tertiary enrolment ratio is calculated by dividing the number of students enrolled in all post-secondary schools and universities by the population in the 20 to 24 age group (World Development Reports, notes to tables).

Tertiary education in the United States increased from 40% in 1965 to 76% in 1992 and has the highest level of all five countries in the above table. In Germany, coming from a low level in 1965, the tertiary education was only half that of the United States in 1992. Japan shows a similar pattern. Korea recorded the same increase as the United States. As it started from a much lower level it is still well below the United States. The growth in Chile was the lowest of the five countries and shows that Chile is falling behind Korea although both countries were at the same level in 1965.

The growth in South Africa's tertiary education level was even lower than that of Chile; increasing only by 10% within 27 years. This indicates that the number of highly skilled people has not increased to a large extent. In today's world with fast advancing technology a highly skilled labour force is significant to build competitive advantages for firms/industries.

FIGURE 27 shows that 35% had either no education or one below standard 4. This indicates that the formal education system is inadequate. This stands in contrast to the amount allocated in the budget as discussed earlier (National Productivity Institute, 1996: 25). The question arises whether the monies spent on education are used optimally or if big proportions are spent on higher education.

In a recent article published by The Economist a comparison was shown of the level of thirteen-year old students in maths and science. South Africa ranked at the bottom of the list of 41 countries for maths as well as for science. Singapore and Korea were shown a the first and second place for maths. In the case of science Singapore was again on the first place and Korea on the fourth place.
FIGURE 27
FORMAL EDUCATION OF ECONOMICALLY ACTIVE POPULATION:
1991

![Bar chart showing formal education levels in millions for 1991.]

Source: National Productivity Institute, 1996: 24

FIGURE 28 illustrates that because of the low number of average school years in South Africa, primary education is not very good. This also gives an indication that too little is spent on primary education. However, as it has been pointed out in this chapter it is important especially for a country like South Africa to concentrate on primary education to integrate young people into the production process (this was also a reason why Korea was so successful).
All kinds of education are important for the build-up of a well equipped labour force with the aim to increase its productivity level. The need for advanced technical education rises with the increasing level of technical sophistication of industries. In Korea more than 50% of students enrolled at universities to study science and engineering. Developing countries with high productivity growth place much emphasis on vocational training (National Productivity Institute, 1996: 27).

Not only is the government responsible for education and training, but also firms and industries are responsible to equip unskilled and semi-skilled workers through intensive in-house training with skills that will be needed for future jobs. The mix of technical education especially must be created to match the requirements of industries with a high technological background (Wefa Group, 1996: 23). Even in labour intensive industries innovations on the shop floor which are responsible for a major share of productivity growth in the manufacturing sector demand higher- and lower-level skills. A good example is Korea where this kind of training was the underlying factor to start a successful export drive (World Bank, 1993: 200).
Human resources in South Africa are inadequate to form the basis of higher labour productivity. Poor basic skills are evident in the low level of literacy as was illustrated in FIGURE 28. The low proportion of the work-force trained to artisan levels is a huge problem. As discussed in this chapter firms are responsible to train their work-force. On the job-training becomes very important to raise the level of education. In comparison to OECD countries where firms spent 4% to 7% of their payroll on training South African firms spent 3.3% of the total amount of wages and salaries on training (Joffe et al., 1995: 85; Nedlac, 1997: 11). This indicates that South African corporations are realising the importance of human capital.

It has been pointed out at numerous occasions that growth in capital and labour productivity stem from technical progress and better quality of labour through education and training. An excellent education system and high levels of education are major reasons why Korea was so successful. There is a strong correlation between education and labour productivity since machinery equipped with high technology needs educated workers or technicians to operate them (National Productivity Institute, 1996: 24).

TABLE 14 illustrates the gap between secondary and tertiary education.

<table>
<thead>
<tr>
<th></th>
<th>1985</th>
<th>1987</th>
<th>1989</th>
<th>1991</th>
<th>1993</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technicons</td>
<td>0.5</td>
<td>0.8</td>
<td>1.0</td>
<td>1.3</td>
<td>1.5</td>
</tr>
<tr>
<td>Universities</td>
<td>3.2</td>
<td>3.4</td>
<td>3.6</td>
<td>3.6</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Source: Central Statistical Year Book, 1994
The trend over the years from 1985 to 1993 illustrates that more pupils are enrolled at universities than at technicons although it seems that technicon attendance is increasing. However university education was still more than double of that of technicons in 1993. More emphasis should be put on education at technicons to develop a broader workforce as technicon education is more job related than university education.

Skill accumulation in South Africa has been inadequate with a growing imbalance between the stock of physical and human capital. Improvement of skills of the workforce raises total factor productivity growth and offsets the decline in capital productivity that tends to follow rapid investments (Fallon et al., 1994: 65).

6 FACTORS INFLUENCING EXPORT PERFORMANCE

On the macro-economic level exchange rates and prices which are determined to a large extent by the productivity performance influence the level of competitiveness. At the microeconomic level unit labour costs have a big impact on the level of competitiveness.

Apart from productivity performance and cost of production factors, international competitiveness is also influenced by exchange rates, terms of trade, an overall price level expressed by inflation and trade and economic policies.

6.1 TRADE AND ECONOMIC POLICIES

Until the mid-1950's South Africa's trade and industry policies used protection to encourage substitution of imports of consumer goods. Instead of opting for export promotion later on South Africa chose to deepen import substitution (Fallon et al., 1994: 75). From 1972 to 1983 the growth of the manufacturing sector of 50,1% was mainly
due to the expansion in domestic demand of 44.6%. The drastic decline of domestic demand from 1983 to 1990 to a mere 1.6% reduced output growth to a meagre 3.5% (ibid: 77). The complex protection system of quantitative restrictions, customs duties and import surcharges was primarily aimed at supporting import substitution. From 1980 a more powerful system of export incentives was introduced with a lower tariff level and the relaxation of import permits. However, the system remained still biased against exports (ibid: 81). Anti export bias through protection allows firms to raise prices in domestic markets above those prevailing under free trade conditions. Furthermore production costs of imported inputs are artificially high which makes exporting firms less competitive on international markets. South African manufacturers are especially dependent to a large extent on the importation of capital goods for their production process.

A general export incentive scheme (GEIS) was started in 1990. It was designed to help offsetting the price disadvantage which South African exporters faced on international markets. "GEIS provides tax-free financial subsidies to an exporter based on the value of exports, the degree of processing and the local content of the exported product" (ibid: 86). A study done by the South African Chamber of Business found that South African manufacturers costs 15% higher than the OECD average. Reasons are that South African manufacturers pay 24% more for their inputs than their OECD counterparts and their capital and productivity adjusted labour costs are higher (ibid: 85).

The advantage of export-led growth can be illustrated by the example of Korea. After import substitution ran out of steam, Korea's primary goal for economic policies was export expansion in the 1960's. Exporters were allowed to retain foreign exchange earnings for the purchase of imports. This was not the case in South Africa because of exchange control. Korean exporters were supported by direct cash payments and were exempted from import controls and tariffs. The state-controlled banking system gave exporters
preferential rates. In addition to this government in consultation with companies, set export targets (OECD, Korea, 1994: 18).

6.2 TERMS OF TRADE

As discussed in chapter III terms of trade measure export prices in relation to import prices. With an increase in the terms of trade and constant export, volumes earnings from exports will increase. Terms of trade can be used as a measurement for international competitiveness because a rise in export prices above world levels which will increase the terms of trade, means a loss in competitiveness (Finance & Development, Sept. 1995: 48).

| TABLE 15 |
| TerMS OF TRADE FOR THE SOUTH AFRICAN MANUFACTURING INDUSTRY |
| | annual average growth |
| | 1972-79 | 1980-88 | 1990-93 |
| Export prices | 14.9 | 13.4 | 7.1 |
| Import prices | 17.6 | 13.6 | 4.0 |
| Terms of trade | -2.2 | -0.2 | 2.9 |

Source: Data from the Industrial Development Corporation

The decline in the terms of trade during the 1970's indicates an increase in competitiveness. This conforms with the rise of exports as a percentage of production from 9% to 11%. The 1980's average growth in terms of trade was virtually unchanged and exports as a percentage of production fell to 7% in 1982/83 and reached 10% of total production only in 1989. The rise of terms of trade during the early 1990's should indicate a loss in competitiveness. However, exports as a ratio to production, rose to 12% in 1993. This seems to be contradictory but the increase in the export ratio can be
attributed to lower domestic demand during the recession and developments in the exchange rate. The growth in the terms of trade during this period also points to the fact that productivity was not rising fast enough to avoid a rise in export prices, or manufacturers increased their profit margin.

6.3 THE REAL EFFECTIVE EXCHANGE RATE AS A MEASUREMENT OF INTERNATIONAL COMPETITIVENESS

Movements in currencies have a major impact on the competitiveness of manufacturing exports in different economies. This impact can be assessed by looking at the movement of the nominal effective exchange rate. It is calculated as the average against those of its trading partners, weighted by the share of each partner in the country's total trade. This measures the impact of exchange rate movements providing other factors remain equal. However, the influence on competitiveness through the variation of exchange rates between two countries can vary because it depends on whether or not these movements are offset by differences in changing prices. A country with lower inflation does not necessarily lose competitiveness when its currency is appreciating. Taking this into consideration the nominal effective exchange is adjusted for changes in prices or costs, the result being the real effective exchange rate (Banque Undosuez, 1996b: 64). The calculation to adjust for changes in prices is done by calculating purchasing power parity as was explained in chapter III. This takes account of the variation in productivity. However, it must be pointed out that price-competitiveness is one factor in an industry's overall competitiveness level. Calculations of costs and prices are based on 'baskets' of representative goods at a certain point in time. Through changes in the composition of output and demand, biases are introduced, especially for calculations of export prices (ibid: 64).

Apart from productivity changes, costs of production factor movements in the rand against the currencies of its competitors are
a major factor influencing the level of international competitiveness of the South African manufacturing industry. The South African Reserve Bank calculates the nominal effective exchange rate as a result of a basket of South Africa's four major trading partners, the United States, the United Kingdom, Germany and Japan. The fact that the rand is appropriately valued, overvalued or undervalued determines to a large extent the export performance of the South African manufacturing industry. The successful economies of East Asia achieved their high growth through exports and kept their currencies internationally competitive. For example Korea underpinned its export promotion in the 1960's through the devaluation of its currency (OECD, Korea, 1994: 18).

6.3.1 SOUTH AFRICA'S INTERNATIONAL LEVEL OF COMPETITIVENESS MEASURED BY THE REAL EFFECTIVE RAND EXCHANGE RATE

During the last decades the rand has been affected by numerous external factors; such as exchange controls, huge fluctuations in the gold price and other commodity prices, extreme variations in capital flows and the need to keep the current account in surplus in order to repay foreign debt since the moratorium in 1985 (South Africa Foundation, 1996: 115).

The nominal effective exchange rate is not a good measurement for the level of competitiveness as it only takes movements in the rand as a price into consideration. A depreciation in the nominal effective exchange rate will benefit exporters as their prices expressed in other currencies will decline. However, a weak nominal effective exchange rate causes imports to become more expensive. This in turn puts upward pressure on domestic inflation and the initial benefits for exporters will be wiped out. A better measurement is the real effective exchange rate which is the nominal effective exchange rate adjusted by price differentials between South Africa and its trading partners.
The South African Reserve Bank calculates the real effective exchange rate of the rand by adjusting it with changes in the producer price index. The graph below depicts changes over the last 25 years.

**FIGURE 29**

THE REAL EFFECTIVE RAND EXCHANGE RATE
adjusted by producer price index

The constant increase until 1983 was driven largely by gold and commodity prices. The steep fall in 1984 and 1985 reflects the collapse of the rand in nominal terms caused by trade and financial sanctions. This led to high inflationary pressures. It recovered quickly during 1986 and 1987. From there on it stayed on average at the same level. It is argued that this kind of measurement is adequate as it also measures prices of non-tradeable goods. This tends to be imprecise and really comparable across countries which make competitiveness comparisons less indicative of prices faced by manufacturers. A better measurement is the nominal effective exchange rate adjusted by terms of trade of manufacturing. However, this measure can be distorted if manufacturers change their profit margins hence pushing their prices either upward or downwards.
Therefore an export based real effective exchange rate does not provide sufficient information on the long-term profitability of South African producers relative to their foreign competitors. A more direct measure is the nominal effective exchange rate adjusted by unit labour costs. This has the advantage of being defined in a similar way across countries. However, according to the definition, average labour costs are measured. A more correct way would be marginal unit labour costs to show incentives for labour allocation in South Africa and its trading partners. These calculations are not possible because of the unavailability of data. Nevertheless average unit labour costs take account of productivity change in labour input.

The graph above compares the three measurements discussed previously. According to the South African Reserve Bank's measure the real effective rand fluctuated around the 100 mark level meaning that it was in a state of equilibrium for most of the years. The real effective rand adjusted by manufacturing prices appreciated by
roughly 33% or had a loss in competitiveness of a quarter from the equilibrium. Consequently profit margins of manufacturers must have dropped immensely and discouraged investment in export-orientated industries (South Africa Foundation, 1996: 118). An even worse picture shows the development of the real effective rand adjusted by manufacturing unit labour costs. It rose steadily from a low in 1985 until it reached a peak in 1992. The decline from 1992 until 1994 coincides with the recession. Since then upward pressure resumed. It moved from gains in competitiveness to a loss in competitiveness.

In the following paragraphs the competitiveness level according to real effective exchange rates of some of South Africa's competitors will be analysed.

### 6.3.2 THE UNITED STATES'S LEVEL OF INTERNATIONAL COMPETITIVENESS MEASURED BY THE REAL EFFECTIVE US DOLLAR EXCHANGE RATE

![Figure 31](image)

**FIGURE 31**

THE US DOLLAR EXCHANGE RATE ADJUSTED BY DIFFERENT PRICE INDICES

Banque Indosuez, 1996b: 65
sharp appreciation in its nominal effective exchange rate. The real effective exchange rate adjusted for unit labour costs shows a even higher appreciation indicating that wages rose faster than labour productivity. The real effective exchange rate adjusted for export prices followed the same trend during this period but at a lower level. It could either indicate a squeeze on profit margins or higher capital productivity. All three indicators show a loss in competitiveness. The second half of the 1980's shows a constant decline in the US dollar. By the beginning of the 1990's the dollar apparently became under-valued in terms of its nominal effective exchange rate leading to an improvement in the competitiveness level which is apparent from the graph above. This was reflected in the good performance of the United States in world markets during this time. The real effective exchange rate adjusted for unit labour costs followed extremely closely to the nominal one. This means that unit wage costs were rising at the same pace as their foreign competitors. The pattern of the real effective exchange rate adjusted for export prices showed a similar pattern indicating that American firms cushioned fluctuations in the nominal effective exchange rate by adjusting margins (Banque Indosuez, 1996b: 64-65).

6.3.3 JAPAN'S LEVEL OF INTERNATIONAL COMPETITIVENESS MEASURED BY THE REAL EFFECTIVE JAPANESE YEN EXCHANGE RATE

The competitiveness level of Japan measured by the nominal effective exchange rate declined during the first half of the 1980's. However, the real effective exchange rate adjusted for unit labour costs showed a decline during 1981 and 1982, but remained at a slightly higher level until 1986. This means that the competitiveness level remained relatively stable and was lower than that of the United States.
FIGURE 32

THE JAPANESE YEN EXCHANGE RATE ADJUSTED BY DIFFERENT PRICE INDICES

Source: Banque Indosuez, 1996b: 65

However, being higher than the nominal effective exchange rate means that the unit wage costs were rising faster than those of the trading partners indicating that productivity did not keep up with increases in wages. Movements of the effective exchange rate adjusted for export prices are in line with those adjusted for unit wage costs albeit at a higher level indicating that exporters took advantage of a relatively good competitiveness level by keeping their margins unchanged. The second half of the 1980's recorded a loss in competitiveness from 1988 to 1990 when there was a short period of a reversal in trend. Since the beginning of the 1990's the Japanese Yen has experienced a steep climb in nominal effective terms. However, the growth in unit wage costs and export prices were not kept in relation to those of Japanese competitors. Therefore, it has not offset the rise in the nominal effective exchange rate which led to substantial competitiveness losses. Japan's efforts to counteract the
6.3.4 THE GERMAN LEVEL OF INTERNATIONAL COMPETITIVENESS
MEASURED BY THE REAL EFFECTIVE DMARK EXCHANGE RATE

The German competitiveness level during the first half of the 1980's lost ground in 1982 but stabilised until 1985. The real effective exchange rate adjusted for unit wage costs moved very much in line with the nominal exchange rate indicating that unit wage costs rose at the same pace as did those of foreign competitors. However, the real effective exchange rate adjusted
which were fluctuating around much higher levels. This indicates a loss of competitiveness since the beginning of that decade.

Since the beginning of the 1990's Germany experienced further losses in competitiveness through further appreciation of its nominal effective exchange rate. The effects of reunification eliminated Germany's advantage in terms of cost and price increases. Only through reduced prices for import inputs and a drastic decline in corporate margins was it possible to limit competitiveness losses, given that the rise in unit wage costs was much faster than in the competitors countries, especially in 1992 and 1993 (Banque Indosuez, 1996b: 65). Unit wage costs rose sharply until the beginning of 1993 because of large rises in wages together with a slowdown in productivity. The recession in 1993, the sharp recovery in 1994 and the slowdown in 1995 are reflected in the movements of the real effective exchange rate adjusted for unit wage costs. The latter takes account of sharp rises in wages accompanied by a decline in productivity and fall in wages accompanied by productivity gains (Banque Indosuez, 1996b: 66).

Variations in export market shares mirrored the evolution of competitiveness.

