FACTORS DETERMINING THE CHOICE OF TECHNIQUE IN THE MANUFACTURING SECTOR IN THE PIETERMARITZBURG ECONOMIC REGION

by

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Except for quotations specially indicated in the text, and such help as I have acknowledged, this thesis is wholly my own work and has not been submitted for a degree in any other university.

A K JONKER
JANUARY 1992

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CHAPTER 1

THE OBJECTIVES OF THE STUDY

1.1 Introduction

Without the support of a sound, vibrant economy it will be impossible to tackle the social and economic challenges of the "new South Africa". Sustained economic growth is a prerequisite for South Africa to accommodate the dreams of all its people.

One of the problems confronting South Africa, one which will certainly hinder economic growth, is the large and growing number of unemployed in the economy. There is a desperate need to provide employment opportunities for the growing workforce of the country.

The population growth rate is predicted to be 2,5 per cent per annum between 1990 and the year 2000. In this decade the South African population will grow from approximately 38 000 000 to close on 50 000 000 (Welcher, 1991, p 1). In the Financial Mail of 27 January 1989 Spies says that if the economic performance of the past 14 years is extended then 67 per cent of the economically active population will be unemployed in South Africa by the year 2000. Something has got to be done to prevent this becoming a reality. Also, with large numbers of potentially economically active people unable to find jobs, the economy is obviously not realising its full potential. How can the problem of unemployment be overcome or at least reduced - what is the potential for job creation in the economy?

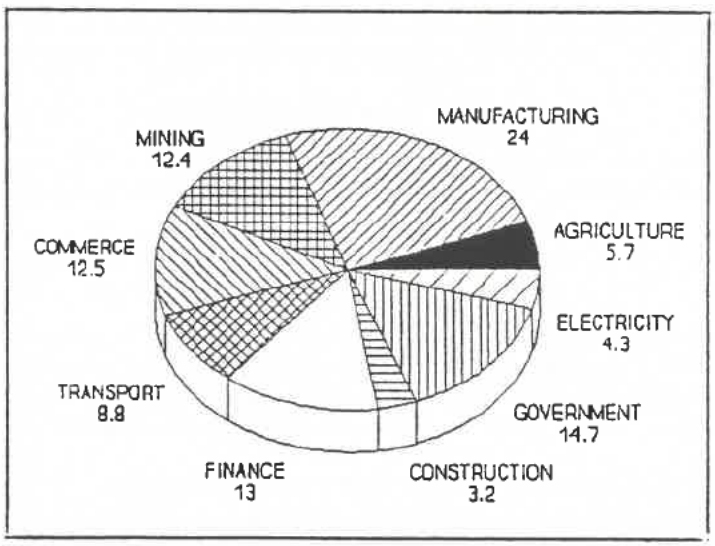
1.2 The South African Manufacturing Sector

There can be little doubt that the manufacturing sector has an important role to play in South Africa's process of economic growth and development. Hunt (1991)

goes as far as to say that the manufacturing sector is generally acknowledged as the South African economy's main hope for providing the employment growth needed for the country's prosperity.

In the first half of this century the mining industry, particularly gold and diamond mining, provided the impetus to South African economic growth. However, the industry, specifically gold mining, is currently undergoing extensive rationalisation, largely as a result of rising working costs, combined with relatively weak mining commodity prices. For this reason, together with an emerging industrial trade policy favouring the development of beneficiated primary products, the manufacturing sector is regarded as the most important growth area within South Africa.

The manufacturing sector is the largest single contributor to Gross Domestic Product (GDP). In terms of value the manufacturing sector contributes approximately one quarter of South Africa's GDP. This fact is represented in Figure 1.1 below:



Sectoral Composition of the Gross Domestic Product in 1988

Figure 1.1

Source: NPI Productivity Focus 1989

The average level of employment in the manufacturing sector for the first quarter of 1989 was 1 456 533. In the corresponding period of 1991 the average had declined to 1 443 785. While this may seem reasonable taking into account the recessionary conditions prevailing during this period, and compared with employment losses that have occurred in the mining and construction industries, the picture is actually that of long-term employment decline.

1.3 The Objectives of the Study

In order to avert a massive unemployment problem, large numbers of jobs have got to be created within the South African economy. With the increasing importance of the manufacturing sector within the economy, the sector will have to play an important role in the creation of job opportunities to accommodate the ever increasing number of job-seekers.

This thesis studies the factors determining the choice of technique in the manufacturing sector in the Pietermaritzburg economic region. Factors that determine the choice of technique in the manufacturing sector have bearing on the potential for the sector to absorb labour.

The basis of the survey was a questionnaire presented, during an interview, to a senior representative of each of the responding firms in a randomly selected sample. The perceptions of Pietermaritzburg businessmen were surveyed from July to September 1990.

The thesis makes use of micro-level data in attempting to answer questions such as: How sensitive is employment to changes in relative factor prices - i.e. if real wages rise, *ceteris paribus*, will employment fall significantly, or if real wages are lowered, *ceteris paribus*, will employment expand? Do industries differ significantly in their sensitivity to factor prices - i.e. are some industries as a whole more insensitive to factor prices in their choice of technique than other industries? Do foreign-owned firms behave differently to locally-owned firms in their choice of

technique? Does the scale of operation affect the choice of technique, for example, could greater mechanisation occur if the market expanded because capital intensive processes require longer production runs than are presently available? Do firms that invest in research and development have specific characteristics? Of the research and development that firms do invest in, is it carried out locally or do firms consider it cheaper to import the results of research and development?

Many black South Africans will judge the success of labour policies by the creation of jobs, not only in agriculture and service industries or the "informal" sector, but especially in the manufacturing sector.

The contribution that the so-called "informal sector" can make in the provision of job opportunities must not be overlooked. The nature of the sector makes accurate measurement of its contribution in the economy almost impossible. Although their estimations of the sector's contribution in the economy differ, all economists agree that to date the informal sector has played a vital role in providing incomes to large numbers of members of the population who would otherwise have been unemployed. The sector's contribution will not be any less important in the years to come. Although the informal sector has an important role to play in the provision of employment in the economy, this study only investigates the situation in Pietermaritzburg's "formal" manufacturing sector.

