THE EFFECTS OF TRADE POLICY ON THE DEVELOPMENT OF THE SOUTH AFRICAN PETROCHEMICAL INDUSTRY

THESIS

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ABSTRACT

THESIS TITLE: The Effects of Trade Policy on the Development of the South African Petrochemical Industry

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The objective of the research was to determine the role which South African trade policy played in shaping the development of the domestic petrochemical industry. The focus of the study falls on the domestic development of the petrochemical industry in general, and the polymer industry in particular. Three broad stages are distinguished in the domestic development of the petrochemical industry.

Prior to the early 1970's development occurred primarily on an *ad hoc* basis, with the establishment of domestic production plants for most major petrochemicals. The development of the

domestic petrochemical industry over the period from the early 1970's to the early 1980's was characterised by rapid growth in the domestic production of petrochemicals, while the period from the early 1980's to the early 1990's saw a significant slowdown in the annual growth rate for the domestic production of petrochemicals. The role of trade policy in the industry's development over each of these three periods could not be established conclusively. In each period a number of factors were identified which may have impacted on the industry's development. However, two factors do appear to have played particularly important roles in the industry's development prior to the early 1980's, namely strong growth in domestic petrochemical demand and the provision of a substantial degree of protection through quantitative import controls and tariffs.

With regard to the industry's development over the period from the early 1980's to the early 1990's, a number of factors were identified which may have influenced trends in domestic petrochemical production, including the withdrawal of quantitative import controls and the progressive lowering of import tariffs, the depreciation of the rand in the mid-1980's, a slowdown in the growth of the domestic demand for petrochemicals, the fall in the international prices of petrochemicals in the early 1980's, and the fall in the international oil price in the mid-1980's.

In view of the small size of the domestic petrochemical market it is recommended that local petrochemical producers should continue to expand their focus beyond that of producing solely for the requirements of the domestic market. In light of the key role played by the petrochemical industry in a modern economy, it is also recommended that the industry in South Africa receive more attention from policy makers than it has in the past.

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Opinions expressed, and conclusions arrived at, are those of the author and are not necessarily to be attributed to any of the persons or organisations noted above.

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CHAPTER 1

INTRODUCTION

1.1 AIM

The aim of this chapter is to provide the reader with a general introduction to the petrochemical industry. A brief overview of the global petrochemical industry and its development is presented, along with an outline of the major components of the industry and a brief discussion of the production processes utilised within the industry. This is followed by a discussion of the need for the study and the aims of the study.

1.2 ORIGIN AND GROWTH OF THE GLOBAL PETROCHEMICAL INDUSTRY

The petrochemical industry is characterised by the wide variety of its products and their end uses, the complexity of alternative routes of production processes, and flexibility in the choice of raw materials. While the petrochemical industry could be defined as that segment of the chemical industry which produces chemical products from raw materials of petroleum origin, petrochemical products do not differ in any significant way from those made using alternative raw materials, such as natural gas or coal (Waddams, 1978: 6). It was only in the mid 1920's that petroleum appeared as a significant source of chemicals.[1]

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[1] According to Waddams (1978: 6) the original function of the petroleum industry was limited to the separation of petroleum into its different fractions by distillation. It was only when

The choice of feedstock used in the production of petrochemicals varies throughout the world, and in the industrialised countries generally depends on the availability of natural gas and the demand for naphtha.[2] At present, petrochemical manufacturers in Europe and Japan tend to rely on naphtha as a basic feedstock, while producers in North America tend to rely on natural gas (Waddams, 1978: 27). Coal is a less important source of petrochemicals, although historically it has played an important role in the development of the industry in that much of the progress in the chemical industry prior to World War II was motivated by the availability of coal (Waddams, 1978: 40). The decline of coal as a chemical feedstock coincided with the greater availability of oil and the rise of the petrochemical industry.[3] Global reserves of coal are, however, much greater

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the petrol fraction was required in greater quantity and better quality that two new separation processes were introduced, namely thermal cracking and thermal reforming. One of the by-products of the cracking process was a stream of olefinic gases which, after considerable research, were found to be suitable raw materials for a range of chemical products and this led to the beginnings of the petrochemical industry in the mid 1920's.

[2] Naphtha is a petroleum fraction which can be used as a raw material either in the production of fuel or in the production of petrochemicals. It is therefore inevitable that the chemical and energy industries sometimes compete for raw materials. While the chemical industry rarely consumes more than 10 percent of refinery output in any given country, it produces products with a higher added value than the energy industry, and can therefore compete successfully in obtaining its raw material requirements (Waddams, 1978: 47).

[3] The chemical and engineering advances of the 1930's, along with the development of synthetic materials during the second world war, were combined with cheap and abundant raw materials from the expanding post-war oil industry to produce materials on a scale and at a cost which allowed plastics, synthetic fibres and other derivatives of petrochemicals to supplant traditional materials and to establish a wide range of new end uses (Fayad & Motamen, 1986: 10).

than those of oil; if petroleum were to become scarce the possibility exists that coal may once again become a primary feedstock for the manufacture of chemicals. At present, however, the South African petrochemical industry is unique in the world in that it is the only country in which this industry is predominantly coal based.

Activity in the petrochemical industry from the mid-1920's up to 1950 was, on the whole, dominated by the United States.[4] The 1950's saw a surge in petrochemical activity in Western Europe, and the 1960's saw a similar surge in developments in Japan (Waddams, 1978: 7). From 1950 to the early 1970's the petrochemical industry became one of the fastest growing sectors of the industrialised economies, with output growing at 2.5 to 3 times the growth of GDP in Western Europe (Fayad & Motamen, 1986: 6). It was over this period that the production of basic petrochemicals became as important in volume terms as the production of iron and steel (Grant *et al.*, 1988: 207). Fayad & Motamen (1986) attribute the industry's high growth rates over this period to a combination of: large capital investments and large research and development expenditures which resulted in rapid technological improvements[5]; the availability of cheap raw

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[4] This can largely be attributed to the fact that the United States had both a domestic source of raw materials and a well-established chemical market (Waddams, 1978: 6).

[5] Broadly speaking there are two types of research within the chemical industry: technology push and demand pull (Fayad & Motamen, 1986: 7). In the former the manufacturer develops new technology and tries to create a market for it. In the latter the manufacturer examines what the market requires and tries to discover technology to provide such products.

materials and low energy costs[6]; the expansion of markets during the post-war construction and industrial boom of the 1950's and 1960's; and the increased applications for synthetic materials which found ready markets because the supply of conventional materials was limited and therefore more costly.

While the period prior to 1970 may be described as the golden era of the petrochemical industry in the industrialised countries, the early 1970's saw the maturation of the petrochemical industry in the industrialised countries with the oil shock of 1973 marking the "beginning of a dozen devastating years for the petrochemical industry" (Stobaugh & Gagne, 1988: 26).[7] The global petrochemical industry underwent extensive restructuring over this period, largely in response to changes in raw material prices and availability, market saturation for basic petrochemical products in developed countries, and the emergence of non-traditional producers as significant partners in world petrochemical trade (Vergara & Brown, 1988: ix).[8]

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[6] The expansion of the petrochemical industry took place against the background of a drop in the real price of crude oil in the 1960's and 1970's (Grant *et al.*, 1988: 207).

[7] The first signs of the industry's approaching maturity were lower growth rates, the spreading of overcapacity, and the sensitivity of production costs to the cost of factor inputs of raw materials and capital (Guinet, 1985).

[8] Forecasts which had been made for the world demand for basic petrochemicals had been too optimistic (being based on the exceptionally high growth rates of the 1950's and 1960's) which led to the closure of large petrochemical complexes in Japan, Western Europe and North America in the early 1980's. Between 1982 and 1985 roughly one quarter of the developed world's bulk or basic chemical's plant capacity was closed (Vergara & Brown, 1988: x).

The mid-1970's saw the start of rapid development of the petrochemical industry in the developing countries, one of the results of which has been a notable change in the geographical distribution of world petrochemical production capacities. Prior to 1970 limited petrochemical capacities had been established in a few developing countries, such as Argentina, Brazil, Mexico, India and South Africa (Chesnais, 1989: 75). In the early 1970's, for example, developing countries accounted for only 2 to 3 percent of global capacity in ethylene. By 1982, however, this figure had risen to 8.5 percent. Growth in the developing countries share of global capacity for the five major plastics (polyvinyl chloride, polypropylene, polystyrene, low-density polyethylene and high-density polyethylene) followed a similar pattern (Chesnais, 1989: 75).[9]

The development of the petrochemical industry in different developing countries has varied according to the level of industrial activity and feedstock potential. The emergence of non-traditional producers since the early 1970's generally fall into one of two groups of operators, namely the oil-producing countries and the newly industrializing countries (NICs) (Fayad & Motamen, 1986: 107).

In the case of the oil-producing developing countries the development of the petrochemical industry proceeded at two

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[9] The active development of the petrochemical industry in developing countries was facilitated by the maturation and increased availability of technology for the production of petrochemicals from engineering firms and oil companies (Fayad & Motamen, 1986: 107).

levels. Middle Eastern countries, particularly Saudi Arabia, sought to become major export-oriented producers of petrochemicals, utilizing vast quantities of associated gas (which had previously been flared) as a basic petrochemical feedstock.[10] Oil-producing countries with larger domestic markets and an already established industrial infrastructure, such as Mexico, opted for a more modest approach in developing their petrochemical industry through the construction of medium-sized plants whose production was aimed at meeting expanding domestic demands, with excess production aimed at regional or international export markets. In the case of the NICs, such as Brazil and South Korea, the petrochemical industry's development was aided by the growing domestic demand for petrochemicals and their rapidly expanding industrial outputs.

By the late 1980's the global petrochemical sector was still in the aftermath of extensive restructuring, with producers in the industrialized countries moving into the manufacture of more sophisticated downstream petrochemical products "where the value added is greater and the quantity required implies the use of advanced technologies usually still protected by proprietary rights" (Vergara & Brown, 1988: xi). The petrochemical sector in developing countries, on the other hand, was still expanding rapidly with growth rates similar to those experienced by the

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[10] The oil price rises of the 1970's had altered the production cost structure within the industry in favour of feedstock and raw materials, and also "gave the major oil exporting countries an immense financial capability which they sought to utilize in improving their poor infrastructure and building an industrial base around the oil sector" (Fayad & Motamen, 1986: 107).

industrialised countries in the 1950's and 1960's. Over the period 1980-1987, for example, the average annual growth rates for the production of ethylene and propylene in the United States, Western Europe and Japan were in the range of 2 to 4 percent per annum, while the same products grew by 11 to 14 percent per annum in Latin America and by 15 to 18 percent in Asia (Vergara & Brown, 1988: ix). Developing countries have also provided a strong dynamic element in world petrochemical trade, accounting for nearly 50 percent of the overall growth in world petrochemical imports and exports over the period 1980-1985 (Bond, 1990: 52).

With regard to the future development of the global petrochemical industry, Vergara & Brown (1988: xi) forecast that growth in the production of established petrochemicals would come mostly from the developing countries, with developed countries moving into the production of more specialised and sophisticated downstream petrochemical products. This shift in basic petrochemical production growth from developed to developing countries is, as noted above, largely attributable to a combination of the maturation of petrochemical markets in the industrialised countries, and to the emergence of non-traditional petrochemical producers in the international market.

1.3 MAJOR COMPONENTS OF THE PETROCHEMICAL SECTOR

Products from the petrochemical industry have a wide variety of applications and are utilised as intermediate inputs in the

TABLE 1.1: MAJOR COMPONENTS OF THE PETROCHEMICAL INDUSTRY

Subsector	Main products
Basic olefins	Ethylene Propylene Butadiene
Aromatics	Benzene Toluene Xylene
Methanol	Methanol
Plastics	Low density polyethylene (LDPE) High density polyethylene (HDPE) Polyvinyl chloride (PVC) Polypropylene (PP) Polystyrene (PS)
Synthetic rubbers	Polybutadiene Styrene-butadiene
Synthetic fibres	Polyesters Polyamides Acrylics

SOURCE: Vergara & Brown, 1988.

production of a number of products.[11] In order to discuss the status of an industry which produces as large a number of diverse products as the petrochemical industry, it is necessary to divide the industry into its major components. The World Bank have, for purposes of analysis, divided the industry into the six subsectors outlined in Table 1.1. Collectively these subsectors accounted for over 80 percent of total global petrochemical production in the mid 1980's (Vergara & Brown, 1988: 20).

Of the six subsectors listed in Table 1.1, the first three, namely basic olefins, aromatics and methanol, can be classified as upstream petrochemicals, while the last three, namely plastics, synthetic rubbers and synthetic fibres, can be classified as downstream petrochemicals. It is the upstream petrochemicals which constitute the major petrochemical building blocks from which most downstream petrochemical products are derived.

The discussion in this study will focus primarily on plastic polymers and, to a lesser degree, on the monomers used in their production. The main reason for this is that in South Africa

[11] Petrochemical products such as commodity resins, speciality rubbers, elastomers, and engineering resins are excellent substitutes for metals in a variety of applications, and for wood and other construction materials in the building industry; polymers are widely used as glazing materials, as panels and as parts in transportation hardware, consumer and industrial goods; polymers are also used as components in computer, electronic and irrigation hardware, and as packaging materials as substitutes for paper and natural fibres; synthetic fibres and rubbers are used as substitutes for traditional fibres and rubbers, with improved performance and at lower cost (Vergara & Brown, 1988: 1).

TABLE 1.2: DERIVATIVE CHAINS

Number	Description
Level 1	This can be described as the raw materials level, and consists of the following primary energy sources: oil, coal and natural gas.
Level 2	This can be defined as the feedstock level, and consists of more refined products such as: ethane, propane, natural gas and naphtha.
Level 3	This can be described as the level of the seven major building blocks from which over 90 per cent of the world's organic chemicals are derived, and consists of: ethylene, propylene, butadiene, benzene, toluene, xylene, and methane.
Level 4	This level includes the first stage derivatives of the seven major building blocks, and consists of products derived directly from these building blocks. Products here include polymers such as polyethylene and polypropylene.
Level 5	This level includes the second stage derivatives of the seven major building blocks, and consist of products which are close to final products, such as polyethylene film (further processed for use as a packaging material) and rubber compounding (further processed for use in the manufacture of tyres).
Level 6	This level consists of the third stage derivatives of the seven major building blocks and consists of final products for use in the packaging, motor and construction industries.

SOURCE: Report by the Working Group for the Promotion of the Chemical Industry, September 1990.

data relating to upstream petrochemicals (ie. monomers) have, for strategic reasons, been grouped together with SIC 353 (petroleum refineries/synthesizers) and SIC 354 (miscellaneous products of petroleum and coal).[12] As a result, data relating to the development of the upstream sector of the petrochemical industry is not readily available. The decision to focus the study on the production of plastic polymers, rather than on synthetic rubbers or synthetic fibres, was made on the basis that, firstly, plastic polymers form the most coherent sector of what is otherwise a relatively diverse industry, and secondly that the plastic polymer industry became the subject of increased attention from the Board of Trade and Industries in the 1980's.

1.4 THE PRODUCTION PROCESS

Following from the discussion of the major components of the petrochemical industry above, the process of production in the petrochemical industry can be described using the concept of "derivative chains", where production occurs at different levels in the chain with the output of one level in the chain becoming an input of the next. For illustrative purposes the industry can be divided into the six levels outlined in Table 1.2.

It should be noted that the definition of each of these levels is arbitrary, and they are used only to illustrate the

[12] These sectoral classifications are based on the Standard Industrial Classification (SIC) used by the Central Statistical Services, which in turn is based on the International Standard Industrial Classification (ISIC) of the United Nations.

TABLE 1.3: DERIVATIVE CHAINS FOR THE PRODUCTION OF FOUR BASIC PETROCHEMICALS

LEVEL 1:	CRUDE OIL			
LEVEL 2:	NAPHTHA			
LEVEL 3:	ETHYLENE	PROPYLENE	C4 OLEFINS	BENZENE (AND ETHYLENE)
LEVEL 4:	POLYETHYLENE	POLYPROPYLENE OXIDE, GLYCOL	SBR RUBBER	ETHYLBENZENE STYRENE
LEVEL 5:	PE FILM	UNSATURATED POLYESTERS	RUBBER COMPOUNDING	POLYSTYRENE
LEVEL 6:	PRINTED FERTILIZER BAGS	FIBREGLASS REINFORCED ROOFING	TYRES	PACKAGING

SOURCE: Report by the Working Group for the Promotion of the Chemical Industry, September 1990.

interdependency of the various levels in the derivative chain. It is possible that the chain could consist of more, or less, than six levels, depending on the particular product for which the production process is being traced. One example of the derivative chains involved in the production of four basic petrochemicals in South Africa is shown in Table 1.3.

If the petrochemical industry is divided into upstream and downstream producers, then levels 1, 2 and 3 would constitute the upstream end of the derivative chain, and levels 4, 5 and 6 would constitute the downstream end of the chain. According to the Working Group for the Promotion of the Chemical Industry in South Africa (September 1990) industries located at the upstream end of the derivative chain tend to have the following characteristics: there are few major producers; plants are built on a large scale; operations are capital intensive relative to downstream industries; and products tend to be high volume bulk commodities.[13]

At the downstream or final product end of the industry the following characteristics tend to be found: there is a large degree of horizontal fragmentation relative to the upstream end of the industry; products tend to be more differentiated than those at the upstream end; technological innovation plays an

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[13] An important characteristic of the upstream end of the petrochemical industry is the use of capital-intensive, continuous production processes; firms in the industry normally manufacture large quantities of homogenous materials which are best produced, processed and traded on a large scale (Martinelli, 1991: 13).

important role at this level; operations are more labour intensive with most employment opportunities being created here; and most value is added in the downstream stages (Working Group for the Promotion of the Chemical Industry, September 1990).[14]

The discussion thus far has been focused on providing a brief introduction to the petrochemical industry from both a global and a local perspective. The need for and aims of this study can now be discussed in more detail.

1.5 NEED FOR THE STUDY

According to a recent study initiated by the World Bank (Vergara & Babelon, 1990) the widespread integration of petrochemical products into general manufacturing and industrial processes has led to the petrochemical industry being identified as a key sector in the industrial strategies of both developed and developing countries. In addition, the industry's development has been linked not only to general industrial modernisation, but also to the ability to promote manufacturing exports (Bond, 1989).

Much research has been undertaken with regard to the development of the petrochemical industry in developing countries, and the future prospects for the established petrochemical industries in

[14] The identity of the petrochemical industry at the final product level often becomes diffuse as the output of the industry merges with the output of other industrial sectors.

developed countries.[15] The role of the petrochemical industry in the South African manufacturing industry, however, appears to have received scant attention from both policy makers and academics alike.[16] It was only recently that the literary drought on the subject of the domestic petrochemical industry was broken by a study forming part of the Industrial Strategy Project, namely "The South African Commodity Plastics Filiere: History and Future Strategy Options" (Crompton, 1993).

1.6 AIMS OF THE STUDY

The future course of South African trade policy has in recent years become the subject of much debate.[17] The dominant view in the early 1990's was that advocated by the Industrial Development Corporation (1990) and the World Bank (Levy, 1991), namely that South Africa should engage in import liberalisation through a programme of comprehensive tariff reductions. The economic desirability of such a strategy for South Africa has, however, recently been called into question (Bell, 1993).

It is within the context of the current debate on the future of South African trade policy, and the important role which the

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[15] General sources on the petrochemical industry are reports prepared by UNIDO (1978, 1981 & 1986) and reports prepared for the World Bank by Vergara & Brown (1988) and Vergara & Babelon (1990).

[16] Only one in-depth government report on the industry has been published by the Board of Trade and Industries, namely a study of the basic chemicals industry (BTI, 1971).

[17] See, for example, the Industrial Development Corporation (June 1990), Levy (1991) and Bell (1992).

petrochemical industry plays in an industrialised economy, that the significance of this study becomes apparent. The main aim of the study is to try and shed some light on the future development of the domestic petrochemical industry by examining the role which South African trade policy played in shaping the past development of this industry.

It should be noted from the outset, however, that the task of establishing a causal link between trade policy and the economic structure and performance of a particular industry is a complex one. An important reason for this is that most trade policies are implemented in an environment where a number of other factors are impacting on the industry simultaneously, with the result that it is often difficult to isolate and determine the significance of any particular factor (Krueger, 1990: 240). Indeed, one of the major problems in economic analysis is the establishment of causation between different variables (Mohr *et al.*, 1988: 126).[18] Since correlation can never show causation, all that can be shown is that a causal link between variables is possible, or that the existence of a causal link cannot be ruled out (Mohr *et al.*, 1988: 126).