The United States increased its market share constantly from 1970 to 1995. Japan kept its gains achieved in 1980 at these levels in 1990 and 1995. The big loser is Germany starting from levels in 1970 well above the ones of the United States and falling by roughly 5% in 1995.
6.3.5 KOREA'S LEVEL OF INTERNATIONAL COMPETITIVENESS

During the period from 1961 to 1973 there was a policy of aggressive export drive. This was supported with multiple exchange rates. Towards the end of the 1970's when the second oil price shock hit, inflation was already high and the exchange had appreciated (World Bank, 1993: 130). Nominal unit labour costs for the manufacturing sector, measured in the national currency, had increased during the 1970's by more than 300% (National Productivity Institute, 1995: 163). This indicates a loss in international competitiveness. In the 1980's the currency was devalued to protect the export industries. The graph below depicts Korea's level of competitiveness during the 1980's and the first half of the 1990's. A decline indicates an improvement in the competitiveness position.
The competitiveness indicators are based on the ratio between domestic and competitors' average values and takes into account the competition in export and import markets. The real effective exchange is the nominal effective exchange adjusted by inflation differentials measured by consumer prices (OECD, 1996: A76). According to the real effective exchange rate in the above graph Korea's competitiveness position improved until 1987 although the Korean currency appreciated against the US Dollar in nominal terms. This indicates that prices rose at a slower pace than those of its trading partners. The trend was reversed until 1989. From then onwards some of the competitiveness was regained. Relative unit labour costs for the manufacturing sector showed a very good competitiveness position until 1986. The trend sharply reversed to a loss of 50% within four years. From 1989 it remained more or less stable, showing no improvement in the level of competitiveness. Relative export prices did not show any great movements on average.
From the above table it becomes very clear that the competitiveness position measured by unit labour costs in the manufacturing sector benefitted from the depreciation in the exchange rate and not from productivity improvements. Unit labour costs measured in the local currency rose by nearly 40% indicating that wages increased much faster than labour productivity. However, measured in a common currency the increase was a mere 8%.

7 EXPORT GROWTH AS A MEASUREMENT FOR INTERNATIONAL COMPETITIVENESS

In the previous paragraphs of this chapter factors have been analysed which influence the competitiveness level such as productivity performance of production factors, their costs, their allocation through trade policies and exchange rates. All these factors impact on the export performance which can be regarded as the most relevant measure of international competitiveness as discussed in chapter III.

Over the last decades exports of the manufacturing sector gained
more and more importance. By the mid-1950's reconstruction after the second world war was virtually complete, and the world economy started a period of unprecedented output and expansion of trade. The manufacturing sector was the leader in output as well as in exports (World Bank, 1987: 43).

Post-war growth in manufacturing was fuelled by a great number of new products and new technologies. The liberalization of international trade was created, especially under the General Agreement on Tariff and Trade (GATT) among industrialized market economies. Increasing integration of the world economy took place at the same time (World Bank, 1987: 43).

The growing performance of manufacturing exports is illustrated in TABLE 17.
In the United States machinery and transport equipment is the biggest category and increased to nearly 50% in 1993. It did not even slow down during the global recession of the late 1970's to the early 1980's which had an impact on the other manufacturing sectors.

| TABLE 17 |
| MANUFACTURING EXPORTS AS PERCENTAGE OF MERCHANDISE EXPORTS |
| United States | 65   | 70   | 75   | 77   | 82   |
| Germany       | 88   | 90   | 88   | 90   | 90   |
| Japan         | 91   | 94   | 98   | 97   | 97   |
| Korea         | 59   | 76   | 91   | 93   | 94   |
| Chile         | 5    | 5    | 7    | 10   | 19   |
| South Africa  | 32   | 41   | 41   | 34   | 74   |


Data for South Africa are for the South African Customs Union comprising South Africa, Namibia, Lesotho, Botswana and Swaziland.

Germany already had a high level of manufacturing exports in 1965 of 88% of its merchandise exports. The global recession had a greater impact on Germany than the United States. But from that low point exports recovered in the later part of the 1980's to 90% and remained at that level.

From 1965 to 1990 Japan emerged as the world biggest exporter of manufactured goods. This becomes very clear from TABLE 17, as manufactured goods account for 97% of total merchandise exports in 1993. Textile exports were relatively high in 1965 and 1970 pointing to the importance of labour-intensive industries during
this time. Machinery and transport equipment more than doubled their share from 1965 to 1993, reflecting the success in the Japanese car export market. The other manufacturing sector lost ground and its share declined from two thirds to less than one third during this period.

TABLE 18
JAPAN
DIFFERENT MANUFACTURING CATEGORIES AS %OF TOTAL

<table>
<thead>
<tr>
<th></th>
<th>1979</th>
<th>1988</th>
</tr>
</thead>
<tbody>
<tr>
<td>natural resource-intensive products</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>unskilled labour-intensive products</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>technology intensive products</td>
<td>38</td>
<td>50</td>
</tr>
<tr>
<td>human capital intensive products</td>
<td>51</td>
<td>42</td>
</tr>
</tbody>
</table>

Source: Baker, Boraine & Krafchik, 1993: 21

TABLE 18 indicates, Japan's manufacturing exports consisted mainly of technology and human capital intensive products. This compares well with the high expenditure in R&D and the well educated labour force as indicated in previous paragraphs. Ten years later the proportion of technology intensive products had risen sharply on the cost of human capital intensive products. Therefore, it is not surprising that Japan has become a world leader in high-technology products (Baker et al., 1993: 18).

Korea did not have a sufficient large domestic market to contemplate a strategy other than export-led development. It did not have natural resources nor an influx of labour or capital inflows. Its economic growth was the result of a systematic program of importing raw materials and intermediate goods to process and export them with value added. In Korea implicit or explicit export targets were used as the basis for awarding access to foreign exchange, investment licenses or credit (World Bank, 1993: 90).
In the 1960's aggressive export promotion was combined with import protection at home. At this stage the manufacturing export was very labour-intensive which increased further in the 1970's. Even in 1979 unskilled labour intensive products accounted for half of the total manufacturing output. The heavy and chemical industries drive took place from 1973 to 1979 (ibid: 127-128). The manufacturing export faltered through rising oil prices which pushed up inflation and battered Korea's terms of trade. At the same time the world recession dampened export demand and the heavy and chemical industry drive was not very successful (ibid: 129). From the mid 1980's manufacturing exports as a percentage of total merchandise picked up again and by 1993 they had reached 94% of total merchandise exports.

<table>
<thead>
<tr>
<th>TABLE 19</th>
</tr>
</thead>
<tbody>
<tr>
<td>KOREA</td>
</tr>
</tbody>
</table>

**DIFFERENT MANUFACTURING CATEGORIES AS % OF TOTAL**

<table>
<thead>
<tr>
<th>Category</th>
<th>1979</th>
<th>1988</th>
</tr>
</thead>
<tbody>
<tr>
<td>natural resource-intensive products</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>unskilled labour-intensive products</td>
<td>51</td>
<td>41</td>
</tr>
<tr>
<td>technology intensive products</td>
<td>16</td>
<td>24</td>
</tr>
<tr>
<td>human capital intensive products</td>
<td>27</td>
<td>33</td>
</tr>
</tbody>
</table>

Source: Baker, Boraine & Krafchik, 1993: 21

TABLE 19 shows that in 1979 about 50 percent of all manufactured exports were unskilled labour intensive products. Ten years later this category had lost 10 percent to the benefit of mainly technological intensive products. It indicates that Korea's manufacturers are trying to keep up with the trend towards high technological products.

Chile's manufacturing exports are hardly noticeable during the 1960's and 1970's. However, there is an upward trend from 1989
when manufacturing exports were 10% of the total. This increased to nearly 20% in 1993 as was shown in TABLE 17.

During 1972 to 1990 exports of the South African manufacturing industry have performed badly compared with the NIC's and 2nd tier NIC's, competitors of South Africa as depicted in the graph below.

FIGURE 37
SOUTH AFRICAN MANUFACTURING EXPORTS VERSUS MANUFACTURING EXPORTS OF THE NIC's AND THE 2ND TIER NIC's

FIGURE 37 indicates very clearly the weak performance of manufactured exports compared with the highly successful NICs and 2nd tier NICs. This compares well with export ratios of total production. In 1972 the ratio was 9% of total production and in 1993 it had increased to a mere 12% of total production.

Only in the 1990's export started to pick-up again. Export incentives like GEIS have helped the performance and also the recession lasting until 1993 helped export performance because
of lower domestic demand. However, this increase in export growth might not be sustainable as it did not stem from a higher competitiveness caused by higher productivity. Poor export performance also constrains the capacity to import. South Africa has a big need to import capital equipment. During the 1970's South Africa's capacity to import (the amount of imports that can be paid for through export earnings) showed a similar trend like the NICs and 2nd tier NICs. However, from the beginning of the 1980's it fell far behind those countries and in 1990 it was at the same level as in 1980 (Joffe et al., 1995: 9). This is in line with the low or even negative growth of productivity and underlines the influence of productivity on international competitiveness.

FIGURE 38
SOUTH AFRICA'S CAPACITY TO IMPORT COMPARED TO THE CAPACITY TO IMPORT OF THE NIC's AND THE SECOND TIER NIC's

Source: Joffe, Kaplan, Kaplinsky & Lewis, 1995: 9

According to TABLE 20 South Africa's manufacturing earnings are much lower than the ones of South Africa's competitors. It is noticeable that the share of South Africa's manufacturing exports
has remained constant between 1970 and 1990. This compares very poorly with countries like Korea, Thailand and Malaysia which recorded big surges in their manufacturing exports (Joffe et al., 1995: 23).

| TABLE 20 |
| MANUFACTURED EXPORTS: SOUTH AFRICA IN PERSPECTIVE |
| (in US$ million) |
| Korea | 634,6 | 14205,2 | 60622,7 |
| Taiwan | 1082,8 | 17437,6 | 62011,9 |
| Hong Kong | 1949,6 | 13083,7 | 27407,3 |
| Mexico | 391,8 | 1837,6 | 11781,0 |
| Brazil | 361,5 | 7489,1 | 16090,2 |
| Thailand | 32,2 | 1605,0 | 14514,5 |
| Malaysia | 109,6 | 2433,6 | 15944,9 |
| South Africa | 738,5 | 5111,7 | 6525,3 |

Source: Joffe, Kaplan, Kaplinsky & Lewis, 1995: 23

Apart from foreign exchange earnings, enhancing exports of the manufacturing industry will lead to better allocation of production factors, introduction of latest technology through interaction in global markets. All this will improve the productivity of capital and labour which will lead in return to higher competitiveness. Exports must be promoted for these reasons and export growth resulting from slackening domestic demand and surplus produced is not desirable. This will not lead to enhanced productivity as the incentive of export growth is starting from the wrong point and will not have necessarily the spill-over effect mentioned above (ibid: 24). A positive indicator would be growing output with growing export performance.
South Africa's overall export performance is underpinned by mining and agriculture. But that means to export into stagnant or slowly growing world markets. World trade is more and more dominated by manufactured commodities and to a significant degree because inputs into production are dominated by manufacturers and services relative to raw material (ibid: 49).

8 EXPORT MARKET SHARE AS THE MOST RELEVANT MEASUREMENT OF INTERNATIONAL COMPETITIVENESS

As discussed in chapter III the level and growth in the export market share might be a better measurement for the degree of international competitiveness. Apart from taking export growth into consideration, growth in international trade is also drawn into the calculation. A good measurement is the export performance of a country by comparing the growth of its export volumes with that of its export markets. This shows whether a country's export is growing faster or slower than its export markets. This indicates whether over time, a country or industry is gaining or loosing markets share (OECD, 1996: 2 & A76).

According to the OECD report on Japan, its export market shares seem to stabilise from the first half of 1996 onwards at a low level of 10%. One reason being that manufacturing output produced outside Japan has risen to 10% through foreign direct investment (OECD, Japan, 1996: 29). Goods produced outside Japan will not be included in the calculation for exports.

In the United States export volumes were quite strong in 1992 and real merchandise export increased more than 6%. During the first half of 1993 exports decreased sharply because of the recession in Europe and Japan (OECD, United States, 1993: 25).
Germany re-emerged as a major trading power in the 1950's. Its share of world exports of manufactured goods rose from 10% to 20% between 1950 and 1960. It kept this position during the 1970's. Japan showed even higher growth rates. In the 1950's its share of world trade rose by 50% and nearly doubled in the 1970's as shown in the table above.

<table>
<thead>
<tr>
<th>TABLE 21</th>
<th>SHARE OF WORLD EXPORTS OF MANUFACTURED GOODS</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>26,6</td>
</tr>
<tr>
<td>Japan</td>
<td>4,3</td>
</tr>
<tr>
<td>Germany</td>
<td>10,0</td>
</tr>
</tbody>
</table>

Source: Gowland, 1983: 5
The United States lost substantial shares in world trades, falling from more than a quarter in 1952 to one sixth in 1980. One reason being the inability to produce reliable goods as quickly and as well as Japan (Gowland, 1983: 3-4).

Even with a small share in world manufacturing exports the growth in developing countries has been faster than that of industrial countries since 1960. In 1965 not one developing economy was among the world's top thirty exporters of manufactured goods. Twenty years later Korea had reached the top fifteen. Even after the slowdown in the world economy after 1973 Korea sustained its progress (World Bank, 1987: 46). A table of manufactured exports published in the World Development Report of 1987 shows Korea in the second place of 43 developing countries with a share of about 10% in 1973. It was still in second place in 1985. Chile ranked 37th with a share of less than 0.2% in 1973 and moved up to 29th in 1985 but still with a share of less than 0.2% (World Bank, 1987: 49).

FIGURE 40

KOREA'S SHARE OF WORLD TRADE

Source: OECD, Korea 1994: 33
How developing countries are becoming a major force in world trade for manufacturing goods becomes evident if one compares their combined share from less than 10% in 1970 to 26% in 1992. South African export did not keep pace and declined from almost 12% share of exports of developing countries in 1955 to a mere 1.5% in 1993 (Wefa Group, 1996: 13). One of the reason being that local exporters tended to stay with slow-growing natural resource markets instead of shifting to industrial exports (National Productivity Institute, 1996: 23). The graph below depicts how much South Africa has lost in market shares.

A shift towards manufacturing exports would benefit the overall export growth since manufacturing goods are gaining increasing importance in world markets. If South African manufacturers are more exposed to world markets this would benefit the productivity growth because of higher competition in international markets and the possibility to learn about new technology and more efficient production processes.
9 SUMMARY

The aim of this chapter was to compare the international competitiveness level of South Africa with its major trading partners at a macro-economic level.

The importance of research and development (R&D) was again stressed and its impact on the creation of economies of scale was highlighted. As a broad measurement for the significance of R&D the real growth in total expenditure on R&D was used. It showed that Korea with its high growth of 11,5% during 1989 to 1993 is trying to catch up with the industrial countries. South Africa showed an absolute decline of -3,3% during this period. As a better indication for the importance of R&D for industries the real growth in business R&D expenditure was shown. In this comparison South Africa showed a better position and was with its growth of 7,6% (during 1989 to 1993) very close to Korea which recorded 9,7% growth. However, it was stated that leading South African corporations spent only 1% of their sales on R&D. That compared badly with other international corporations (e.g. Hitachi and Fuji) who spent between 5,6% and 7,2% of their sales on R&D.

It was analysed that together with the industrial development a shift towards medium and high-technology and scale based industries in the manufacturing sector occurred. Therefore, more emphasis is put on the development in high technology. It was illustrated that the United States is still the world's technological leader. But the other industrialised countries have caught up through faster growth in investment.

It was stated that investment must be financed by savings. It was
shown that the High Performing Asian economies recorded a high growth in their savings which were used for investment. This created high economic growth and lead to a virtuous circle of more savings, more investments and more economic growth. It was shown that the savings rate in the United States recorded a very low average. However, capital investment was sustained through foreign borrowing.

It was illustrated that South Africa's gross domestic savings rate as a ratio to GDP fell on average from 1960 to 1990. This did not compare well with the high savings rates of East Asia's economies where domestic savings account for 30% to 40% of GDP. It was stated that government is responsible for creating the right basis for private savings. High taxes in South Africa destroy any savings drive. The dissaving of the South African government takes away investment opportunities.

To stimulate output growth the accumulation of physical capital through investment is of vital importance. It was analysed that the quality of investment is as important as the quantity of investment. It was stated that high quality investment is of vital importance for gains in capital productivity, especially with regard to the fast advancing technology. Investment in capital in general is also a factor to raise labour productivity. It was illustrated that the real growth in investment slowed in the United States during the period 1986 to 1990 as a result of sufficient unused capacity.

High investment levels in Japan during the period 1986 to 1990 corresponded well with the higher GDP growth during this period.

It was discussed that the low growth of Germany's investment
during the period 1980 to 1985 was a reflection of the recession during this period. It was analysed that the high growth during the second half of the 1980's was related to the recovery and the anticipation of reunification. This high growth rate in investment was not sustained as it declined sharply again during the first half of the 1990's reflecting the weakening in the economy. It was also argued that the low level of investment was a correction of the rapid build-up of capital stock immediately after the reunification. It was illustrated that the investment level in Japan increased very sharply during the period 1987 to 1991 whereas capital formation in Germany and the United States remained relatively flat during the period 1987 to 1991. However, from 1991 the United States recorded a strong increase in its capital stock which coincides with the recovery of the American economy.

It was demonstrated that the trend in the investment of the South African manufacturing industry was strongly influenced by strategic considerations and exogenous shocks. The sharp decline in the period 1982 to 1985 was attributed to the end of large mineral related investments. Financial sanctions from the beginning of 1985 and political uncertainty in South Africa dampened investment levels further. Only from 1993 investment growth started to increase again.

It was stated that Korea's level of investment was very high compared to that of South Africa. Korea's investment as a percentage of GNP was already 30% in 1980 and grew close to 40% in 1990.

To compare South Africa's human resources with those of its competitors the level of education was analysed. It was stated that a country's industrial performance in an economic sense depends largely on human resources available. As a broad
measurement government expenditure on education was used. It showed that South Africa's government expenditure as a percentage of total expenditure was very high compared with the other countries. However, the per capita expenditure was low in comparison to the industrial countries and also lower than Korea. It was pointed out, that high government expenditure on education does not guarantee larger accumulation of human capital. It was stressed that for developing countries it is important to put more emphasis on basic education to build-up human capital. In 1985 Korea allocated nearly 90% of its education budget to basic education.

In comparison to Korea and South Africa, countries like Germany and the United States show a relatively low expenditure pattern. This was explained by the declining or slowly growing school age population and means that resources available for per capita education will increase.