1.4 Outline of the Study

Chapter 2 of the study explores the formal economic theory on how choices of production technique are made. Chapter 3 follows with an analysis of features of the surveyed manufacturing sector as well as particulars about the survey questionnaire and the survey sample. In Chapter 3 the basis of the empirical analysis is also outlined. The results of the questionnaire survey are reported in Chapters 4, 5 and 6. In Chapters 4 and 5 the results of an analysis of the sensitivity of firms to factor prices in their choice of technique is reported. The

characteristics of firms that reported that they were insensitive to factor prices when choosing a production technique are investigated in Chapter 4. Chapter 5 follows with an investigation of the characteristics of firms that were sensitive to factor prices when selecting a production technique. In both Chapters 4 and 5 answers are sought to explain firms' sensitivity, or otherwise, to factor prices. In Chapter 6 an investigation of firms' attitudes towards research and development is undertaken. The aim of the investigation is to ascertain whether firms invest in research and development to alter imported techniques to suit conditions in the South African economy. In the final chapter, Chapter 7, the main findings of the questionnaire survey are summarised. In closing, the chapter highlights some of the implications that the results of the survey have for policies aimed at labour absorption.

CHAPTER 2

THEORETICAL BACKGROUND

2.1 Introduction

The technology available to a particular economy is all those techniques it knows about (or may with not too much difficulty obtain knowledge about) and could acquire, while the technology in use is that subset of techniques it *has* acquired. The technology available to a country cannot be identified with all known techniques: on the one hand weak communication may mean that a particular country only knows about part of the total methods known to the world as a whole. This can be an important limitation on technological choice. On the other hand, methods may be known but they may not be available because no one is producing the machinery or other inputs required. This too limits technological choice.

The number of alternatives that are open to a developing economy is often quite large and the amount of capital per unit of labour varies widely from technique to technique. In weaving cloth, for example, there is a wide spectrum of techniques varying from primitive hand looms to the most advanced automatic power looms. In some other fields, e.g., in making steel, the scope for choice may be more restricted, because one cannot make steel very efficiently by any hand technique. Even in steel making though, there is a choice between alternative mechanised methods of making steel.

Different strategies of economic development often imply quite different techniques with very different effects on the performance of the economy.

The actual technology in use is circumscribed first by the nature of world technology, then by the availability to the country of known techniques, and finally by the choice made among those available. If the technology in use is thought to

be inappropriate, it may be inappropriate because world technology is inappropriate, or because an inappropriate subset is available to the country, or because an inappropriate selection is made, or for some combination of the three reasons.

In this chapter the theory underlying the choice of technique is discussed. Theoretical answers are supplied to the questions: what determines the choice of technique and what causes the choice of technique to change? In Chapters 4, 5 and 6 the results of the questionnaire survey carried out in the Pietermaritzburg manufacturing sector will be assessed against the economic theory set out in this chapter.

Before attempting a discussion on the choice of technique and what changes such choices, the terms "technique" and "technology" must be defined.

The Concise Oxford Dictionary defines "technique" as "the means of achieving one's purpose". From economic theory, the term "technique" refers to the way outputs are produced by inputs. Each technique is defined by the specific ratio of the factor inputs, capital and labour, used to produce a certain output. Simply then, when speaking of a "choice of technique" reference is being made to a choice of input combination from a given spectrum of alternatives (Robinson, 1956). Choosing a technique, firms are choosing how much labour and how much capital (the input mix) to use to produce a certain quantity of a product. This choice is obviously influenced by the objectives of the firm in question.

Over time the technical nature of the range of alternative techniques can change. This is referred to as a change in technology. With changes in technology taking place, when choosing a technique firms will be choosing a specific factor input ratio from a changing set of alternatives. When firms make technique decisions they will not only be choosing between alternative *techniques* (i.e. the capital/labour ratio from a given spectrum), they will also be choosing between *technologies* (i.e. choosing from a changing range of capital/labour ratios).

In practice the division between a change in technique which refers to a change in the relationship between inputs and outputs in the production process and a change resulting from a change in the technical nature of the range of alternative techniques over time, is not that clear-cut. Factors influencing the choice of technique can influence changes in the technology actually available over time. The two forces influencing technical change are obviously not easily distinguished from one another. Rosenberg (1982) notes that inventions do not function in isolation. Technologies depend on one another and interact with one another in ways which are not always apparent to either casual observer or specialist.

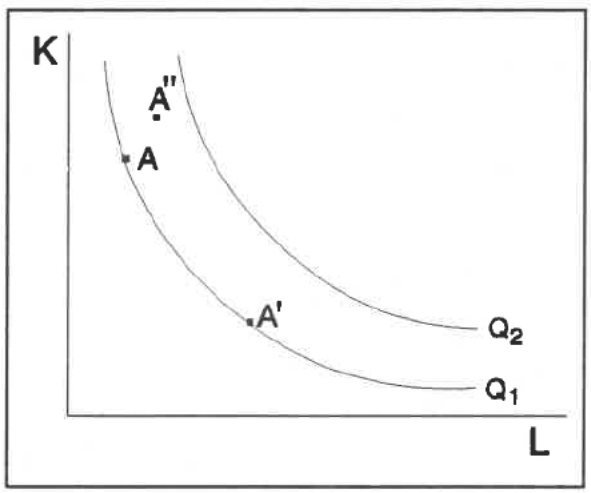
2.2 The Neoclassical Theory

The neoclassical approach regards the question of choice of technique as consisting of choosing between techniques of differing factor intensity, out of a given set of technical alternatives in order to produce a given product. It is usually defined in terms of labour or capital intensity as the factor of production land is subsumed in aggregate capital. The theory assumes infinitely divisible capital and labour, and hence the mappings of input combinations used to produce a set output (isoquants) are continuous. A technique is therefore a particular combination of the factors of production labour and capital.

The relative price of labour and capital is regarded as the determinant of this choice, with that technique being selected that minimises costs of production, and hence maximises profits. In the production process, the firm is assumed to be a price-taker: its decisions to buy or sell inputs or outputs will not affect the prices of those commodities.

The assumptions and relationships described above can be simply formalised. Technically efficient methods are deduced by eliminating all those techniques of production that use absolutely more of all inputs than another available technique. Suppose the firm is seeking to make output Q_1 per unit of time with

inputs K and L in the same time period (Figure 2.1). K and L represent the inputs capital and labour respectively. A point such as A" represents an inefficient combination of inputs since it uses more of both K and L than the technique A. However, points A and A' cannot be compared on technical grounds alone, since A' uses more of L, but less of K, than A. Points such as A and A' represent the technically efficient combinations of K and L in the production of Q_1 per unit of time. The whole mapping of technically efficient input combinations in output space is called the production function and is written $Q = F(K,L)$. This may be plotted, for varying levels of Q, as an isoquant diagram. Thus, in Figure 2.1, Q_1 and Q_2 are isoquants, and trace the locus of combinations of K and L that produce outputs Q_1 and Q_2, respectively. Every possible level of output may be represented by an isoquant. The same level of output cannot be produced by using less of one production factor and the same of the other, or less of both factors. The convexity of the isoquants stems from the assumption of the diminishing marginal rate of technical substitution.