The discussion of the development of the South African petrochemical industry will proceed in terms of three broad

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[18] For example, when, in a recent World Bank study, the analysts attempted to establish the relationship between export performance and long term liberalisation they found that "the strong association of export performance and long-term liberalisation does not unequivocally imply *causality*" (Michaely, 1991: 127).

periods. The discussion of the industry within three periods was dictated, firstly, by data constraints, and secondly, by developments within the industry itself. The non-availability of systematic data for the petrochemical industry prior to 1970 led to the discussion in Chapter 2 of the development of the industry from its inception up to the early 1970's. The period from the early 1970's to the early 1980's was characterised by rapid growth in domestic production, and is discussed in Chapter 3. The period following the early 1980's, on the other hand, saw a significant slowdown in the domestic production of petrochemicals, and is discussed in Chapter 4. Within each of these three periods a more general discussion of developments in the industry is interwoven with a more detailed discussion of developments in the production of specific petrochemicals, with the focus falling primarily on the production of plastic polymers.[19]

In Chapter 5 an overview of the preceding chapters is provided in terms of the need for the study, the aims of the study, and the findings of the study. Finally, after a brief discussion of two related issues, some recommendations, as well as possible areas for future research, are also presented.

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[19] The discussion in this study will, as mentioned before, focus primarily on plastic polymers and, to a lesser degree, on the monomers used in their production.

CHAPTER 2

EARLY DEVELOPMENT OF THE DOMESTIC PETROCHEMICAL INDUSTRY

2.1 AIM

This Chapter will concentrate on a discussion of the development of the South African petrochemical industry from the industry's inception up to the early 1970's.

2.2 FROM INCEPTION TO THE EARLY 1970's

A broader perspective of the development of the domestic petrochemical industry is obtained when it is placed within the context of the general historical development of the chemical industry as a whole in South Africa. The early development of the basic chemicals industry in South Africa can be seen as a natural or spontaneous response to the rapidly growing domestic demand for certain basic chemicals. In the case of explosives, for example, import substitution was spurred by a combination of growing domestic demand from the local gold mining industry, and the fact that explosives did not lend themselves to long distance transportation. The first major investment in domestic chemical manufacture took place in 1894 with the establishment of an explosives plant at Modderfontein (le Roux, 1982: 7).

A number of intermediate chemical products required in the manufacture of explosives (such as sulphuric acid and nitric acid) are also essential raw materials in the manufacture of fertilizers. It was the convenient access to these fertilizer feedstocks and the growing demand for fertilizers that led to the establishment of the first domestic fertilizer plants alongside the first explosives plants. In the three decades following the establishment of the first explosives plant, investment in the chemical industry was directed mainly toward the production of explosives for the mining industry and the production of fertilizers for the growing agricultural sector of the economy (le Roux, 1982: 7).

The establishment of a coke-based ammonia plant at Modderfontein in 1932 marked a turning point in the development of the chemical industry in South Africa since it was the first plant to use a relatively sophisticated chemical process and it marked the beginning of the local chemical industry's involvement with coal as a chemical feedstock (le Roux, 1982: 8). This was followed by another coal based development in 1933 when domestic steel production commenced and a range of aromatic chemicals became available on a small scale from the first coking plant at Iscor (le Roux, 1982: 9).[1] The choice of feedstock for these two developments can be attributed to a combination of South Africa's abundant coal reserves and, as was noted in Chapter 1, to the fact that much of the progress in the global chemical industry prior to World War II was motivated by the availability of coal (Waddams, 1978: 40). These coal based developments were thus not

[1] Benzene, toluene and xylene are collectively known as aromatics, and are important inputs to the production of many basic petrochemical products.

out of line with international trends in the basic chemicals industry at the time.

The following two decades saw relatively little significant development in the local basic chemicals industry and at the start of the 1950's the industry comprised a rather limited number of chemical plants[2]. It was during this period, however, that South Africa first began to import petrochemicals. The first imports of plastic raw materials into South Africa were recorded in 1944, and 1945 saw the first imports of synthetic rubber.[3]

While the development of the local basic chemicals industry can be traced back to the beginning of this century, and the beginnings of a local market for petrochemical products such as plastics and synthetic rubbers can be traced back to the 1940's,

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[2] The basic chemicals industry, as defined by the Board of Trade and Industries (1971: 2), refers to basic chemical substances which are normally used as a basic raw material by other industries, such as organic and inorganic substances, synthetic resins, synthetic rubbers, and fertilizers. The industry was mainly composed of plants for: (1) the fixation of nitrogen through the coal gasification process, the production of sulphuric acid, the manufacturing of explosives and the production of superphosphate (all in one geographical complex); (2) the electrolysis of brine for the production of chlorine and caustic soda used *inter alia* in the paper industry as well as in the manufacture of chlorinated pesticides; (3) the fermentation of molasses for the production of alcohols, solvents and flotation agents; (4) the production of sodium silicates; (5) the extraction of maize products; (6) the production of industrial gases; (7) the processing of chrome chemicals; and (8) the limited production of coal distillation by-products arising from coke production for the manufacture of steel (BTI, 1971: 17).

[3] These were the first petrochemical imports recorded in the Annual Statement of the Trade and Shipping of the Union of South Africa and the Territory of South West Africa.

it was only in the 1950's and 1960's that we see the development of a *bona fide* domestic petrochemical industry. Development of the petrochemical industry over this period was spurred by a number of factors, including: the advent of Sasol; the establishment of domestic oil refineries; strong growth in domestic demand for petrochemical products; protection from imports in the form of duties and quantitative restrictions; the establishment of sub-optimally sized plants by producers to ensure a foothold in the market; and the tremendous generation of capital by South Africa's mining industry seeking new investment outlets. Each of these factors will now be discussed in more detail.

Although Sasol was originally conceived as a producer of synthetic fuels, when the first synthetic fuels plant (Sasol One) came on line in 1954, it also produced a number of petrochemical by-products, such as ethylene and butadiene, which were made available in limited quantities for further processing (BTI, 1971: 18). In the same year the first petroleum refinery in South Africa came on line. It also produced a number of petrochemical by-products, which allowed a small complex of chemical plants to develop in the Durban area (le Roux, 1982: 9). Two additional refineries were later built, one at Cape Town and one at Sasolburg. The by-products of the Sasolburg refinery were integrated with the by-products of the synthetic fuels plant at

Sasolburg (Sasol One) and this transformed Sasolburg into the petrochemical centre of South Africa.[4]

By the mid-1950's the demand for plastics and synthetic resins had grown sufficiently to make the domestic production of at least some petrochemical products attractive (BTI, 1971: 18). Imports of plastics, for example, had grown fairly steadily from 108 tons in 1944 to 3 700 tons per annum in 1956, and imports of synthetic rubber had reached 10 000 tons per annum by 1956. In the case of plastic imports, this translates into a rapid average growth rate of 32 percent per annum, over the period 1944-1956.[5]

The first domestic plants to produce major petrochemicals were established in the 1950's and 1960's, and these included: a plant for the production of polyvinyl chloride in 1955 (le Roux, 1982: 10); a plant for the production of low-density polyethylene in 1966 (BTI, 1966); another plant for the production of polyvinyl chloride in 1966 (Financial Mail, 1974a: 160); a plant for the production of polystyrene in 1964 (BTI, 1964a); plants for the production of synthetic rubbers such as styrene-butadiene rubber in 1964 (BTI, 1964c) and synthetic rubber latex in 1968 (BTI, 1969); and plants for the production of synthetic fibres

[4] In addition, petrochemical products that later came to be produced by Sasol 2 and Sasol 3 at Secunda, such as ethylene, were piped to the downstream polymer plants at Sasolburg.

[5] Calculated from trade data taken from various issues of the Annual Statement of the Trade and Shipping of the Union of South Africa and the Territory of South West Africa. The term "plastics" is taken here to refer to import categories 962 and 963 which include imports of plastic raw materials in powder, granular or flake form, as well as in blocks, slabs, tubes, rods, rolls and sheets.

such as polyamide fibres in 1965 (BTI, 1964b) and polyester fibres in 1968 (BTI, 1968b). Domestic production of petrochemical feedstocks at the start of the 1970's included naphtha, ethylene, styrene, vinylchloride, and the production of small quantities of propylene (BTI, 1971: Annexure A).

The establishment in South Africa of domestic petrochemical manufacturing capacities in the 1950's and 1960's is not surprising considering that over the same period the petrochemical industry became one of the fastest growing sectors of the industrialised economies (Fayad & Motamen, 1986: 6). Prior to 1970 a handful of other developing countries, including Argentina, Brazil, Mexico and India, had also begun to establish their own domestic petrochemical capacities (Chesnais, 1989: 75).

Although the availability of petrochemical feedstocks from both Sasol and the domestic oil refineries played an important role in stimulating the development of the local petrochemical market, these feedstocks, particularly ethylene, were not available in sufficient quantities to meet the growing domestic demand for plastic raw materials (BTI, 1971: 18). This led to the establishment of the first domestic naphtha cracker by Sasol at Sasolburg in 1965, with an ethylene capacity of 35 000 tons per annum (BTI, 1971: 18). Due to the rapidly increasing demand for ethylene on the part of the domestic low-density polyethylene producer this was shortly followed by a larger 110 000 ton cracker in 1968. Apart from establishing the first significant domestic source of ethylene these crackers also made available significant quantities of propylene, butadiene and styrene, facilitating the further development of the domestic petrochemical industry from the late 1960's onwards (le Roux, 1982: 10).

While the 1960's can be characterised as a period in which major strides were made towards the domestic production of a number of major petrochemical products, the plants which were established during this period received, without exception, protection from competing imports in the form of moderate *ad valorem* duties in the region of 15 to 20 percent (BTI, 1971: 12).[6] On occasions when *ad valorem* duties offered insufficient protection from imports, additional protection was afforded through quantitative import controls.

A number of duties on basic chemicals, including petrochemicals, were bound in terms of the General Agreement on Tariffs and Trade. These duties were negotiated at a time when the possibilities of developing a basic chemicals industry in South Africa were still remote (BTI, 1971: 133). For example, in the case of polyester fibres (BTI, 1968b) and artificial resins (BTI, 1966) *ad valorem* duties could not be increased above 17.5 and 20 percent respectively. As a result, when the world prices of petrochemical products dropped sharply in 1967 the Board found that in order to prevent "disruptive competition" in the domestic

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[6] The producers of polyamide yarns (BTI, 1964b), polystyrene (BTI, 1964a), synthetic rubber (BTI, 1964c), polyethylene (BTI, 1966), and polyester fibres (BTI, 1968b) were all afforded protection via *ad valorem* duties.

market "it was ... necessary, owing to a GATT tie, to reintroduce a measure of restriction by means of import control" (BTI, 1968a: 2).[7]

When considering applications for the protection of domestic petrochemical producers in the 1960's the Board tended to consider each application on its own merits, rather than within the context of a particular policy aimed at promoting the domestic development of the petrochemical industry as a whole. According to Dr Etienne Rousseau, chairman of Sentrachem and of Sasol in 1968:

> Experience in other countries has shown that in the case of the chemical industry ... a certain amount of benevolent guidance and protection through government action is essential. The problem [in the South African case] is that Ministers and Government officials ... are inclined to deal with problems as they crop up on an *ad hoc* basis (Financial Mail, 1968: 33).

The Board was nevertheless consistent in its approach to considering applications for protection in the sense that it endeavoured to find a balance between securing the domestic market for domestic producers and at the same time trying to keep to a minimum the cost raising effects of such protection. For example, when considering an application in 1964 for the protection of the industry manufacturing polyamide filament yarns

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[7] Import controls in the form of quantitative restrictions were applied to imports of low-density polyethylene, polyvinyl chloride and synthetic rubber in 1968 (Government Gazette, No. 1917, 15 December 1967) and also to polystyrene and polyester fibres in 1969 (Government Gazette, No. 2203, 25 October 1968).

the Board intended that the domestic market should be secured for the domestic producer, and noted that:

> The capital intensity of the undertakings concerned results in fixed costs constituting an important part of total costs. For this reason it is desirable that the capacity of the equipment used should be utilised to the fullest possible extent in order to keep production costs low (BTI, 1964b: 7).

The Board of Trade and Industries also weighed the cost raising effects of protection against the advantages of local manufacture. For example, in the case of synthetic rubber the Board noted that the "manufacture of synthetic rubber on an almost completely local basis entails unquestionable advantages and can justify a measure of sacrifice on the part of the consumer" (BTI, 1964c: 6).[8] Similar sentiments were expressed in the Board's consideration of applications for protection in the 1960's from the domestic producers of polyamide yarns (BTI, 1964b) and low-density polyethylene (BTI, 1966).

In their report on the basic chemicals industry, in 1971, the Board of Trade and Industries considered the role of tariffs in

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[8] The advantages to which the Board refers included, presumably, benefits such as the promotion of South Africa's technological and engineering capabilities in the production of chemicals, employment creation, and the saving of foreign exchange. It should also be noted, however, that in the 1960's there existed a list of strategic chemicals which the government believed needed to be produced in South Africa, in order to become "independent of the whims and fancies of other countries" (Financial Mail, 1968: 35).

the development of the industry both at home and abroad.[9] The Board noted that "protective duties have played an important role in the development of the industry all over the world" (BTI, 1971: 16) and that the levels of protection which had been afforded to the domestic petrochemical industry in the 1960's were found to be substantially lower than in countries such as Australia, Austria, West Germany, France, Italy, Japan and the United Kingdom (BTI, 1971: 16). Two qualifications should be noted regarding this comparison. The first is that in the 1960's petrochemical producers in the industrialised countries were relatively well established, while the industry in South Africa was still in its infancy. Secondly, domestic producers benefitted from the natural protection afforded to the local industry by virtue of South Africa's distance from major international petrochemical markets, which was estimated at 20 percent of the free-on-board (FOB) value in coastal markets and 30 percent in the interior (BTI, 1971: 96).

When looking at plastics and synthetic rubbers the Board found that South African tariffs were generally lower than elsewhere, and were considerably lower than in Australia, a country which, like South Africa, was also in the process of developing a domestic petrochemical industry (BTI, 1971: 16). In 1969 imports into Australia of low-density polyethylene, high-density

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[9] It would appear, however, that the Board did not take into consideration the role of quantitative import controls when deliberating on the future role of tariff protection in the development of the industry. This might be due to the fact, as will be noted further in this Chapter, that it was the governments' intention at the start of the 1970's that quantitative import controls be replaced with tariffs.

polyethylene and polyvinyl chloride were subject to a tariff of 60 percent, and imports of polystyrene were subject to a tariff of 40 percent (Financial Mail, 1969: 1433).[10] Given the fact that the Board was aware of the disparity between South African petrochemical tariffs and those of other countries with a developed, or developing, petrochemical industry, it nevertheless felt that:

> ... it would be irresponsible ... to state categorically that it will be prepared to recommend levels of duties beyond those which have become customary in the Republic on the type of commodities now under consideration. The most it can say is that in exceptional circumstances where the contribution of the proposed project to the national economy is so valuable in economic terms as to exceed the cost raising effects of above normal protection, it will be prepared to consider requests for ordinary duties which exceed 20 per cent to 25 per cent *ad valorem* (BTI, 1971: 107).

The Board's reluctance to provide the domestic petrochemical industry with more substantial tariff protection at the start of the 1970's might be attributable to the Board's finding that "the cost structure of the [basic chemical] industry at its present stage of development is high measured by world standards" (BTI, 1971: 115). This finding is based on a comparison of domestic and foreign chemical prices which were presented in the Board's report on the Basic Chemical Industry (1971). In the case of monomers the Board found that local monomer prices (in 1970) were higher, and in some cases substantially higher, than those

[10] In addition each of the aforementioned tariffs were also subject to support values, which would appear to be the Australian equivalent of the South African formula duty (Financial Mail, 1969: 1433).

obtaining overseas (BTI, 1971: 71). The Board noted that as the profit yield of the local companies examined had not been excessively high "the price comparisons would signify a high cost structure for the local industry in comparison with overseas" (BTI, 1971: 71). In the case of polymers the disparity between prices of the domestic product and the landed prices of the imported products (excluding duties) was "anything between 10 per cent and 30 per cent and even higher" (BTI, 1971: 73).

One of the main factors contributing to the high cost structure of domestic plants in the late 1960's was, according to the Board, the "tendency... for manufacturers to establish projects somewhat prematurely, that is, at a stage when the market could not as yet support an economically sized unit" (BTI, 1971: 115). Premature establishment of domestic plants was in turn attributed to "a scramble to be the first in the market, a natural outcome of the traditional policy of free entry into manufacturing activities" (BTI, 1971: 96). Since the distance of South Africa from international markets precluded large scale exports of surplus petrochemical production, producers who wished to gain a foothold in the domestic market were essentially faced with one of two choices: they could either establish an economically sized plant in the belief that the domestic market would "grow" into the plant's available capacity (BTI, 1971: 115); or they could establish a sub-economically sized plant that was just large enough to serve the domestic market but which would be too small to benefit from the economies of scale available to larger world scale plants (BTI, 1971: 94-95).

In the late 1960's, for example, low-density polyethylene, high-density polyethylene, and polyvinyl chloride were all produced domestically in sub-optimally sized plants that were below world scale at the time (BTI, 1971: 94-95). The establishment of these plants was described by the Board as being "premature" in the sense that plants for the domestic production of these petrochemicals should only have been built when domestic demand was sufficient to justify the establishment of world scale plants. Instead, sub-optimally sized plants were built by producers in order to ensure a foothold in the rapidly expanding domestic market. Some producers believed that, in view of the small size of the domestic market and the high capital investment associated with the manufacture of petrochemicals, few potential competitors would be so foolish as to subsequently set up in opposition (BTI, 1971: 116).

One other factor which should also be taken into account when considering the early development of the domestic petrochemical industry is "the tremendous generation of capital by South Africa's mining industry seeking new investment outlets. The national shortage of skilled labour made a capital-intensive industry like chemical manufacture an especially attractive diversification" (Financial Mail, 1968: 19).

When considering the course of future developments in its report on the basic chemicals industry the Board of Trade and Industries found that the local industry was faced, on the one hand, with "a small domestic market which precludes plants of an economic

[sic] optimum size, and on the other by high transport costs which absorb advantages which can be attained by enlarging the market through exports" (BTI, 1971: 76).[11] Having identified the major obstacle to internationally competitive development in the basic chemicals industry, the Board shied away from proposing any kind of long term development plan for the industry.

With regard to the future development of the basic chemicals industry, the Board noted that due to the high cost structure of the domestic industry, and the establishment of sub-optimally sized units in order to gain a foothold in the market, "the country can ill afford further development in the industry <u>on other than a highly selective basis</u>" (BTI, 1971: 116). Despite the Board's emphasis on selective development it was not prepared to go so far as to recommend the establishment of an authoritative body that would have the power to ensure that all further developments in the industry took place on a selective basis. The Board noted in its recommendations that the establishment of a Chemical Council (acting as a central planning authority) was unacceptable on the grounds that such a body "composed partly or entirely of representatives of the private sector or State corporations" would be a "major departure from

[11] It is worth noting here that petrochemical production is subject to significant economies of scale. These economies of scale arise not only from improved technology but also from purely geometric factors. With regard to the latter, the capacity of a great deal of chemical equipment, such as storage tanks and distillation columns, varies with its volume (ie. the cube of its linear dimensions). The cost of such equipment, on the other hand, is the cost of the surface used to enclose the volume, and varies with the square of its linear dimensions. As a result cost is proportional to $(\text{capacity})^{2/3}$ (Witcoff & Reuben, 1980: 25).

accepted practice in Government bodies" and "may in the final analysis cause serious harm to the relations between State and private enterprise" (BTI, 1971: 119). The Board took the view that the future growth of the industry would depend on the development of the economy as a whole, and recommended that the industry should, within the framework of existing policy and administrative machinery and the laying down of certain ground rules, be left to "work out its own salvation" (BTI, 1971: 119).[12]

In light of the above views which were expressed by the Board, and its beratement of local basic chemical producers for their premature establishment of domestic production facilities, it would appear that at the start of the 1970's it was the government's intention that the basic chemicals industry receive protection in the form of tariffs at the level of 20 to 25 percent *ad valorem*.[13] This seems to have been in line with the proposed policy regarding future protection of manufacturing as

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[12] The major ground rules recommended by the Board were that: further development in the industry should take place in consultation with government with a view to settling relevant issues such as tariff protection; the government should recognise the need for adequate protection of approved projects; new ventures would be considered by a two-man committee (consisting of a representative of the Department of Industries and a representative of the Board of Trade and Industries) which would act as a clearing house for proposed developments "without playing the role of arbiter"; monopoly production "would require discipline through measures such as control over prices and other forms of market conduct as well as a periodic review of the protection granted" (BTI, 1971: 131).

[13] As mentioned before, these were the levels which had become "customary" in South Africa for petrochemical producers, and the Board was not prepared to consider increased levels of protection in the form of higher tariffs.

a whole as expressed by the Board in their Annual Report for 1969, where the "possible relaxation of import control" in 1970 was expected to lead to industry becoming "increasingly dependent on the Customs Tariff as the instrument for protecting viable industries against their overseas competitors on the South African market" (BTI, 1969: 3).