It was analysed that a better measurement for human capital is the level of school enrolment at different levels. South Africa's competitors had reached universal education at the primary level already in 1965. However, South Africa reached universal education at the primary level only in 1970. It was pointed out that it was not clear whether the data published by the World Bank included the black population.

At the secondary education level the United States and Japan reached nearly a universal level in 1984 with Korea very close behind them with 90% of the age group. Germany's secondary education level was much lower at that time. It was illustrated that South Africa's secondary education level was lagging behind its competitors and reached 71% of the age group in 1993. This indicates that not enough is done to build-up South Africa's human capital.
The development in South Africa's level of tertiary education increased by a mere 10% within 27 years. This compares very badly with the growth rates of South Africa's competitors. For example Korea's level of tertiary education increased from 6% of the age group in 1965 to 42% in 1992. It was stated that in today's world industries need a highly skilled labour to make use of high technological machinery.

It was illustrated that 35% of South Africa's economically active population either had no education or one below standard 4. This indicates that the formal education system is inadequate. A comparison of the average number of school years between South Africa and other developing countries showed South Africa at the bottom of the list.

It was analysed that the private sector is also responsible for education through in-house training because this raise the level of education and influences the level of labour productivity. It stated that OECD countries spend on average between 4% and 7% of their payroll on training compared with South African firms who spend 3,3% of their payroll on training. Furthermore, it was pointed out that a strong correlation between education and labour productivity exists. The high level of education in Korea was one of the reason for Korea's successful economic performance.

It was stated before that export performance is a good measurement of the level of international competitiveness. Apart from the importance of physical and human capital there are other factors which influence the export performance of an industry. Trade and economic policies were analysed as a factor to impact on export performance. It was noted that the inward looking trade and economic policies in South Africa undermined export performance since the mid 1950's. The complex protection system
(customs duties and import surcharges) were aimed at supporting import substitution. That made it difficult for manufacturers to export because production costs of imported inputs were artificially high. From 1980 lower tariff levels and the relaxation of import permits were introduced. In 1990 the general export incentive scheme (GEIS) was introduced to help offset the price disadvantage which South African exporter faced on international markets.

A good example of the importance of export-led growth is Korea. In the 1960's Korea's primary goal of economic policies was export expansion. The success in export growth lead to high economic growth.

As another measurement of the level of international competitiveness terms of trade were discussed. It was explained that a rise in terms of trade (the ratio of export prices to import prices) indicates a loss in competitiveness. It was illustrated that the terms of trade for the South African manufacturing industry fell in absolute terms by -2.2% in the 1970's and recorded another slight decline in the 1980's. However, in the early 1990's the growth in the terms of trade became positive indicating a loss in competitiveness.

The real effective exchange rate was discussed as another measurement which impacts on the level of international competitiveness. It was pointed out that the calculation of the real effective exchange rate takes account of movements of price levels between trading partners. The level of the real effective exchange influences to large extent the export performance of industries.
During the last decades the South African rand was effected by numerous external factors. It was illustrated how the rand moved over the years. High gold and commodity prices lead to a constant increase in the rand until 1983. Financial sanctions caused the rand to collapse in 1984 and 1985. During 1986 and 1987 the rand recovered again and moved around these level from then onwards. To illustrate the impact of different prices on the real effective rand, a comparison of three different measurement was shown. The worst picture on a competitive basis showed the rand adjusted by unit labour costs. It was analysed that the rand was overvalued since the beginning of the 1990's which indicates a loss in competitiveness.

To compare South Africa's international competitiveness position with its competitors the level of international competitiveness of these countries was measured by their real effective exchange rate. During the first half of the 1980's the US dollar showed a constant appreciation in nominal as well as in real terms. The trend was reversed when the US dollar started to decline. From the beginning of the 1990's the US$ became undervalued which increased the United States' level of competitiveness which was reflected in the good performance in world markets.

Japan recorded a good level of competitiveness during the first half of the 1980's. It was shown that exporters took advantage of this position by keeping their profit margins unchanged. The appreciation of the Japanese Yen during the second half of the 1980's lead to a loss in competitiveness. This trend continued in the 1990's and because unit wage costs did not offset the rise in the nominal effective Yen , the Yen in real terms increased further which lead to a loss in competitiveness.

The movements in Germany's level of competitiveness measured by the real effective German Mark was very similar to that of Japan.
Since the beginning of the 1990's Germany experienced further losses in competitiveness through further appreciation of the nominal effective DM. Only through a drastic decline in corporate margins was it possible to limit competitiveness losses. Unit wage costs in Germany rose much faster than those of German competitors.

It was analysed that Korea's level of competitiveness was reduced by high growth rates in unit labour costs. In the 1980's the Korean currency was devalued to protect the export industries. It was illustrated that Korea's competitiveness gained until 1986. From 1986 to 1989 Korea experienced a huge loss in competitiveness. From 1990 onwards some of the losses were regained and it remained at these levels until 1995.

After the explanation of factors influencing the export performance, export growth was used as measurement for the level of international competitiveness. It was shown that manufacturing exports grew constantly as a percentage of total merchandise export from 1965 to 1993. In Germany, Japan and Korea manufactured exports made up more than 90% of the total merchandise exports by 1993. South Africa's manufacturing exports had also increased to large extent and was 74% of total merchandise exports by 1993.

It was shown that there was a substantial shift from labour intensive goods to technology intensive products in Japan's and Korea's export sector. This indicates that these two countries make use of technology advancements.

South Africa's manufacturing exports were compared with those of the NIC's and the second TIER NIC's. It showed that South
Africa's growth in manufacturing exports compared very badly with these countries and was falling far behind. It was stated that poor export performance constrains the capacity to import. The capacity to import capital goods is very important for South Africa's manufacturing industry to keep up with the newest technology. Furthermore, the achievement of export growth will force manufacturers to allocate production factors efficiently and will therefore lead to a rise in productivity.

Finally export market shares were applied as a measurement of the level of international competitiveness. It was illustrated that the United States share of world exports of manufactured goods had declined from 1951 to 1980. Germany's and Japan's shares of world exports of manufactures had increased over this period. However, the share of the United States had increased since the beginning of the 1990's where as those of Germany and Japan had decreased. This corresponds with the development of the levels of competitiveness for those countries. Korea's share of world exports grew from virtually zero in 1962 to over 2% in 1992. South Africa in comparison to Korea did very poorly. Its share of manufacturing exports of developing countries declined from almost 12% in 1955 to a mere 1,5% in 1993. This indicated very clearly that South Africa is falling behind its competitors.
CHAPTER VI

QUANTITATIVE ANALYSIS OF THE MICRO-LEVEL OF ECONOMIC COMPETITIVENESS

1 INTRODUCTION

The aim of this chapter is to analyse the productivity of capital and labour in the South African manufacturing industry.

Measurements discussed in chapter IV will be applied to establish the productivity of the input factors, capital and labour, at the microeconomic level.

A Cobb-Douglas production function which can be easily applied to empirical data will be estimated for the South African manufacturing industry for the period 1972 to 1993. With the Cobb-Douglas production function the marginal productivity of capital and labour as well as the marginal rate of technical substitution will be determined.

It will be shown that the output elasticities for capital ($\alpha$) and labour ($\beta$) will vary if production functions for different periods are estimated. Furthermore, it will be established if the South African manufacturing industry was labour or capital intensive for the period 1972 to 1993.
intensive for the period 1972 to 1993.

In order to establish if the input factors, labour and capital, were combined efficiently the marginal productivity of labour and capital will be compared with their relative prices. As another technique for the optimal combination of input factors the efficiency criterion will be calculated. The estimation of the optimum utilization of the budget outlay will lead to conclusions whether economic waste occurred.

Finally the calculations to estimate economies of scale will indicate if economies of scale prevailed in the South African manufacturing industry during the period 1972 to 1993.

The second part of this chapter will show a comparison of labour and capital productivity of the South African manufacturing industry with those of its major competitors. As it was not possible to obtain data for the manufacturing sector of these countries data for the business sector or the economy as a whole were used as a proxy. The results will lead to conclusions about the level of international competitiveness of the South African manufacturing industry.

2 THE COBB-DOUGLAS PRODUCTION FUNCTION FOR THE SOUTH AFRICAN MANUFACTURING INDUSTRY

As outlined in a previous chapter the Cobb-Douglas production function is often used to measure productivity levels at the input base. It is expressed as
\[ Q = AR^2 L^8 \]

The constants in this function are \( A, \alpha \) and \( \beta \) and the variables are \( Q, K \) and \( L \). \( Q \), as an explicit function of \( K \) and \( L \), can be varied by changing the input of \( K \) and \( L \) alone or together. Also both inputs must be used to obtain a positive output, because \( Q \) will be zero if either \( K \) or \( L \) are zero. Furthermore, it is possible to substitute the inputs with each other through different combinations but maintain the same level of output (James et al., 1980: 136, 137; Heathfield, 1971: 34).

Data used for the estimation of the production function of the South African manufacturing industry are shown in APPENDIX 1. Production and capital stock data are expressed in rand million at constant 1993 prices where capital stock has been adjusted by capital utilisation. Employment data are expressed in thousands of employees.

The estimated production function was calculated in TSP and checked in LOTUS and yielded the following results:

\[ Q = 66,936K^{0.3332}L^{0.6084} \]

The \( R^2 \) of 0.96 indicates that the estimated production function explains 96% of the total variation of the values for the actual production. The standard error of the regression is 0.03 and the calculated F-ratio of 259.68 is greater than the critical value of \( F_{0.05} = 3.52 \). On these grounds one can reject the null hypothesis. However, the Durban Watson statistics indicates that there is first-order autocorrelation because the calculated DW is 0.62 and smaller than the theoretical value of \( D_L \) of 0.91 at
The TSP results are shown in the TABLE below.

**TABLE 22**

**TSP RESULTS FOR THE ESTIMATED PRODUCTION FUNCTION**

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>STD. ERROR</th>
<th>T-STAT.</th>
<th>2-TAIL SIG.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>4.2037438</td>
<td>0.8802524</td>
<td>4.7756117</td>
<td>0.0001</td>
</tr>
<tr>
<td>LCAPUTI</td>
<td>0.3332444</td>
<td>0.0692856</td>
<td>4.8097214</td>
<td>0.0001</td>
</tr>
<tr>
<td>LEMP</td>
<td>0.6084327</td>
<td>0.2175003</td>
<td>2.7973875</td>
<td>0.0115</td>
</tr>
</tbody>
</table>

R-squared 0.964709 Mean of dependent var 12.38067
Adjusted R-squared 0.960994 S.D. of dependent var 0.149807
S.E. of regression 0.029587 Sum of squared resid 0.016632
Log likelihood 47.84538 F-statistic 259.6893
Durbin-Watson stat 0.615918 Prob(F-statistic) 0.000000

Source: Data from IDC and SARB

To establish if the estimated values for $\alpha$ and $\beta$ are statically significant their estimated t-values must be compared with the critical value of $t$. The calculated value of $t_\alpha = 4.8097$ and the one of $t_\beta = 2.7975$. Since both values are greater than the critical value of $t_{0.025} = 2.093$, one can reject the null hypothesis at a 95% significance level and can conclude that $\alpha$ and $\beta$ are greater than zero.

It must be established if $\alpha$ and $\beta$ conform to the properties of the production theory discussed in chapter IV. The estimates themselves suggest that the properties of diminishing returns are satisfied, since $\alpha$ is $0<0.3332<1$ and $\beta<0.6084<1$. But to determine, if these conditions are really satisfied, one must perform t-tests for these estimated coefficients. With a degree of freedom of 19 the critical value of $t_{0.025}$ is 2.093 at a 95% confidence level. To test if the marginal products are
perform t-tests for these estimated coefficients. With a degree of freedom of 19 the critical value of $t_{0.025}$ is 2.093 at a 95% confidence level. To test if the marginal products are decreasing, one must determine if $\alpha$ and $\beta$ are both significantly less than one.

This requires a calculation:

\[
\begin{align*}
  t_\alpha &= \frac{(\alpha - 1)}{s_\alpha} \quad \text{and} \quad t_\beta = \frac{(\beta - 1)}{s_\beta} \\
  &= \frac{(0.3332 - 1)}{0.0693} \quad = \frac{(0.6084 - 1)}{0.2175} \\
  &= -9.6219 \quad \quad \quad = -1.8000 \\
  t_\alpha > t'_{0.025} = 2.093 & \quad t_\beta > t'_{0.05} = 1.729
\end{align*}
\]

The critical value for $t_{0.025}$ is 2.093 at a 95% confidence level and $t_\alpha$ is -9.622. The critical value for $t_{0.05}$ is 1.729 at a 90% confidence level and $t_\beta$ is -1.801. Since the absolute values for the calculated t-statistics for $\alpha$ and $\beta$ exceed the critical t values, one can conclude that $\alpha$ and $\beta$ are significantly less than one. Thus the estimated production function does satisfy the properties of the production theory. Therefore it can be assumed that the $\Delta MP_k$ and $\Delta MP_l$ are diminishing.

In the Cobb-Douglas production function $\alpha$ and $\beta$ are output elasticities for capital and labour respectively. In the estimated production function for the South African manufacturing industry $\alpha$ is 0.3332 which means that a 10% increase in capital will lead to 3.3% increase in output. A 10% increase in labour will lead to 6.1% increase in output because $\beta$ is 0.6084. This shows that variations in labour input have a greater effect on output than capital.
With the estimated production function a new production estimate can be calculated by replacing K and L with the actual data from APPENDIX 1. The results of the estimated output are shown in APPENDIX 2. The close relationship between actual estimated production data is illustrated in FIGURE 42 which indicates that the estimated production function is acceptable.

![Estimate Production Function Diagram](image)

**FIGURE 42**

**ESTIMATED PRODUCTION FUNCTION VERSUS ACTUAL PRODUCTION**

Source: Data from Industrial Development Corporation and South African Reserve Bank

3 CAPITAL AND LABOUR EFFICIENCY MEASURED BY VARIOUS TECHNIQUES

3.1 AVERAGE PRODUCTIVITY OF CAPITAL AND LABOUR

Using the estimated production function the average productivity
of labour and capital can be calculated.

\[
AP_L = \frac{(AK^aL^b)}{L}
= \frac{(66.936K^{0.3332}L^{0.6084})}{L}
\]

\[
AP_K = \frac{(AK^aL^b)}{K}
\]

and

\[
AP_K = \frac{(66.936K^{0.3332}L^{0.6084})}{K}
\]

### 3.2 MARGINAL PRODUCTIVITY OF CAPITAL AND LABOUR

Apart from changes in average product per unit as a measurement for productivity, changes in the marginal productivity of labour and capital are a better measure. This indicates how much more output will be achieved with an additional unit of capital and labour. This also gives an indication if the additional inputs are used efficiently.

As discussed in chapter IV the marginal productivity for capital and labour in the Cobb-Douglas production function

\[
Q = AK^aL^b
\]

becomes

\[
MP_K = aAK^aL^b = aQ/K
\]

and

\[
MP_L = bAK^aL^{b-1} = bQ/L
\]

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From the above expression one can see that \( MP_K = \alpha AP_K \) and \( MP_L = \beta AP_L \) this yields that

\[
\frac{MP_K}{AP_K} = \alpha \quad \text{and} \quad \frac{MP_L}{AP_L} = \beta
\]

Because of the specific relationship in the Cobb-Douglas production function where \( \alpha \) and \( \beta \) are constants, the ratio of \( MP \) to \( AP \) is constant regardless of the level of output and input ratio. In general \( \alpha \) and \( \beta \) do not equal 1. If \( \alpha, \beta > 1 \) for \( K \) and \( L \), \( MP \) is always greater than \( AP \) which then increases. In the case of \( \alpha, \beta < 1 \) \( MP \) is always less than \( AP \) which is then decreasing (Sher et al., 1981: 96-97). The coefficient \( \alpha \) measures the output elasticity of capital and \( \beta \) that of labour. Changes in \( \alpha \) and \( \beta \) indicate what effect changes in the capital and labour inputs will have on total output.

In order for the properties of the Cobb-Douglas production function to conform to the law of diminishing returns \( \alpha \) and \( \beta \) are required that \( \alpha \) and \( \beta \) to be less than one. Through the second partial derivative one arrives at

\[
\Delta MP_K = \alpha(\alpha-1)AK^{\alpha-2}L^\beta
\]

and

\[
\Delta MP_L = \beta(\beta-1)AK^\alpha L^{\beta-2}
\]

If \( \Delta MP_K \) and \( \Delta MP_L \) are diminishing it means they are less then one, then \( \alpha \) and \( \beta \) must be less than one (Maurice et al., 1988: 340). If the value of \( \alpha \) is \( 0<\alpha<1 \) and \( \beta \) is \( 0<\beta<1 \) the Cobb-Douglas production function conforms to the theoretical properties of the production theory (ibid: 308).
Since the marginal productivity for capital and labour is calculated as

\[ MP_k = \alpha AP_k \quad \text{and} \quad MP_l = \beta AP_l \]

\[ = 0.3332 \ AP_k \quad = 0.6084 \ AP_l \]

one can estimate the marginal products for capital and labour for the South African manufacturing industry by calculating \( AP_k \) and \( AP_l \) from the actual data shown in APPENDIX 1. The estimated data for \( MP_k \) and \( MP_l \) are shown in APPENDIX 3.

In the case of labour the number of employees only increased by 1.1% (on a compound basis) from 1972 to 1993 whereas production grew by 2.1% over the same period. Therefore \( MP_l \) grew on average from 1972 to 1993 as it is illustrated in FIGURE 43 below.

**FIGURE 43**

**EMPLOYMENT AND MARGINAL PRODUCTIVITY OF LABOUR**

Source: Data from Industrial Development Corporation
For example in 1972 the South African manufacturing industry produced an output of $Q = \text{R168922m}$ with 1137,95 thousand workers. The average productivity of labour was

$$AP_l = \frac{Q}{L}$$

$$= \frac{168922}{1137,95}$$

$$AP_l = \text{R 148,44 per worker}$$

The marginal productivity was

$$MP_l = \beta AP_l$$

$$= 0,6084 \times \text{R 148,44}$$

$$MP_l = \text{R 101,00 per worker}$$

In 1980 the marginal productivity of labour increased to R105,00 and in 1993 to R112,28. However, the capital available per worker increased over this period. Therefore labour was not necessarily more efficient because it had more capital available to increase its marginal productivity.