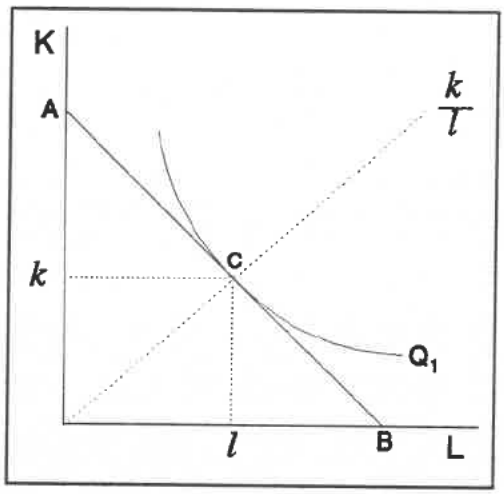


Comparing Technically Efficient Production Methods

Figure 2.1

The choice of the least-cost technique from the technically efficient set for a given output per unit of time depends on the price of the factors of production. The problem is to minimise total cost of inputs, subject to the required output constraint.

This cost-minimising technique will be represented by the point at which the *isocost curve* is tangental to the *production isoquant*. The isocost curve is the locus of all input combinations that may be purchased or hired for a given expenditure of funds. Its slope at every point is the negative of the input-price ratio. When input prices are fixed, isocost curves are straight lines (Ferguson, 1971). In this study input prices are assumed constant and hence the isocost curve is a straight line. In Figure 2.2 the isocost curve is represented by the line AB.



The Cost-Minimising Production Technique

Figure 2.2

In Figure 2.2 all the points on Q_1 are technically efficient, whilst only *C* is economically efficient. At the point of tangency of the isocost curve AB to the given isoquant Q_1, the factor price ratio is equal to the ratio of the marginal product of capital to the marginal product of labour. The latter ratio is defined as the marginal rate of substitution between labour and capital (MRS). At the cost-minimising point the MRS of the inputs is equal to the factor price ratio.

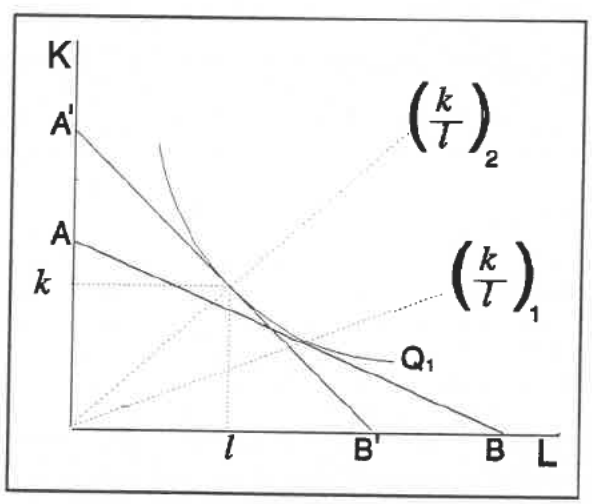
Where costs are minimised, the capital-labour ratio of the most economically efficient technique is given by the slope of the line (k/l) drawn from the origin passing through the point of tangency of the isocost curve and the production isoquant.

2.2.1 Comparative Statics

2.2.1.1 Varying the Factor Price Ratio With Constant Output

If there is a change in the factor price ratio, ie a change in the price of labour relative to that of capital, the slope of the isocost curve will change and, given that the isoquants are convex to the origin, the capital-intensity of the most economically efficient technique will change. This change of technique is illustrated in Figure 2.3.

The capital intensity of the cost-minimising technique is given by the slope of the line $(k/l)_1$ at the point of tangency of the isoquant with the isocost curve AB. The swivel of the isocost curve to the steeper A'B', reflects an increase in the price of labour relative to that of capital. The capital-intensity of the cost-minimising technique is now given by the slope of the line $(k/l)_2$, which is greater than $(k/l)_1$. A negative relationship exists between the price of capital relative to labour, and the capital-intensity of the technique chosen.

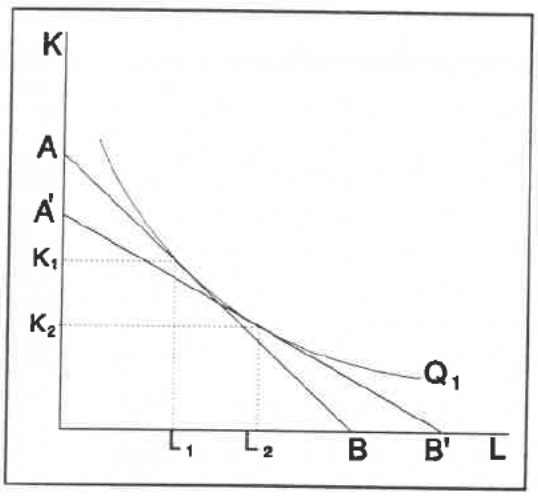


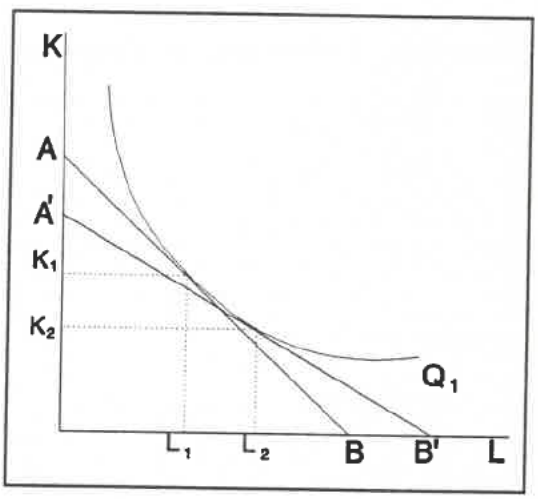
A Change in the Factor Price Ratio

Figure 2.3

The possibility of substituting one factor of production for another is, however, not infinite. The convex shape of the isoquant means that as capital replaces

labour, the process of substitution becomes increasingly difficult and the choice of techniques will depend upon the limits to the range of alternative techniques available. The flatter the isoquant, the more "alike" are the production factors and the easier they can be substituted for one another and therefore the greater the proportionate change in capital-intensity generated by a given proportionate change in the factor price ratio will be. Figures 2.4(i) and (ii) illustrate this factor. The isoquant Q_1 in Figure 2.4(i) is flatter than the isoquant Q_1 in Figure 2.4(ii). Factors of production are more easily substituted for one another along Q_1 in Figure 2.4(i) than along Q_1 in Figure 2.4(ii). In Figure 2.4(i), the proportionate change in capital-intensity generated by the change in the factor price ratio is larger than in Figure 2.4(ii) i.e. $(L_2 - L_1)/(K_2 - K_1)$ in Figure 2.4(i) > $(L_2 - L_1)/(K_2 - K_1)$ in Figure 2.4(ii).