2.3 CONCLUDING REMARKS

The early development of the domestic petrochemical industry occurred largely on an *ad hoc* basis. By the late 1960's plants had been established for the domestic production of most major petrochemicals, with all producers receiving protection in the form of tariffs and, where tariffs offered insufficient protection, in the form of quantitative import controls. The basic chemical industry at the end of the 1960's was found by the Board of Trade and Industries to be characterised by a relatively high cost structure. This was attributed primarily to the "premature" establishment of domestic plants, whereby domestic producers entered into the domestic production of petrochemicals before domestic demand was sufficient to justify the establishment of world scale plants.

A number of factors appear to have played a role in the early development of the domestic petrochemical industry, including the establishment of domestic oil refineries and the establishment of Sasol, strong growth in domestic demand for petrochemical products, protection from imports in the form of duties and quantitative restrictions, the establishment of sub-optimally sized plants by producers to ensure a foothold in the domestic market, and the tremendous generation of capital by South Africa's mining industry seeking new investment outlets.

In light of the discussion in this Chapter, the early development of the domestic petrochemical industry cannot be solely attributed to any one of the above factors. Nevertheless, there are two factors which do appear to have played more important roles. On the one hand, the strong growth in domestic demand for petrochemical products would seem to suggest that the early development of the domestic petrochemical industry was a natural or spontaneous response to this growth. On the other hand, the general willingness on the part of the authorities to provide domestic petrochemical producers with protection might suggest that the industry's development was encouraged by protection. The "premature" establishment of sub-optimally sized plants by producers in order to ensure a foothold in the domestic petrochemical market would seem to point to a combination of the two aforementioned factors being responsible for a substantial part of the domestic petrochemical industry's early growth.

CHAPTER 3

RAPID GROWTH OF THE DOMESTIC PETROCHEMICAL INDUSTRY

3.1 AIM

This Chapter will concentrate on developments in the South African petrochemical industry from the early 1970's to the early 1980's, with attention being given to the various factors that may have been responsible for developments in the industry over this period. The discussion will proceed in four parts, beginning with a look at the general performance of the petrochemical industry. This is followed by a discussion of the protection which was afforded to the petrochemical industry, which in turn is followed by a discussion of trends in petrochemical imports. Finally, the impact which trends in the international petrochemical industry during the 1970's may have had on the development of the South African petrochemical industry is discussed.

3.2 PERFORMANCE OF THE INDUSTRY

In terms of the indicators presented in Table 3.1 below, domestic demand and domestic production of petrochemicals in South Africa grew more than twice as fast over the period 1972-1980 than the respective rates for manufacturing as a whole over the same period. Similarly high growth rates, relative to the manufacturing average, were recorded in respect of both imports

TABLE 3.1: ANNUAL GROWTH RATES FOR SELECTED INDICATORS OF ECONOMIC ACTIVITY, 1972-1990[a]

Indicator	1972-90		1972-80		1980-90	
	Petro-chemicals	Manu-facturing	Petro-chemicals	Manu-facturing	Petro-chemicals	Manu-facturing
Demand[b]	8.2	2.6	13.2	5.3	4.4	0.4
Production[c]	7.4	2.5	13.8	5.2	2.6	0.4
Imports	10.5	2.8	10.4	5.5	10.7	0.6
Exports	8.9	5.8	10.6	6.8	7.5	5.1
Employment	4.2	1.4	5.8	2.9	2.9	0.2
Capital stock[d]	8.9	4.7	6.2	8.2	11.1	2.0

SOURCE: Calculated from the Industrial Development Corporation Sectoral Data Series for Manufacturing (1992).

NOTES:
[a] All growth rates calculated from constant 1990 rand values.
[b] Includes domestic production and imports.
[c] Includes production for domestic use and for export.
[d] Defined as the accumulation of gross fixed investment after provision for depreciation over time, and includes components such as buildings, machinery, vehicles, roads, railway lines, etc.

and employment in the petrochemical industry over this period (Table 3.1).

Over the period 1972-1980 the domestic production of petrochemicals increased by 13.8 percent per annum (Table 3.1). One possible explanation for this impressive performance is strong growth in domestic petrochemical demand, which grew by 13.2 percent per annum (Table 3.1) over the same period. In terms of this explanation, the development of the domestic petrochemical industry can be seen as a natural or spontaneous reaction to strong growth in the domestic demand for petrochemical products. Additional support is lent to this explanation when the structure of the South African market for petrochemicals is analyzed using input-output techniques.

An input-output analysis of the domestic petrochemical industry is presented in Appendix A. A number of interesting points emerge from the analysis. Firstly, the demand for the output of the petrochemical industry tends to be widely dispersed among various sectors of the economy. Secondly, a large number of sectors are dependent to varying degrees on both direct and indirect inputs from the petrochemical industry. Thirdly, the petrochemical industry has a relatively strong forward linkage coefficient, indicating that the petrochemical industry plays an important role as a supplier of intermediate inputs to a diverse range of sectors in the economy. The general thrust of the above is that the South African petrochemical industry forms an integral part of virtually all sectors of the South African economy. The development of the South African petrochemical industry might therefore be seen as natural accompaniment of South African industrialisation in general.[1]

Further analysis of the data in Table 3.1 provides some interesting insights into the development of the domestic petrochemical industry over period 1972-1980. While growth in domestic petrochemical exports over the period 1972-1980 exceeded the manufacturing average (Table 3.1), it should be borne in mind that exports accounted for no more than 3 to 4 percent of the total value of domestic petrochemical production in any particular year over the period 1972-1980 (IDC, 1992).[2]

Growth in capital stock for petrochemicals was slightly lower than the manufacturing average over this period. This might seem rather incongruous considering the rapid growth of domestic petrochemical production over the same period, and the highly capital intensive nature of the petrochemical industry. Assuming the data to be reliable, and the definition used in measuring

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[1] As was noted in Chapter 1, it is the widespread integration of petrochemical products into general manufacturing and industrial processes that has led to the petrochemical industry being identified as a key sector in the industrial strategies of both developed and developing countries (Vergara & Babelon, 1990).

[2] This would seem to indicate that exports constituted a relatively fixed percentage of domestic production, and that growth in exports over this period was due to growth in domestic petrochemical production, and not to any discernable move towards export orientation on the part of domestic producers. The marginal growth of exports over this period was primarily attributable to the sale of relatively small quantities of petrochemical products to neighbouring Southern African countries, rather than to sales on the overseas petrochemical markets.

capital stock to be adequate (see Table 3.1), then this anomaly might point to abnormally capital intensive development in the South African manufacturing industry as a whole over this period. A more plausible explanation, however, is that most domestic petrochemical plants were established in the 1960's (ie. prior to 1972), with the exception of the large Coalplex complex which was established in the mid-1970's.[3] The next major development was the establishment of Sasol Two and Three in the 1980's. Thus, growth in capital stock in the petrochemical industry over the period 1972-1980 consisted primarily of additions to existing plants in order to increase capacities (a far less capital intensive route to increasing capacity than the construction of a new plant).

Finally, the rapid growth in domestic petrochemical demand over the period 1972-1980, and the slightly faster growth in domestic petrochemical production over the same period (Table 3.1), would seem to imply that domestic producers were able to capture the rapid growth in domestic demand that was experienced over this

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[3] In the early 1970's a consortium of oil companies considered the construction of a large oil refinery at Richards Bay. This refinery was to serve as the focal point for the construction of an oil-based petrochemical complex, which included plans to build ethylene-based polyvinyl chloride plants (Financial Mail, 1978: 17). After the first oil-shock, however, these plans were abandoned and local chemical companies began exploring the feasibility of producing polyvinyl chloride from coal. This led to the establishment of Coalplex in 1978, the world's largest coal-based polyvinyl chloride plant. With a capacity of 100 000 tons per annum it was designed not only to meet the domestic demand for polyvinyl chloride, but also to make South Africa an exporter of polyvinyl chloride (Financial Mail, 1978: 17).

period.[4] One possible explanation for this, which will be discussed below, is that domestic producers were afforded considerable protection from imports.

3.3 PROTECTION

South African trade policy in the early 1970's was generally characterised by considerable vacillation. At the close of the 1960's the government had, as noted in Chapter 2, announced its intention to phase out import controls in favour of the customs tariff. However, before any headway could be made in this direction, balance of payments problems lead to a tightening of import controls in November 1971 (Bell, 1992: 5). Shortly thereafter, in July 1972, government reiterated its intention to phase out the use of import controls. The period 1972-76 saw a move towards the replacement of quantitative controls with tariffs, and a gradual reduction in overall levels of protection (Bell, 1992: 5).

While the South African manufacturing sector as a whole underwent a period of mild trade liberalisation over the period 1972-76, local petrochemical producers were not subjected to this episode of trade liberalisation. The domestic petrochemical industry continued to receive protection from imports through both tariffs and quantitative controls. The tariffs afforded to domestic polymer producers in the 1960's were, as mentioned in Chapter 2,

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[4] It would also seem to point to a degree of import substitution over this period.

in the region of 20-25 percent. These tariffs remained in place for the duration of the 1970's, as did the quantitative controls on petrochemical imports. In fact, the 1970's were generally characterised by the "rigorous application of quantitative import control restrictions" for petrochemical products in general and for plastic raw materials in particular (BTI, 1983: 12).

Quantitative import controls were generally administered by the government, or, in some cases, by the domestic producer of a particular product. In the case of controls administered by government, products which were on the "restricted" list could only be imported if the importer was in possession of a valid import permit, which in turn was only issued after consultation between agents of the government and domestic producers to establish whether the product was available from a local source. If it was found that the product could be supplied from a local source then the permit would be denied. In the case of quantitative controls administered by domestic producers of particular products, the government would grant the domestic producer of a product which was on the "restricted" list an import license.[5]

When the Board of Trade and Industries recently considered the role of protection in the development of the domestic polymer industry, they came to the conclusion that "[t]he extent of the

[5] For example, in the case of low-density polyethylene the local producer (AECI) was granted the sole import license (Financial Mail, 1974a: 160), and in the case of polypropylene the local producer (Safripol) controlled all imports of polypropylene (Financial Mail, 1974b: 520).

influence of import control ... cannot be determined in view of the non-availability of systematised information in respect of the degree to which import control has restricted imports" (BTI, 1991: 8). Even if the exact extent of the influence of protection on the development of the domestic petrochemical industry cannot be determined, it can still be argued that it is possible that protection played an important role in the industry's rapid development during the 1970's. The discussion in this section of the manner in which quantitative restrictions functioned is not incompatible with such an assertion. In view of the way in which quantitative restrictions operated, it is possible that import controls and import licenses effectively allowed the domestic producer secure access to the domestic market, while at the same time ensuring that local consumers were supplied with necessary imports in cases where domestic production was insufficient to meet domestic demand or where domestic consumers required grades which were not produced locally.

3.4 <u>PETROCHEMICAL IMPORTS</u>

The aim of this section is to discuss trends in petrochemical imports, and to show that these trends are not incompatible with the assertion, made at the end of the previous section, that import controls and import licenses effectively allowed the domestic producer secure access to the domestic market, while at the same time ensuring that local consumers were supplied with

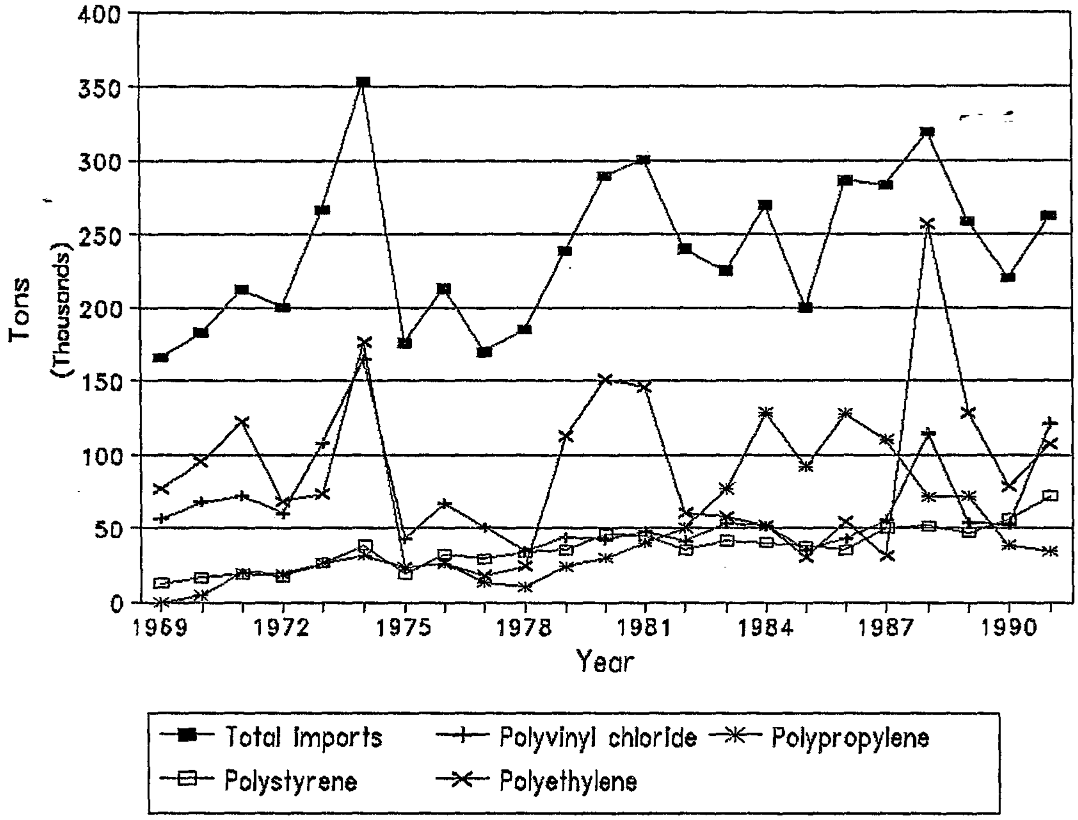

FIGURE 3.1: PETROCHEMICAL IMPORTS, 1969-1991

SOURCES: Data for the period 1969-1973 obtained from various issues of Foreign Trade Statistics; data for the period 1974-1991 obtained from the Industrial Development Corporation.

NOTES:

(a) Total petrochemical imports includes all tariff codes under SIC 3513 except for the four digit codes beginning with 39.07 since the latter are denominated by units of area rather than by weight.

(b) Import quantities of polyvinyl chloride, polypropylene, polystyrene and polyethylene have been multiplied by a factor of three for purposes of scaling.

necessary imports in cases where domestic production was insufficient to meet domestic demand.

The import quantities for total petrochemical imports and for the major plastic polymers, over the period 1969-1991, are presented in Figure 3.1. It would appear, from Figure 3.1, that import quantities for petrochemicals as a whole in South Africa have tended to peak in concert with economic fluctuations in the domestic economy (ie. with gross domestic expenditure) in 1974, 1981, 1984 and 1988.[6] This tendency is far less pronounced in the case of the individual polymers, namely polyvinyl chloride, polyethylene, polystyrene, and polypropylene. This might be explained by the fact that domestic demand for these polymers did not exhibit cyclical fluctuations. However, such an explanation is unlikely, given the fact that the international petrochemical industry has been characterised by cyclical variations in demand (Witcoff & Reuben, 1980: 28). A more plausible explanation would be that the domestic production of polymers has generally been sufficient to meet cyclical variations in domestic polymer demand.

The latter explanation is based on the assumption that domestic polymer producers have generally been able to keep the production capacities of their polymer plants ahead of domestic polymer

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[6] Data for gross domestic expenditure based on various issues of the South African Reserve Bank's **Quarterly Bulletin of Statistics.**

demand.[7] Such an assumption implies that during periods of slack domestic demand local producers would probably tend to export any surplus production, and that only during periods of exceptionally strong domestic demand would any shortfalls in domestic supply be met through imports.[8] The view that domestic production capacities have generally been in excess of domestic demand is reinforced by the fact that petrochemical export quantities have shown noticeable decreases during the cyclical booms of 1981, 1984 and 1988 (see Figure 4.3 in Chapter 4). The following discussion of trends in imports of specific polymers also lends support to the view, expressed above, that the domestic production of polymers was generally sufficient to meet cyclical variations in domestic polymer demand.

In the case of polyvinyl chloride, import quantities appear to have been largely unaffected by cyclical variations in domestic demand (Figure 3.1). The absence of cyclical variations in imports, coupled with the plausible assumption of cyclical variations in domestic demand, would seem to imply that the domestic demand for polyvinyl chloride has been met by domestic producers.

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[7] This assumption would appear to be well grounded, given the numerous expansions to capacity which took place in the polymer industry in the 1970's and 1980's.

[8] Domestic producers would tend to export surplus production in order to keep their plants operating at, or close to, full capacity in order to achieve the necessary economies of scale (Witcoff & Reuben, 1980: 28).

The large increase in polyvinyl chloride imports in 1973/74 was the result of large increases in international petrochemical prices after the first oil-shock in 1973 which sparked a panic amongst local downstream polyvinyl chloride processors and led to a large increase in orders for polyvinyl chloride, the lion's share of which had to be met through increased imports (Financial Mail, 1976: 27). Similarly, the apparently erratic increases in polyvinyl chloride imports in 1988 and 1991 are largely attributable to production problems at the Coalplex polyvinyl chloride plant which necessitated imports in order to meet the shortfall between domestic demand and domestic production.[9]

In the case of polypropylene, import quantities have also been largely unaffected by cyclical variations in demand (Figure 3.1). What is interesting about polypropylene imports is the elimination of the substantial levels of imports of the 1980's after Sasol's 120 000 tons per annum polypropylene plant came on-line in 1990, which would seem to point to a degree of import replacement (Financial Mail, 1990: 46). A similar, but less noticeable decrease in polypropylene imports occurred in the five years following the commencement of polypropylene production at Safripol in 1974 (Financial Mail, 1974c: 974). The decrease in imports following the start-up of polypropylene production at Safripol in 1974 is possibly attributable to the use of import controls, while the decrease in imports following the start-up of Sasol's polypropylene plant in 1990 can be attributed to a number of factors, including the major depreciation of the rand

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[9] Industry source.

in the mid-1980's, the *ad valorem* tariff of 20 percent to which polypropylene imports were subject at the time, and fact that this plant was large enough to benefit from economies of scale and so was in a better position to compete with imports than the smaller 1974 plant.

The rapid increase in polypropylene imports from 1978 to 1984, and the relatively high level of polypropylene imports in the following five years, can be attributed to a combination of strong growth in domestic polypropylene demand in the early 1980's (Financial Mail, 1981b: 17), problems experienced by the domestic producer of polypropylene in obtaining a secure supply of propylene feedstocks following the closure of Sasol's naphtha cracker in the early 1980's (Financial Mail, 1983: 8), and the inability of the domestic producer to meet the increasingly wide variety of polypropylene grades required by the domestic market (Financial Mail, 1980: 717).

Import quantities of polystyrene (Figure 3.1) tend to show relatively consistent growth over the period 1969-1991, with imports increasing markedly after the removal of quantitative import controls in 1986 and the removal of tariff protection in 1990. The increase in polystyrene imports from approximately 5 000 tons in 1969 to approximately 25 000 tons in 1991 would seem to indicate that the domestic polystyrene industry has been unable to achieve efficiency in production or to meet growing domestic demand for polystyrene.

The polystyrene industry's inability to meet growth in domestic demand can be attributed to a number of factors. Of the major polymers produced in South Africa (and internationally) it is polystyrene which accounts for the smallest volumes in terms of total polymer demand and production. This factor, combined with the already small size of the South African polymer market and the wide variety of product grades required by downstream industries, led to the establishment of "a batch plant which is less efficient in world terms then [sic] the continuous plants run overseas" (BTI, 1988: 5). A more serious disadvantage in the domestic production of polystyrene, however, arose from the fact that following the closure of Sasol's styrene plant in the early 1980's, virtually all styrene monomer had to be imported (BTI, 1990: 5). Since styrene monomer represents approximately 80 percent of the total production costs of polystyrene, the volatility of the international styrene monomer price and the fall in the value of the rand in the mid-1980's, led to the domestic polystyrene producer being placed at a competitive disadvantage (BTI, 1988 :5). In addition, the 1980's saw the progressive lowering of the levels of protection previously afforded to the domestic polymer industry.[10] The result was the closure of Styrochem's suspensive polymerisation units (which accounted for the major portion of Styrochem's polystyrene production) and an increase in polystyrene imports in the late 1980's and early 1990's.

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[10] Trends in the protection afforded to domestic polymer producers during the 1980's will be discussed in more detail in Chapter 4.

In the case of polyethylene, import quantities (Figure 3.1) tend to have been more responsive to fluctuations in the South African business cycle than any of the other polymers under discussion. The fall in imports between 1971 and 1972 could be attributed to the start of domestic high-density polyethylene production in 1972 (Financial Mail, 1973: 468), while the decrease in imports from 1982 to 1985 could be attributed to the commencement of linear low-density polyethylene production in 1983. The sharp increase in imports in 1974 is, as was the case with polyvinyl chloride imports, attributable to the oil-shock induced panic of downstream converters, while the sharp increase in 1988 can be attributed to the removal of controls in 1987 and to shortages of ethylene following operational problems at the Sasol plants.[11] In view of the fact that polyethylene imports fell sharply in 1989 and 1990, and the fact that quantitative controls were not reimposed, the main factor in the sharp rise in imports in 1988 was probably the domestic shortage of ethylene. The increase in imports in 1979/80 is partly attributable to the business cycle, but the level of imports thereafter decreased relatively sharply due to expansions to existing low-density polyethylene and high-density polyethylene plants, and the addition of a new plant for the production of linear low-density polyethylene in 1983.