The marginal productivity for capital can be estimated in the same way as for labour. FIGURE 44 shows an on average a decrease in the $MP_k$ compared with the increase in the amount of capital.
For example in 1972 the South African manufacturing industry produced an output of R168922m and used capital of R43434m. The average productivity of capital was

\[ AP_K = \frac{Q}{K} = \frac{168922}{43434} \]

\[ AP_K = R\ 3,89 \text{ per unit of capital} \]

The marginal productivity of capital was

\[ MP_K = \alpha AP_K = 0,3332 \times R\ 3,89 \]

\[ MP_K = R\ 1,30 \text{ per unit of capital} \]

In 1980 the marginal productivity of capital fell to R1,02 and in 1993 it declined further to R0,86.
The marginal productivity of labour will decline if $\beta < 1$. In the estimated production function of the South African manufacturing industry $\beta$ equals 0.6084 and should indicate a decline in $MP_L$. However, this applies only when there is a constant amount of physical capital. In the case of the South African manufacturing industry the stock of capital grew faster than employment, therefore one can expect an increase in $MP_L$. The marginal productivity of capital declined on average between 1972 and 1993 because the capital stock increased on average faster than employment during this period.

### 3.3 Elasticity of Substitution

In a highly competitive world it is important that production factors are used in an optimal way. It was pointed out in the previous chapter that in order to be competitive, it is important to increase productivity. One way to do this is to substitute one production factor for another one; e.g. capital for labour. Especially in a world where technology is moving fast with a constant development of new machinery which leads to a more efficient production process. The introduction of new machinery often means that labour is substituted for capital. A concept to measure this is the elasticity of substitution.

If a production process indicates a fall in the productivity of labour and an increase in the one for capital, the result will be that more and more labour will be substituted for capital to obtain an optimal input mix. The relationship between the possible substitution of capital for labour or vice versa is called the marginal rate of technical substitution. In the Cobb-Douglas production function it is defined as
MRTS_{L,K} = \beta AP_L / \alpha AP_K

= (\beta (Q/L)) / (\alpha (Q/K))

MRTS_{L,K} = (\beta / \alpha) (K/L)

For example in 1972 the South African manufacturing industry used R43434m of capital and employed 1137.95 thousand workers. The MRTS_{L,K} yielded

MRTS = (0.6084/0.3332)(43434/1137.95)

= R 69.69

For example in 1993 the South African manufacturing industry used R102500m of capital and employed 1439.35 thousand workers. The MRTS yielded

MRTS = (0.6084/0.3332)(102500/1439.35)

= R 130.03

The MRTS_{L,K} increased constantly from 1972 to 1984 because of the rate of growth in capital was greater than that of in labour. The years 1986 to 1988 showed a decline resulting from a decline in capital. The corresponding data are shown in APPENDIX 4.

To see how easily input factors are substituted with each other the measurement of the elasticity of substitution (\sigma) is used, under the assumption of given technology. It relates changes in relative factor inputs to a proportional change in MRTS between labour and capital or the proportional change in the relative factor-price ratio on the basis of marginal productivity theory (Koutsoyiannis, 1979: 75).
It is defined as follows:

\[ \sigma = \frac{\text{%change in } K/L}{\text{%change in MRTS}} \]

It is a pure number independent of the units of the measurements of capital and labour, since both the numerator and denominator are measured in the same units (Koutsoyiannis, 1979: 74).

For example in 1973 for the South African manufacturing industry it yielded

\[ \sigma = \frac{(40.57/38.17)*100-100}{(74.08/69.69)*100 - 100} \]

\[ = \frac{6.28}{6.30} \]

\[ = 1.00 \]

and in 1993 it was

\[ \sigma = \frac{4.89}{4.89} \]

\[ = 1.00 \]

If \( \sigma < 1 \) the ratio of capital's share to labour share will decrease; if \( \sigma = 1 \) it will stay the same and if \( \sigma > 1 \) it will increase.

During the period from 1972 to 1983 the South African manufacturing industry showed an elasticity of substitution (\( \sigma \)) of 1 which means that the ratio of capital's share to labour's
share remained the same. The reason for this is, when there is only one estimated production function for the whole period. If there were several estimated production function, $\alpha$ and $\beta$ would vary. This would result in different elasticities of substitutions.

3.4 THE ESTIMATION OF THE PRODUCTION FUNCTION OF THE SOUTH AFRICAN MANUFACTURING INDUSTRY FOR DIFFERENT PERIODS

As mentioned above because there is only one production function, estimated $\alpha$ and $\beta$ are constant for the whole period. This does not give an indication how $\alpha$ and $\beta$ have changed over time. This paragraph analyses movements in $\alpha$ and $\beta$ over time. TABLE 23 shows movements in $\alpha$ and $\beta$ for different periods.

To establish if the estimated values for $\alpha$ and $\beta$ are statistically significant their estimated $t$-values must be compared with the critical value of $t$. In the case of $\alpha$ the estimated values for all periods are greater than the critical $t$-value at a 95% significance level and one can conclude that $\alpha$ is greater than zero. The null hypothesis cannot be rejected for $\beta$ during the periods of 1972-82 and 1972-83. According to the results, labour should not be part of the equation because of $\beta$ negative. In the period of 1972 to 1984 the estimated value for $\beta$ was greater than the critical $t$-value at a 90% significance level. For the periods that followed, the estimated value for $\beta$ was greater than the critical $t$-value at a 95% significance level.
The estimates themselves suggest that the properties of diminishing returns are satisfied, since \( \alpha \) is \( 0 < \alpha < 1 \) in all cases; and \( \beta \) is \( 0 < \beta < 1 \) except for the period 1972 to 1982. But to determine, if these conditions are really satisfied, one must perform the t-test for these estimated coefficients. To test if the marginal products are decreasing, one must determine, if \( \alpha \) and \( \beta \) are both significantly less than one. The results are listed in TABLE 24.
The absolute values for the calculated values for $\alpha$ exceed the critical t-values at a 95% significance level for all periods. One can conclude that $\alpha$ is significantly less than one. Thus it can be assumed that $\Delta MP_K$ are diminishing and satisfy the properties of the production theory. For all periods under consideration the absolute values for $\beta$ are less than the critical t-values at a 95% significance level. Therefore it cannot be assumed that $\Delta MP_L$ are diminishing and they do not satisfy the properties of the production theory.

**TABLE 23 shows a rapid decline of $\alpha$ from the period of 1972 to 189**
1982 up to the period of 1972 to 1985. From 1972 to 1986 up to the period 1982 to 1992 $\alpha$ increased constantly. This indicates a rise in the output elasticity of $\alpha$ during this time and means that the marginal productivity of capital was growing and capital became more efficient.

3.5 FACTOR INTENSITY OF CAPITAL AND LABOUR

Factor intensity can be measured by input ratios. One can show the production function as output per labour input or as a function of capital per labour input. The latter is known as the capital-labour ratio.

If capital input is growing faster than labour input, a situation of capital deepening prevails. In contrast to capital deepening one speaks of capital widening when the quantity of capital is increased and additional labour is employed so that the proportions of factor inputs remain unchanged (Lipsy, 1983: 394).

The capital/labour ratio of the South African manufacturing industry over the period 1972 to 1993 is illustrated in FIGURE 45. The rise in the capital/labour ratio points to a situation of capital deepening. In this case capital deepening has negative effect on $MP_k$ which was on average declining as is shown in FIGURE 44. From 1972 to 1984 the capital/labour ratio increased constantly and declined during 1985 to 1988. The reason for this was a decline in capital and an increase in employment. From then on up to 1993 it increased again because capital started to increase and employment fell from 1991 onwards.
Factor intensity in the Cobb-Douglas production function, where $\alpha$ and $\beta$ are the output elasticities for capital and labour respectively, is measured as the ratio of $\beta$ to $\alpha$. The estimated production function yielded $\alpha = 0.3332$ and $\beta = 0.6084$. Since $\alpha$ and $\beta$ are output elasticities, it means that 1% increase in labour will increase the output by 0.61% and 1% increase in capital will increase the output by 0.33%. The factor intensity for the estimated production function of the SA manufacturing industry during the period from 1972 to 1993 is $(\beta/\alpha) = 1.8259$. This means that the South African manufacturing industry is labour intensive. As there is only one estimated production function for the whole period under consideration the factor intensity remains the same. This is because $\alpha$ and $\beta$ are constants. With different estimated production functions for different periods, $\alpha$ and $\beta$ would change, hence the factor intensity would change. For example for the period 1972 to 1983 the ratio of $\beta/\alpha$ was 1.4043 and for the period 1972 to 1988 it was 2.7710.
The cases of capital or labour deepening as mentioned above it is assumed that there is an absence of technical progress, (e.g. no innovation of new machinery which will shift up the isoquant). The reason for capital deepening can be a low level of interest rates in the markets which was the case in South Africa during 1973 to 1980. Relatively low costs for capital make it more attractive for companies to invest in new machinery even if it could result in over-utilization of capital. Another reason is relatively high labour costs in comparison to the costs for capital. This also makes it more attractive to employ more machinery in relation to labour. In the case of labour deepening, wages will be lower than the cost of capital and therefore it will be profitable to employ more labour. The nature of the production processes of some industries in the manufacturing sector are more labour intensive than others. However, it will remain only profitable to be more labour intensive as long as wages are in line with the productivity level of labour. Otherwise a loss of competitiveness will result.

A reason for capital deepening is a low level of real interest rates in the markets. There is a good inverse correlation between the growth in capital in the South African manufacturing industry and the real prime overdraft rate (deflated by CPI). During the years of low or even negative real prime overdraft rate, the rate of growth in capital stock was high. Another factor influencing capital deepening is the business cycle. In a downswing phase growth in capital is declining because of lack in demand or higher capital utilization. The cost of labour is another reason influencing the capital/labour ratio.
3.6 PRICES OF PRODUCTION FACTORS IN THE SOUTH AFRICAN MANUFACTURING INDUSTRY

It was outlined in chapter II that competitiveness is determined by productivity as well as the cost of production. Prices for production factors, capital and labour, are determined by demand and supply in their respective markets.

3.6.1 PRICE OF LABOUR

The price of labour \( w \) was calculated by dividing total remuneration by the number of people employed. This gave average \( \text{w} \) in thousand rand. The data for total remuneration were obtained from the Industrial Development Corporation. In order to make the price of labour comparable with the price of capital, the average wages were deflated by the PPI. It was decided to take the PPI as deflator because wages are a cost factor and not considered as income. The calculated data are shown in APPENDIX 5.

3.6.2 PRICE OF CAPITAL

The price of capital \( r \) is expressed as \( r = q_K (i + \delta) \) where \( q_K \) is the unit acquisition cost of capital stock. Since capital stock is measured in rand, the unit acquisition cost is one. The real rate of interest \( i \) has been calculated by subtracting the CPI from the prime overdraft rate. The rate of depreciation \( \delta \) has been obtained by using the deflator for GDFI manufacturing to convert the amount of capital stock into current prices, to make it comparable to the amount of depreciation. The rate of depreciation was then calculated as the ratio of depreciation to
capital stock. The calculated data are shown in APPENDIX 6.

3.7 THE COMBINATION OF CAPITAL AND LABOUR IN THE SOUTH AFRICAN MANUFACTURING INDUSTRY

It was shown that there was a declining marginal productivity of capital because of increasing use of capital. On the other hand, the marginal productivity of labour was rising on average between 1972 and 1993. However, the rise in labour productivity was caused by an increased capital labour ratio. More capital equipment was used by the labour force. Therefore it does not necessarily mean a more efficient labour force. The question arises why managers in firms did not reduce the amount of capital to raise its productivity. To answer this question one must compare the productivity level of production factors with their relative prices. An optimum situation is reached when the marginal productivity equals the price of the production factor. It yields

\[ MP_K = r \quad \text{and} \quad MP_L = w \]

A firm is in equilibrium when it equates the ratio of the marginal productivity of factors to the ratio of their prices.

That is

\[ \frac{MP_L}{MP_K} = \frac{w}{r} \]

(Koutsoyiannis, 1979: 89-90).
A firm will try to work as efficient as possible, to achieve a maximum profit. This can be done by achieving a maximum output with a given level of costs which determines the amount of inputs affordable.

For example in 1972 the South African manufacturing industry used capital of R43434.68 million and 1,137950 million of employees. The cost of capital was \( r = 0.1484 \) and wages were R 26,142 thousands. The result of the marginal rate of technical substitution was

\[
\left( \frac{B}{a} \right) \left( \frac{K}{L} \right) = \left( \frac{0.6084}{0.3332} \right) \left( \frac{43434.68}{1,137950} \right)
\]

\[
= 69.692
\]

The ratio of input prices was

\[
w/r = \frac{26,142}{0.1484}
\]

\[
= 176.16
\]

Since 69.692 < 176.16 it shows that labour was over-utilized.

1990 yielded the following results:

\[
\left( \frac{B}{a} \right) \left( \frac{K}{L} \right) = \left( \frac{0.6084}{0.3332} \right) \left( \frac{98822.18}{1,542790} \right)
\]

\[
= 116.96
\]

\[
w/r = \frac{28,609}{0.1626}
\]

\[
= 175.95
\]

In 1990 there was also evidence of over-utilisation of labour,
since $116.96 < 175.95$. During all the years from 1972 to 1993 labour was over-utilized. The results for each year are shown in Appendix 4.

### 3.8 THE EFFICIENCY CRITERION AS A MEASUREMENT OF OPTIMAL INPUT COMBINATION

The previous paragraph examined whether the South African manufacturing industry is over utilizing labour or capital or if the industry uses an optimal input combination. It was found that labour was over-utilized for all the years from 1972 to 1993 by comparing the results of the marginal rate of technical substitution with the ratio of wages to the cost of capital. A similar measure is the efficiency criterion. In the Cobb-Douglas production function the optimal condition for a firm prevails when

$$\frac{MP_L}{MP_K} = \frac{\beta}{\alpha} \frac{K}{L}$$

This yields

$$\frac{\beta}{\alpha} \frac{K}{L} = \frac{w}{r} \quad \text{or} \quad \frac{\beta}{\alpha} \frac{K}{L} - \frac{w}{r} = 0$$

The efficiency criterion is expressed as

$$\psi = \beta \frac{K}{L} - \alpha \frac{w}{r}$$

This means that if $\psi$ equals zero the optimal condition is reached. If $\psi > 0$ capital is over-utilized and if $\psi < 0$ labour
is over-utilized (Maurice et al., 1988: 342-343).

For example in 1972 the efficiency criterion gave the following results

\[
\psi = 0.6084 \left( \frac{43434}{1137.95} \right) - 0.3332 \left( \frac{26.142}{0.1484} \right) \\
= 23.22 - 5870 \\
= -35.47
\]

This yields \( \psi < 0 \) which indicates an over-utilization of labour.

In 1993 the efficiency criterion showed a result of

\[
\psi = 0.6084 \left( \frac{102500}{1439.35} \right) - 0.3332 \left( \frac{31.482}{0.1487} \right) \\
= 43.33 - 70.54 \\
= -27.21
\]

Since \( \psi < 0 \) in 1993 an over-utilization of labour was also the case.

These results confirm the results of the previous paragraph. According to the results shown in APPENDIX 7 the efficiency criterion indicates that for the years from 1972 to 1993 the South African manufacturing industry was over-utilizing labour. This corresponds with the results in the previous paragraph. However, it is unlikely that \( \psi \) is exactly equal to zero. Therefore it must be tested if \( \psi \) is significantly different from zero. This is done by applying the t-test. The calculated t-value is calculated as:
\[ t_\psi = \psi / S_\psi \]

To arrive at \( S_\psi \), the variance for \( \psi \) must be calculated.

\[
\text{var}\psi = (K/L)^2 \text{var}\beta + (w/r)^2 \text{var}(\alpha) - \alpha(K/L)(w/r) \text{cov}(\alpha, \beta)
\]

\[
S_\psi = \sqrt{\text{var}(\psi)}
\]

For example in 1972 the calculated t-value yielded the following results:

\[ \psi = -35,48 \]

\[
S_\psi = \sqrt{(43434/1137,95)^2 \ast 0,0473 + (26,142/0,1484)^2 \ast 0,0048 - 2 \ast (43434/1137,95) \ast (26,142/0,1484) \ast (-0,01423)}
\]

\[ S_\psi = 20,23 \]

\[ t_\psi = -35,48 / 20,23 \]

\[ = -1,7538 \]

Comparing the calculated t-value of 1,7538 with the critical value of 1,729 at a 90% confidence level, one can see that \( \psi \) is statistically significant for 1972. Thus the hypothesized over-utilisation of labour can be confirmed.

For example in 1988 the calculated t-value yielded the following results:

\[ \psi = -31,24 \]

\[
S_\psi = \sqrt{(94323/1528,07)^2 \ast 0,0473 + (27,172/0,1316)^2 \ast 0,0048 - 2 \ast (94323/1528,07) \ast (27,172/0,1316) \ast (-0,01423)}
\]

\[ S_\psi = 27,34 \]
Comparing the calculated t-value of 1.1427 with the critical value of 1.729 at a 90% confidence level, one can see that \( \psi \) is not statistically significant for 1988. Thus the hypothesized over-utilisation of labour cannot be confirmed. One cannot reject the hypothesis that the South African manufacturing industry in 1988 was using optimal amounts of capital and labour. Results for all years from 1972 to 1993 are shown in APPENDIX 7. The calculated t-values for 1972 to 1975 are greater than the critical t-value which means that the South African manufacturing industry was over-utilising labour. During 1976 to 1978 \( \psi \) was not statistically significant at a 90% confidence level thus an over-utilization for these years cannot be confirmed.

3.9 THE OPTIMUM INPUT RATIO FOR THE SOUTH AFRICAN MANUFACTURING INDUSTRY

An alternative way to examine if an optimal combination of labour and capital was used is possible by comparing the capital-labour ratio with the ratio of input prices. It was found that the optimal combination of input factors is achieved when

\[
\frac{(B/a)(K/L)}{w/r}
\]

Substituting \( Z \) for \( \frac{(\alpha w)}{(\beta r)} \)

it follows:

\[
K/L = Z
\]

Production factors are used efficiently, if \( K/L = Z \).
For example in 1972 the South African manufacturing industry used capital of R43433.68 million and employed 1,137950 million workers.