Factor Substitution Along an Isoquant

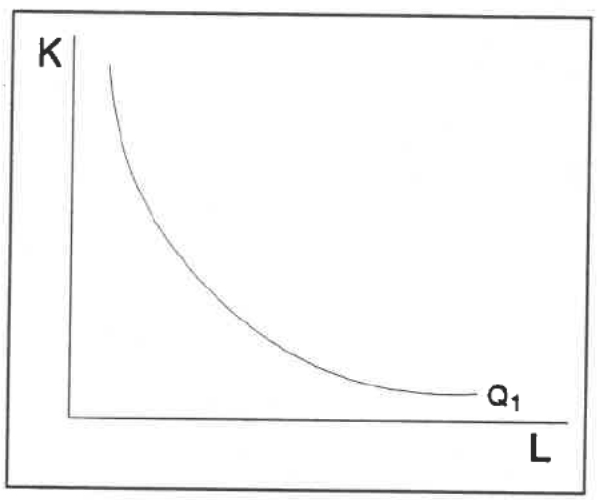
Figure 2.4 (i)

Figure 2.4 (ii)

The term *elasticity of substitution* (σ) is the term used to describe the degree of substitutability between the inputs in the production process. It measures the ratio of the percentage change in input proportions to a small percentage change in

relative prices of inputs[1]. A large elasticity indicates that the two inputs are close substitutes in production, and vice versa.

Theoretical economics can encompass a wide spectrum of possibilities for factor substitution (i.e. for the value of σ). At the one extreme the well-known Cobb-Douglas production function assumes the elasticity of substitution equal to unity which implies that factors of production can be substituted for each other over an infinite range of capital-labour ratios (Cobb and Douglas, 1928). For every value of the factor price ratio a unique economically efficient production technique exists (see Figure 2.5). In this instance therefore, if the factor price ratio were to change then the choice of production technique would by implication have to change to take account of the new production conditions.



The Cobb-Douglas Production Function

Figure 2.5

At the other extreme, the neo-Keynesian Harrod-Domar model of economic growth assumes factors of production, capital and labour, are complementary.

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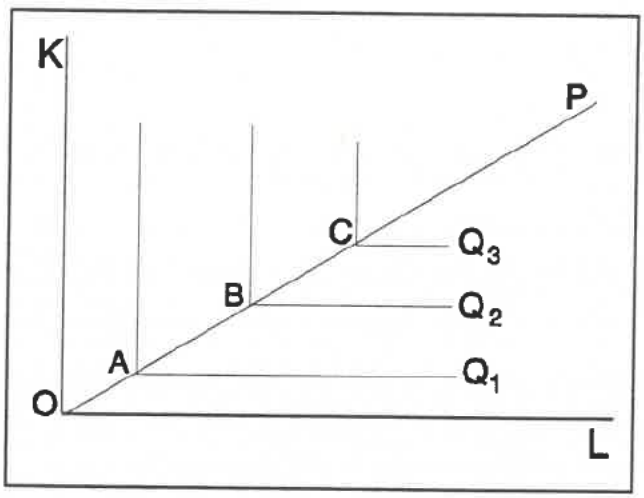
1 The elasticity of substitution between labour and capital is defined as

$$\left[\frac{\Delta(K/L)}{K/L} \Big/ \frac{\Delta(P_K/P_L)}{P_K/P_L}\right]$$

This implies right-angled isoquants where the scope for and elasticity of factor substitution are both zero. If the factor price ratio were to change there would be no scope for a compensatory substitution between labour and capital in technique choice. The Leontief production function arises in such a situation. As is shown graphically in Figure 2.6, the isoquants Q_1, Q_2 and Q_3 are L-shaped with vertices which lie the ray OP. It will not pay a firm wanting to produce Q_1 to use any factor input combination other than that found at the point A. An extra unit of either K or L would be a waste.



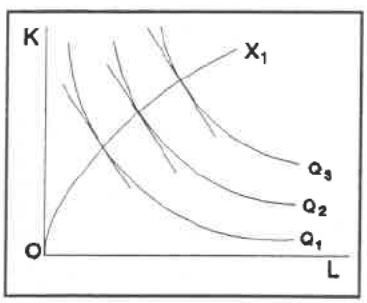
Leontief Production Functions

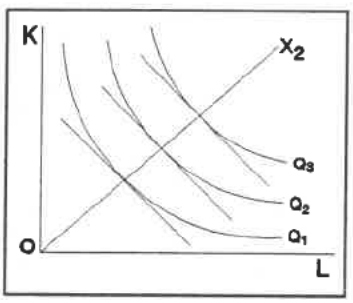
Figure 2.6

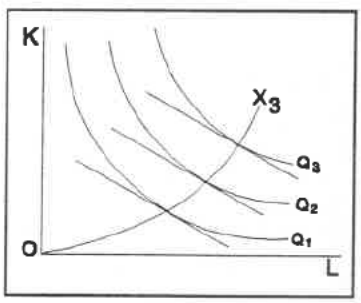
In reality, as outlined in the seminal paper on capital-labour substitution and economic efficiency by Arrow, et al (1961), there are varying degrees of substitutability in different types of production. In tests carried out, factor substitution was found to vary within the two extremes of zero and unity. In some sectors technological alternatives were "numerous and flexible" while in other sectors they were limited. Uniform substitutability was found to be most unlikely. The resulting constant-elasticity-of-substitution (CES) production function points to an estimated value of σ which was typically less than unity.

2.2.1.2 Varying Output With Constant Prices

A changing level of output, holding the factor price ratio constant, is represented graphically by parallel shifts of the isocost curves. Figure 2.7 shows that the effect of changes in the level of output on the capital-intensity of the most economically efficient technique may be neutral (ii), or non-neutral (i) and (iii). Hick's definition of neutral and non-neutral are adopted in this study[2]







Neutral and Non-Neutral Technical Change

Figure 2.7 (i) Figure 2.7 (ii) Figure 2.7 (iii)

Isoquants Q_1, Q_2 and Q_3 represent expanding output ($Q_1 < Q_2 < Q_3$). The lines OX_1, OX_2 and OX_3 (called expansion paths) join points of tangency of these isoquants and the constant-sloped isocost curves. The expansion path is the locus of input combinations for which the marginal rate of technical substitution equals the input-price ratio (Ferguson, 1971). It illustrates the effect that the change in the level of output alone can have on the choice of technique. The effect may be "neutral" or "non-neutral".