[11] Industry source.

3.5 INTERNATIONAL DEVELOPMENTS

As was noted in Chapter 1, it was from the early 1970's to the early 1980's that the petrochemical industry in the industrialised countries experienced the worst period in its history, as it had to contend with the effects of the two oil-shocks of the 1970's and the problem of global overcapacity in petrochemical production during the general world recession of the early 1980's (Stobaugh & Gagne, 1988: 26).

While the petrochemical industry in the industrialised countries was experiencing the worst period its history, the petrochemical industry in the developing countries was just starting to grow. As mentioned in Chapter 1, it was the mid-1970's that saw the start of rapid development in the petrochemical industry in developing countries (Chesnais, 1989: 75). In particular, countries with a substantial and rapidly expanding industrial base, such as India, South Korea, Brazil, Mexico and Argentina, gave protection to their petrochemical industry by "erecting high tariff barriers against imported products" (Fayad & Motamen, 1986: 111). Protection, however, was not the only factor responsible for the rapid expansion of the petrochemical industry in these countries. According to Fayad & Motamen (1986: 112) "[t]he sufficiently large home markets, the expanding industrial output and the well-established infrastructure of these countries" all contributed to "the rapid expansion of their petrochemical output".[12]

The rapid growth of the domestic production of petrochemicals in South Africa over the period from the early 1970's to the early 1980's would appear to be in line with the experience of the developing countries discussed above. An important factor driving the development of the petrochemical industry in these developing countries, and in South Africa, was the strong growth in domestic demand for petrochemical products. That these countries managed to establish domestic petrochemical capacities at a time when the petrochemical producers in the industrialised countries were experiencing difficult times is possibly partly attributable to the fact that these developing countries, like South Africa, afforded their domestic producers protection from imports.

3.6 CONCLUDING REMARKS

Two competing explanations for developments in the domestic production of petrochemicals over the period from the early 1970's to the early 1980's have been presented in this Chapter. The rapid growth in the domestic production of petrochemicals over this period could possibly be explained, firstly, in terms of trade policy and, secondly, in terms of strong growth in domestic demand.

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[12] Of the countries mentioned here, only Mexico had a large reserve of oil and gas, and was a major exporter of oil (Fayad & Motamen, 1986: 111).

With regard to the first explanation, it was noted that while South African industry was subjected to a period of mild trade liberalisation between 1972 and 1976, the domestic petrochemical industry was not subjected to this episode of trade liberalisation. Instead, it was protected by *ad valorem* tariffs in the region of 20-25 percent, and by the vigorous application of quantitative import controls. The actual extent of the influence of protection on the development of the domestic petrochemical industry is difficult to determine in the absence of systematised information regarding the degree to which import control has restricted imports. Nevertheless, in view of the manner in which quantitative restrictions operated, it is possible that import controls and import licenses effectively allowed the domestic producer secure access to the domestic market.

This view was echoed in the discussion of trends in petrochemical imports where it was argued that it was possible that the combination of *ad valorem* tariffs and quantitative import controls provided a protective blanket behind which domestic producers were able, through numerous expansions to domestic plant capacities, to capture the rapid growth of domestic demand for petrochemicals.

Additional support is lent to the view that domestic petrochemical producers received a considerable degree of protection from imports when the experience of the international petrochemical industry is taken into account. It was during the

1970's that the petrochemical industry in the industrialised countries had to contend with the effects of two oil-shocks, global overcapacity in petrochemical production, and a worldwide recession. The fact that the petrochemical industry in South Africa and other developing countries was able to grow so rapidly in the face of such adversity is compatible with the assertion that domestic producers received a considerable degree of protection from imports. Since petrochemical tariffs were relatively low and fairly constant over the 1970's, a substantial proportion of the protection afforded to domestic producers is likely to have been in the form of quantitative restrictions.

The development of the South African petrochemical industry over the period from the early 1970's to the early 1980's cannot, on the basis of the information presented in this Chapter, be attributed solely to the effects of trade policy. An alternative explanation for the rapid growth in the domestic production of petrochemicals over this period rests on the strong growth of domestic petrochemical demand. The development of the domestic petrochemical industry might therefore be seen as a natural or spontaneous reaction to strong growth in the domestic demand for petrochemical products. This explanation would be in line with the experience of other developing countries that had a substantial and rapidly expanding industrial base, such as India, South Korea, Brazil, Mexico and Argentina.

Finally, while protection and strong growth in domestic demand have both been identified as potentially important factors in the development of the domestic petrochemical industry over the period from the early 1970's to the early 1980's, it has not been established which of these was the more important factor.

CHAPTER 4

PROGRESSIVE LOWERING OF PROTECTIVE BARRIERS

4.1 AIM

Following the discussion in the previous two Chapters of the development of the domestic petrochemical industry from its inception up to the early 1980's, this Chapter will concentrate on a discussion of developments in the industry over the period from the early 1980's to the early 1990's, with attention being given to the various factors that may have been responsible for developments in the industry over this period. The discussion will proceed in four parts, beginning with a look at the general performance of the petrochemical industry over this period. This is followed by a discussion of the protection which was afforded to the petrochemical industry, a discussion of trends in petrochemical imports and exports, and a comparison of domestic and foreign prices of polymers in 1983 and 1993.

4.2 PERFORMANCE OF THE INDUSTRY

Shortly after the second oil-shock, speculation in the financial press was that South Africa was now in a position to become a net exporter of chemicals and plastics (Financial Mail, 1979b: 616).[1] This speculation was based on the fact that the

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[1] One of the proponents of this view was T.K. le Roux, a consultant to local chemical companies at the time.

South African petrochemical industry could become almost entirely coal-based once the production of ethylene at Sasol Two came on line in the early 1980's (Financial Mail, 1979b: 616). In addition South Africa already had the world's largest polyvinyl chloride from coal plant, and once Sasol Two started to produce ethylene from coal this was expected to give local polyethylene and polyvinyl chloride producers a competitive price advantage over the rest of the world's oil-based producers.[2]

Following the high growth rates of the 1970's, the early 1980's saw the announcement of a major new round of investment in plastic raw materials, mainly in the form of the expansion of existing plant capacities, for the production of high-density polyethylene, polypropylene, low-density polyethylene and polystyrene (Financial Mail, 1979a: 951). At the end of 1979 the decision was also taken to go ahead with the construction of a large (coal-based) synthetic rubber plant at Newcastle, with the aim of making South Africa independent of imports of natural rubber (Financial Mail, 1979a: 932).[3]

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[2] For a short period following the 1979 oil-shock South African chemical producers were able to profitably export coal-derived chemicals and plastics (Financial Mail, 1984a: 10).

[3] The plant was engaged primarily in the production of polyisoprene rubber, a synthetic substitute for natural rubber. By the time the plant came on line in 1982, however, the price of natural rubber had fallen dramatically, with the result that the operation remained generally unprofitable over the course of the 1980's (even though it received protection in the form of an *ad valorem* duty on natural rubber imports of 25 percent) and was subsequently shut down in 1990.

TABLE 4.1: ANNUAL GROWTH RATES FOR SELECTED INDICATORS OF ECONOMIC ACTIVITY, 1980-1990[a]

Indicator	1980-90		1980-84		1984-90	
	Petro-chemicals	Manu-facturing	Petro-chemicals	Manu-facturing	Petro-chemicals	Manu-facturing
Demand[b]	4.4	0.4	2.6	0.4	5.6	0.4
Production[c]	2.6	0.4	3.3	0.6	2.1	0.2
Imports	10.7	0.6	1.4	-0.6	19.5	1.5
Exports	7.5	5.1	9.5	-0.1	6.2	8.6
Employment	2.9	0.2	5.6	1.0	1.1	-0.2
Capital stock[d]	11.1	2.0	19.4	6.2	6.0	-0.7

SOURCE: Calculated from the Industrial Development Corporation Sectoral Data Series for Manufacturing (1992).

NOTES:
[a] All growth rates calculated from constant 1990 rand values.
[b] Includes domestic production and imports.
[c] Includes production for domestic use and for export.
[d] Defined as the accumulation of gross fixed investment after provision for depreciation over time, and includes components such as buildings, machinery, vehicles, roads, railway lines, etc.

The rapid development of the domestic petrochemical industry in the 1960's and 1970's did not continue through the 1980's. The annual growth rate for domestic petrochemical production fell from 13.8 percent in the 1970's to 2.6 percent in the 1980's (Table 3.1). One possible explanation for this growth retardation in the domestic production of petrochemicals may have been a concomitant decline in the domestic demand for petrochemicals. The annual growth rate for domestic petrochemical demand fell from 13.2 percent over the period 1972-80 to 4.4 percent over the period 1980-1990 (Table 3.1). However, when the period 1980-90 is broken up into the two sub-periods 1980-84 and 1984-90 a slightly different picture begins to emerge (Table 4.1).

Over the period 1980-84 domestic petrochemical production proceeded at a slightly faster pace than domestic petrochemical demand, with annual growth rates for production and demand of 3.3 and 2.6 percent respectively, while over the period 1984-90 domestic demand outpaced domestic production, with annual growth rates of 5.6 and 2.1 percent respectively (Table 4.1). The significantly faster growth of domestic petrochemical demand relative to growth in domestic petrochemical production over the period 1984-90 can also be seen in Figure 4.1 below, where there is a notable divergence between the value of domestic petrochemical demand and the value of domestic petrochemical production over the latter half of the 1980's.[4]

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[4] The data utilised for the calculation of annual growth rates in domestic demand and domestic production in Tables 3.1 and 4.1 has been displayed graphically in Figure 4.1.

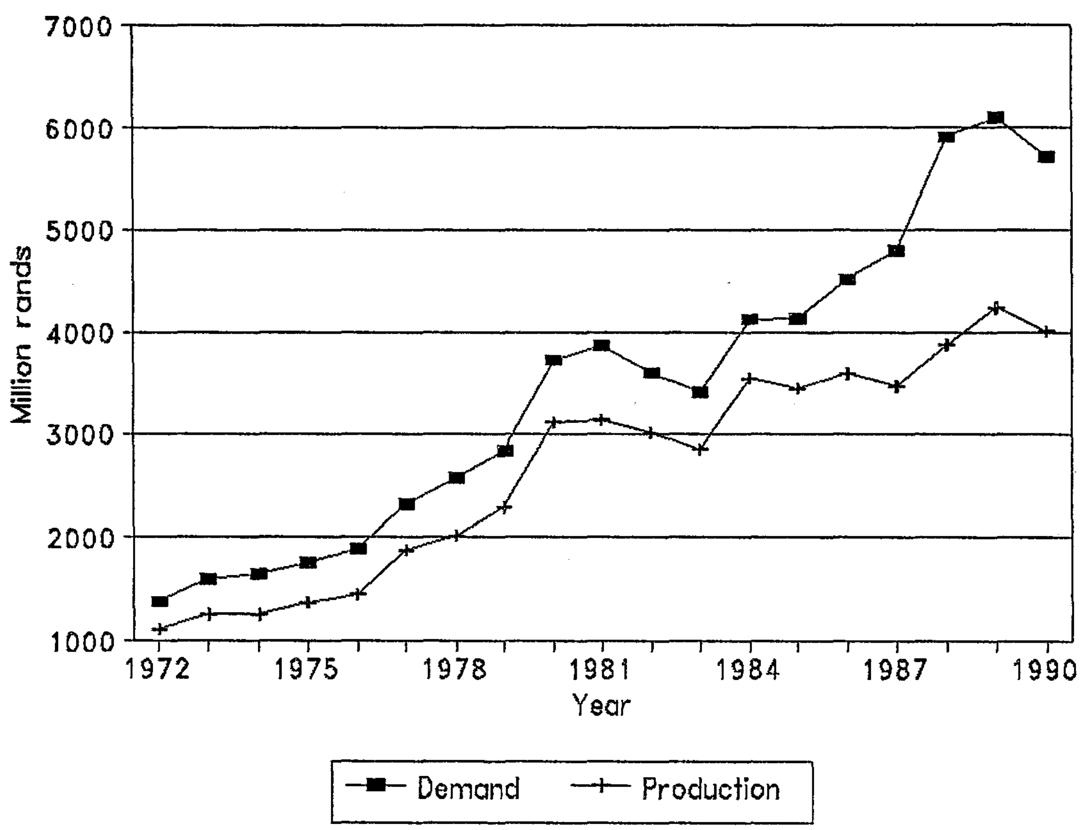

FIGURE 4.1: DOMESTIC PETROCHEMICAL DEMAND AND PRODUCTION, 1972-1990 (CONSTANT 1990 RANDS)

SOURCE: Calculated from the IDC Sectoral Data Series for Manufacturing, January 1992.

In view of the fact that over the first half of the 1980's the annual growth rate in domestic production was slightly higher than that for domestic demand, while over the latter half of the 1980's the annual growth rate in domestic demand was more than twice as fast as that for domestic production, it would appear to be unlikely that changes in the domestic production of petrochemicals during the 1980's were caused primarily by changes in domestic petrochemical demand. Developments in the domestic petrochemical industry during the 1980's must have been influenced by other factors as well. One particular factor which may have played an important role in the growth retardation of the domestic production of petrochemicals during the latter half of the 1980's was, as will be argued in this Chapter, a change in the overall level of protection afforded to domestic petrochemical producers. Before moving on to a discussion of the protection afforded to the petrochemical industry during the 1980's, however, a brief discussion of two of the other indicators in Tables 3.1 and 4.1, namely employment and capital stock, will be presented.[5]

Employment growth in the petrochemical industry fell from 5.8 percent per annum in the 1970's to 2.9 percent per annum in the 1980's (Table 3.1). These figures, however, mask a trend of uninterrupted and steady increases in employment in the industry from 1972 to 1985, followed by very slow growth over the period 1985-1990. In terms of the growth rates presented in Table 4.1

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[5] The remaining two indicators in Tables 3.1 and 4.1, namely imports and exports, will be discussed later in this Chapter.

employment growth in the petrochemical industry fell from 5.6 percent over the period 1980-84, to 1.1 percent over the period 1984-90. Employment growth in the industry prior to 1985 could be attributed to the staffing of plants, or expansions to existing capacities, which had been commissioned at the start of the 1980's and which were still coming on-line in the first half of the decade.

The rate of growth in capital stock, on the other hand, actually increased from 6.2 percent per annum in the 1970's to 11.1 percent per annum in the 1980's (Table 3.1), growing uninterruptedly and rapidly from 1978-1985, and then very gently from 1985-1990. In terms of the growth rates presented in Table 4.1, the rate of growth in capital stock fell from 19.4 percent over the period 1980-84, to a relatively low 6.0 percent over the period 1984-90. This anomaly could, as mentioned before, be attributed to the creation of Sasol Two and Three in the early 1980's, to a number of expansions to existing capacities in the early 1980's, as well as to the construction in the early 1980's of a linear low-density polyethylene plant and a large synthetic rubber plant.

4.3 PROTECTION

The early 1980's saw the government announcing once again its intention to phase out the general use of quantitative import controls in favour of the customs tariff (Bell, 1992: 7). The process of dismantling quantitative import controls began in earnest in 1983, and by 1985 the proportion of tariff items subject to controls had fallen from 77 percent in 1983 to 23 percent in 1985 (Bell, 1992: 7).[6]

While the domestic petrochemical industry retained the protection afforded to it by quantitative import controls during the previous episode of mild trade liberalisation in the 1970's this was not the case in the 1980's. As early as 1980 the Board of Trade and Industries requested applications from local polymer producers for customs tariffs which could be used to replace quantitative import controls (Financial Mail, 1981a: 476). These producers requested extremely high levels of tariff protection, ranging from 45 percent in the case of polypropylene and high-density polyethylene to 100 percent in the case of polyvinyl chloride (Government Gazette, No. 7386, 30 January 1981).

The Plastics Converters Association submitted their own application to the Board in respect of the protection to be afforded to local polymer producers, and requested duties in the region of 20 percent, far lower than those requested by the polymer producers themselves (Government Gazette, No. 8112, 19 March 1982). Downstream processors of plastic raw materials feared that a reduction in the overall levels of protection afforded to them, without a concomitant decrease in the levels of protection afforded to the upstream producers of plastic raw

[6] The cumulative effect of the removal of quantitative controls and their replacement with customs tariffs, which were lower than the tariffs implicit in the quantitative controls, was a "major reduction in the level of protection in the period 1983-1985" (Bell, 1992: 7).

materials who supplied them with inputs, would place them in a position in which they would not be able to compete with imports of processed plastic materials (Financial Mail, 1983: 4).

Subsequent to the two applications mentioned above the Board conducted its own investigation into the protection which should be afforded to the local polymer industry. The Board came to the conclusion that:

> ... this industry, protected as it has been for many years through the rigorous application of quantitative import control restrictions, does not on the whole present a picture of keen competitiveness or marked efficiency (BTI, 1983: 12).

The Board recommended that import controls on plastic polymers be removed, that imports of low-density polyethylene, high-density polyethylene and polypropylene be subject to *ad valorem* tariffs of 20 percent, that imports of polystyrene receive protection of 22.5 percent, and that imports of polyvinyl chloride receive protection of 25 percent (BTI, 1983).[7] Although the recommended tariffs were implemented and took effect from February 1984 (Government Gazette, No. 9035, 20 January 1984), import controls were only phased out in the latter half of the decade.[8] The Board also recommended that the level of protection afforded to the industry should be further

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[7] All these operated in conjunction with formula duties.

[8] The delay in lifting controls could be attributed to the Board of Trade and Industries' finding that "to subject the [polymer] industry suddenly to open world competition ... would surely spell an end to [domestic] operations..." (BTI, 1983: 12).

investigated after a period of four years "with a view to the possible reduction of duties as the industry adjusts to a more competitive milieu" (BTI, 1983: 12).[9]

The implementation of the tariffs recommended by the Board of Trade and Industries for the polymer industry coincided with the depreciation of the rand, beginning in late 1983 and then falling sharply from mid-1984 to late 1985 (Bell, 1992: 8). It was only after the depreciation of the rand that the government began to remove quantitative import controls from petrochemical imports. According to Bell (1992: 8) the depreciation of the rand is basically attributable to the substantial decline in South African exports in 1981-84, and to the collapse of the gold price. The depreciation of the rand should not, therefore, be seen as a deliberate move on the part of the authorities in order to compensate for the impact which the removal of quantitative restrictions may have had on imports.[10] Controls on polystyrene and polypropylene were removed in 1986 (Government Gazette, No. 10371, 1 August 1986), controls on polyethylene were removed in 1987 (Government Gazette, No. 11069, 18 December 1987), and in 1990 controls on polyvinyl chloride and polyamide fibres were removed (Government Gazette, No. 12907, 21 December 1990).

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[9] The level of protection afforded to domestic polymer producers was reviewed by the Board of Trade and Industries in February 1987. The recommendations made in that report are discussed below.

[10] For a discussion of the role of the real exchange rate in the implementation of an episode of trade liberalization, see Michaely *et al.* (1991: 196-231).

When the Board of Trade and Industries reviewed the protection afforded to domestic polymer producers in February 1987, it noted that in the case of low-density polyethylene, high-density polyethylene and polyvinyl chloride the international prices of these polymers had decreased since 1983, when the existing tariffs had been determined, and that "the devaluation of the rand ... has resulted in a drastic narrowing of the gap between foreign domestic prices expressed in rands, and the South African domestic prices of the polymers" (BTI, 1987: 4). Prompted largely by these two developments, the Board proceeded to lower the *ad valorem* duties on high-density polyethylene, low-density polyethylene and polyvinyl chloride to 10 percent (BTI, 1987).[11]

The governments intention to further reduce overall levels of protection afforded to the domestic petrochemical industry became apparent in July 1990 when the Minister of Trade and Industry and Tourism requested that the Board of Trade and Industry investigate and revise the tariff protection afforded to the industries which manufacture plastics and chemical and related products with special reference to a possible reduction of tariffs. After considering the position of the domestic polymer producers, the Board found that a duty of 10 percent *ad valorem* would, in respect of most polymers, provide the domestic industry

[11] While such a move would seem to defeat the whole purpose of the devaluation of the rand, it was the intention of the Board of Trade and industries that the prices of domestic polymers should be lowered. As a result the Board felt it necessary to counter what was effectively an increase in the overall level of protection afforded to domestic polymer producers by lowering the *ad valorem* duties on polymer imports.

with sufficient protection and would "enable the industries to develop further and to improve their competitiveness" (BTI, 1991: 9).