The capital labour ratio was

$$K/L = \frac{43433.68}{1,137950}$$

$$= R\ 38,168\ thousand$$

The cost for labour was R 26142 and the cost for capital was 0.1484. This yielded

$$Z = \frac{(0.3332\times 26142)}{(0.6084\times 0.1484)}$$

$$= R\ 96,476\ thousand$$

This indicates that $K/L \neq Z$ and therefore the combination of labour and capital was not efficient.

If the amount of capital used would have been R 109790.2m then

$$K/L = \frac{109790.2}{1,137950}$$

$$= R96,480\ thousand$$

$$Z = R\ 96,479\ thousand$$

If labour would have been 450,1796 thousand workers then

$$K/L = \frac{43433.96}{4501796}$$

$$= R96,481\ thousand$$

$$Z = R96,479\ thousand$$

APPENDIX 8 shows the comparison of the capital labour ratio to the ratio of costs.
From the equation \((\beta/\alpha)*(K/L) = w/r\) the optimal input for capital can be determined. Solving the above equation for \(K\), it yields

\[ K = (w/r)(\alpha/\beta)L \]

For example in 1972 the optimal input of capital with a given number of workers would have been

\[ K = (26142/0.1484)*(0.3332/0.6084)*1137950 \]

\[ = \text{R109790,2 m} \]

Substituting the actual amount of \(K = \text{R43433,68m}\) with \(K = \text{R109790,2m}\) it yields

\[(\beta/\alpha)((K/L) = (0.6084/0.3332)*(109790,2/1137,950) \]

\[ = 176,17 \]

\[ w/r = 176,17 \]

Thus, if the amount of capital of \(\text{R109790,2m}\) instead of \(\text{R43433,68m}\) would have been used, an optimal combination of inputs would have been achieved under the condition of given factor prices.

The optimal input of labour with a given amount of capital can be arrived at by solving equation \((\beta/\alpha)*(K/L) = w/r\) for \(L\). It yields

\[ L = (\beta/\alpha)*(r/w)K \]

The optimal input of labour would have been

\[ L = (0.6084/0.3332)*(26142/0.1484)*43433,68 \]
Substituting the actual amount of $L = 1137.95$ with $L = 450,1796$ into

$$(\beta/\alpha)*(K/L) = (0.6084/0.3332)*(43433.68/450,1796)$$

$$= 176,17$$

$w/r = 176,17$

Thus, if 450,1796 thousand workers instead of 1137.95 thousand workers would have been employed, an optimal combination of inputs would have been achieved under the condition of given factor prices. Appendix 9 shows a comparison between the actual amount of capital used and the optimal amount of capital, as well as the actual number of workers employed and the optimal number of workers.

### 3.10 THE OPTIMUM UTILIZATION OF THE BUDGET OUTLAY

The optimal allocation of production factors will be reached at a point where the output equals total cost. As shown before output is expressed as $Q = AK^aL^b$ and total cost are expressed as $TC = rK + wL$.

It was shown in the previous paragraph that the optimal combination of inputs is reached when

$$(\beta/\alpha)*(K/L) = w/r$$

solving for $L$ it becomes

$$L_o = (\beta/\alpha)*(r/w)K$$
Solving the cost equation for \( L \), it becomes

\[
L = (TC - \bar{r}K)w
\]

Since an optimal combination of inputs is achieved when

\[
(\beta/\alpha)(r/w)K = (TC - rK)w
\]

then \( K_0 \) can be calculated as follows

\[
K_0 = \frac{(Caw)}{(Brw + arw)}
= \frac{(\alpha C)}{(r(\alpha + \beta))}
\]

The actual cost spent (calculated with the equation \( C = rK + wL \)) can be compared with the cost of optimal factor allocation determined by \( C_0 = rK_0 + wL_0 \). The difference indicates the amount of cost wasted as a result of the non-optimal allocation of factors.

For example in 1972 the South African manufacturing industry used \( K = R43433,68 \)m and \( L = 1137,95 \) thousand workers. The cost for labour was \( w = R26,142 \) thousand and the cost for capital was \( r = 0,1484 \). The actual cost spent was:

\[
TC = rK + wL
= (0,1484*43433,68)+(26,142 \text{ thousand} * 1137,950 \text{ thousand})
\]

\[
TC = R 36193,8945 \text{ million}
\]

The amount of capital according to the optimal allocation of factors would have been:
\[ K_o = \frac{(\alpha C)}{(r(\alpha+\beta))} \]
\[ = \frac{(0.3332 \times R36193,8945m)}{0.1484 \times (0.3332+0.6084)} \]
\[ K_o = R86305,7955m \]

\[ L_o = \frac{(\beta/\alpha)}{(r/w)}K_o \]
\[ = \frac{(0.6084/0.3332)}{(0.1484/26,142)} \times 86305,7955 \]
\[ L_o = 894,5653 \text{ (thousand workers)} \]

This conforms with the previous findings that labour was over-utilized. The optimal labour input would have been 894,5653 thousand instead of the 1137,950 thousands workers employed.

One can calculate the amount of output that could have been produced with an optimal input combination and given cost of labour and capital.

\[ Q_o = AK^\alpha L^\beta \]
\[ = 66,936 \times 86305,7955^{0.3332} \times 894,5653^{0.6084} \]
\[ = R184547 \text{ m} \]
\[ Q_{true} = R169953 \text{ m} \]

\[ Q_o - Q_{true} = R184547m - R169953m \]
\[ = R 14,594 \text{ bn} \]

It shows that in 1972 an additional amount of R 14,6 billion could have been produced if labour and capital would have been
allocated efficiently. Results for all the years are shown in APPENDIX 10.

3.11 ECONOMIES OF SCALE

3.11.1 RETURNS TO SCALE

As discussed in chapter IV the aim of a firm is to increase its output. This can be achieved by increasing the capital input or the labour input. The law of returns to scale is the responsiveness of output to changes in changes of inputs.

In the Cobb-Douglas production function $\alpha$ and $\beta$ are output elasticities and determine to what extent changes in capital and labour will change output. It can be defined as

$$E = \left(\frac{\% \text{change in output}}{\% \text{change in input usage}}\right)$$

The change in input usage can be divided into individual changes of capital and labour and one can define $E$ according to the two inputs.

$$E = \left(\frac{\% \text{change in output}}{\% \text{change in } K}\right) + \left(\frac{\% \text{change in output}}{\% \text{change in } L}\right)$$

In the Cobb-Douglas production function $E_K$ can be expressed as

$$E_K = (\alpha (Q/K))*(Q/K) \text{ that yields } E_K = \alpha$$

and

$$E_L = (\beta (Q/L))*(Q/L) \text{ that yields } E_L = \beta$$
That yields that $E = \alpha + \beta$.

The South African manufacturing industry for the years of 1972 to 1993 had returns of scale

$$E = 0,3332 + 0,6084 = 0,9416$$

This indicates decreasing returns to scale since $0,9416 < 1$. To determine if the sum of $\alpha$ and $\beta$ is significantly less than one, the t-test must be applied. In this case the t-statistic is

$$t_{\alpha+\beta} = \frac{(\alpha+\beta) - 1}{S_{\alpha+\beta}}$$

the estimated standard error for $\alpha$ and $\beta$ is

$$S_{\alpha+\beta} = \sqrt{\text{var}(\alpha) + \text{var}(\beta) + 2\text{cov}(\alpha,\beta)}$$

$$S_{\alpha+\beta} = \sqrt{0,0048 + 0,0473 + 2*(-0,0142)}$$

$$= 0,1538$$

therefore

$$t_{\alpha+\beta} = \frac{(0,3332+0,6084)-1}{0,1538}$$

$$= 0,3797$$

This value is less than the critical t-value of 1,729 at a 90% confidence level. Therefore the null hypothesis cannot be rejected and it cannot be confirmed whether the estimated sum of $\alpha$ and $\beta$ is less than one. One cannot conclude that decreasing returns to scale existed. The returns to scale are the same for the period of 1972 to 1993 because only one production function was estimated for the time and $\alpha$ and $\beta$ are constants for this period. According to the estimated $\alpha$ and $\beta$ shown in TABLE 25 the following returns to scale are obtained.
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1972-82</td>
<td>0.5612</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1972-83</td>
<td>0.8533</td>
<td>1.0129</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1972-84</td>
<td>0.9266</td>
<td>1.0299</td>
<td>1.0345</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1972-85</td>
<td>0.9990</td>
<td>1.0222</td>
<td>1.0032</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1972-86</td>
<td>0.9806</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1972-87</td>
<td>0.9828</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Data from IDC and SARB; Calculations done in TSP

The above table shows increasing returns to scale for the periods of 1972 to 1989 until 1972 to 1992. However, to determine if the results are significantly greater than one, the t-test should be applied.

3.11.2 THE MEASUREMENT OF ECONOMIES OF SCALE

As shown in the previous paragraph, calculations to determine returns to scale take only account of variations in inputs under the assumption of constant factor costs. In the case of increasing returns to scale, the average long-run cost curve will be decreasing. This is referred to as economies of scale. There is a specific relationship between returns to scale and the long-run cost curve. Changes in returns to scale will influence the cost curve and vica versa. This combination of changes in factor inputs and their relative prices influences the production output. As explained in chapter IV the long-run cost function is defined as:

\[ TC = rK + wL \]
expressed as a power function, it yields:

\[ TC = AQ^6 w^7 r^6 \]

Expressed in logarithms under the assumption of \( \gamma + \delta = 1 \), it yields:

\[ \log TC = \log A + \beta \log Q + \gamma \log (w/r) + \log r \]

\[ \log (TC/r) = \log A + \beta \log Q + \gamma \log (w/r) \]

The long-run cost function for the South African manufacturing industry was estimated in TSP and gave the following results:

\[ TC/r = 0.0892Q^{0.8723}(w/r)^{0.8348} \]

The coefficient \( \beta \) of 0.8723 is the elasticity of cost with respect to output. It can also be expressed as:

\[ \beta = \text{%change in cost}/\text{%change in output} \]

This indicates if \( \beta > 1 \) the average long-run average costs will be increasing and diseconomies of scale prevail. Conversely if \( \beta < 1 \) the average long-run cost will decrease and economies of scale exist (Maurice, 1988: 328). The estimated cost function for the South African manufacturing industry yielded \( \beta = 0.8723 \) (which is smaller than 1) and indicates economies of scale. Since \( \beta \) is quite close to 1 the economies of scale might not be so strong. To determine if the coefficient is statistically significant, it is necessary to perform the t-test. The methodology to be used is

\[ t_8 = (\beta - 1)/S_8 \]
The standard error of $\beta$ was calculated by TSP.

$$t\beta = (0.8723-1)/0.3093$$

$$= -0.4129$$

The critical $t$-value is 1.729 at a 90% confidence level. Since 0.4129 is much smaller than 1.729 one cannot reject the null hypothesis and $\beta$ is not statistically significant. Therefore one cannot conclude that economies of scale exist. As it is the case for the production function, only one long-run cost function was estimated and $\beta$ is the constant applicable for the whole period of 1972 to 1993. Different estimated long-cost functions would result in different $\beta$ and hence different results of economies or diseconomies of scale.

4 PRODUCTIVITY OF INPUT FACTORS OF THE SOUTH AFRICAN MANUFACTURING INDUSTRY VERSUS THOSE OF ITS COMPETITORS

In the following paragraphs productivity of capital and labour of the South African manufacturing industry will be compared with those of its competitors. The results will show how well South Africa's labour and capital productivity contribute to the level of international competitiveness of the South African manufacturing industry.

As it was discussed in chapter IV total factor productivity is a measurement of technical progress at the input base. In the following paragraph total factor productivity in the South African manufacturing industry will be compared with those of its competitors.
4.1 THE IMPORTANCE OF TOTAL FACTOR PRODUCTIVITY FOR CAPITAL AND LABOUR PRODUCTIVITY

Total factor productivity (TFP) in the Cobb-Douglas production function is measured by the constant A. It is commonly defined as the portion of real output which is not accounted for by labour and capital input. TFP growth gives an indication of efficiency gains in the production process. This can be achieved through technical progress which is not necessarily measured in capital productivity. Therefore, a significant link between TFP growth and the quality of capital accumulation is evident. Increased capital formation may raise TFP growth and the standard of living of the labour force without being harmful to employment. Growth in TFP can also be achieved through higher and/or better education which is not necessarily included in labour productivity (OECD, 1987: 39 & 42). For countries with access to similar technologies, persistent differences in the levels of TFP are a sign of differences in efficiency. This can result from many sources, including country-specific institutions, human capital endowments and infrastructure (Englander & Gurney, 1994: 113).

TFP gains in manufacturing have exceeded those in the total business sector over the last two decades which can be explained by the openness to international trade of the manufacturing sector. This leads to the exchange of information about innovation and new technology. TFP gains can also be through imports of capital goods which is very important for industries in developing countries (OECD, 1987: 42).

The expansion of world trade during the 1950's and 1960's was to a large extent the vehicle through which technology was diffused and economies 'caught up' with productivity levels of the United
The weakening in TFP growth in the 1973-79 period can be explained by the influence of a number of structural factors. Some of these were the end of post-war reconstruction, less rapid expansion of international trade and the slowdown of technological advances (ibid: 44). TABLE 26 below shows trends in TFP in the South African manufacturing industry compared with its competitors.

<table>
<thead>
<tr>
<th></th>
<th>Pre-73</th>
<th>1974-79</th>
<th>1980-90</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>1,5</td>
<td>-0,4</td>
<td>0,2</td>
</tr>
<tr>
<td>Germany</td>
<td>2,5</td>
<td>1,7</td>
<td>1,0</td>
</tr>
<tr>
<td>Japan</td>
<td>4,6</td>
<td>0,9</td>
<td>1,6</td>
</tr>
<tr>
<td>Korea</td>
<td>2,1</td>
<td>0,3</td>
<td>2,3</td>
</tr>
<tr>
<td>South Africa</td>
<td>not available</td>
<td>0,1</td>
<td>-0,9</td>
</tr>
</tbody>
</table>

Source: OECD Medium Trend, p.116 for the United States, Germany and Japan; OECD, Korea 1996, p.5 for Korea; IDC for South Africa

Starting years: United States and Germany 1961, Japan and Korea 1963

Data for the United States, Germany and Japan represents the business sector; for Korea the whole economy and for South Africa the manufacturing sector.

Korea showed high values of TFP changes in most sectors by international standards. During the export promotion period from 1961 to 1973 TFP growth was relatively rapid, boosted, inter alia, by massive migration of agricultural workers to higher productivity jobs in manufacturing and services (OECD, Korea, 1994: 29). During the period 1973 to 1979 TFP growth declined rapidly, (suggesting
that government intervention in investment decisions during the HEAVY INDUSTRY AND CHEMICAL INDUSTRY drive reduced efficiency). Nevertheless, Korea does not appear to fit the picture of newly industrialised countries of Asia achieving rapid growth almost exclusively through increased inputs, while efficiency improved very little. In fact, TFP growth in Korea was comparable to that in the OECD area prior to 1980 and has been significantly higher since then (OECD, Korea, 1996: 5).

In comparison with its competitors, the South African manufacturing industry did not show good results. This points to the fact that production factors have not been used efficiently. Especially in 1981 and 1982 after the gold boom even with high growth in capital stock of 10.2% and 6.8% the TFP recorded negative growth of -0.9% and -8.0% respectively (Prinsloo et al., 1996: 34). Negative real interest rates made it attractive to increase capital stock without putting enough emphasis on its efficiency and technical progress. It confirms the results of declining capital productivity and the high age of capital stock that will be discussed in the next paragraph. The poor performance of TFP was among the factors dampening the competitive performance of the South African manufacturing industry.

Rapid TFP change in developing countries can be the result of the ability to move quickly closer to international best practice - productivity-based catching up. The rapid formation of human capital which resulted in highly skilled domestic engineers and workers is important to make productive use of foreign knowledge and imported capital. Intensive efforts by highly skilled managers and technicians in individual plants in inward-orientated Latin American economies (to improve the productivity of existing capital stock with internal innovations) did not generate high productivity growth. Openness to trade has often generated positive interaction between human capital, physical capital and knowledge (World Bank, 1993: 320). The disappointing results of TFP performance in the South African manufacturing industry lead to the conclusion that efforts to introduce technical progress were not sufficient enough to catch-up with international standards.
In recent years there have been frequent challenges to the traditional growth model of Solow (1956) in which technological progress is exogenous. A first alternative view, initially suggested by Romer (1986), predicts that increases in total factor productivity and therefore the rate of growth are linearly related to the rate of capital accumulation, implying the optimality of investment subsidies. A second widely-held version of the endogenous nature of technology is based on the influential role of R&D in determining the long-run growth rate. Recent research has recognised that R&D intensity is by no means exogenous and has concentrated on the determinants of R&D or knowledge production more generally. Technological opportunities and conditions are key determining factors (OECD, United States, 1993: 83).

4.2 THE LEVEL AND THE AGE OF FIXED CAPITAL STOCK AS A DETERMINANT OF CAPITAL PRODUCTIVITY

A commonly used measurement for capital stock is the perpetual inventory method as explained in chapter III. TABLE 26 shows average growth rates in fixed capital stock.