In figure 2.7(ii) the expansion path OX_2 is linear implying a neutral effect of a change in the level of output on the capital-intensity of the most economically efficient production technique. The capital-labour ratio remains constant despite the change in the level of output.

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2 Hick's neutral effect requires an unchanged ratio of marginal products when factor proportions are constant. See Stiglitz and Uzawa 1969, pp 120 and 126.

Expansion paths OX_1 and OX_3 are non-neutral. In Figure 2.7(i) the points of tangency indicating that the economically efficient technique occurs at lower capital-labour ratios for higher levels of output. In Figure 2.7(iii) the opposite situation exists - as the level of output increases, with a given factor price ratio, the capital-labour ratio of the economically efficient technique increases. A positive relationship exists between the capital-intensity of the production technique and the level of output in Figure 2.7(iii) and a negative such relationship in Figure 2.7(i).

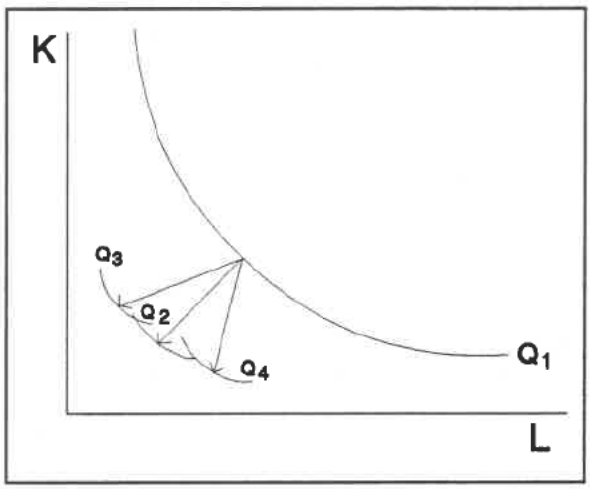
The theory outlined above leads to the conclusion that, if information about the factors of production required by the available manufacturing techniques is supplied, and if capital and labour costs are known, the economist can provide a simple foundation for technique choice. Given identical factor prices, the same minimum-cost production technique should be chosen by firms producing the same product in a particular industry. Any firm that deviates from the optimum will incur higher manufacturing costs than its competitors and will consequently be forced by the market to modify its technology or to leave the market. Faced with low wages and high capital costs, managers in poor countries will choose more labour intensive techniques than would managers in the advanced countries.

2.2.1.3 Technological Change

Technical changes in the production methods used are subject to the influence of two forces, viz. a change in the choice of technique from a given spectrum of alternatives, and, a change in the available spectrum of alternative techniques itself.

The former can refer to a change in the alternative ways in which outputs can be produced by inputs. A technological change can occur as a result of changes in the technical nature of the range of alternative techniques over time. It is to this change in the range of alternative techniques over time that attention now turns.

Technical progress in the neoclassical theory of production is defined as an increase in efficiency of all techniques. Graphically, technical progress is reflected as a shift of the production isoquant towards the origin. In Figure 2.8, Q_2, Q_3 and Q_4 correspond to more advanced technologies than Q_1.



Technical Progress

Figure 2.8

The movement towards the origin can, however, follow a number of paths. At constant factor prices Q_2 uses the same combination of inputs as Q_1, Q_3 uses proportionately more capital and Q_4 uses proportionately more labour. Using the Hick's definition of neutrality[3], $Q_1 \rightarrow Q_2$ is an example of a neutral technical change, $Q_1 \rightarrow Q_3$ of a labour saving technical change and $Q_1 \rightarrow Q_4$ of a capital saving technical change. In the case of a neutral technical change the efficiency of both labour and capital increase proportionately. In a capital saving (labour-using) change ($Q_1 \rightarrow Q_4$) the slope of the isoquant increased as it shifted. With a decrease in the slope of the isoquant with the shift $Q_1 \rightarrow Q_3$ labour is saved or the technological change is said to have a capital-using bias. Biased technological changes affect the MRS between labour and capital for all combinations of capital and labour (Coombs, Saviotti and Walsh, 1987).

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3 See footnote 2 for the definition of "neutrality".

In terms of this analysis it can be postulated that as long as technological change is Hicks neutral, changes in capital-intensity can arise only from changes in the choice of technique, ie: from movements along an isoquant following changes in the factor price ratio alone.

From this analysis it can be seen that the actual extent of a technical change will be the sum of the intensity of technological bias and the extent of any change in the factor price ratio that might occur. If the relative price of capital increases, a labour saving bias in technological change may either partially or entirely offset the potential decrease in capital-intensity. In Section 2.3 the theory which can shed some light on whether or not there is any reason to suppose that the technological bias will follow the direction of factor substitution implied by a change in the factor price ratio is reviewed.

2.2.2 Limitations of Neoclassical Theory

There are clearly some limitations to the neoclassical theory of production which affect its value as a framework for understanding the economics of technical change. Because of the simple and abstract nature of the theory of production, factors such as the relationship between scale of output or the nature of the product and the capital intensity of production, are not considered in any detail. In terms of selection mechanisms the theory concentrates on just one characteristic - relative prices of labour and capital - corresponding to one type of decision maker, the profit-maximising entrepreneur with unlimited access to finance at constant rates of interest. The presence of infinite techniques at a given level of technology is also unrealistic: real-life situations often imply a choice between a restricted number of options. The substitutability of labour and capital is sometimes limited when, for example, they are bought in lumpy, indivisible units.

The neoclassical assumption of a wide range of economically efficient techniques of production, given the state of know-how, assumes that capital is malleable and

divisible. This is obviously not an accurate reflection of reality. The choice of technique is necessarily affected by the features of existing machinery which determine both the feasibility and opportunity of making piecemeal changes to the plant.

Continuous disturbances and a slow adjustment process are essential features of technical progress. Real problems arise because this continuous change in techniques is allied to a slow adjustment process caused by durable equipment. The flow of new techniques outstrips the ability of the system to adjust and a gap appears between "potential" technical change and "actual" technical change (Salter, 1969).

The neoclassical theory predicts unidirectional changes of technique following changes in the factor price ratio. The assumptions ignore the thorny problem in "re-switching" i.e. the possibility of one technique being the most economically efficient at two or more values of the factor price ratio. However, it must be mentioned that Harrod points out that contrary to common belief, it is wrong to take it for granted that in models of the neoclassical sort a change in money wage-rates relative to interest rates will lead to a change in the capital-labour ratio. His reasoning follows the following lines. If money wage-rates change but there is no change in the interest rate, then this does not necessarily provide an inducement for using methods of greater capital-intensity. The result may simply be that all prices, including those of capital goods, rise in the same proportion as the money wage-rate and hence the price of real "capital disposal", as well as real wage-rate, stay unchanged (Fellner, 1961, p 306).