The change in the Board of Trade and Industries approach to applications for protection on behalf of domestic petrochemical producers, from one in which applications in the 1960's and 1970's were generally considered in the light of their contribution to furthering South Africa's aim of self-sufficiency in the production of strategic chemicals, to one in which increased emphasis has been placed on promoting the development of a more internationally competitive industry, is clearly illustrated by the experience of the local polystyrene industry. In May of 1990 the Board recommended that all duties on imports of polystyrene be removed, in view of the fact that the industry had made no progress in improving its "competitive posture" (BTI, 1990). The Board noted "the industry's apparent inability to reduce cost disadvantages" and that "after being in existence for some 25 years, during which time it was heavily protected, the industry is still only able to meet less than half of local demand, and can only supply certain grades" (BTI, 1990: 8).[12] In addition to the cost-raising effects of domestic polystyrene production, the Board also took into consideration the industry's

[12] As was noted in Chapter 2, the small size of the domestic market for polystyrene, the wide variety of grades required by downstream industries, and the virtual assurance of substantial levels of protection, led to the establishment of a domestic polystyrene industry which was based on a relatively inefficient production process (ie. to the establishment of a "batch plant" as opposed to the "continuous" production processes employed by foreign producers).

negative effect on the balance of payments, due to the industry's need to import its basic raw material, styrene monomer.[13] The industry's relatively poor export performance was also taken into consideration by the Board.[14] The removal of all duties on imports of polystyrene forced Styrochem to close its suspensive polymerisation units and to concentrate solely on the production of expanded polystyrene (Chemicalweek, 1991: 28).[15]

In light of the discussion in this section, it would appear that the cumulative effect of the removal of quantitative import controls and the progressive lowering of tariff protection afforded to the domestic petrochemical industry over the course of the 1980's represents a reduction in the overall level of protection afforded to the domestic petrochemical industry. The impact which this may have had on the domestic production of petrochemicals will now be discussed in the following two sections in terms of trends in petrochemical imports and exports and in terms of a comparison between domestic and foreign polymer

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[13] This point was also raised in Chapter 2, where it was noted that the domestic production of styrene monomer ceased in the early 1980's, after the Board of Trade and Industries (1983) recommended that the duty on the monomer be removed in order to provide the polystyrene industry with access to cheaper raw materials. The volatility of the international price of styrene monomer, and the fall in the value of the rand in the mid-1980's, led to the domestic polystyrene industry being placed at a competitive disadvantage (BTI, 1988: 5).

[14] Prior to 1988 polystyrene exports did not exceed 300 tons per annum, and from 1988 to 1991 did not exceed 1300 tons per annum (data obtained from the IDC).

[15] Styrochem resorted to producing approximately 5 000 tons per annum of expanded polystyrene, compared to the approximately 20 000 tons per annum of high impact and crystal polystyrene it used to produce when the suspensive polymerisation units were in operation.

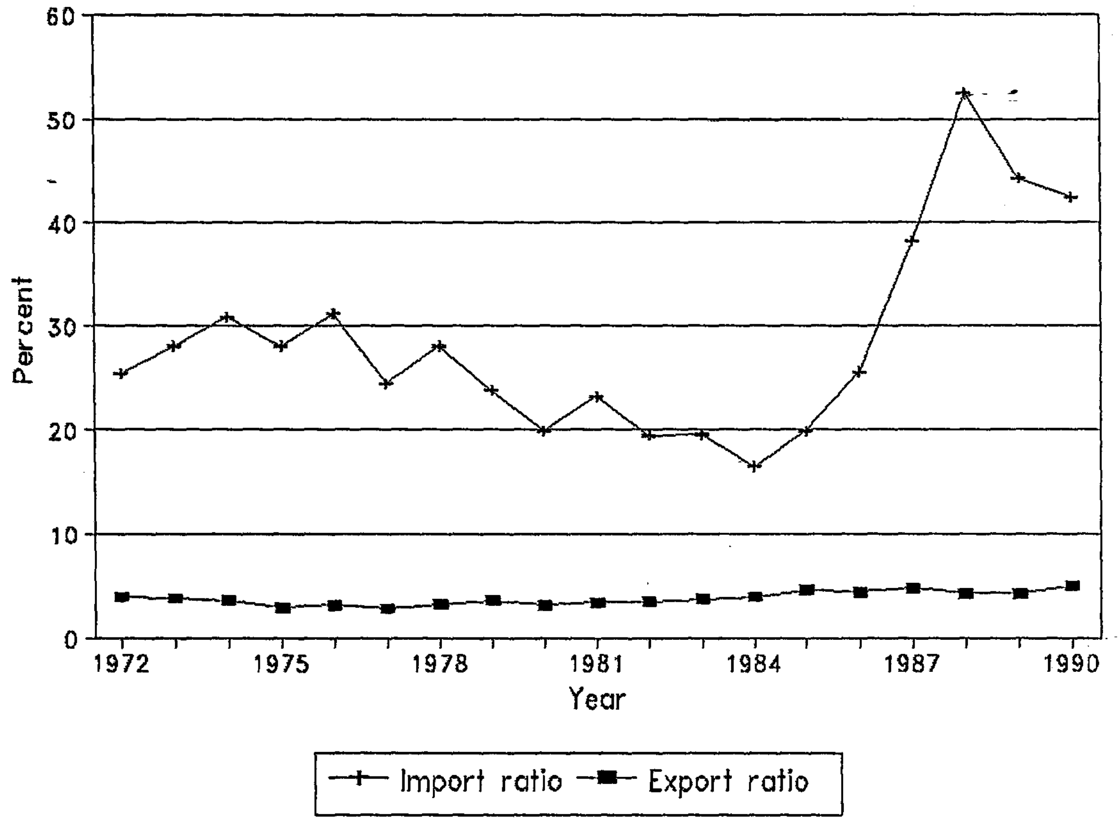

FIGURE 4.2: IMPORT AND EXPORT VALUES FOR PETROCHEMICALS AS A PERCENTAGE OF THE VALUE OF DOMESTIC PRODUCTION, 1972-1990

SOURCE: Data for import and export ratios are based on the Industrial Development Corporation's Sectoral Data Series for Manufacturing (1992).

NOTE: The ratio of the value of imports to the value of domestic consumption, also known as the import penetration ratio, is calculated as M_i / (Pr_i + M_i - X_i) where M and X are the domestic values of imports and exports respectively, and Pr is the value of domestic production in industry i (Kahn, 1987: 238-239). The export ratio is calculated as the total value of exports over the total value of domestic production (X_i/Pr_i).

prices in 1983 and 1993. It should be noted, however, that while the following sections will not prove the existence of a causal relationship between changes in levels of protection and trends in imports and exports, or between changes in levels of protection and changes in the domestic prices of monomers and polymers, it will show that there is at least some correlation between these variables and that the existence of a causal link is therefore possible. Thus, while the results of the analysis in the following two sections cannot be said to be conclusive, they do at least lend some support to the assertion that protection played an important role in the industry's development during the 1980's.

4.4 PETROCHEMICAL IMPORTS AND EXPORTS

The slightly faster growth rate of domestic production relative to domestic demand in the 1970's (Table 3.1), taken together with a decrease in the share of imports as a percentage of the value of total domestic petrochemical production from between approximately 25 and 30 percent in the early 1970's to between approximately 15 and 20 percent in the early 1980's (Figure 4.2), would seem to point towards a degree of import substitution over this period. In contrast to this the significantly faster growth rate of domestic demand relative to domestic production over the period 1984-90 (Table 4.1), taken together with an increase in the share of imports as a percentage of the value of total domestic petrochemical production from between approximately 15 and 20 percent in the early 1980's to between approximately 40 and 50 percent by the late 1980's (Figure 4.2), would seem to indicate that the domestic industry was unable to meet continued growth in domestic demand, which was subsequently met through increased imports.[16] Indeed, in terms of the indicators presented in Table 4.1, the annual growth rate for petrochemical imports increased from 1.4 percent per annum over the period 1980-84, to 19.5 percent per annum over the period 1984-90. In addition, the petrochemical industry's real profits fell sharply in 1984 (after having peaked in 1981) and subsequently showed only a partial recovery to the levels of the early 1970's (IDC, 1992).[17] Finally, as discussed in Section 4.2, the domestic petrochemical industry experienced slow growth in capital stock and employment in the latter half of the 1980's, in spite of strong growth in domestic petrochemical demand at the time.

One possible explanation for the trends described in the preceding paragraph is the lowering of the overall level of protection afforded to the domestic petrochemical industry. As discussed in section 4.3, the Board of Trade and Industries lowered the *ad valorem* duties on major polymers in February 1984,

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[16] This trend is also apparent in Figure 4.1, where, as noted earlier, there is a notable divergence between the value of domestic petrochemical demand and the value of domestic petrochemical production over the latter half of the 1980's.

[17] Real profits, as defined in the Industrial Development Corporation's Sectoral Data Series for Manufacturing (1992), refers to net profit (before tax) which is the amount arrived at: after debiting interest paid, depreciation, losses on sale or revaluation of assets and inventory valuation adjustments; before debiting of income tax and dividends paid; after crediting interest received, dividends received, profit on sale or revaluation of assets and after deducting losses shown by firms (IDC, January 1992).

and again in February 1987. Quantitative controls on the imports of the major polymers were removed over the course of the latter half of the 1980's (see section 4.3). In terms of this explanation, local producers did not feel it was worthwhile for them to make additions to local capacity in view of the fact that they felt that they would not be able to compete with growing competition from imports as protection afforded to the industry was removed (Financial Mail, 1984a: 3).

It could be argued, however, that the major depreciation of the rand from mid-1984 might be responsible for the marked increase in the value of petrochemical imports over the period 1984-90, since the data used to measure import growth in Tables 3.1 and 4.1 are denominated in rands. Similarly, the import penetration ratio in Table 4.2 has also been calculated using data denominated in rands. As a result it is possible that the increase in the value of petrochemical imports (expressed in the domestic currency) over the period 1984-90 is due to the depreciation of the rand, and not to an increase in the physical quantity of petrochemical imports. Similarly, it is possible that the import penetration ratio would rise purely as a result of the depreciation with the quantity of imports remaining constant, or even falling.

If the depreciation of the rand is largely responsible for the increase in import values for petrochemicals, then import quantities for the major petrochemicals should not exhibit any significant growth over the latter half of the 1980's. However, the import quantities of polyvinyl chloride, polyethylene, and polystyrene all increased significantly, with annual growth rates for the period 1984-91 of 12.8 percent, 11 percent, and 9 percent, respectively.[18] These substantial annual growth rates would seem to indicate that the annual growth rate for the value of petrochemical imports of 19.5 percent (Table 4.1) over the period 1984-90 is not solely due to the depreciation of the rand.

In addition, if the depreciation of the rand is largely responsible for the increase in import values for petrochemicals, then the same should hold for import values for manufacturing as a whole. However, this does not appear to be the case, since the growth rate in the value of manufacturing imports increased from 1.4 percent per annum over the period 1980-84 to 19.5 percent per annum, compared to the relatively small increase in the value of manufacturing imports from 0.6 percent over the period 1980-84 to 1.5 percent over the period 1984-90 (Table 4.1).

The two factors discussed above, namely the depreciation of the rand and a reduction in the levels of protection afforded to domestic petrochemical producers, are not the only factors that may have been responsible for the slowdown in the domestic production of petrochemicals during the 1980's. The high expectations at the close of the 1970's may have been frustrated by the fall in the international prices of petrochemicals in the early 1980's due to global overcapacity and the general world

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[18] Calculated from data obtained from the Industrial Development Corporation. This data was also used for the construction of Figure 3.1.

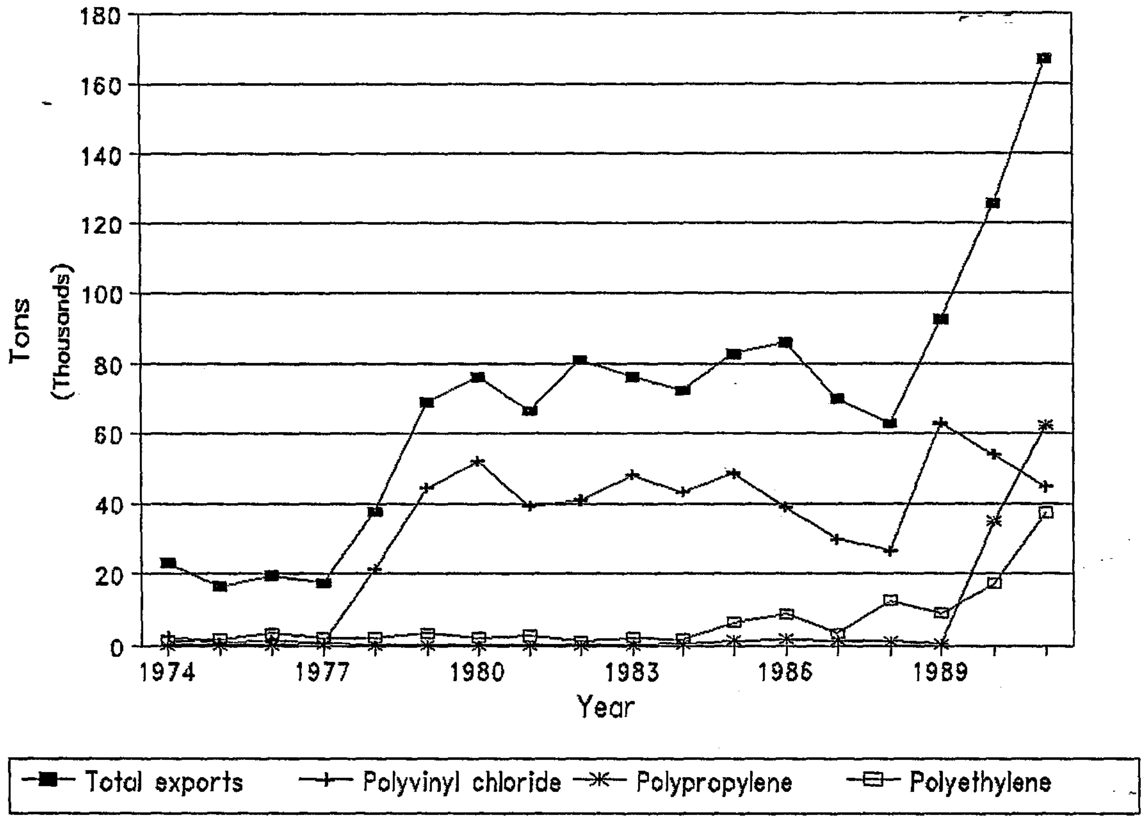

FIGURE 4.3: **TOTAL PETROCHEMICAL EXPORTS, AND EXPORTS OF POLYVINYL CHLORIDE, POLYPROPYLENE, AND POLYETHYLENE**

SOURCES: Data for the period 1974-1991 obtained from the Industrial Development Corporation.

NOTE: Total petrochemical exports includes all tariff codes under SIC 3513 except for the four digit codes beginning with 39.07 since the latter are denominated by units of area rather than by units of weight.

recession.[19] Another factor which should also be taken into consideration is that the international oil price began its descent in early 1983 and then fell substantially in 1986, thereby erasing any comparative advantage which the largely coal-based South African producers might have had in the production of petrochemicals (Financial Mail, 1983: 3).

By the late 1980's it would appear that local producers had begun to adjust to a more liberal trade policy, with a number of polymer producers making a substantial move towards the export market in the late 1980's and early 1990's. From Figure 4.3 it is evident that the total quantity of petrochemical exports increased from just over 60 000 tons in 1988 to over 160 000 tons by 1991. Prior to this, over the period 1979 to 1988, petrochemical exports were in the region of 70 000 to 80 000 tons per annum, the lion's share of which were polyvinyl chloride exports from the Coalplex plant.[20] It is also evident from Figure 4.3 that polypropylene exports were negligible prior to 1990, and it was only when Sasol's large polypropylene plant came on line in 1990 that exports of polypropylene became more substantial. Similarly large increases in exports in the late

[19] As noted in Chapter 1, the global petrochemical industry underwent a period of extensive restructuring during the 1980's with the industrialised countries moving towards the production of specialised or advanced petrochemicals, while developing countries started to expand their production of the more established petrochemicals.

[20] Polyvinyl chloride exports, while a little more erratic in the late 1980's and early 1990's due to production problems at the Coalplex plant, have generally remained at a relatively high level since the Coalplex plant began production in 1978.

1980's and the early 1990's can be seen in Figure 4.3 in the exports of polyethylene.[21]

The substantial increase in petrochemical export quantities discussed above do not appear to be evident in the export ratio displayed in Figure 4.2, or in the annual growth rates for the value of petrochemical exports in Tables 3.1 and 4.1. The export ratio in Figure 4.2 is given by the value of exports over the value of domestic production. As a result it is possible for the export ratio to remain constant if the numerator and denominator increase proportionately. The value of petrochemical exports increased by 23 percent over the period 1987-90, and the value of domestic petrochemical production increased by 16 percent over the same period, with the result that the export ratio increased only slightly from 4.65 percent in 1987 to 4.94 percent in 1990.[22]

The annual growth rates for the value of petrochemical exports in Tables 3.1 and 4.1 decrease from 10.4 percent per annum over the period 1972-80 (Table 3.1) to 9.5 percent over the period 1980-84 (Table 4.1) to 6.2 percent over the period 1984-90 (Table 4.1). The fact that the annual export growth rates have been falling over the aforementioned periods, while the export

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[21] In 1990 collective exports of polyvinyl chloride, polypropylene and polyethylene accounted for 74 percent of the total value of South African petrochemical exports (IDC, 1992).

[22] The increases in the value of imports and exports, and the export ratios, have all been calculated using data contained in the Industrial Development Corporation's Sectoral Data Series for Manufacturing (1992).

ratio has remained fairly stable at around 5 percent over the same three periods (Figure 4.2), would seem to indicate that the value of petrochemical exports must have been increasing roughly proportionately with increases in the value of domestic production. The fact that annual growth rates for the value of petrochemical production in Tables 3.1 and 4.1 also decrease over the same three periods lends support to this explanation.[23]

The substantial increase in the export quantities in Figure 4.3 might be attributed to the depreciation of the rand in the mid-1980's, and the consequent increase in competitiveness which this gave to domestic producers. The increase in exports might also be attributable to the lengthy domestic recession at the time, with domestic producers selling their surpluses abroad due to weak domestic demand for polymers (Business Day, 24 December 1991).

Another factor to be taken into consideration is that as the protective barriers afforded to the domestic petrochemical industry were lowered, local producers had an incentive to employ larger plants which would enable them to compete with imports. Due to the small size of the domestic market, however, the establishment of a plant large enough to benefit from economies of scale required that a large portion of the plant's output be exported. For example, when Sasol entered into the domestic

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[23] The annual growth rates for the value of petrochemical production in Tables 3.1 and 4.1 decrease from 13.8 percent over the period 1972-80, to 3.3 percent over the period 1980-84, to 2.1 percent over the period 1984-88.

production of polypropylene in 1990, it did so on the basis that in order to compete with imports on the domestic market it would have to operate a plant large enough to benefit from economies of scale. Due to the small size of the domestic polypropylene market the major portion of Sasol's polypropylene production had to be exported, thus contributing to the increase in petrochemical exports as a whole (Figure 4.3).

The increase in the quantities of petrochemical exports in the late 1980's and early 1990's might also be partly attributed to the General Export Incentive Scheme (GEIS), which was implemented in April 1990. According to the Industrial Development Corporation 80 percent of the export value of SIC 3513 consists of refined primary products which therefore qualify for export assistance under category 2 of the General Export Incentive Scheme. As a result it would appear that GEIS may have played an important role in promoting export growth over this period. It should be noted, on the other hand, that according to a senior member of the domestic petrochemical industry the incentive offered by GEIS has been negligible, and has generally not been included as a factor in their planning strategies.[24] Similarly, Crompton (1993: 138) found that "[d]ue to economies of scale and

[24] Also, by 1992 it was generally believed that the General Export Incentive Scheme would be brought to an end for fiscal reasons, with the result that the scheme was not taken into account in the formation of long term investment plans (Bell, 1992: 37).

the need to keep capacity utilization high, polymer plants probably would have exported with or without GEIS incentives".[25]

4.5 COMPARISON OF LOCAL AND FOREIGN PRICES FOR SPECIFIC PETROCHEMICALS

The aim of this section is to measure the protection received by domestic polymer and monomer producers in the early 1980's and the early 1990's (ie. before and after the lowering of tariffs and the removal of quantitative import controls). Ideally the protection received by domestic producers should be measured via the calculation of the effective rates of protection in both periods. However, while effective protection is, in theoretical terms, a very precise concept, there are a number of complications which arise when attempting to estimate it empirically (Greenaway & Milner, 1993: 78).[26] In particular, when quantitative restrictions are present these need to be converted into their tariff equivalents. The conversion of quantitative restrictions into tariff equivalents are notoriously difficult to measure since detailed information on the extent to

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[25] GEIS operates in terms of a formula which makes the rate of subsidisation an increasing function of the stage of production and the local content of the export (Bell, 1992: 9). In view of the fact that 80 percent of exports from SIC 3513 are classified as beneficiated primary products it is not surprising that the incentive offered by GEIS has been described as negligible. If these products were to be further processed in South Africa and then exported as higher value-added products, not only would the GEIS incentive be more substantial, but foreign exchange earnings would also benefit.