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average growth</td>
<td>7,7</td>
<td>7,7</td>
<td>3,0</td>
<td>3,4</td>
</tr>
</tbody>
</table>

Source: Prinsloo & Smith, 1996: 35

The sustained strong growth during most of the 1970's was due to projects like Alusaf, Natref, Iscor's Newcastle works, Sasol II and expansion programmes at Iscor Pretoria and Vanderbijlpark works. This should have had a positive influence on the efficiency of capital. It can be argued that new fixed capital stock embodies the latest technology. However, as discussed in a previous paragraph, the marginal productivity declined during this time. This means that
capital was not used efficiently. The decline in the rate of growth from 1974 to 1976 can be attributed to lower demand during the economic downswing during this time and existing surplus in production capacity. During the 1980's the growth rate in fixed capital stock slowed down substantially; with negative growth rates from 1985 to 1988. The successive years of drought and the completion of large expansion projects by Sasol, affected capital formation negatively. In addition to this, increasing political and socio-economic instability which resulted in trade sanctions, boycotts and disinvestment by foreigners made the situation worse. The high level of "user costs" of capital goods (which will be discussed in another paragraph) was another factor contributing to the decline of capital formation. Since the beginning of the 1990's an about-turn in the trend can be seen. Specially from 1993, a reversal of negative factors like the lifting of sanctions on trade were largely responsible for the stronger growth in capital formation. Since the election in April 1994 the political violence declined encouraging investment expenditure by domestic and foreign investors. Foreign direct investment started to increase which is more beneficial for growth in the manufacturing industry. This involves foreign technical knowledge (know-how), management practices which lead to better production processes thus increasing the efficiency of labour and capital. Problems in the labour markets which caused high unit labour costs were a benefit to the production factor capital relative to labour (Prinsloo et al., 1996: 34-38).

As mentioned before in chapter III the growth in fixed capital stock determines the average age of capital stock for assets with the same lifespan. The general aging of capital stock will lead to backwardness in technology and hence to losses in productivity and competitiveness. The FIGURE below depicts the development of the age of real fixed capital stock and gross fixed investment.
This clearly shows the inverse correlation between the two variables. In the first quarter of 1989 the average age reached a historically high point of 4.72 years. This indicates the need for replacement of obsolete stock. One can conclude that there was an increasing loss in competitiveness starting from 1984 until 1989 with mostly negative growth rates in capital formation. In the fourth quarter of 1995 the average age had come down to 3.49 years which was below the long-term average of 4 years (ibid: 33). The age of capital stock gives a good indication about its efficiency since the lower the age of capital stock the better the level technology.

4.3 THE INFLUENCE OF CAPITAL STOCK ON CAPITAL PRODUCTIVITY

The amount of capital stock and its efficiency determines capital productivity and to a large extent the level of competitiveness of a firm or industries. The growth in capital stock contributes to
output growth and one can arrive at the growth of capital productivity by subtracting growth in capital stock from the growth in output. This also gives an indication about the average age of capital stock. A slow growth rate would indicate that the age of capital stock is increasing, pointing to a loss of efficiency. TABLE 28 below illustrates the contribution of capital growth over three periods in different countries.

TABLE 28
GROWTH IN OUTPUT COMPARED WITH GROWTH IN CAPITAL
average percentage change at annual rates

<table>
<thead>
<tr>
<th></th>
<th>Pre-1973</th>
<th>1974-79</th>
<th>1980-90</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Output</td>
<td>Capital</td>
<td>Output</td>
</tr>
<tr>
<td>USA States</td>
<td>3.8</td>
<td>3.7</td>
<td>2.5</td>
</tr>
<tr>
<td>Germany</td>
<td>4.3</td>
<td>5.7</td>
<td>2.3</td>
</tr>
<tr>
<td>Japan</td>
<td>9.3</td>
<td>12.1</td>
<td>3.4</td>
</tr>
<tr>
<td>Korea</td>
<td>9.0</td>
<td>3.7</td>
<td>9.3</td>
</tr>
<tr>
<td>South Africa</td>
<td>not availab</td>
<td>le</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Source: OECD Medium Trend for the United States, Germany and Japan; OECD Korea 1996 for Korea; IDC for South Africa

Data for the United States, Germany and Japan represent the business sector; for Korea the whole economy; for South Africa the manufacturing sector.

After 1973 the rate of growth in capital stock fell by over 40% in Japan and Germany during the second half of the 1970's and the deceleration continued into the 1980's. Output growth in these two countries showed a similar pattern. Calculations done with the relevant weighting for capital showed that the growth in capital contributed roughly to half of the output growth. This underlines the importance of capital to output growth.
In the United States capital growth remained at the same level until the 1980's when it started to decline slightly. It also accounted for roughly half of the output growth.

In the case of Korea capital growth was relatively moderate in comparison to Japan in the early 1970's. However, it accelerated sharply during the period of 1974 to 1979 because of the "Heavy Industrial and Chemical Industry" drive initiated by the Korean government. During the 1980's capital growth in Korea experienced a decline similar to Germany and Japan reflecting global recession of the late 1970's and early 1980's.

The results in capital growth contribution to output growth in the South African manufacturing industry do not compare favourably with the other countries. Especially compared with Korea, South Africa is loosing more and more. Its capital growth compares very favourably with those of Germany and Japan, however, its capital contribution to output is poor. This again proves that capital is not used efficiently.

4.4 DEVELOPMENTS IN THE COST OF CAPITAL IN THE SOUTH AFRICAN MANUFACTURING INDUSTRY

In a previous paragraph the combination of capital and labour input was analysed. It was shown that for all the years from 1972 to 1993 labour was over-utilized. This resulted as the ratio of marginal productivities was smaller than the ratio of factor prices. This indicates that labour was more expensive in relation to capital.

Investment in fixed capital and therefore its growth is a good indication of the efficiency of capital. However, new capital must also be affordable to firms in the manufacturing industry. In chapter III the calculation of relative user costs of capital was explained. FIGURE 47 illustrates the movements of relative user costs in the manufacturing sector over the last three and half decades.
During the 1960's and 1970's the user cost of capital did not show any erratic movements. In 1979 it had reached a lower-turning point reflecting among other things low real interest rates and higher output prices. From 1983 to 1986 the increase accelerated very sharply. The collapse of the rand in 1984 and 1985 caused extreme upward pressure on prices for imported capital goods which make up a large part of capital investment. There is a good correlation between gross fixed investment and imports in general. In addition higher domestic interest rates arising from negative developments in the balance of payments pushed up relative user costs even further. The highest level was reached in 1991. The steep rise during 1983 to 1991 was also caused by higher corporate taxes and fewer tax rebates (Prinsloo et al., 1996: 37). Since 1992 relative user costs started to decline showing the effect of lower interest rates, the phasing-out of the recession with higher corporate profits. Since April 1994 a marked net inflow of foreign funds made financing of capital goods easier. The slight pick-up since 1994 reflects stricter monetary
policies to keep inflation under control.

4.5 CAPITAL PRODUCTIVITY

In previous paragraphs determinants of capital productivity have been discussed. In this paragraph the developments in capital productivity will be outlined.

By the early 1970's a combination of structural factors lead to reduced capital productivity in the United States, Germany and Japan. The post-war reconstruction had ended in Germany and Japan; international trade expanded less rapidly; and there was a slowdown of technological advancement. A change in the composition of the labour force and perhaps government regulations also contributed to a slowdown in capital productivity (OECD, 1987: 44).

According to TABLE 29 the 1960's and early 1970's recorded virtually no growth in the United States and negative growth for Germany and Japan. This can be explained by a high growth in capital deepening as capital growth was much higher than employment growth. In the case of Japan, capital grew by an average of 12.1% per annum compared with a growth in employment by a mere 1.3% per annum.

The period 1974 to 1979 recorded negative growth for all three countries with Japan still showing the greatest decline. Higher inflation triggered off by the two oil price shocks indicated that the cost of capital were rising faster than its productivity. This lead to a slowing down in capital accumulation mainly in Japan and Germany as it was illustrated in the previous paragraph.

During the first half of the 1980's (which was influenced by the global recession) capital productivity continued to decline at about the same rate as in the previous period in the United States, and to a higher extent in Germany. In the second half of the 1980's Germany
recorded positive growth in capital productivity. In Japan the rate of decline during the first half of the 1980's was less marked than during the 1970's. The rate of decline slowed down even further in Japan reflecting the slowing growth in the capital labour ratio.

<table>
<thead>
<tr>
<th>TABLE 29</th>
<th>CAPITAL PRODUCTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>0,1</td>
</tr>
<tr>
<td>Germany</td>
<td>-1,4</td>
</tr>
<tr>
<td>Japan</td>
<td>-0,3</td>
</tr>
<tr>
<td>Korea</td>
<td>5,3</td>
</tr>
<tr>
<td>South Africa</td>
<td>-2,2</td>
</tr>
</tbody>
</table>

Source: Englander & Gurney, 1994: 116-177 for the United States, Germany and Japan; OECD, Korea, 1996: 5 for Korea; IDC for South Africa.

Data for the United States, Germany and Japan represent the business sector; for Korea the whole economy; for South Africa the manufacturing sector.

According to a report published by the McKinsey Global Institute (The Economist, June 8, 1996: 19 & 90) American firms made far better use of their capital than those in Japan or Germany during 1990 and 1993. The report states that for the business sector one unit of capital in Japan or Germany produced about one third less in output than in America. There was a remarkable difference between the savings rates of the three countries. Between 1974 and 1993 America's gross saving averaged 25% of its GDP compared with 31% in Germany and 36% in Japan. Since savings finance investments, one can assume that investment were higher in Germany and Japan. This points to higher capital productivity in America because American firms make far better use of their capital stock than their counterparts.
in Germany or Japan. One reason can be the way managers run their companies such as choosing the right product mix and the setting of prices. The structure of capital markets can play a big part. American managers are under greater pressure from investors to focus on financial performances. This tends to make them more discriminating in decisions about new capital products. A large effect has been the intensity of competition. Low barriers to entry and high competition forces managers to make the most of their capital stock. By contrast, regulations such as zoning laws keep new players out as is the case in Japan. Unproductive firms are protected (The Economist, June 8, 1996: 19 & 90).

The picture in Korea is quite different. Capital productivity recorded a high level of an average of 5.3% during the period 1963 to 1973. In the 1970's it fell to 3.8% which can be attributed to the acceleration in capital accumulation with constant growth in the labour input; a case of capital widening. This was triggered off by the Heavy-Chemical-Industry (HCI) drive by which the government decided to shift from general export production to heavy and chemical industries. This led to an over-investment and low profitability in certain industries favoured by the HCI drive. This situation was intensified by high inflation and a loss in the terms of trade stemming from the oil price shocks (OECD, Korea, 1994: 19). This showed that capital was not used efficiently. During the 1980's capital productivity rose again to an average of 5% although the growth in the capital-labour ratio remained at the same level. This indicates that capital was used more efficiently (OECD, Korea, 1996: 5).

During the second half of the 1970's the South African manufacturing industry recorded a decline in its capital productivity. This can be attributed to the high growth of capital stock especially during the late 1970's which was caused by the gold boom. It is noticeable that South Africa's decline was less than Japan's but it compares badly with Korea. The period 1980 to 1985 recorded an even more pronounced decline in capital productivity which was related to high growth in capital stock at the beginning of the 1980's. Real
negative interest rates which prevailed during the late 1970's and early 1980's made investment in capital stock more affordable. South Africa compared badly with its competitors. The trend turned around dramatically during the period 1985 to 1990 when capital productivity increased by 1.6%. This rate was higher than that of its competitors except for Korea. The collapse of the value of the rand in 1984/85 lead to a cutback in investment as capital imports became very expensive. High real interest rates starting from 1983 added to the cost of capital. Consequently capital utilisation increased and lead to growth in capital productivity. This positive trend reversed again in the early 1990's.

4.6 CAPITAL DEEPENING AND LABOUR PRODUCTIVITY

In the United States and across other OECD countries a strong correlation between capital deepening, additions to the stock of capital per worker and productivity growth prevailed. In the immediate post-war period capital deepening was very rapid in the US and continued at a rate of 2.8% p.a. from the early 1960's until 1973. During the same time output per hour in the business sector grew by 2.5% p.a. From the early 1970's capital deepening slowed to about 0.8% p.a. with a growth of output per hour to also 0.8% p.a. (OECD, US, 1993: 66). In the rest of OECD capital deepening has also slowed in recent years together with productivity growth. Both remained well above US rates (OECD, United States, 1993: 66).

To a large extent, new technology is embodied in capital equipment: there has been a historical correlation between growth in TFP and capital deepening. For the United States it is suggested that productivity growth is highly positively correlated with increases in the capital output ratio over the previous 2 years. No positive correlation is evident between growth in capital-output ratio and current and past changes in labour productivity. Equipment and productivity growth are linked although not as much since the mid 1970's (OECD, United States, 1993: 66-67 & 68).

As was shown before the South African manufacturing industry...
recorded an average growth of 3.27% in the capital-labour ratio during the 1970's. During the 1980's the average growth was still positive but by a mere 0.08%. This was due to slower and negative growth in capital stock as discussed in a previous paragraph.

| TABLE 30 |
|------------------|------------------|------------------|
| CAPITAL-LABOUR RATIO FOR THE SOUTH AFRICAN MANUFACTURING INDUSTRY |
| average annual percentage change |
| 1970-80 | 1980-90 | 1990-95 |
| 3.27 | 0.08 | 4.94 |
| Source: Wefa Group, 1996 |

The high capital-labour ratio can be ascribed to inappropriate relative prices in the 1970's and early 1980's. Reasons were low interest rates, tax concessions, a fast increase in wages and price controls. The low growth during the 1980's reflects the impact of higher real interest which lead to a decline in capital stock. The first half of the 1990's shows a reversal in the trend back to high levels even with the high cost of capital since 1989 when the SARB implemented stricter monetary policies.

4.7 LABOUR PRODUCTIVITY

By far the most common measure of productivity for international comparison is labour productivity applied to industries or firms. Reasons for this state of affairs is that data for labour inputs are more easily obtainable than for capital and the share of labour costs in the production process are very often the highest (Wefa Group, 1996: 6-7). According to the OECD the average share of labour for the United States, Japan and Germany is very close to 70% (Englander et al., 1994: 116). The average productivity of labour can be measured by the ratio of the real output of the number of
FIGURE 48 shows labour productivity in the manufacturing sector of the United States, Germany and Japan. There is a big gap between Japan's labour productivity and that of the United States and Germany. Both are running very closely together until 1991 when they start to diverge. The increase in the American labour productivity coincides with the start of the recovery from 1992. By 1993 the German economy recorded negative growth after the effects of reunification had lost momentum. Labour productivity in Germany shows signs of a decline even from such low levels. Japan entered a period of low economic growth starting from 1992 which shows its effect on labour productivity.

An alternative and better measurement is a comparison of growth in labour productivity on an international level. TABLE 31 shows a comparison between South Africa and its major competitors.

Labour productivity in the South African manufacturing industry
performed poorly in comparison to the other countries except for the
United states. The high growth in the capital-labour ratio during
the second half of the 1970's should have increased the growth in
labour productivity because more capital per worker was available.
The picture is even more disappointing during the first half of the
1980's when no growth at all was recorded because the capital-labour
ratio did not increase. This points to a declining efficiency of
labour. During the second half of the 1980's labour productivity
recorded a slight growth of 1,0%. even with a decline in the
capital-labour ratio. The decline in employment and the fear of
losing jobs increased the motivation of labour to be more efficient.
The overall trend shows that the low performance of South Africa's
labour productivity especially when compared with that of Korea
keeps the prospect of a rise in competitiveness rather subdued.

| TABLE 31 |
| GROWTH IN LABOUR PRODUCTIVITY |
| average percentage change at annual rates |
| United States | 2,1 | 0,0 | 0,7 | 0,5 |
| Japan | 8,0 | 2,9 | 2,8 | 3,1 |
| Germany | 4,4 | 3,0 | 1,3 | 2,1 |
| Korea | 6,3 | 6,4 | 6,5 (1970-90) |
| South Africa | not available | 1,8 | 0,0 | 1,0 |

Source: Englander & Gurney, 1994: 116-117 for the United
States, Japan and Germany; OECD, Korea, 1996: 5 for Korea; IDC
for South Africa

Data for the United States, Germany and Japan represent the business
sector; for Korea the whole economy; for South Africa the
manufacturing sector.

The 1960's and early 1970's recorded high growth in labour productivity in Germany and even higher ones in Japan. The main reason for the high labour productivity growth during this period was the reconstruction that took place during the post-war era in Japan and Germany. During this time the growth in the capital-labour ratio was very high with capital growth of 12.1% and an employment growth of only 1.3% in Japan. Germany showed a similar trend with growth in capital of 5.7% and a decline in employment of -0.1%. Since 1973 labour productivity has broadly returned to pre-war historical trends. It declined sharply in the period of 1973 to 1979 compared with the previous period, reflecting the slower growth in the capital-labour ratio (OECD, 1987: 42). This was not caused by higher employment growth in Germany and Japan as Germany recorded a negative growth of -0.7% and Japan's employment growth declined to 0.6% during the period 1974 to 1979. The slowdown in the capital-labour ratio and hence lower productivity was marked by a slower growth in capital formation which declined in Japan to 6.9% and in Germany to 3.3%. In the United States the reasons for absence of growth in labour productivity were different. There, employment growth increased from 1.7% in the 1960's and early 1970's to 2.5% during the period 1974 to 1979 with a constant growth in capital formation which lead to a lower capital-labour ratio.

In the 1980's labour productivity growth caught up slightly in the United States and remained constant in Japan and declined further in Germany.

Korea recorded an exceptional high growth in labour productivity as indicated in TABLE 31. During the 1960's and 1970's labour input growth remained at roughly 3% while capital accumulation accelerated during the 1970's. The rapid rise in capital stock was the key factor in boosting labour productivity. The capital-labour ratio nearly tripled between 1966 and 1985 and has since increased
further. During the 1980's labour input expanded by 1.7% as employment growth decelerated and hours worked declined. This was probably offset by a better educated labour force (OECD, Korea, 1994: 29).

Another way to measure labour productivity is the output per hour worked. During the 1960's the average hours worked per year seemed to have declined rapidly. They continued to slow down during the 1970's after productivity slowed down. The trend continued in the 1980's although at a slower pace (Englander et al., 1994: 119). The TABLE below illustrates labour productivity growth measured by output per work-hour.

<table>
<thead>
<tr>
<th>TABLE 32</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROWTH IN LABOUR PRODUCTIVITY MEASURE BY OUTPUT PER WORK HOUR</td>
</tr>
<tr>
<td>average annual growth</td>
</tr>
<tr>
<td>--------------------------------</td>
</tr>
<tr>
<td>United States</td>
</tr>
<tr>
<td>Japan</td>
</tr>
<tr>
<td>Germany</td>
</tr>
<tr>
<td>Source: Englander &amp; Gurney, 1994: 119</td>
</tr>
</tbody>
</table>

The overall trend still remains the same as the one shown in TABLE 31.