2.3 Alternative Explanation of Choice of Technique

2.3.1 Introduction

Hay (1983) argues that two major historical changes in the nature of firms have helped to precipitate new developments in the theory of the firm. Firstly the

growth in the number of very large industrial firms has made it increasingly difficult to rely on a theory which presents the firm as atomistic and small in relation to its markets and secondly, the divorce of ownership and control in industrial firms has diminished the incentive to maximise profits. The significance of this development is that it has increased the scope of managerial action and its motivations as a central theoretical concern in explaining the behaviour of firms, thus providing an alternative point of reference to market phenomena alone (Wildsmith, 1973).

Some of the new directions in the theory of the firm are highlighted in the following sections. In keeping with the section on the neoclassical theory of technique choice, attention is given initially to the determinants of technique from a given spectrum of techniques. The possible effects on the choice of technique of a change in the available spectrum of alternative techniques are explored thereafter.

2.3.1.1 The Managerial Theories of the Firm

The managerial models are more general than the profit-maximising neoclassical model in the sense that they can be shown to include it as a special case. The managerial theories conceive the firm as a coalition whose members have conflicting goals that must be reconciled if the firm is to survive. Furthermore, the divorce of ownership from management permits the top management to deviate from the goal of profit maximisation when the firm operates in imperfectly competitive markets and pursue goals which maximise their own utility. However, the managers' discretion in defining the goals of the firm is not unlimited. A minimum level of profit is necessary for a dividend policy acceptable to the body of shareholders; for undertaking the investment necessary for a satisfactory operation of the firm; for keeping a good reputation with banks so as to secure adequate finance for current transactions; for avoiding a relative fall in prices of shares on the stock exchange and the risk of a take-over. If these conditions are

not satisfied, the top management runs the risk of dismissal; their job security is endangered.

The basic feature of all marginal managerial models is that the managers maximise their own utility, subject to a minimum profit constraint necessary for management's job security. The models differ in the factors which enter into the managerial utility function, in the key variables which the managers will use in attaining their goals and in their predictions of consequences of changes of various parameters of the model.

In the managerial theory the desire for steady performance with satisfactory profits tends to make managers reluctant to adopt promising but risky projects. Often changes in choice of technique are spread over time to avoid wide swings in economic performance of the firm (Williamson, in Koutsoyiannis, 1984).

The firms' managerial hierarchies have considerable degrees of autonomy in their actions, they are internally differentiated, face considerable uncertainty and are likely to pursue growth as an objective, but via a variety of different strategies depending on the firms' internal and external structures. Marginal managerial theories of the firm introduce technical change as an active component of firm behaviour. Therefore, given either changes in the factor price ratio or changes in firm output, the actions of the firms in managerial theories are no longer as clear-cut as is the case in the neoclassical theory of the firm (Coombs, Saviotti and Walsh, 1987).

2.3.1.2 Selection Mechanisms

Stewart (1977) sees the development of techniques essentially as a historical process in which one technique with one set of characteristics replaces another in the light of the historical and economic circumstances of the time. Economic/historic circumstances are therefore seen to condition the characteristics of techniques. Clearly, this has an impact on the choice of

technique as it will necessarily affect the techniques which are available from which choices can be made. This section outlines some of the selection mechanisms which may influence firms' technique decisions.

The choice of technique actually made may depend on the nature of the decision makers and their objectives, the economic circumstances in the economy concerned, and the characteristics associated with different techniques.

Decision makers differ as to motive, knowledge and circumstances, so who takes the decision may determine what decision is made. For example, a subsidiary of a multinational firm may have, as prime motive, maximisation of profits after tax, on a worldwide basis. Locally and privately owned firms may aim to maximise local profit after tax. This difference can make a considerable difference to choice of technique in terms of nature of output, scale, specialisation, type of inputs used, price of such inputs, etc. A government-owned corporation may aim to maximise local profits before tax; it may also include other aims that are given little weight by the private sector - e.g. employment maximisation, or the spread of opportunities to the rural areas. As explained in the section on the managerial theories of the firm, individual income and/or prestige maximisation may alter decision making, sometimes allowing corruption to be decisive in choice of technique. The aims of family enterprises are likely to be in terms of total income of the enterprise, rather than profits.

The circumstances in which firms operate also differ and may affect choice of technique. For example, access to funds for investment, in quantity and quality, differs between firms. Multinational firms may obtain more or less unlimited funds. Large-scale firms may borrow from the banks, often at low interest rates. Smaller-scale enterprises may find it difficult to raise funds in any quantity and may have to pay high prices.

Different types of firms tend to serve different markets: for many subsidiaries of multinational firms the world is their market. Locally-owned firms tend to be

more confined with the larger-scale firms doing some exporting. Small-scale firms may have even more confined markets.

Scale of operations is a function of organisation, availability of funds and the nature of the market. The scale of operation is often the decisive characteristic in determining selection of technique.

There may be only one technique that is efficient at each scale. Machines tend to be designed for a particular level of production and are not divisible for smaller quantities of production, though they may be multiplied for larger. The small producer may have the choice between operating a small-scale technique at full capacity or a large-scale technique at less than full capacity. The large-scale producer, on the other hand, may have the choice between operating one large-scale plant, at perhaps full capacity or near full capacity, or a number of small-scale techniques all at full capacity.

Similarly, some products have a lower limit and some an upper limit, in scale of production. Nuclear power plants can, for example, evidently not be made too small, since the very physical properties of the process and the necessary control systems have a minimum size.

The quality of the product and resulting scale of production may also affect the production technique chosen. In the case of paper high requirements on strength, whiteness and printing properties will limit the choice of pulping techniques to chemical methods and thereby to a large scale paper pulp factory. If, on the other hand, lower and more uneven quality can be accepted, then simpler mechanical pulping methods can be chosen and thereby smaller scale of production is made possible.

A further scale factor is involved in the production of the machines themselves. To the extent that the production of machines is itself subject to economies of

scale the price of the machines will depend on the quantity in which machines themselves are being produced.

Another characteristic that is often decisive in technique choice is product specification. Product specification depends on the nature and income levels of consumers, and the structure of the economy as a whole. Different types of firms tend to have different product requirements - mainly because their markets differ.

The choice of product limits the possible ranges of technical choices. In making a decision on the product to produce, the producer may limit his choice of technique as it may be that certain product designs or qualities can only be produced using specific techniques or that the economic efficiency of production techniques is determined by the scale of the plant.