[26] For a more detailed discussion of the complications which arise when attempting to measure effective protection, see Greenaway & Milner (1993: 84-95). For a more general exposition of the concept of effective protection see Corden (1966).

which quantitative restrictions have restricted imports is difficult to obtain (Greenaway & Milner, 1993: 83). The presence of quantitative import restrictions on petrochemical imports into South Africa in 1983, and the lack of systematised information with regard to the degree to which quantitative restrictions have restricted polymer imports (BTI, 1991: 8), has necessitated the estimation of protection on the basis of price comparisons rather than on the basis of tariff schedules.[27] While quantitative restrictions on polymers had been removed by 1993, the estimation of protection in 1993 has also been conducted on the same basis for comparative purposes.

The analysis here will focus on the prices of South African polymers and those of West European polymers in 1983 and in 1993.[28] It should be noted, however, that the results of the analysis reflect not only the impact of the removal of quantitative import controls and the progressive lowering of import tariffs, but also the impact of other factors, including the substantial depreciation of the rand in the mid-1980's and changes in West European petrochemical prices over the period

[27] A similar approach was employed by Levy (1991: 47), where protection afforded to domestic polymer producers was estimated on the basis of price comparisons rather than on the basis of tariff schedules. See also Winters (1985: 80-89), where an alternative approach to measuring the protection afforded by non-tariff barriers is the estimation of their effects in terms of the price differential they induce between local and world prices.

[28] Such a comparison is made all the more interesting in light of the fact that the data for 1983 is based on that used by the Board of Trade and Industries in their report of 1983. It was in this report that the Board signalled it's intention to move toward a more liberal policy of protection with regard to the polymer industry.

Table 4.2: MONOMER AND POLYMER PRICES, 1983 (RANDS PER METRIC TON)

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Monomer and related polymer	Current overseas domestic prices of monomer	Sasol selling price of monomer	Excess of Sasol price over price of West European monomer (C-B)	(C-B)/B	West European domestic price of polymer	Landed cost of West European polymer in R.S.A. without duty[1]	S.A. polymer producers' ex-factory price for polymer	Excess of S.A. polymer price over domestic West European price (H-F)	(H-F)/F	Excess of S.A. polymer price over landed cost of West European polymer in S.A. before duty (H-G)	(H-G)/G	Margin between input monomer and output polymer		Margin between input monomer and output polymer as a percentage of the polymer price	
												South Africa (H-C)	Western Europe (F-B)	South Africa (H-C)/H	Western Europe (F-B)/F
Ethylene: LDPE	548	627	79	14%	756	926	1575	819	108%	649	70%	948	208	60%	28%
Ethylene: HDPE	548	627	79	14%	889	1059	1810	921	104%	751	71%	1183	341	65%	38%
Propylene: PP	424	801	377	89%	767	937	1500	733	96%	563	60%	699	343	47%	45%
Styrene: PS	764	990	226	30%	862	1032	1704	842	98%	672	65%	714	98	42%	11%
PVC (polymer only)	-	-	-	-	660	830	1283	623	94%	453	55%	-	-	-	-

SOURCE: Board of Trade and Industries, Report No. 2249, November 1983.

NOTE: 1 In this table the total of shipping, ocean freight, landing and insurance costs was approximated at R170 per ton.

1983 to 1993. Finally, by comparing the domestic values of monomers and polymers with their respective West European domestic values it should be possible to gauge whether South Africa's competitive disadvantage lies with the domestic producers of monomers or the domestic producers of polymers.

4.5.1 Pricing of Monomers

From the data presented in Table 4.2 it would appear that the prices of domestically produced monomers in 1983 exceeded those of their West European equivalents by 14 percent in the case of ethylene, 30 percent in the case of styrene, and 89 percent in the case of propylene. The large price differentials in the case of both styrene and propylene monomers prompted the Board of Trade and Industries to suggest that "the Sasol group should make a significant contribution to the viability and competitiveness of the polymer industries by holding down its monomer selling prices" (BTI, 1983: 14). In the same report the Board also recommended that the duties on styrene and propylene imports be scrapped and that:

> ... steps be taken by the authorities to ensure that the prices in South Africa of ethylene, propylene and styrene should not exceed (a) the relative European prices plus shipping, freight, handling, landing and insurance costs on such monomers if imported duty-free into the Republic, or (b) the relative European prices plus fifteen per cent, whichever is the less (BTI, 1983: 19).

Following the Board's recommendation in 1983 that the price of Sasol's monomers be lowered and that the import duties on

Table 4.3: MONOMER AND POLYMER PRICES, 1993 (RANDS PER METRIC TON)

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Monomer and related polymer	Current overseas domestic prices of monomer	Sasol selling price of monomer	Excess of Sasol price over price of West European monomer (C-B)	(C-B)/B	West European domestic price of polymer	Landed cost of West European polymer in R.S.A. without duty[1]	S.A. polymer producers' ex-factory price for polymer	Excess of S.A. polymer price over domestic West European price (H-F)	(H-F)/F	Excess of S.A. polymer price over landed cost of West European polymer in S.A. before duty (H-G)	(H-G)/G	Margin between input monomer and output polymer		Margin between input monomer and output polymer as a percentage of the polymer price	
												South Africa (H-C)	Western Europe (F-B)	South Africa (H-C)/H	Western Europe (F-B)/F
Ethylene: LDPE	1300	1650	350	27%	2400	2735	3100	700	29%	365	13%	1450	1100	47%	46%
Ethylene: HDPE	1300	1650	350	27%	2150	2485	3100	950	44%	615	25%	1450	850	47%	40%
Propylene: PP	979	1420	441	45%	2200	2535	2800	600	27%	265	10%	1380	1221	49%	56%
PVC (polymer only)	-	-	-	-	1900	2235	2680	780	41%	445	20%	-	-	-	-

SOURCE: Prices for Western Europe obtained from various issues of **European Chemical News**, and South African prices obtained from AECI.

NOTE: [1] In this table the total of shipping, ocean freight, landing and insurance costs was approximated at R335 per ton.

propylene and styrene be removed, Sasol decided to cease production of both monomers in 1984.[29] Sasol continued to supply the domestic market with ethylene produced at its synthetic fuels plants, and it was only when Sasol moved downstream into the production of polypropylene in 1990 that it resumed the domestic production of propylene (also from its synthetic fuels plants).

In the case of the production of high-density polyethylene, low-density polyethylene, and polypropylene, input-monomers account for between 45 and 70 percent of the final polymer selling price (van den Heever *et al.*, 1985). As a result the pricing of monomers has a substantial effect on the competitiveness of the polymer industry. In 1983 the Board of Trade and Industries noted that relatively high monomer prices in South Africa had "imposed a competitive handicap upon the industries producing polymers" (BTI, 1983: 1). From the data presented in Table 4.3 it would appear that by 1993 the situation had not improved. A comparison of domestic propylene and ethylene prices in 1993 with those in Western Europe, as shown in Table 4.3, reveals that the domestic price of propylene exceeded that in Western Europe by the substantial margin of 45 percent (as opposed to 89 percent in 1983), while the domestic price of ethylene exceeded that in West Europe by a margin of 27 percent (as opposed to 14 percent

[29] Sasol's decision was also precipitated by pressure for cheaper monomer inputs from downstream polymer producers, who expected an increase in low-priced polymer imports due to weak international petrochemical prices in the early 1980's and the expected removal of quantitative controls on polymer imports.

in 1983).[30] On the whole the price of South African monomers are still significantly higher than the domestic prices of their West European counterparts.

4.5.2 Pricing of Polymers

From Table 4.2 it would appear that South African polymer prices in 1983 were approximately double those of their European counterparts, and were between 55 and 71 percent higher than the approximate landed cost of West European polymers in South Africa without duty.[31] By 1993 the prices of South African polymers were only 10 to 25 percent higher than the approximate landed cost of West European imports, and were between 29 and 44 percent higher than the corresponding West European domestic values of these polymers (Table 4.3). The above would seem to indicate that it is possible that there was a substantial lowering of the overall level of protection afforded to the domestic polymer

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[30] Sasol's selling prices for ethylene have, since 1982, been based on those of North-West European domestic prices plus half the cost of ocean freight of polyethylene from Rotterdam to Durban plus the transport cost of ethylene from Secunda to Sasolburg (BTI, 1983: 1). Criticisms of such a pricing policy are, firstly, that Sasol produces ethylene from coal rather than naphtha (which is the predominant feedstock in Western Europe) and therefore the price of South African ethylene should not need to fluctuate with changes in the price of oil as does the West-European ethylene price, and, secondly, that the West-European ethylene price is amongst the highest in the international petrochemical market (Financial Mail, 1984a: 21).

[31] The approximate measure of protection afforded to domestic polymer producers in 1983, via quantitative import controls and import duties, would therefore be an *ad valorem* tariff equivalent of between 55 and 70 percent.

industry.[32] As was noted at the beginning of Section 4.5, the removal of quantitative import controls and the lowering of import tariffs over the period 1983-1993 are not the only factors which may have played a role in narrowing the price differential (in domestic currency) between domestic and foreign polymers. Another factor which must have played a role was the substantial depreciation of the rand in the mid-1980's. Nevertheless, the fact that domestic polymers were twice the price of West European polymers in 1983 (at which time the average *ad valorem* tariff on polymers was in the region of 20 to 25 percent) would seem to indicate the presence of non-tariff barriers, such as quantitative import controls, which were being used to protect the domestic industry from imports.

It is also apparent from Table 4.2 that South Africa's competitive disadvantage in the production of major plastic materials in 1983 lay primarily with polymer producers rather than with monomer producers. In the case of polyethylene, for example, the price of the South African monomer (ethylene) was only 14 percent higher than the West European price, while the prices of the South African polymers (low-density polyethylene and high-density polyethylene) were over 100 percent higher than the equivalent West European domestic prices. On the other hand,

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[32] Were it not for the rather fortuitous, and substantial, depreciation of the rand in the mid-1980's, the level of tariff protection afforded the industry at the end of 1983 (between 20 and 25 percent) would almost certainly have afforded the industry inadequate protection from imports. It was probably for this reason that quantitative controls on polymer imports were only removed in the latter half of the 1980's, after the depreciation of the rand.

in the case of polystyrene and, in particular, polypropylene the domestic producers could probably have been far more competitive if they had been able to obtain their monomer inputs at West European domestic prices, rather than at South African prices which were, respectively, 30 and 89 percent higher than those in Western Europe.

By 1993, however, the price differential between South African and West European polymers had narrowed considerably compared to the situation in 1983. The excess of South African polymer prices over the equivalent West European prices fell from between 94 and 108 percent in 1983 to between 27 and 41 percent in 1993 (see column J in Tables 4.2 and 4.3). Similarly, the excess of South African polymer prices over the equivalent landed cost of West European polymers in South Africa without duties fell from between 55 and 71 percent in 1983 to between 10 and 25 percent in 1993 (see column L in Tables 4.2 and 4.3). The increased competitiveness of South African polymer manufacturers is particularly marked in the case of high-density and low-density polyethylene, considering the fact that the domestic price of the input monomer (ethylene) had actually increased over the same period relative to the West European price of the monomer (domestic ethylene was 27 percent higher than the West European price in 1993, as opposed to 14 percent in 1983).

Apart from the decrease in the price differentials between South African and West European polymers, the data in Tables 4.2 and 4.3 also point to a significant fall in the South African polymer manufacturer's margins to levels more in keeping with those of West European manufacturer's. From columns M and N in Tables 4.2 and 4.3 it would appear that the margin between the input monomers and the output polymers were significantly higher in South Africa than in Western Europe in 1983, as opposed to 1993. When the margin between the input monomer and the output polymer is taken as a percentage of the respective polymer price (columns O and P in Tables 4.2 and 4.3) the margin of South African polymer producers has shown a significant decline between 1983 and 1993, while the margin of West European producers has shown a slight increase. The increase in the margins of West European polymer producers could be attributed to the firming of international petrochemical prices in the early 1990's, while the relatively narrower margins in 1983 could be attributed to the exceptionally poor state of the international petrochemical market in the early 1980's.

In the case of low-density polyethylene, for example, the margin between the input monomer and output-polymer in 1983 was 60 percent in the case of the South African manufacturer, while the equivalent ratio for West European producers was only 28 percent. By 1993 these ratios had converged, with that of the South African producer decreasing to 47 percent and that of the West European manufacturers increasing to 46 percent. A similar trend was evident in the case of high-density polyethylene. In the case of polypropylene the ratio for South African producers in 1993 was actually slightly lower than that for West European producers (49 percent and 56 percent, respectively). Looking at columns O and P in Table 4.3 it would appear that on the whole South African producers compare favourably with West European manufacturers in terms of the margin between the input monomer and the output polymer as a percentage of the price of the output polymer, which may be seen as an indication of the major strides that domestic producers have made towards the production of more competitively priced polymers.

4.6 CONCLUDING REMARKS

The period from the early 1980's to the early 1990's saw a significant slowdown in the annual growth rate for the domestic production of petrochemicals. One possible explanation for this was the concomitant slowdown in the domestic demand for petrochemicals. In view of the fact that over the first half of the 1980's the annual rate of change in domestic production was slightly higher than that for domestic demand, while over the latter half of the 1980's the annual rate of change in domestic demand was more than twice as fast as that for domestic production, it was argued that it was unlikely that changes in the domestic production of petrochemicals were influenced primarily by changes in domestic petrochemical demand.

Another factor which was put forward to explain the growth retardation of the domestic production of petrochemicals during the latter half of the 1980's was a change in the overall level of protection afforded to domestic petrochemical producers. Following a discussion of protection afforded to domestic petrochemical producers, the view was expressed that the cumulative effect of the removal of quantitative import controls and the progressive lowering of tarfff protection over the course of the 1980's represents a reduction in the overall level of protection afforded to the domestic petrochemical industry. Such an explanation was then found to be compatible with trends in petrochemical imports and exports. It was also found to be compatible with changes in domestic and foreign polymer prices in 1983 and 1993. While there seems to be some degree of correlation between the overall level of protection and the aforementioned variables, the analysis in sections 4.4 and 4.5 does not prove the existence of a causal link between these factors.

The removal of quantitative import controls and the lowering of tariffs were not the only factors which might have played an important role in the slowdown of the domestic production of petrochemicals. There were a number of other factors impacting on the domestic production of petrochemicals during the 1980's. As a result it cannot be argued conclusively that the slowdown in the domestic production of petrochemicals during the 1980's is primarily attributable to the lowering of levels of protection. Other factors which may have played an important role include the depreciation of the rand in the mid-1980's, the fall in the international prices of petrochemicals in the early 1980's due to global overcapacity and the general world recession, and the fall in the international oil price in the mid-1980's.

CHAPTER 5

SUMMARY AND CONCLUSIONS

5.1 AIM

This chapter has three broad aims. The first is to provide an overview of the preceding chapters in terms of the need for the study, the aims of the study, and the findings of the study. The second is to consider the role of Sasol in the domestic petrochemical industry's development and to consider some of the other factors which impact on the competitiveness of petrochemical producers. The third is to make some recommendations in light of the findings of the study, and to highlight areas for further research.

5.2 OVERVIEW

5.2.1 Need for the Study

The downstream end of the domestic petrochemical industry (SIC 3513) constitutes a relatively small part of the South African manufacturing industry. In 1990, for example, it accounted for 2.1 percent and 0.8 percent of manufacturing demand and manufacturing employment, respectively (IDC, 1992). Nevertheless, when the industry's role in the South African economy is examined with the aid of input-output techniques in Appendix A, it becomes apparent that the industry plays an important role in the domestic economy as a supplier of a diverse range of intermediate inputs to a large number of sectors in the economy. In addition, the petrochemical industry has been identified as a key sector in the industrial strategies of both developed and developing countries, yet research into the South African petrochemical industry has, until recently (Crompton, 1993), been largely neglected.

5.2.2 Aims of the Study

Given the important role of the domestic petrochemical industry as a supplier of intermediate inputs to a large number of sectors in the South African economy, and the paucity of research on the domestic petrochemical industry, the main aim of this study has been to examine the development of the South African petrochemical industry and, in particular, to establish the role which South African trade policy has played in the industry's development.

The main focus of the study fell on the production of plastic polymers, due partly to the fact that polymers form the most coherent sector of what is otherwise a relatively diverse industry, and partly to the fact that it was the protection of this sector of the industry which became the subject of increased government attention in the 1980's.

5.2.3 Findings of the Study

The findings of this study will be discussed in terms of the three broad stages that were distinguished in the development of the domestic petrochemical industry. Following this, the findings of another study of the domestic petrochemical industry will be compared and contrasted with the findings of this study. Finally, the experience of some other developing countries will be considered.

The first stage of the domestic petrochemical industry's development, from its inception up to the early 1970's, occurred largely on an *ad hoc* basis. During the 1950's and 1960's plants had been established for the domestic production of most major petrochemicals. By the late 1960's the basic chemical industry was found by the Board of Trade and Industries to be characterised by a relatively high cost structure. This was attributed primarily to the establishment of domestic plants which were too small to benefit from economies of scale.

Factors which may have played a role in the development of the domestic petrochemical industry during the 1950's and 1960's include the following: strong growth in the domestic demand for petrochemical products; protection from imports in the form of duties and quantitative restrictions; the establishment of domestic oil refineries; the establishment of Sasol; and the tremendous generation of capital by South Africa's mining industry seeking new investment outlets.

Of the factors listed above, two were identified as possibly having played more important roles in the industry's development, namely strong growth in domestic demand and protection. Strong growth in domestic demand for petrochemical products would suggest that the early development of the domestic petrochemical industry may be seen as a spontaneous response to this growth. On the other hand, the general willingness on the part of the authorities to provide domestic petrochemical producers with protection might suggest that the role of trade policy was to encourage the establishment of the domestic production of petrochemicals through the provision of substantial levels of protection which initially took the form of *ad valorem* duties and later, when it was found that, owing to a GATT tie, higher duties could not be implemented, through the use of quantitative import controls. While a combination of the two aforementioned factors may have been responsible for a substantial part of the domestic petrochemical industry's early growth, the relative importance of these two factors is difficult to determine.

The second stage of the domestic petrochemical industry's development, from the early 1970's to the early 1980's, was characterised by relatively high rates of growth in domestic petrochemical production. Two possible factors were put forward to explain this, namely trade policy and strong growth in domestic demand.

With regard to the first explanation, the actual extent of the influence of protection on the development of the domestic petrochemical industry is difficult to determine in the absence of systematised information regarding the degree to which import control has restricted imports. Nevertheless, it was argued that one possible explanation for the rapid growth in the domestic production of petrochemicals was that a combination of *ad valorem* tariffs and quantitative import controls provided a protective blanket behind which domestic producers were able, through numerous expansions to domestic plant capacities, to capture the rapid growth of domestic demand for petrochemicals.

With regard to the second explanation, the rapid growth in the domestic production of petrochemicals during the 1970's was the result of strong growth in the domestic demand for petrochemicals. In terms of this explanation, the development of the domestic petrochemical industry might be seen as a natural or spontaneous reaction to strong growth in the domestic demand for petrochemical products.

While both protection and strong growth in domestic demand have been identified as potentially important factors in both the first and second stages of the development of the domestic petrochemical industry, it must be emphasized that on the basis of the analysis in Chapter 2 and in Chapter 3 it is difficult to determine which of these may have been the more important factor. As a result the role of trade policy in the development of the domestic petrochemical industry prior to the early 1980's can best be described as being supportive of developments in the industry, rather than crucial to the development of the industry.

The third stage of the domestic petrochemical industry's development, from the early 1980's to the early 1990's, saw a significant slowdown in the annual growth rate for the domestic production of petrochemicals. One possible explanation for this was the concomitant slowdown in the domestic demand for petrochemicals. Another factor may have been a change in the overall level of protection afforded to domestic petrochemical producers. In terms of the last mentioned explanation, the cumulative effect of the removal of quantitative import controls and the progressive lowering of tariff protection over the course of the 1980's was arguably a reduction in the overall level of protection afforded to the domestic petrochemical industry. Other factors which may have played an important role in the slowdown of the domestic production of petrochemicals include the depreciation of the rand in the mid-1980's, the fall in the international prices of petrochemicals in the early 1980's, and the fall in the international oil price in the mid-1980's.

Changes in South African trade policy were not the only factors which might have played an important role in the general development of the domestic petrochemical industry. There were a number of other factors impacting on the industry's development. As a result it cannot be argued conclusively that the development of the domestic petrochemical industry is primarily attributable to changes in trade policy.

Now that the general findings of this study have been outlined, they can be compared and contrasted with the findings of a recent study of the South African commodity plastics filiere (Crompton, 1993). Before doing so however, it should be noted that although both studies deal with the South African petrochemical industry, the Crompton study has a wider focus than this one. This study focuses primarily on plastic polymers and , to a lesser degree, on the monomers used in their production, while the Crompton study also includes the plastic converters in the Plastic Products industry (ie. the plastic products made from polymers). In addition, while this study addresses the question of the effects of trade policy on the development of the South African petrochemical industry, the question which the Crompton study addresses is: "How has the commodity plastics filiere developed under apartheid and what changes could be made to improve its contribution to manufacturing value added (MVA), employment generation and exports?" (Crompton, 1993: viii).