Another way to estimate labour productivity is the calculation in nominal terms and in a common currency. The output is evaluated at purchasing power parity. This adjusts outputs to a common set of relative prices and a common currency. However, such calculations are always approximate (ibid: 119).
According to TABLE 33 the United States remains the leader with Germany and Japan trying to catch-up and Germany getting close to American levels. Japan which started off at a very low base has tripled its productivity level in the past 24 years. The above table indicates that Japan has experienced remarkable gains in labour productivity but still remains below the United States and Germany. This, despite its leadership in some manufacturing sectors (ibid: 122).

It has been shown that a change in labour productivity is caused by the output per worker. This stems from growth in physical capital per worker or from increases in human capital through better education. In addition, greater efficiency in production practices with the same stock of physical and human capital can lead to increases in labour productivity (World Bank, 1993: 46-47). It seems that the labour input-driven growth has passed and the increase in labour productivity through higher human capital will avoid diminishing returns of the high capital stock.

Another way to increase labour productivity is through structural changes within the manufacturing sector. That was the case for OECD countries and the Newly Industrialised Countries. The structural change was characterised by a movement from labour-intensive, low-
technology and resource based industries to high and medium-technology and scale and science-based industries (Wefa Group, 1996: 26).

4.8 UNIT LABOUR COSTS

An industry's ability to compete cannot be fully understood without an analysis of price changes. A common measure for the level of international competitiveness (including prices) is a comparison of unit labour costs. Another reason for using unit labour costs is that in a value-added framework labour costs represent a major component of input costs. The link between productivity and unit labour costs has to be emphasised. Unit labour costs equal earnings per employee divided by output per employee which is labour productivity. In a dynamic context the growth rate of unit labour costs equal the growth rate of earnings per employee minus the growth of output per employee. Rapid increases in high wages are not harmful, provided they are accompanied by concomitant increases in productivity (Wefa Group, 1996: 17).

FIGURE 49
UNIT LABOUR COSTS IN THE MANUFACTURING SECTOR
measured in national currencies

Source: Data from the National Productivity Institute, 1995
Therefore, low wages are not necessarily an indication of higher levels of competitiveness if they are accompanied by low labour productivity. The worst case scenario is low productivity and high wages which will lead to high unit labour costs resulting in a loss of competitiveness in domestic and international markets. A comparison between the growth rates in unit labour costs of South Africa and its competitors is listed in TABLE 34.

<table>
<thead>
<tr>
<th>TABLE 34</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNIT LABOUR COST IN THE MANUFACTURING SECTOR IN THE NATIONAL CURRENCY</td>
</tr>
<tr>
<td>average annual growth rates</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>6,9</td>
<td>1,5</td>
<td>0,5</td>
<td>-0,5</td>
</tr>
<tr>
<td>Japan</td>
<td>8,0</td>
<td>-0,3</td>
<td>5,2</td>
<td>3,3</td>
</tr>
<tr>
<td>Germany</td>
<td>5,5</td>
<td>2,6</td>
<td>5,5</td>
<td>4,8</td>
</tr>
<tr>
<td>Korea</td>
<td>19,1</td>
<td>5,3</td>
<td>6,3</td>
<td>1,7</td>
</tr>
<tr>
<td>South Africa</td>
<td>10,9</td>
<td>15,1</td>
<td>11,8</td>
<td>10,2</td>
</tr>
</tbody>
</table>

Source: National Productivity Institute, 1995

In the United States growth in unit labour costs had its highest level in the 1970's and declined quite dramatically in the 1980's and even become negative in 1993. This is an indication that the manufacturing sector in the United States increased its level of competitiveness starting in the 1980's. Despite America's meagre gains in productivity the overall competitiveness level improved by a large extent through the 1970's because wage increases were more modest than those of its trading partners. American labour costs remained below the levels of their trading partners until 1980. By 1985 they had surged to 30% above their trading partners. From this level they started to decline again and are now well below the weighted average foreign level (OECD, United States, 1993: 63).
Japan had a strong increase in its level of competitiveness when unit labour costs recorded a negative growth. However, in the early 1990's the trend was reversed. In 1993 wages increased at a lower rate than in 1992. With output per worker growing more slowly; this resulted in an upward pressure on unit labour costs (OECD, Japan, 1991-1992: 21). In 1992 labour productivity fell by 7% and unit labour costs in manufacturing rose by 8%. By the beginning of 1993 wage and productivity growth had lined up with one another. The rate of increase in manufacturing unit labour costs was estimated at around 2% in 1993 and the trend is declining (OECD, Japan, 1993: 20).

Germany's level of competitiveness might have improved slightly during the 1980's but the trend was also reversed in the early 1990's. Average wages and salaries accelerated from about a 3% annual average during the period of 1983 to 1989 to over 5% in 1991 and 1992. There have been moderate wage settlements since 1983 and a pick-up of productivity growth during the production boom in the late 1980's. Optimistic expectations concerning the robustness of the recovery from the business sector and union militancy lead to substantial nominal wage increases in the 1992 bargaining round which was in contrast to productivity developments. In 1993 wage settlements declined in nominal terms. So far, in the present business cycle, nominal wage growth has been weaker than in the period 1978 to 1982. Total unit labour costs have advanced in a similar pattern to those in previous periods with relative high inflation because of a weaker productivity growth (OECD, Germany, 1993: 60-61).

During the 1960's Korea's rapid growth in labour demand was matched by increased supply to keep real wage growth broadly in line with labour productivity, hence there was no upward pressure on unit labour costs. During the second half of the 1970's real wages rose twice as fast as labour productivity putting big upward pressure on unit labour costs. After a period of relative stability during the early 1980's real wages started to grow markedly faster than labour productivity (OECD, Korea, 1994: 78-79).
TABLE 34 shows that the level of competitiveness of the South African manufacturing industry, according to unit labour costs, is constantly declining. It indicates very clearly that real wages rose much faster than labour productivity. Specifically during the period 1980 to 1990, the growth rate of 15.1% was extreme compared with the other countries. This was caused by increased strength in the bargaining power of trade unions forced by industrial actions like strikes and stay-aways. It lead to a rapid rise in wages of unskilled workers which is especially harmful to unit labour costs. Although there was a decline in the growth rate of unit labour costs during the beginning of the 1990's, these levels are unacceptable in a fiercely competitive world. To raise it's competitiveness position the South African manufacturing industry has to reduce its growth in unit labour costs either through increased productivity or a reduction in real wages.

4.9 PRODUCTIVITY AND REAL REMUNERATION AS A MEASUREMENT OF COMPETITIVENESS

In the case of labour, wages and salary increases must be in line with increases in productivity. If remuneration in real terms increases at a faster rate than productivity it will lead to a loss in competitiveness. This was the case for the South African manufacturing industries as it is illustrated in FIGURE 50 below.

The shaded area indicates a loss in competitiveness. If an industry gains competitiveness labour productivity runs above real remuneration. According to FIGURE 50, above during most years the South African manufacturing industry recorded a loss in the level of it's competitiveness. This conforms with previous findings that labour was over-utilised and proves that labour was too expensive in comparison with it's productivity.

In a fast changing world with increasing globalisation, international competitiveness is a key factor for an industry to prosper. Therefore, it's productivity performance becomes the focal point which builds the base for international competitiveness. The
development of the level of productivity indicates if an industry becomes more competitive than its foreign competitors (ABSA Bank, 1995: 5).

FIGURE 50
GROWTH IN LABOUR PRODUCTIVITY AND REAL EARNINGS IN THE SOUTH AFRICAN MANUFACTURING INDUSTRY

Source: Data from Industrial Development Corporation

5 SUMMARY

The aim of this chapter was to analyse the actual productivity level of the South African manufacturing industry. Measurements which had been analysed in chapter IV have been applied to establish the productivity level of the South African manufacturing industry.

The Cobb-Douglas production function was applied for the calculation of an estimated production output. It was established through various t-tests that the estimated production function conformed to the properties of the production theory. The output elasticity for capital \( (\alpha) \) was 0.3332 and lower than the output elasticity for labour \( (\beta) \) which was 0.6084. This indicated that the South African manufacturing industry was labour intensive during the period 1972.
to 1993.

Calculations of the marginal productivity for capital (MP_k) and labour (MP_L) showed that MP_L was on average increasing and MP_k was decreasing. However, stock of capital grew at a faster rate than employment.

The elasticity of substitution (σ) was calculated to see how easily labour can be replaced by capital. The result was 1 which means that the ratio of capital share's to labour share's will remain unchanged for the period 1972 to 1993. It was pointed out that α and β are constants during the period of 1972 to 1993 because only one production function was estimated. Various estimated production functions for different periods would result in different σ.

The estimation of production functions for different periods showed variation in α and β. From the period 1972 to 1985 up to the period 1972 to 1992 α showed a constant increase. This indicates that the efficiency of capital was rising.

In the context of the Cobb-Douglas production function, factor intensity is expressed as the ratio of the coefficients β to α (β/α). The result for the South African manufacturing industry was β/α = 1.8259 meaning that the South African manufacturing industry was labour intensive and capital deepening prevailed. During the period 1982 to 1993 capital stock per worker nearly doubled. Reasons for the constant deepening of capital were ascribed to inappropriate prices in the 1970's and early 1980's, e.g. low interest rates and the rapid rise in wages especially for unskilled labour.

It was concluded that the optimal combination of production factors is not only determined by their productivity but also by their costs. An efficient combination of labour and capital is achieved when \((\beta/\alpha)(K/L) = w/r\). The results for the South African manufacturing industry showed that for all years (1972 to 1993) labour was over-utilised. The degree of labour over-utilisation varied. For example in 1984 and 1985 it came quite close to the
optimal combination.

As another measurement for the optimal factor combination the efficiency criterion was applied. It is expressed as \( \psi = \beta(K/L) - \alpha(w/r) \). The optimal combination of inputs is achieved when \( \psi \) equals zero. Results confirmed over-utilization of labour, since \( \psi \) was smaller than zero for all years. However, t-tests showed that the efficiency criterion was not statistically significant for all years. Hence, for a number of years labour over-utilization could not be confirmed.

The technique to establish if the combination of labour and capital was optimal \( (K/L) = (\alpha w)/(\beta r) \) was used. The results for all years indicated that no optimal combination of labour and capital existed. The equation \( K/L = (\alpha w)/(\beta r) \) was applied to calculate the optimal input for capital with a given amount for labour and given prices for labour and capital by \( K = (w/r)(\alpha/\beta)L \). The results showed that for all years (1972 to 1993) the optimal input for capital should have been higher than the actual amount of capital used. For the calculation of the optimal input of labour the equation \( L = (\beta/\alpha)(r/w)K \) was applied. The results indicated that the optimal number of workers employed was less than the actual number of workers employed for all years. This confirms previous results.

The technique of the optimal utilization of the budget outlay it was used to calculate if economic waste occurred. According to calculations for the cost of optimal factor allocation \( C_0 = rK_0 + wL_0 \) it was shown that for all years (1972 to 1993) more output could have been produced, hence economic waste occurred. The magnitude of economic waste changed over the years, for example in 1972 it was R14,598bn and in 1984 it was only R307m.

Furthermore, it was determined if changes in input usage lead to a proportionately higher, lower or the same change in input usage by applying the technique of returns to scale. In the context of the Cobb-Douglas production function returns to scale are measured by the sum of \( \alpha \) and \( \beta \). Since, for the estimated production function \( \alpha \).
+ $β = 0,9416$ decreasing returns to scale prevailed in the South African manufacturing industry. However, from the t-test it followed that decreasing returns to scale could not be confirmed. This was not surprising as the result was close to 1. If more than one production function would have been estimated for different periods returns to scale would have shown different results.

According to calculations for economies of scale in the context of the Cobb-Douglas production function it yielded that for the South African manufacturing industry the average long-run cost function showed economies of scale. The coefficient $β$ was 0,8723 and smaller than 1. The t-tests showed that $β$ was not statistically significant and hence economies of scale could not be confirmed. Different estimated production functions would have resulted in different $β$ to determine economies or diseconomies of scale.

In the second part of this chapter the productivity level of the South African manufacturing industry was compared with some of its competitors. The performance of total factor productivity was used as a measurement for technical progress. The results showed that developments in total factor productivity were poor compared with the other countries indicating a low level of technical progress and efficiency in the production process.

The results for capital growth contribution to output growth did not show an encouraging picture either compared to Korea. Compared with the other countries the outcome was more favourable. It was shown that the age of real fixed capital stock reached a historically high point in 1989 and increased on average during the period of 1960 to 1990, with exceptions of a sharp decline during the period of 1981 to 1985. It was stated that an increasing loss in the level of competitiveness occurred in the period of 1984 to 1989 because of a rapid rise in the age of capital.

The high age of fixed capital stock in the South African manufacturing industry was accompanied by high relative user cost of capital. Also the collapse in the rand in 1984/1985 put upward
pressure on prices for imported capital goods which make up a large part of capital investment. In addition to this higher domestic interest rates pushed up relative user costs even further.

The analysis of capital productivity with its real negative average growth rate was more or less in line with the industrial countries during 1974 to 1979. But during the first half of the 1980's it converged sharply. Compared with Korea the two countries moved in opposite directions. Only during the second half of the 1980's South Africa seemed to have caught up. The high capital-labour ratio caused increases in labour productivity as there is a good correlation between capital deepening and labour productivity.

The comparison of South Africa's labour productivity with its competitors showed a very disappointing picture with the discrepancy accelerating over the years. South Africa is lagging more and more behind Korea, Korea being more of a benchmark than the industrial countries.

The final comparison was unit labour costs. Its importance was underlined as it includes productivity and costs. Results showed why South African manufacturing industry has such a low competitiveness level. It showed very clearly that South Africa's unit labour costs had by far the highest growth rate of all countries. It means that wages rose at a much faster pace than productivity, a situation which is unsustainable.

The comparison between the growth of South Africa's manufacturing productivity and real remuneration showed that for most years (1970 to 1993) the growth in real earnings was higher than the growth in productivity. This indicates that for most years the level of competitiveness measured by this comparison was declining. In a world with increasing globalisation, productivity performance becomes the focal point which builds the base for international competitiveness.
CHAPTER VII

CONCLUSIONS

The aim of this study was to determine the level of capital and labour productivity in the South African manufacturing industry and their impact on the industry's level of competitiveness on the international markets.

The ultimate goal for a country is prosperity for all its people. As growth in exports was the driving force behind the success of South and East Asian economies, international competition is a critical ingredient of economic success.

It was established at the outset that there is an important link between productivity at the microeconomic level and the level of international competitiveness. Consequently, it was necessary that the levels of capital and labour productivity in South African manufacturing be established and their impact on the level of South Africa's industrial competitiveness on international markets measured. However, before a quantitative analysis of South African manufacturing and that of some of this country's major international competitors could be done, it was first necessary to build sound theoretical foundations behind the concepts of competitiveness and productivity.

Accordingly, Chapter II provided a sound theoretical analysis of the concept of economic competitiveness. It was argued that the ultimate goal of competitiveness is to create wealth. Competitiveness was therefore defined as the ability of firms and/or industries to proportionately generate more wealth than their competitors as measured by an increase in market shares and profits. International competitiveness can therefore be judged in terms of the ability of countries to generate more wealth relative to their competitors.
It was established that the main driving forces for achieving these goals is growth the productivity of input factors. At the macroeconomic level four major determinants of the productivity performance of an industry were analysed. The first of these human capital and its development was shown to form the basis of labour productivity. It was suggested that government is largely responsible for improvements in human capital through formal education, though the private sector can also improve human capital through training. The second major determinant of productivity identified was technological progress. The benefits of which are derived from the introduction of new machinery and more efficient production processes. The importance in this regard of research and development in bringing about innovation, better products and more efficient production processes was highlighted. To ensure their successful development of these forces driving improvements in productivity government is responsible for creating the necessary macroeconomic framework for the efficient allocation of resources. If all these factors (highly educated labour force, physical capital with the latest technology, efficient production processes and the necessary macroeconomic framework) are in place the necessary basis for the fourth determinant of productivity and hence competitiveness – namely economies of scale is given. It was shown that large scale usually have an important impact on productivity as a result of a qualitative change in the equipment used. The quantitative advantage was represented by a decline in the average cost curve with increased output.

The academic debate about the importance of competitiveness in domestic and international markets was highlighted. On the one side of the debate, Paul Krugman argues that the well-being of a nation is determined only by the degree of competition in its domestic markets. International competitiveness he argues is irrelevant for economies are not like firms: for an economy with limited resources greater global market penetration by one industry can be achieved only by contraction in another with no benefit to national welfare. In contrast to Krugman, supporters of the importance of international competitiveness argue that international competition
is beneficial for the domestic wellbeing in that it forces necessary
domestic economic changes and gives access to technology and best
management practices developed by foreign competitors. This school
of thoughts argues that global competition is not a zero-sum game in
which some will gain and others will lose. In an open world economy
every participant can benefit through the exchange of goods and
services and ideas.

A further school of thought argues that while international
competitiveness is important for domestic wellbeing, the degree of
competition in domestic markets is important in determining an
economy's international competitiveness. The most famous example of
this thesis is Michael Porter's diamond theory which stresses the
importance of pressure and challenge to innovate and upgrade
industries' capacities. The DIAMOND OF NATIONAL ADVANTAGE is
constituted by four driving forces. The most valuable for this study
is 'FACTOR CONDITIONS'. Porter shows that factors, like capital and
labour, must be constantly upgraded and specialised and deployed
efficiently to achieve the highest possible productivity growth.
According to Porter, production factors with sustained and extensive
investment and great specialisation play a major role to this end.
As major factors Porter identifies human resources, capital
resources, knowledge resources and physical resources. The creation
of factor conditions is determined by the other driving forces
within the diamond. As the second driving force, demand conditions
were analysed. The needs and demands of consumers can put pressure
on firms to produce more sophisticated good that a firm's
competitors. This will result in an advantage on local and
international markets. The third driving force of Porter's diamond
model was related and supporting industries. Supplier's industries
can create advantages through the supply of most cost-effective
factor inputs which are also equipped with the latest technology.
The presence of related industries which are competitive themselves
will enhance competition. The driving force which is based on firm
strategy, structure and rivalry showed that the motivation of
managers and employees play a major role for the success of firms.
It was pointed out that domestic rivalry will lead to risk-taking
and investment which are necessary conditions to create competitive advantages.