In the opinion of Edquist and Edquist (1979) choice of technique is not the primary choice. Techniques are the means to reach certain goals. Usually the choice of product comes first. Keddie found that research carried out in Indonesia strongly supported the hypothesis that the primary concern of firms in adopting techniques is product advantage (Stobaugh and Wells, 1984, p 77). Keeping up standards, the prestige of the firm and maintaining the value of the brand name also help determine product standards and this may determine techniques.

Product developments take place continuously. These may be in the form of changes in quality of existing products or the development of new products. The producer has to consider not only existing products but also potential new products when considering which technique (and what scale of the technique) to adopt in his production process.

The production of most goods can be regarded as a series of processes. Each set may involve a different activity, set of skills and machinery. Choosing a method for producing a product requires that the following be chosen simultaneously: raw materials, process sequence and type of equipment at each process stage. Many

of these decisions are interdependent. Bottlenecks may occur in the production process if decisions of this nature are not properly streamlined.

The price and availability of inputs may differ between types of firms within the economy. Raw materials may be obtained at a lower price by the large-scale firm than the small-scale firm. The different sized firms may also differ in their access to different types of labour, and the price they pay for it. Small-scale firms may escape the trade union activity which holds up wages.

There are many environmental factors that necessarily have distinct impacts on the viability of certain techniques. In textile weaving, for instance, the quality of the yarn used (in particular, its strength) has a major influence on the speed at which looms may be operated. Similarly, a production technique requiring a stable supply of large amounts of electricity for its operation may not be able to be considered for utilisation by manufacturers operating in a location which does not have a reliable electricity supply.

While there are major differences in objectives and circumstances between different types of firms within the economy, within each category selection of technique also depends on the way in which the economy as a whole operates. The operation of the economy determines the price and availability of different inputs. It further determines income distribution which determines the nature of markets. The openness/closedness of the economy determines the extent to which products have to compete internationally.

There is a package aspect to technology. Any one technique which looked at by itself may appear efficient and appropriate, but may be inefficient in the context of the technology in use. For example, the decision on the technique to be adopted in tyre manufacture will depend on the nature of the economy and income distribution within it. It will depend on whether cars are being consumed locally, or whether it is a bicycle economy, the standard of the roads, the extent to which the tyres have to compete with other tyres manufactured locally or

imported, the standard and prices of the competitive goods, and the availability and price of inputs required.

The decision has to be made in the light of, and may be uniquely determined by, the nature of the economic structure as a whole. A system in which firms have free access to foreign technology may lead to oligopolistic competition via product differentiation rather than competition based on price. This may force each firm to adopt the latest techniques in order to secure its market by providing the most recent product.

2.3.1.3 Reliance on Foreign Technologies

A further factor which may impinge on a firm's choice of technique is the extent to which the firm is reliant on foreign production technology. Merhav (1969, p 16) classifies technological dependence as "the technical incapacity to produce the capital goods required for modern technology".

Firms' technique decisions may be affected by a country's dependence on imported technologies for a number of reasons.

The range of techniques available to the dependent country is likely to be restricted to those currently available in the supplying country because the dependent country is not able to rediscover or produce techniques to change this situation. Outdated techniques do not get produced in developed countries once new ones are discovered to replace them. As mentioned by Merhav (1969), the equipment not only may not be made, but "engineers no longer know the techniques, and workmen no longer have the skills for the older processes." As the small dependent country market would not require mass production of the "outdated" plants, the production of these "outdated" plants would not be viable and therefore not undertaken in the industrialised countries, in any case. Jenkins (1986) argues that the domestic production of technology is not feasible, both

because of the high costs and risks associated with innovation, and because of the lack of skilled manpower in host countries.

As innovation becomes diffused through the system, the typical size of the plant tends to increase. The imported techniques evolved in the advanced countries, with their vastly larger markets, are seldom economically viable in the dependent country with their narrow markets. The modest market size is also usually not able to support more than a few firms in each line of production. This extends the problem of local manufacture of the capital goods.

The rapid rate of technological advance in the more industrialised countries, and the increasing capital-intensity and scale of the available technology would, in the long-run, tend to counter even a tendency towards decreased capital-intensity which might have arisen from a fall in the price of labour relative to that of capital.

The long-run social benefits to be gained from the development of more "appropriate" techniques of production in the dependent country may be negated by it being more economically efficient to use the tried and tested techniques available in the more industrialised countries. Such imported techniques are at least guaranteed to work. This hypothesis could account for the fact that there is relatively little demand for indigenous R & D in less industrialised countries.

The introduction of capital-intensive technologies by foreign subsidiaries may encourage local firms to operate similarly inappropriate techniques because of the "demonstration effect" or because of competitive pressures, and it may generate inappropriate patterns of consumption (Jenkins, 1986). As argued earlier, the product produced may determine the production technique chosen by a firm. "Inappropriate" products[4] might encourage the use of inappropriate techniques.

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4 This is a normative term coined by left wing development economists, and based on a value judgement about what should be produced and consumed.

Furthermore, certain factors may militate against multinational enterprises (MNEs) adapting their production techniques to the needs of host countries:

(i) technologies appropriate to conditions in less highly industrialised economies may not exist;

(ii) distortions in the prices of goods and factors may encourage the use of capital-intensive techniques:

(iii) skilled labour may be scarce, causing MNEs to adopt capital-intensive techniques in an attempt to reduce skilled labour requirements.

The choice of technique of a producer operating in a country dependent on imported technologies is obviously also affected by the international trade conditions facing the country where production is to take place. These may include limitations on the availability of foreign exchange, the cost of foreign exchange and trade distorting factors such as trade sanctions.

Multinational enterprises operating in developing countries often have patents on the products produced or have licensing agreements attached to the imported machinery used in production. Technology contracts may also frequently require the affiliate to buy expensive machinery, technical services, parts etc., from the parent corporation or from its other foreign subsidiaries. These practices restrict the dependent country's autonomy in technique decisions.

2.3.1.4 Linear Programming

Earlier, when discussing the Leontief production function, it was pointed out that isoquants need not be perfectly smooth and perfectly continuous, in other words firms' choices of techniques are not always infinite. According to Harrod and Domar firms may face a single production process. Alternatively, firms may face a choice between two or more production processes, however, each with fixed input proportions. In this section the two process situation is discussed.