The Crompton study attributes the development of the South African petrochemical industry to "Import Substitution Industrialisation policies and to the influence of apartheid's consistent efforts at fuel self-sufficiency" (Crompton, 1993: 71). Developments prior to the 1973 oil-shock are attributed to "self sufficiency type policies" (Crompton, 1993: 81), while developments after 1973 are attributed to "military/strategic reasons" (Crompton, 1993: 82). These explanations contrast with the finding of this study, namely that there are a number of factors which may have been responsible for the development of the domestic petrochemical industry. The Crompton study does not give any consideration to the fact that there may have been other factors involved in the industry's development (Crompton, 1993: 71-85). Both studies, on the other hand, found that following the move towards a more liberal trade policy in the 1980's a "slow process of restructuring is gaining momentum as plant scales increase towards world scale" and that a move towards "a more outward orientation is emerging" (Crompton, 1993: 119).

With regard to the role of trade policy in the development of the petrochemical industry in other developing countries, Vergara & Babelon (1990: 1) found that each of the six Asian countries which were studied in their report experienced government intervention during the establishment of their petrochemical industries, the main aim of which was to encourage import substitution. They also found that the policy framework tended to change over time according to circumstances and by the late 1980's there was a general tendency towards the liberalisation of trade policies in these countries. The general development of the industry in South Africa appears to have followed a similar course, namely that of import substitution followed by a move towards a more liberal trade policy.

5.3 RELATED ISSUES

There are two related issues concerning the development of the South African petrochemical industry. The first concerns the past and future roles of Sasol in the development of the domestic petrochemical industry. The second concerns the variety of factors which affect the competitiveness of petrochemical producers.

5.3.1 The Role of Sasol

Sasol's role in the development of the domestic petrochemical industry needs to be seen within the context of its general historical development as a producer of synthetic fuel.[1] Since its creation in 1950 Sasol has passed through four broad stages in its development, each of which appears to have impacted on its role in the development of the domestic petrochemical industry.[2] The first stage, from 1950 to 1960, saw Sasol primarily concerned with the technological development of the oil-from-coal process, and the construction of Sasol One. As mentioned above, the development of Sasol One indirectly helped spur the development of a domestic petrochemical industry by making available a number of petrochemical by-products, albeit in limited quantities. Expansion of Sasol's synthetic fuel activities were shelved in the early 1960's due to "developments in petroleum production and

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[1] According to le Roux (1982) the first attempts at producing liquid transport fuels in South Africa began during the inter-war period. In 1935 the Anglo Transvaal Consolidated Investment Company became interested in the oil-from-coal process and obtained a licence from Germany to build a Fischer-Tropsch plant. Development of the plant was disrupted by the war, and could only be resumed in the late 1940's. In that time, however, the basic Fischer-Tropsch technology had been improved upon by the American Kellog firm. When Anglo Vaal realised that it did not have the financial resources to continue with an oil-from-coal process, their interests were taken over by the Government and the Sasol company was formed.

[2] The discussion of these four stages of development is, unless otherwise indicated, based on information contained in a supplement to the Financial Mail (1990) dealing with the Sasol corporation.

prices, as well as the prices of machinery and equipment required in oil-from-coal production" which adversely affected the economic viability of any further development (BTI, 1971: 112). This led to Sasol entering the second stage of its development, in the 1960's, which was characterised by diversification into the production of basic chemicals and, in particular, the construction of two naphtha crackers which began to supply the domestic market with basic petrochemicals such as ethylene and propylene on a more significant scale than before, and which had a significant impact on local developments within the industry.[3] Sasol's diversification into chemicals was a logical extension of the role which it now saw itself as occupying, namely that of a supplier of raw materials to secondary industry, and as "the instrument of the Government for the development of the petrochemical industry" (BTI, 1971: 112).

Sasol's third stage of development, sparked by the oil-crises of the 1970's, was primarily in the field of synthetic fuels production and led to the establishment of Sasol Two and Three. The fourth stage of Sasol's development occurred after its privatisation in 1979 and its listing on the Johannesburg Stock Exchange. Sasol once again began to diversify its activities in the chemical field, but this time development was dependent almost solely on Sasol's own coal-based feedstocks and not on

[3] Other activities into which Sasol diversified included the construction of the Natref oil refinery at Sasolburg, the creation of Gaskor for the piping of industrial gas, and the construction of an ammonia synthesis plant for the fertilizer and explosives markets.

imported feedstocks (ie. oil-based feedstocks), as had been the case in its diversification drive in the 1960's.[4]

While Sasol has undoubtedly played an important role in the development of the domestic petrochemical industry, its activities in this arena have generally been subordinated to its primary function as a producer of synthetic fuels in the 1970's, and, more recently, to its goal of profit maximisation since its privatisation in 1979. Now that Sasol has been "privatised" it would appear that it is eager to move away from the production of synthetic fuel and towards the production of petrochemicals and high value added speciality chemicals. According to the Chemical Workers Industrial Union, Sasol realises that the role of synthetic fuel will be downgraded in a post-oil embargo age and is consequently seeking to move into other areas of production (Weekly Mail, October 9 to 15, 1992). Such a view would tend to be supported by Sasol's entry into the production of downstream petrochemicals (with the construction of a polypropylene plant in 1988) and by Sasol's recent announcement in 1991 of a capital-intensive expansion programme (worth about R3 billion), aimed at shifting the company's emphasis away from

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[4] Sasol's return to coal-based production was marked by the closure of its naphtha crackers in the early 1980's. It is interesting to note that through the 1960's and 1970's a good deal of South Africa's domestically produced feedstocks were sourced from petroleum, and it was only after the closure of Sasol's naphtha crackers in October 1982 that the industry once again became dependent on a combination of imports and domestically produced coal-based feedstocks. South Africa's dependence on coal can largely be attributed to her abundance of relatively cheap coal deposits, combined with steep hikes in the oil price following the two oil crises, as well as considerations of strategic self-sufficiency by the government of the day.

the production of synthetic fuel and into other spheres of the chemical industry (Sasol Annual Report, 1991).[5]

The fact that all of Sasol's chemical investments have been based on feedstocks which are obtained from the oil-from-coal process (Levy, 1991: 49) raises two issues which, although not strictly part of the present study, are noteworthy for their potential impact on Sasol's future role in the South African chemical industry. Firstly, the recent controversy concerning the protection afforded to Sasol's production of synthetic fuel raises the question of whether the synthetic fuel plants are viable without protection. If they were found not to be viable without protection, and protection were to be removed, it is not clear whether Sasol's chemical operations could continue independently of the production of synthetic fuel. Secondly, in light of the assertion that the production of petrochemicals from the co-products of the oil-from-coal process is more profitable than the alternative of transforming the co-products of the oil-from-coal process into synthetic fuel (Levy, 1991: 49), it is not clear why Sasol does not abandon the production of synthetic fuel and concentrate on the production of the more profitable petrochemicals.

Due to the secrecy surrounding Sasol's operations conclusive answers to these questions are not forthcoming. Nevertheless,

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[5] Sasol is also a major producer of a variety of other chemical products, including fertilizers and explosives, with sales of chemicals accounting for approximately 20 to 30 percent of Sasol's revenue in the early 1990's (Levy, 1991: 49).

with regard to the first issue, it should be noted here that it was discussed at length in a recent study of the commodity plastics filiere (Crompton, 1993). The results of the discussion, however, were inconclusive due to the fact that much of the relevant data was, and still is, not freely available. Nevertheless, after considering the issue, Crompton (1993: 97) noted that:

> At the very least it can be concluded that there is more than sufficient cause for a complete lifting of the veils of secrecy that hang over SASOL and the oil industry immediately so that the real costs of synfuel production may be included in economic planning.

5.3.2 Other Factors Impacting on Competitiveness

Apart from the influence of trade policy on the development of the petrochemical industry, there are a host of other factors which impact on the competitiveness of petrochemical producers. Some of the more important factors will be briefly discussed here, and include: the availability and cost of technology; the availability and cost of major building blocks; plant location and transportation costs; size economies; export competitiveness of user industries; and changes in the composition of petrochemical products utilized by a developing country in progressive stages of development.

The availability and cost of technology and know-how need not be viewed as binding constraints on the competitiveness of new entrants to petrochemical production in developing countries.

The technology required for the production of basic petrochemicals (as well as for resins, synthetic rubbers and fibres) is readily available on the world market. For example, over 50 percent of all synthetic fibres are now produced in countries other than Japan, the United States and Europe - the countries where this technology was first developed (Bond, 1991: 53). South Africa does not appear to have encountered any difficulties in procuring the technology required for the production of petrochemicals. The domestic production of petrochemicals from coal-based feedstocks indicates that South Africa has developed a considerable degree of indigenous technological capacity through the adaptation of conventional oil-based petrochemical production processes to that of coal-based production processes.[6]

The availability of major petrochemical building blocks at internationally competitive prices is, as was emphasized by the Working Group for the Promotion of the Chemical Industry (1990), an important determinant of the success of downstream petrochemical activities. The range of domestically produced building blocks in South Africa has been limited due to the nature of coal-based petrochemical production.[7] In addition, those building blocks which are produced locally are priced at levels above those prevailing in developed countries (Table 3.2).

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[6] The most notable examples here being the coal-based production of ethylene, polyvinyl chloride, and synthetic rubber.

[7] South Africa does not produce those chemicals known as aromatics - benzene, toluene, and xylene - due to the nature of the oil-from-coal process (The Star, 9 December 1991).

Location of plant and transport costs to domestic and international petrochemical markets also impact on the competitiveness of petrochemical producers. The geographical dispersion of South Africa's petrochemical industry has an adverse effect on petrochemical transportation costs. In the case of petrochemical raw materials required for the production of synthetic fibres, for instance, producers located around Cape Town have found it cheaper to import their raw material requirements than to source them from Sasol's inland plants.[8]

Size economies play an important role in the competitiveness of petrochemical production. The sensitivity of the economies of petrochemical production to plant size is evident in an analysis of Korean ethylene production: a naphtha-based cracker with a capacity of 600 000 tons per annum has the potential to generate a 21 percent rate of return on investment, while a cracker with a capacity of 300 000 tons per annum generates a rate of return on investment of only 14 percent (Bond, 1990: 54).[9]

Finally, the export competitiveness of industries which utilize imports also play a role in determining the competitiveness of petrochemical producers in developing countries. Dynamic growth in exports of manufactured goods which utilize petrochemical products provide an additional stimulus to petrochemical

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[8] Based on discussions held with members of the South African chemical industry.

[9] The constraints imposed on the domestic petrochemical industry become clear when one considers that South Africa's total ethylene capacity is currently only 400 000 tons per annum.

competitiveness, as does growth in domestic consumption of such goods (Bond, 1990: 54). In the case of the main Asian developing country exporters of manufactured goods today, many began their early expansion with the production of relatively simple products such as textiles and clothing. These products then declined in importance as countries shifted their production to other, more sophisticated products such as footwear, transistors, telecommunication products, motor vehicle parts, and general articles of plastic.[10] The production of each of these products implies differing demands in both the consumption and the composition of petrochemical inputs. Since the pattern of industrial specialisation within a given country is dynamic, as the country progresses from one stage of industrial growth to the next, the composition of petrochemical products utilized within that economy are also likely to change (Bond, 1990: 54).

5.4 RECOMMENDATIONS AND AREAS FOR FURTHER RESEARCH

In light of the important role played by the petrochemical industry in the South African economy, and the active role of developing country governments in the development of their domestic petrochemical industries, the future development of the South African petrochemical industry certainly warrants more attention from policy makers than it appears to have received in the past.

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[10] Based on the findings of a study by Alexander Yeats entitled "Developing Countries Exports of Manufactures: Past and Future Implications of Shifting Patterns of Comparative Advantage", World Bank Working Paper (March 1989), cited in Bond (1990: 54).

Given South Africa's already precarious balance of payments position, South Africa can ill afford the cessation of petrochemical activities, through the complete removal of protection afforded to the industry or through the termination of the domestic production of petrochemical building blocks. Termination of local production would necessitate the importation of up to four billion rands worth of petrochemical products which were previously produced domestically.[11] On the other hand, given the highly integrated nature of petrochemical products in South Africa's industrial processes, South Africa can ill afford to allow the domestic petrochemical industry to supply the economy with intermediate inputs at prices which are not comparable with those prevailing in other developed and developing countries.

When the major constraint facing the South African petrochemical industry is taken into account, namely the small size of the domestic market, the future course of development would appear to be specialisation in the production of selected petrochemical products (which would have to be produced primarily for the export market in order to benefit from economies of scale) and an increased dependence on imports to meet the diverse requirements for petrochemical products in the domestic economy. The sharp increase in polypropylene exports in the late 1980's would seem to indicate that domestic producers have already embarked on such a course of development.

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[11] In 1990 the value of domestically produced petrochemicals (SIC 3513) was worth approximately four billion rand (IDC, 1992).

An important area which merits attention is Sasol's role as the sole domestic producer of basic petrochemical building blocks. Since basic petrochemicals, such as ethylene, do not lend themselves to long distance transportation, the domestic production of these building blocks is crucial to the continued survival of the downstream petrochemical producers that are dependent on them. Thus an important area which warrants further research would be the economic viability of Sasol's chemical operations and, more generally, the future role of Sasol in the South African economy as a whole.

APPENDIX A

STRUCTURE OF THE SOUTH AFRICAN MARKET FOR PETROCHEMICALS IN THE LATE 1980's

A.1 AIM

The aim here is to make use of input-output techniques to analyze the structure of the South African market for petrochemicals, and to establish the extent to which the South African petrochemical industry had developed as an integral part of the South African economy by the late 1980's.[1]

The South African petrochemical industry is defined here as sector 40 (SIC 3513) of the South African Input-Output Tables.[2] Input-output techniques will be used here to identify major users of sector 40 products, to identify those industries which make substantial use of materials from sector 40 in meeting their final demand, and to identify those sectors which are major suppliers of inputs to sector 40. The analysis is based on the

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[1] The method of analysis employed in this section is based on that in a similar study conducted for the petrochemical industry in the United Kingdom by Fayad & Motamen (1986).

[2] As was noted in Chapter 1, SIC 3513 (synthetic resins, plastic materials and man-made fibres excluding glass) constitutes the downstream end of the petrochemical industry, as defined by the World Bank, and includes the production of plastics, synthetic rubbers and synthetic fibres. The structure of the South African market for upstream petrochemicals, which includes products such as ethylene and propylene, does not lend itself to input-output analysis since these products have, in South Africa, been grouped together with SIC 353 (petroleum refineries/synthesizers) and SIC 354 (miscellaneous products of petroleum and coal).

1988 Input-Output Tables for South Africa for which imports are listed separately.[3] The advantage of using such a table is that since imports have been filtered out of the table and are listed separately, the analysis can focus on domestically produced goods.[4]

A.2 THE ALLOCATION OF THE OUTPUT OF SECTOR 40 TO OTHER INDUSTRIES

By considering the inter-industry flows in Table 1 of the Input-Output tables for 1988 (imports separately) the direct sales of sector 40 products to other industries can be traced, allowing for the determination of the major purchasing industries of these products, and also the determination of the importance of sector 40 inputs to these industries. The identification of these industries is significant in that it is largely the development and growth of these industries which determine the level of demand for the products of sector 40, since the demand for output of sector 40 is mainly accounted for by intermediate rather than final consumption. As indicated in Table A.1 below the total output of sector 40 in 1988 had a value of over R2800 million,

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[3] This is the most recent Input-Output table available that has been compiled from basic data, as opposed to preliminary estimates.

[4] The standard input-output table includes imports and treats them as if they were produced domestically, with the result that the gross outputs of the industries producing import substitutes tend to be inflated (Yan, 1969: 62).

Table A.1: ALLOCATION OF THE OUTPUT OF SECTOR 40 TO TWENTY-FIVE MAJOR PURCHASING INDUSTRIES AND FINAL DEMAND (SOUTH AFRICA, 1988 - IMPORTS SEPARATELY)

No.	Sector	Output distribution (Rm) (1)	Output coefficient (direct purchase) % (2)	Output coefficient (direct purchase) rank (3)	Direct and indirect purchase of sector 40 materials by final demand (Rm) (4)	Direct and indirect purchase of sector 40 materials by final demand rank (5)
8	Canning and preserving of fruits and vegetables	11.45	0.41	24	44.50	18
20	Tobacco products	29.08	1.04	14	44.98	17
21	Wool scouring, cotton ginning and dyeing of wool and cotton	9.64	0.34	28	29.22	28
22	Spinning, weaving and finishing of yarns and fabrics	259.02	9.25	3	103.55	6
23	Made-up textile goods, except wearing apparel	21.44	0.77	18	27.75	29
24	Garment and hosiery knitting mills	5.05	0.18	33	19.98	38
26	Carpets and rugs, mats and matting	94.64	3.38	8	61.99	10
27	Cordage, rope and twine industries	19.53	0.70	20	12.73	46
28	Textiles, not elsewhere classified	28.84	1.03	15	8.72	58
31	Leather products and leather substitutes	5.86	0.21	32	9.89	55
32	Footwear	49.45	1.77	13	75.86	9
36	Paper containers	175.45	6.28	4	14.37	45
40	Synthetic resins, plastic materials and man-made fibres, except glass	392.48	14.02	2	314.38	1
41	Paints, varnishes and lacquers	99.57	3.56	7	15.78	44

Table A.1 (continued)

No.	Sector	Output distribution (Rm) (1)	Output coefficient (direct purchase) % (2)	rank (3)	Direct and indirect purchase of sector 40 materials by final demand (Rm) (4)	rank (5)
42	Medicinal and pharmaceutical preparations	27.72	0.99	16	37.99	20
44	Other chemical products	78.95	2.82	10	36.12	21
46	Tyres and tubes	126.67	4.52	5	38.62	19
47	Other rubber products	67.92	2.43	11	7.53	60
48	Other plastic products	598.65	21.38	1	188.40	3
50	Glass and glass products	18.5	0.66	21	11.61	47
59	Other fabricated metal products, except machinery and equipment	59.37	2.12	12	34.56	23
63	Special industrial machinery and equipment	23.98	0.86	17	19.20	39
69	Other electrical apparatus and supplies	111.5	3.98	6	21.84	35
72	Motor vehicles	85.91	3.07	9	196.04	2
77	Other manufacturing industries	20.77	0.74	19	31.80	25
	Total intermediate output	2531.10	90.39			
	Consumer's expenditure	12.74	0.45			
	Government consumption	9.18	0.33			
	Change in inventories	90.14	3.22			
	Exports	157.10	5.61			
	Total final demand	269.16	9.61			
	Total production	2800.31	100.00			

SOURCE: Calculated from the South African Input-Output Tables for 1988 (imports separately).

of which over 90% was used by other industries as intermediate input with the remainder being accounted for by final demand.[5]

Table A.1 lists twenty-five of the major direct purchasers of the output of sector 40. The first column lists the direct sales of sector 40 products in millions of rands, which range from sales of R5.05 million purchased by sector 24 (garment and hosiery knitting mills) to sales of R598.65 million to sector 48 (other plastic products). Eight sectors accounted for sales of over R90 million each, namely: other plastic products (sector 48); the petrochemical industry itself (sector 40); spinning, weaving and finishing of yarns and fabrics (sector 22); paper containers (sector 36); tyres and tubes (sector 46); other electrical apparatus and supplies (sector 69); paints, varnishes and lacquers (sector 41); carpets and rugs, mats and matting (sector 26). Sector 40 itself was the second largest buyer with an intra-industry purchase of R392.48 million.

A clearer picture of the distribution of sector 40's output amongst downstream users is obtained if the output to each industry is considered as a percentage of the total output of sector 40. These figures are shown in column 2 of Table A.1, and are ranked in descending order in column 3 of Table A.1. From these columns it is evident that the three largest direct purchasers of sector 40 output, namely other plastic products (sector 48), sector 40 itself, and spinning, weaving and

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[5] Approximately 58 percent of final demand was destined for the export market and for further processing abroad.