For the school stressing the importance of international competitiveness in a world of globalisation and increasing interaction of companies and industries in world markets is driving force behind changes in national wellbeing. In this regard Ricardo's analysis of 'COMPARATIVE ADVANTAGE' was shown to be still valid with regard to the importance it gives to raising productivity in order to keep costs at low levels. In the real world the achievement of this goal is not always easy. Important underlying factors are policies set by government to influence trade, such as import tariffs or quotas. As a general principle it was stated that free trade is necessary to assure high degrees of international competitiveness. The positive effect of GATT, now WTO, on trade liberalization was highlighted.

In the final part of chapter II an analysis of common tactics employed today to protect existing market shares was given. It was shown that companies create barriers to sustain comparative advantages, the most common of which are barriers to mobility and entry. These include product differentiation, absolute cost advantages and scale related advantages.

In Chapter III the theoretical aspects surrounding the macroeconomic measurements of competitiveness were analysed. It was explained that government policies are responsible for creating the right macroeconomic framework to achieve growth in productivity and thus a rise in competitiveness.

The importance of research and development (R&D) was again stressed. At the macroeconomic level it gives a good indication if a good basis for future growth in productivity is created. Development in R&D impacts to a large degree on physical capital through innovation incorporated into new machinery. Investment in physical capital plays a major role in the development of the production process, particularly on capital productivity. Therefore the growth in
investment was considered as a good indicator for the build-up of capital stock. As a broad indicator of capital productivity the amount of output per unit of capital was mentioned. Another important indicator for changes in capital productivity is the measurement of capital efficiency as shown by the incremental capital-output ratio. An increase in this ratio shows a loss in efficiency. The perpetual inventory method which is used by the South African Reserve Bank to calculate the net fixed capital stock was analysed as a useful measurement to make conclusions about changes in the efficiency of capital stock. The perpetual inventory method also makes the calculation of the average age of capital stock possible. This evaluates the necessity for replacement demand because the higher the average age, the less efficient the capital stock is. This leads to a loss in competitiveness because of backwardness in technical progress. The vintage approach which considers new investment as embodied technical change was discussed as a technique that calculates the effect of new investment as a separate variable in the Cobb-Douglas production function. It emphasises the importance of the average age of capital stock.

Not only the efficiency of capital but also its costs determine the level of fixed capital stock and its productivity performance.

The second factor determining the overall level of competitiveness is the development in human capital. Investment in human capital are the basis for labour productivity. Adequate measurements to apply to human capital are the education level and investment in education and training either by government or by the private sector. It was stated that the labour-output ratio can be applied to obtain an indication of labour productivity. As is the case for capital, so also the cost of labour impacts on the efficient employment of labour. The best measurement of such costs which is also used for international comparison is unit labour costs. It was stressed that it combines labour productivity with labour costs. The outcome can vary because of changes in productivity and/or changes in remunerations.
As the aim of this study was a comparison of international competitiveness, possible measurements on this basis were also discussed. Terms of trade taking into account prices for exports and imports is a useful measure because terms of trade measure prices which are determined by productivity and costs. A more important measure is the calculation of purchasing power parity which is used to establish the level of the real effective exchange rate expressed as an index. This is a commonly used measure of industry's export competitiveness. A rise in the index implies a fall in competitiveness and vice versa. The final and most valid measure for international competitiveness is the export performance of an industry, applied through calculations of export growth. It was stated that a better measure is the growth in export market shares. Even substantial growth in exports does not really prove a rise in international competitiveness. The development in export market shares takes also into consideration changes in world trade. The development in export market shares is calculated as the difference between export growth and the growth in import demand of an industry's trading partners.

In Chapter IV attention shifts away from the macroeconomic determinants and measurements of productivity and competitiveness to the theoretical basis of microeconomic determinants and measurements. The level of efficiency of the utilisation of input factors, capital and labour was found to be critical to productivity performance. This can be measured using the Cobb-Douglas production function and applying it to empirical data. It was found that the Cobb-Douglas production function is the most useful theoretical application of a power function that conforms with the theoretical properties of the production theory.

In the context of the Cobb-Douglas production function the marginal productivity of capital can be established as $MP_K = \alpha AP_K$ and the marginal productivity for labour as $MP_L = \beta AP_L$. This yields the output elasticities for capital ($\alpha$) and labour ($\beta$) equals to the ratio of the marginal productivity (MP) to average productivity (AP). Furthermore, the marginal rate of technical substitution (MRTS) can
be established as \( \text{MRTS} = (\beta/\alpha)(K/L) \). This technique measures to what degree input factors are substituted for each other. The size of the elasticity of substitution \((\sigma)\) indicates if capital's share to labour's share will change. Factor intensities were analysed to be the ratio of the output elasticities \((\beta/\alpha)\). Variations in this ratio will point to capital or labour intensities. Apart from productivity of the input factors their prices, (for capital \(r\) and labour \(w\)) were evaluated as determinants of the level of output.

The ultimate aim of a production process is the optimal combination of input factors. It was found that such an optimal combination of input factors is reached when \((\beta/\alpha)(K/L) = w/r\). This is needed together with the ratio of the cost of labour \((w)\) to cost of capital \((r)\) to establish the optimal allocation of input factors. It was found that inputs are allocated efficiently when \((\beta/\alpha)(K/L) = w/r\). Another way to determine the optimum allocation of inputs was established by the efficiency criterion \((\Psi)\) with the optimal combination of capital and labour being reached when \(\Psi\) was equal zero. In the context of the Cobb-Douglas production function is was expressed as \(\Psi = \beta(K/L) - \alpha(w/r)\). In the case of \(\Psi < 0\) over-utilisation of labour is the case and in the case of \(\Psi > 0\) capital is over-utilised. It was explained that with a specific budget outlay the optimal point for capital and labour utilisation can be established. The optimal utilization of the budget outlay of firms or industries can then be used to compare actual output with the potential output in a position of optimal allocation. The difference between the two results shows whether or not economic waste has occurred.

The importance of economies of scales for international competitiveness was discussed before in Chapter II. In the context of the Cobb-Douglas production function the sum of \(\alpha\) and \(\beta\), the output elasticities for capital and labour, indicate if constant \((\alpha+\beta = 1)\), increasing \((\alpha+\beta > 1)\) or decreasing returns to scale \((\alpha+\beta < 1)\) exist. In the case of increasing returns to scale the output is increasing faster than the increase in inputs. The kind of returns to scale makes it possible to draw conclusions about the efficiency
of the production process. The specific relationship between returns to scale and long-run average cost curves can also be used to determine whether economies or diseconomies of scale exist. The coefficient $\beta$ in the estimated long-run cost function is the elasticity of total cost with respect to output. If $\beta$ is smaller than 1 economies of scale prevail and vice versa, with its absolute size showing the strength of such economies or diseconomies of scale.

Finally the importance of technical progress at the microeconomic level was highlighted. As a broad measurement of technical progress total factor productivity was analysed as it is calculated by the National Productivity Institute in South Africa.

In Chapter V attention was turned to quantifying South Africa's international level of competitiveness at the macroeconomic level. South Africa's performance in turn of macroeconomic measurements was compared with that of some of its competitor countries.

As a broad measurement of the significance of research and development (R&D) nationally the real growth in total expenditure on R&D was used. It showed that Korea (growth of 11,5% during the period 1989 to 1993) was trying to catch up with the industrial countries which recorded much lower R&D growth levels. In contrast, South Africa's R&D expenditure showed negative real growth of -3,3% over the same period. The comparison of real growth in business R&D expenditure showed South Africa in a better position with an average growth rate of 7,6% during 1989 to 1993 which was comparable to the 9,7% for the same measure in Korea. However, it was pointed out, that leading South African corporations spent only 1% of their sales on R&D. In contrast international corporations (Hitachi and Fuji) spent between 5% to 7% of their sales on R&D.

As explained in Chapter III savings are needed to finance investment. The low savings rate of South Africa limits the scope for investment (in part the result of high private tax levels). This is demonstrated by the persistent problem of current account.
deficits during periods of economic upswings. It was shown that South Africa's level of savings compares poorly with those of the East Asian economies where domestic savings account for 30% to 40% of GDP. Consequently, it is not surprising that the average growth in real fixed investment of the South African manufacturing industry compares poorly with that of South Africa's major competitors - in particular Korea.

Growth in investment is significantly influenced by the business cycle. It was shown that growth in investment in the United States, Germany and Japan correlates well with growth in their economies. Korea's investment as a share in GNP had reached already 30% in 1980 and reached nearly 40% in 1991. In contrast, the investment level of South African manufacturing has been strongly influenced historically by exogenous shocks. An example of such a shock is the impact of financial sanctions and political uncertainty from the beginning of 1985. The consequent fall in investment resulted in a significant ageing of the fixed capital stock and the consequence was declining efficiency of machinery and equipment resulting in a loss in competitiveness. Only from 1993 when investment growth started to pick up again has the major driving force for economic growth been on the supply side.

Chapter III showed that a country's international economic performance depends largely on the quality of available human resources. As a broad measurement of the level of education government expenditure on education was used. South Africa's government expenditure on education (over 20% in the 1996/97 budget) was high compared with that of its competitors. In a recent article (published in The Economist in March this year) a comparison of the level in maths and science for thirteen-year old students was published. It showed South Africa at the bottom of the list of 41 countries and Singapore and Korea ranking at first and second place. This indicates very clearly that the results achieved in South Africa compared with the high government spending is very poor. It was pointed out that for developing countries it is vital to put more emphasis on basic education. Korea was mentioned as a good
example where in 1983 more than 80% of education expenditure was spent on basic education.

A better measurement of the level of human capital is given by school enrolment for different age cohorts. It was found that South Africa's school enrolment was lagging far behind that of its competitors in terms of this measurement. South Africa achieved universal education at the primary level only in 1970. However, it was pointed out, that it was not clear whether the data published by the World Bank included the black population. The slowest development was found in tertiary education where South Africa showed a mere 10% increase over 27 years (from 4% in 1965 to 14% in 1992). A comparison of average number of school years between South Africa and other developing countries in 1991 showed South Africa at the bottom of list with under 6 years compared to Hong Kong with 9 years. This indicates that the formal education system is completely inadequate. Efforts made by the private sector to train compared more favourably (with 3,3% of the payroll spent on training) against the 4% to 7% spent by corporations in the OECD countries.

For South Africa all the results mentioned above provide an inadequate basis for growth in capital and labour productivity. In addition, the level of international competitiveness of the South African manufacturing was undermined by inward-looking economic and trade policies. High customs duties and import surcharges dampened export performance, especially during the 1970's, as they made the cost of imported inputs artificially high which made exporting firms less competitive on international markets. From 1980 import permits were relaxed and tariffs were reduced. But the policies still remained anti export. The general export incentive scheme introduced in 1990 led to a more export orientated outlook. From 1994 the government started to cut tariffs further which improved the level of competition.

Another factor which influenced the international competitiveness level were movements in the nominal and real effective exchange rate. It was stated that the rand was effected by numerous external
factors like extreme variations in capital movements caused by the gold boom in the early 1980's and financial sanctions beginning in 1984. The real effective exchange rate adjusted by unit labour which is the most relevant measurement for manufacturers showed a big loss in the competitiveness level coming from a level of undervaluation to hugely overvaluation. The United States showed a constant increase in international competitiveness since the mid 1980's. Where as Germany and Japan showed a similar trend to South Africa, losing international competitiveness. However, Korea showed an increase in its competitiveness position since the beginning of the 1990's.

It was not surprising that South Africa's manufactured exports compared very badly against the other countries. Even with its improvement over the years from 32% of merchandise exports in 1965 to 74% in 1993 manufactured exports were still far behind the ones of the other countries. The results of improving manufactured export performance did not look so favourable when it was analysed by its market share performance. It was stated that South Africa's market share of manufacturing exports of developing countries declined from almost 12% in 1955 to a meagre 1.5% in 1993.

The aim of Chapter VI was a quantitative analysis of South African manufacturing industry at the microeconomic level and its relative position in an international context. Measurements which had been discussed in chapter IV were applied. The Cobb-Douglas production function was used to estimate a production function for the South African manufacturing industry for the period 1972 to 1993.

Statistical tests showed that the estimated production function satisfied the theoretical properties of the production theory. Results showed that the output elasticity for capital, \( \alpha \) was relatively small (0.3332) compared with that of labour, \( \beta \) (0.6084). During the period under consideration calculations showed that the marginal productivity for capital (\( MP_K \)) was decreasing on average where as the marginal productivity for labour (\( MP_L \)) was increasing on average. Statistical tests showed that the estimated production
function satisfied the theoretical properties of the production theory. Calculations of the marginal productivity of labour ($\beta_{AP_L}$) showed on average a constant increase. This correlated well with the development of employment; a fall in employment led to a rise in the marginal productivity. In contrast to increases in marginal productivity of labour, the marginal productivity of capital ($\alpha_{AP_K}$) declined on average. It was stated that the opposite development of labour and capital productivity was caused by a constant rise in the capital-labour ratio. A situation of capital-deepening prevailed.

From 1982 to 1993 capital stock per worker nearly doubled. This was confirmed by the result of factor intensity ($\beta/\alpha = 1.8259$) that South African manufacturing industry was labour intensive.

It was pointed out that only one production function was estimated for the period 1972 to 1993 with $\alpha$ and $\beta$ being constant for this period. Therefore, factor intensity and the elasticity of substitution ($\sigma$) remained unchanged. Estimations of various production functions for various periods showed an increase in $\alpha$ indicating that capital became more efficient over the years.

Calculations of the optimal combination of labour and capital by applying the mathematical equation of $(\beta/\alpha)(K/L) = w/r$ showed overutilization of labour. The comparison of the input ratio of capital to labour $(\beta/\alpha)(K/L)$ was always lower than the ratio of wages to cost of capital $(w/r)$. It indicated very clearly that labour was too expensive relative to its productivity. Also the calculation of the efficiency criterion yielded over-utilization of labour. However, the calculated $t$-value compared with the critical $t$-value showed that the hypothesized over-utilisation of labour could not be confirmed for all these years. Variations are ascribed to inappropriate prices of production factors; low interest rates and the rapid rise in wages, especially for unskilled labour. In years with low or negative real interest rates, the hypothesised over-utilisation of labour was confirmed. Whereas in years of high real interest rates, it could not be confirmed. Results of increasing marginal productivity of labour and results of over-utilisation of labour seem to be contradictory. However, the calculation of
marginal productivity of capital and labour did not include prices of the two input factors. The comparison of marginal productivity to prices showed that, in fact, the development in marginal productivity was not in line with rises in prices for input factors.

According to the comparison of actual output to the possible output with an optimal combination of inputs, it was shown that economic waste occurred. The magnitude of economic waste was also determined by the level of real interest rates. It showed that during years with low or even negative real interest rates the economic waste was much higher than during years of high real interest rates. The calculation for returns to scale indicated the presence of decreasing returns to scale as the sum of the estimated $\alpha$ and $\beta$ was 0.9416 i.e. smaller than 1. The result was however, close to one. Therefore it was not surprising that the hypothesised decreasing returns to scale could not be confirmed by statistical tests. As $\alpha$ and $\beta$ are constants the result was applied to all years. The possibility exists that for some years constant or even increasing returns to scale prevailed cannot be excluded.

The international comparison of the labour and capital productivity of the South African manufacturing industry showed very clearly the bad performance of productivity of the input factors. Productivity of both factors is lagging behind that of South Africa's major trading partners. They are also lagging behind Korea which, while not a major trading partner, is a much more significant competitor of South African goods in this country's major export markets. The results of total factor productivity which incorporate technical progress were bad for South Africa in comparison to the other countries: this indicates clearly that South Africa is falling behind in the employment of technical progress. Negative growth rates for capital productivity confirmed the results of low total

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factor productivity. The disappointing results for capital productivity can be attributed to inappropriate pricing of production factors during most of the years examined in this study. Low real interest rates together with rapid wage increases caused an increase in capital stock which outweighed increases in output. Growth in labour productivity also showed a disappointing result proving that here too, South Africa is falling behind the level of its main competitors. This was confirmed by the widening gap between South Africa and the other countries in terms of unit labour costs. This indicated that South Africa's competitiveness is severely dampened by a wage overhang. This situation makes it impossible for the South African manufacturing to keep up with its competitors in international markets.

It was stressed before that manufacturing industries dominate more and more trade flows. Therefore it is of vital importance that South African manufacturing improve their export performance. To achieve this it is necessary to put more emphasis on technology intensive products and to move away from exports into stagnant or slowly growing world markets.

The agreement of GATT to reform trade policies signed in Marrakesh in 1994 will lead to trade liberalization. The first steps have done already by reducing tariffs which has impacted already on higher competition. The government policies outlined in GEAR will, once put in place, provide a better framework for improving productivity. The rigidity of labour markets is still a serious problem for growth in labour productivity. With the prevailing high labour costs it is difficult for new business to enter the market. With the opening to world markets the South African manufacturing industry will have to adapt to a new environment and it will be tested how well it can compete on international markets.
## APPENDIX

### APPENDIX 1

PRODUCTION, CAPITAL AND LABOUR DATA FOR THE SOUTH AFRICAN MANUFACTURING INDUSTRY

<table>
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<th>K (R million 1993 prices)</th>
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Data: South African Reserve Bank & Industrial Development Corporation
## APPENDIX 2

### ACTUAL PRODUCTION VERSUS ESTIMATED PRODUCTION

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Data: South African Reserve Bank & Industrial Development Corporation
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### MARGINAL RATE OF TECHNICAL SUBSTITUTION

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## APPENDIX 5

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Source: IDC and Central Statistical Services
## APPENDIX 6

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DATA SOURCE: SOUTH AFRICAN RESERVE BANK & INDUSTRIAL DEVELOPMENT CORPORATION
## APPENDIX 7

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The critical t-value at a 90% confidence level is 1.729.
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Source: Industrial Development Corporation
### APPENDIX 9

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Source: Industrial Development Corporation
## APPENDIX 10

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Source: Industrial Development Corporation
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