Table A.2: THE IMPORTANCE OF THE OUTPUT OF SECTOR 40 IN RELATION TO THE STRUCTURE OF INPUTS OF TWENTY-FIVE MAJOR INDUSTRIES (SOUTH AFRICA, 1988 - IMPORTS SEPARATELY)

No.	Sector	Input coefficients for sector 40's purchasers			Inverse coefficients for sector 40's purchasers	
		Intermediate input % (1)	Total output % (2)	Rank (3)	% (4)	Rank (5)
8	Canning and preserving of fruit and vegetables	0.95	0.63	25	2.71	29
20	Tobacco products	5.36	3.46	14	5.58	16
21	Wool scouring, cotton ginning and dyeing of wool and cotton	2.96	2.88	16	10.97	11
22	Spinning, weaving and finishing of yarns and fabrics	22.51	9.19	10	13.30	8
23	Made-up textile goods, except wearing apparel	5.89	2.58	17	6.87	14
24	Garment and hosiery knitting mills	2.44	1.21	23	5.34	18
26	Carpets and rugs, mats and matting	51.54	25.40	1	31.20	2
27	Cordage, rope and twine industries	46.18	22.11	2	26.50	3
28	Textiles, not elsewhere classified	21.58	19.02	3	25.53	4
31	Leather products and leather substitutes	6.51	3.34	15	7.34	12
32	Footwear	8.07	3.73	12	6.60	15
36	Paper containers	14.70	9.45	9	12.23	10

Table A.2 (continued)

No.	Sector	Input coefficients for sector 40's purchasers: Intermediate input % (1)	Total output % (2)	Rank (3)	Inverse coefficients for sector 40's purchasers: % (4)	Rank (5)
40	Synthetic resins, plastic materials and man-made fibres, except glass	24.66	14.02	5	116.80	1
41	Paints, varnishes and lacquers	19.34	10.75	7	14.58	7
42	Medicinal and pharmaceutical preparations	2.80	1.64	19	3.90	22
44	Other chemical products	6.79	3.67	13	5.55	17
46	Tyres and tubes	24.30	13.60	6	17.30	6
47	Other rubber products	20.95	10.27	8	13.14	9
48	Other plastic products	37.11	18.02	4	22.52	5
50	Glass and glass products	3.89	1.78	18	4.11	19
59	Other fabricated metal products, except machinery and equipment	2.19	1.32	21	2.47	31
63	Special industrial machinery and equipment	1.54	0.80	24	1.62	39
69	Other electrical apparatus and supplies	10.50	5.15	11	7.25	13
72	Motor vehicles	2.35	1.24	22	3.18	24
77	Other manufacturing industries	3.57	1.36	20	3.04	25

SOURCE: Calculated from the South African Input-Output Tables for 1988 (imports separately).

finishing of yarns and fabrics (sector 22) account for 21, 14, and 9 percent of the total output of sector 40 respectively. Taken as a whole the twenty-five industries listed in Table A.1 account for over 86 percent of the total output for sector 40, or over 95 percent of total intermediate output.[6]

A.3 SECTOR 40 MATERIALS AS INPUTS TO TWENTY-FIVE INDUSTRIES

The first three columns of Table A.2 deal with plastics materials as input coefficients to the twenty-five industries identified in Table A.1. The first column of Table A.2 expresses the amount of sector 40 products going into each industrial sector as a percentage of the respective total intermediate inputs of these sectors.[7] From column 1 of Table A.2 we can identify those industries which are intensive direct users of the intermediate output of sector 40. There are eleven sectors for which sector 40's output constitutes between 11 and 52 percent of the total intermediate inputs in each sector, and most of these tend to be clustered around a few industrial groupings: the chemical industry itself - synthetic resins and plastic materials (sector 40) and paints, varnishes and lacquers (sector 41); the textiles and related industries - spinning, weaving and finishing of yarns and fabrics (sector 22), carpets and rugs, mats and matting (sector 26), cordage, rope and twine industries (sector 27), and

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[6] Columns 4 and 5 of Table A.1 will be discussed later in this Appendix.

[7] Input coefficients express the combination of the inputs used by each industry according to the technology of the predominant process of production in that industry.

textiles not elsewhere specified (sector 28); the rubber industry - tyres and tubes (sector 46), and other rubber products (sector 47); and paper containers (sector 36), other electrical apparatus and supplies (sector 69), and other plastic products (sector 48). It is the sectors mentioned above which depend the most on direct inputs from sector 40 in meeting their final demands.

Column 2 of Table A.2 gives the direct use of inputs from sector 40 as a percentage of the total output of each industry. Intensive users of direct inputs from sector 40 are then ranked in column 3, according to the results in the preceding column. Inputs from sector 40 into the carpets and rugs, mats and matting industry (sector 26) constitute more than 25 percent of the total output of this sector, and can thus be described as an industry which is highly dependent on supplies from sector 40. This industry is then followed by the cordage, rope and twine industry (sector 27), textiles not elsewhere specified (sector 28), other plastic products (sector 48), synthetic resins and plastic materials (sector 40), tyres and tubes (sector 46), paints, varnishes and lacquers (sector 41), other rubber products (sector 47), paper containers (sector 36), and spinning, weaving and finishing of yarns and fabrics (sector 22). For each of the aforementioned industries direct inputs from sector 40 account for between R9.19 to R25.40 per R100 of output.

Column 4 of Table A.2 lists the inverse coefficients for the major purchasers of the output of sector 40.[8] The coefficient for each industry shows the total direct and indirect requirements of inputs from sector 40 per R100 of output delivered to final demand. By taking both direct and indirect inputs into account, inverse coefficients incorporate linkage effects.[9] A good example of the process of linkage effects is that of the motor vehicle industry (sector 72). Apart from direct inputs from sector 40, this industry receives a far more substantial amount of indirect inputs from sector 40 in the form of intermediate inputs supplied by other industries to the motor industry in the form of paints, wires and cables, instrument panels and many other items which make use of intermediate inputs from sector 40.

When the inverse coefficients in column 4 of Table A.2 are compared with the input coefficients of column 2 of Table A.2 it can be seen that most of the coefficients increase, due to the inclusion of indirect inputs in their calculation. In absolute terms the coefficients only increase slightly by between 0.8 and 8 percentage points.[10] In relative terms, however, the

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[8] The inverse are taken from Table 3 of the 1988 Input-Output Tables for South Africa.

[9] Inverse coefficients take into account not only direct inputs from sector 40 used in the production of final products, but also indirect inputs which are used in other industries as components of their intermediate products which in turn are used in the production of final products.

[10] Sector 40 has an inverse coefficient of 116.80 giving it first rank as both a direct and indirect user of its own products. The inverse coefficient of over 100 percent implies that every R100 of final demand for products of sector 40 induces

coefficients for a number of industries increase by substantial amounts from their initial values: garment and hosiery knitting mills (sector 24) increases by 343 percent; canning and preserving of fruit and vegetables increases by 331 percent; wool scouring, cotton ginning and dyeing of wool and cotton (sector 21) increases by 281 percent; made up textile goods, except wearing apparel (sector 23) increases by 166 percent; motor vehicles (sector 72) increases by 157 percent; medicinal and pharmaceutical preparations (sector 42) increases by 139 percent; glass and glass products (sector 50) increases by 131 percent; other manufacturing industries (sector 77) increases by 125 percent; leather products and leather substitutes (sector 31) increases by 120 percent; and special industrial machinery and equipment increases by 103 percent.

When the ranking of inverse coefficients (column 5 of Table A.2) is compared to the ranking of total input coefficients (column 3 of Table A.2) seventeen of the twenty-five industries experience a decline in their ranking, in spite of the fact that for each industry the inverse coefficient is larger than the total input coefficient. This could be attributed to the fact that although only twenty-five of the ninety-three sectors in the input-output table are displayed in Table A.2, the ranking of industries in column 5 has been conducted using all of the ninety-three sectors included in the input-output tables.

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an overall output of R116.80 of synthetic resins and plastics materials. This can be broken down into R100 of final demand for products of sector 40 and R16.80 of intra-sectoral purchases of sector 40 products within the industry itself, to produce a final output of R100.

Table A.3: **GROSS DEMAND FOR SECTOR 40 OUTPUT BY THE TEN LARGEST BUYERS IN ACCORDANCE WITH THEIR MAJOR FINAL DEMAND COMPONENT (SOUTH AFRICA, 1988 - IMPORTS SEPARATELY)**

		Final demand by major component column			Total final demand
Rank	Industry	Sector	(Rm)	%	(Rm)
1	Synthetic resins and plastic materials (40)	exports	183.49	58	314.38
2	Motor vehicles (72)	consumer's expenditure	82.99	42	196.04
3	Other plastic products (48)	consumer's expenditure	120.65	64	188.40
4	Building construction (80)	gross fixed capital formation	176.86	95	185.72
5	Wholesale and retail trade and motor trade (82)	consumer's expenditure	115.69	77	150.00
6	Spinning, weaving and finishing of yarns and fabrics (22)	consumer's expenditure	49.41	48	103.55
7	Gold mining (3)	exports	96.09	99	97.04
8	Wearing apparel except footwear (29)	consumer's expenditure	71.21	77	92.18
9	Footwear (32)	consumer's expenditure	63.90	84	75.86
10	Carpets and rugs, mats and matting (26)	consumer's expenditure	33.69	54	62.00
	Total (1 to 10)				1465.16
	Gross output of sector 40				2800.31

SOURCE: Calculated from the South African Input-Output Tables for 1988 (imports separately).

Thus, while the twenty five sectors listed in Table A.2 may be the main direct users of output from sector 40, when indirect use of sector 40 output is also taken into account there are a number of industries which are found to depend on total (direct and indirect) inputs from sector 40 to a greater degree than industries which rank in the top twenty-five users of direct inputs from sector 40. This highlights the considerable role which sector 40 plays in the supply of inputs to South African industries.

In the preceding discussion we have seen how inverse coefficients for each industry showed the total direct and indirect requirements of inputs from sector 40 per R100 of output delivered to final demand (ie. as a ratio of the total output delivered to final demand), and that this can be seen as an indicator of the intensity with which various sectors in the economy make use of sector 40's output. We now turn to Table A.3 and an analysis of the effects of final demand components on the demand for petrochemicals.

A.4 THE DEPENDENCE OF SECTOR 40'S PRODUCTION ON OTHER INDUSTRIES ACCORDING TO THEIR FINAL DEMAND COMPONENTS

This section analyses the importance of final demand in stimulating production in sector 40, both directly and indirectly, by multiplying the inverse coefficients for each industry with the value of each industry's final demand. An assessment is also made of the varying importance of the major industrial users of petrochemicals, according to their main final demand components. The data in Table A.3 has been calculated by multiplying the row of inverse coefficients corresponding to sector 40 in the Input-Output Tables by the matrix of final demand components of all 93 industries in Table 1 of the Input-Output Tables:[11]

$$X = (I - A)^{-1}F$$

where: X = the matrix corresponding to the total output of each sector.

$(I - A)^{-1}$ = the matrix of inverse coefficients, which corresponds to row 40 of Table 3 of the Input-Output Tables.

F = the matrix of final demand components which corresponds to Table 1 of the Input-Output Tables.

Column 4 of Table A.1 lists the major markets for sector 40 products, arranged according to the total direct and indirect expenditure on petrochemicals induced by the final demand for the products of the respective industries. It is interesting to note that industries which made large direct purchases of sector 40 output, tend to make less indirect use of sector 40's output. For example, the five largest direct user's of sector 40's output (sectors 48, 40, 22, 36, and 46) are not the five largest users when both direct and indirect purchases are taken into account.

[11] Only the ten largest buyers have been shown in Table A.3.

When looking at the ten largest direct and indirect purchasers of sector 40's output by final demand, the following industries did not feature in the list of the twenty five largest direct consumers of sector 40 products: building construction (sector 80); wholesale and retail trade and motor trade (sector 82); wearing apparel except footwear (sector 29); and gold-mining (sector 3).[12]

In Table A.3 the ten largest buyers of sector 40 output, in terms of direct and indirect use are listed according to their major final demand component. The largest five of these, which have total inputs of sector 40 materials valued at over R150 million each, are synthetic resins and plastic materials (sector 40), motor vehicles (sector 72), other plastic products (sector 48), building construction (sector 80), and wholesale and retail trade and motor trade (sector 82).

Synthetic resins and plastic materials (sector 40), other plastic products (sector 48), and spinning, weaving and finishing of yarns and fabrics (sector 22) are respectively the first, third, and sixth largest markets for sector 40 products by final demand, and are also important intensive-direct users of sector 40 products (as shown in column 3 of Table A.1). This makes them

[12] While the gold-mining industry does not incorporate petrochemical products in its final product, it does make use, in its production processes, of a number of intermediate inputs which incorporate inputs from sector 40. In addition, the sheer size of this sector in the South African economy ensures that it is a major indirect consumer of the output of sector 40, even though it has a relatively small direct and indirect inverse coefficient.

highly dependent on sector 40 in meeting their output requirements.

Building construction (sector 80) is the fourth most important market for plastics materials by final demand, yet this sector does not rank in the twenty five largest direct consumers of sector 40 products (column 3 of Table A.1), nor does it rank in column 3 or column 5 of Table A.2 as an intensive user of sector 40 products (whether direct or indirect) as inputs. It is the sheer size of this industry and its importance to final demand expenditures which make it the fourth most important market for petrochemicals by final demand.

Motor vehicles (sector 72) rank as the second most important market for plastics materials by final demand, moving up from ninth place as a direct user of intermediate output from sector 40 (column 3 of Table A.1) and from position 22 in terms of sector 40 inputs relative to total inputs to the industry (column 3 of Table A.2), and from twenty-fourth position when direct and indirect input requirements are considered in terms of inverse coefficients (column 5 of Table A.2). The importance of motor vehicles as a market for sector 40 products could be attributed to the derived-demand pattern for plastics materials through the use in motor vehicle manufacture of various components which are intensive users of plastics materials.

The motor vehicle, construction and plastic product industries account for a combined share of over 20 percent of total final demand for sector 40. As a result the future growth and development of these three industries could have a significant effect on developments in sector 40. The demand for sector 40 products by these three industries is contingent not only on the rate of growth of overall output from these three industries, but also on the intensity with which these three sectors use sector 40 products. There has been a fairly recent trend in the construction and motor vehicle industries towards more intensive use of petrochemical materials. In the international motor vehicle industry, for example, the use of plastics increased from 10 kg per car in 1960 to over 60 kg per car by 1978 (Fayad & Motamen, 1986: 36). There has also been a move toward increased use of plastics in the construction industry where they are being substituted for conventional building materials since they "consume less energy to produce than their alternatives, they are light and hence will cost less to transport and to handle, and ... they save energy when used for insulation ... [and they] also offer corrosion resistance" (Fayad & Motamen, 1986: 39).

A.5 THE DEMAND FOR SECTOR 40 PRODUCTS BY FINAL DEMAND

The most important final demand factor influencing the demand for the output of sector 40 in 1988 was that of consumer expenditure, which accounted for over 42 percent of total output. This is in contrast to the United Kingdom where, in 1974, exports accounted for over 50 percent of the total output of ISIC 3513.[13]

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[13] It should be noted, however, that the petrochemical industry in the United Kingdom is highly developed, and is one of the United Kingdom's main foreign exchange earners in the

Table A.4: INPUTS TO SECTOR 40

Industry	Intermediate inputs to sector 40: Rands (million)	Intermediate inputs to sector 40: As a percentage of total intermediate inputs (excluding imports)	Inputs as a percentage of total inputs
Other basic chemical products (sector 45)	804	51	29
Synthetic resins and plastic materials (sector 40)	392	25	14
Electricity, gas and steam (sector 78)	81	5	3
All other sectors	303	19	11
Total intermediate inputs	1592	100	57
Imported intermediate inputs	340	-	12
Total intermediate inputs (including imports)	1932	-	69
Other inputs[a]	868	-	31
Total inputs	2800	-	100

SOURCE: Calculated from the South African Input-Output Tables for 1988 (imports separately).

NOTES: [a] This includes items such as remuneration of employees, gross operating surplus, net indirect taxes, as well as products transferred to and from other industries.

In South Africa exports accounted for just over 26 percent (R731.04 million) of total output, which includes direct exports of sector 40 products in intermediate form (R157.10 million) and indirect exports via the export of finished goods that include plastics materials in their manufacture (R573.94 million). The ten largest markets by final demand for sector 40 products, shown in Table A.3, account for over 52 percent of the total output of sector 40, with exports as the predominant factor of final demand for only two industries, namely sector 40 itself and gold mining (sector 3).

A.6 INPUTS TO SECTOR 40 FROM OTHER INDUSTRIES

As can be seen in Table A.4 below the main supplier of inputs to sector 40 is sector 45 (other basic chemical products, petroleum and coal products) which supplies 51 percent of the intermediate inputs required by sector 40. Sector 45 includes the output of the synthetic fuels and chemicals manufacturer, Sasol, and also the output of the domestic oil refineries, all of whom provide sector 40 with raw materials for further processing into synthetic resins and plastics materials. The second most important supplier of intermediate inputs is sector 40 itself, with 25 percent of total intermediate inputs. This is followed by the supply of inputs from sector 78 (electricity, gas and steam) with 5 percent of total intermediate inputs to sector 40. When measured in terms of total inputs to the industry, imported intermediate inputs accounted for only 12 percent of total inputs

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manufacturing sector (Fayad & Motamen, 1986: 80).

in 1988, which might be seen as a reflection of the success achieved by South Africa's pursual of import substituting industrialisation *vis-à-vis* the petrochemical industry.

A.7 LINKAGE ANALYSIS

In this section an attempt is made at measuring both forward and backward linkages for sector 40 using the 1988 Input-Output Tables for which imports are listed separately. The standard measure of linkages concerns the relation of intermediate to total transactions.[14] Backward linkages (u_j) can be used to measure the potential stimulus to other activities from investment in any sector j.

$$u_j = \frac{\text{total purchase of intermediate input of industry } j}{\text{total output of industry } j}$$

$$u_j = \sum_i a_{ij} \qquad (1)$$

Where a_{ij} = the i, j'th element of Table 1 of the South African Input-Output Tables for 1988 (imports separately).

Forward linkages (w_j) give an indication of the direction of supply, although measures of forward linkages are generally weaker than those of backward linkages since output produced is not necessarily met by adequate demand.

[14] The method of analysis in this section is, unless otherwise indicated, based on the work of Schultz (1977: 77-96).

$$w_j = \frac{\text{total sales of intermediate product by industry } j}{\text{total output of industry } j}$$

$$w_j = \sum_j a_{ij} \qquad (2)$$

Sector 40 was found to have a fairly low backward coefficient of 0.57, indicating that this sector does not draw heavily on other sectors in the economy for its inputs. In terms of forward linkages sector 40 was found to have a relatively high coefficient of 0.90, indicating that this sector produces relatively little for final demand relative to intermediate demand.

So far the analysis has concerned itself with measuring inter-industry relatedness by focusing only on direct links and by taking into account the magnitude of transactions in Table 1 of the 1988 Input-Output Tables. In order to measure both direct and indirect linkages the inverse coefficients in Table 3 of the South African Input-Output Tables for 1988 (imports separately) are utilized. To obtain the direct and indirect backward linkage:

$$y_b = (1/n \sum_i r_{ij}) \; / \; (1/n^2 \sum_i \sum_j r_{ij}) \qquad (3)$$

Where r_{ij} = the i, j'th element of the inverse coefficients in Table 3 of the South African Input-Output Tables for 1988 (imports separately).

To obtain the direct and indirect forward linkage:

$$y_f = (1/n \sum_j r_{ij}) \; / \; (1/n^2 \sum_j \sum_i r_{ij}) \tag{4}$$

In order to make comparisons between sectors a normalisation procedure is carried out in equations (3) and (4) whereby the coefficient for sector j is taken as a ratio of the average coefficient for the whole economy. In terms of direct and indirect backward linkages, sector 40 had a relatively low coefficient of 0.0218, which was only slightly higher than the overall industry average of 0.0210. Thus, in terms of direct and indirect backward linkages (y_b) sector 40 was found to have a relatively low index of 1.041, which implies that investments in sector 40 do not yield above average backward linkages. Sector 40 was found to have a relatively high forward linkage coefficient of 0.048, nearly double the overall average of 0.021. In terms of direct and indirect forward linkages (y_f) sector 40 was found to have a relatively high index of 2.269, implying that investments in sector 40 yield above average forward linkages.[15]

A.8 CONCLUDING REMARKS

The input-output analysis undertaken above highlights the extent to which the South African petrochemical industry has developed from its inception in the 1950's into an industry which, by the

[15] Of the 93 sectors in the table, sector 40 had the seventh highest direct and indirect forward linkage index (y_f = 2.269).

late 1980's, formed an integral part of virtually all sectors of the South African economy.

From the analysis of South Africa's Input-Output Tables for 1988, a number of conclusions can also be drawn concerning the general characteristics of the petrochemical industry in South Africa. The first is that the demand for outputs from the petrochemical industry tends to be widely dispersed among various sectors of the economy, with no single industry accounting for a sufficiently large proportion of the industry's output that rapid increases in petrochemical production could be encouraged by the development of any particular industry. Secondly, while the petrochemical industry is not significantly dependent on any particular sector of the South African economy for the sale of its output, a large number of sectors are dependent to varying degrees on both direct and indirect inputs from the petrochemical industry. Future growth in the domestic production of petrochemicals could therefore be described as being largely dependent on the general growth of the South African economy as a whole, rather than on the development of any one or two specific industries. Finally, in terms of backward and forward linkages, the petrochemical industry has a relatively weak backward linkage coefficient and obtains inputs from a limited number of sectors in the economy; it also has a relatively strong forward linkage coefficient, emphasizing the petrochemical industry's important role as a supplier of intermediate inputs to a diverse range of sectors in the economy.

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