The two process situation is shown in Figure 2.9(i). The isoquants illustrate the two processes each producing one unit of the product X. If a firm can produce using process 1 or process 2 or both, then its isoquants are shown in Figure 2.9(ii). The portion AB of the isoquant for 1 unit of output X in Figure 2.9(ii) is the portion A'B' of the isoquant for 1 unit of output using process 2 in Figure 2.9(i). For these input bundles, process 2 yields a larger output. Similarly, the portion CD of the isoquant for 1 unit of output in Figure 2.9(ii) corresponds to the portion C'D' of the isoquant for 1 unit of output using process 1 in Figure 2.9(i). For the input bundles along CD, process 1 yields a larger output. The segment BC in Figure 2.9(ii) is a linear combination of the points B' and C' in Figure 2.9(i). The input bundle along BC will produce 1 unit of output only if both production processes are used. A point along the segment BC will not contain enough of the two factors to produce the 1 unit of output with only one process. Combining the two processes will enable production to take place.

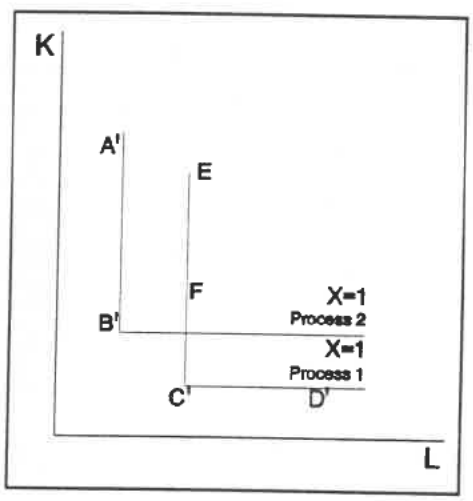

Figure 2.9 (i)

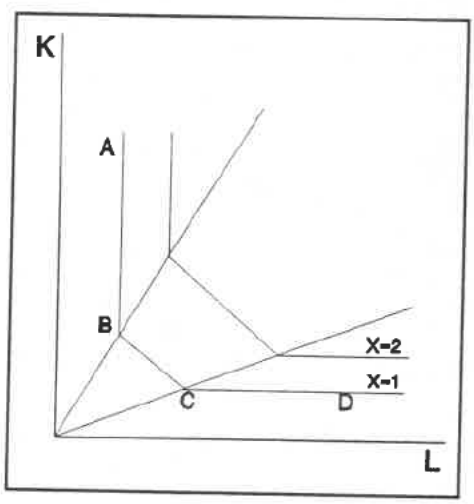

Figure 2.9 (ii)

From the above discussion on linear programming it is obvious that fixed input proportions limit technique choice. Facing fixed input proportions firms do not face infinite alternatives from which to choose their techniques.

2.3.1.5 Alternative Explanations of Technological Change

In this section some differing views about the forces guiding innovative energies are presented. The section looks at the process of change in the range of techniques from which firms can choose.

Many economists were initially content to treat the process of technological change as an exogenous variable. However, attitudes did begin to change. It became increasingly obvious that inventive activity responded to economic needs. Governments and business firms directed research into specific problem areas. Economic growth could not be adequately understood in terms of the use of more and more physical inputs, but rather it had to be understood in terms of learning to use inputs more productively. The endogenous rather than previously assumed exogenous nature of technical and institutional change took shape. Economists have become more and more confident of their ability to deal with technological events in economic terms (Rosenberg, 1982).

Hicks (1963, p 125) distinguishes two sorts of inventions; those which are the result of a change in the relative prices of the factors he calls "induced" inventions and the rest he calls "autonomous" inventions. As he explains, in practice, all or nearly all induced inventions should be labour-saving, but there is no reason why autonomous inventions should be predominantly labour-saving. In the absence of special knowledge a random dispersion of autonomous inventions as labour-saving or capital-saving may reasonably be assumed. It is conceivable though that scientific discovery may tend to produce inventions with a bias in one direction over quite long periods.

At least on analytical grounds, Hicks' ideas appear to have gone unchallenged, until a number of theorists later began to question the existence of any "mechanisms" in the framework of traditional analysis which would relate factor prices to the process of innovation. Salter, for instance, denied completely that a change in the relative price of factors might influence the nature of investment

(Salter, 1969). He distinguished between fundamental, or basic, and applied knowledge and argued that no firm could be induced to develop new fundamental knowledge. According to Salter the theory of induced biases must be rejected:

> If ... the theory implies that dearer labor stimulated the search for new knowledge aimed specifically at saving labor, then it is open to serious objection. The entrepreneur is interested in reducing costs in total, not particular costs such as labor costs or capital costs. When labor's costs rise, any advance that reduces total costs is welcome, and whether this is achieved by saving labor or capital is irrelevant. There is no reason to assume that attention should be concentrated on labor-saving techniques, unless, because of some inherent characteristic of technology, labor-saving knowledge is easier to acquire them capital-saving knowledge. (Salter, 1969, pp 43-44).

Salter argues that it is not sufficient to consider recent new techniques in considering the biases in technological development, as techniques which are actually observed coming into use are themselves the result of a complex interaction between the characters of technical advances and factor substitution. For Hicks (1963), however, the distinction between inventions "induced" by a change in factor prices and an adaption to a change in "a given state of knowledge" is somewhat tenuous.

Fellner dismisses Salter's criticism, asserting that an anticipation of a rise in the relative price of a factor might influence the nature of invention but that an actual rise would not do so. He therefore claims that we cannot have a theory of induced invention if we adhere to the traditional comparative static analysis (Fellner, 1961). For Fellner there are two central mechanisms determining inventive activity. In some cases a preference may develop for inventions which are particularly factor-saving in the resource that is getting scarcer, because a learning process may induce atomistic firms to behave as if they were big enough to notice that macroeconomically the factors of production are not in infinitely elastic supply. Fellner is proposing that firms will learn by watching trends in factor prices. If a firm is faced by a change in technology and needs to choose between two innovations it would act on its experience and expectations of factor

scarcities and resulting factor price ratios when making the decision. It may be necessary to make substantial allowance for the possibility of further invention or innovation when making a decision on investment spanning a number of periods. Secondly, market imperfections may give rise to further market imperfections of a different kind which counteract, or in some cases wholly neutralise, the initial distortion. If, for example, innovations become too labour-saving resulting in a relative shortage of capital, the firm finding itself in a quasi-monopsonistic position in the capital market may direct innovations at more capital-saving techniques.

For Schumpeter and Schmookler, although in quite different ways, technological change was a very important component of economic development. According to Coombs, Saviotti and Walsh (1987), Schumpeter was concerned with long-term economic development and structural change in capitalist societies. Schumpeter believed that one of the most fundamental features of capitalism was its tendency to disequilibrium. The entrepreneur discovers, often in an existing knowledge pool, ideas untried and introduces them into economic life, introducing disequilibrium into the economic system. Radically new innovations lead to the emergence of completely new industries and create a renewed momentum for economic development. The supply of new technologies is more important than the adaption to existing patterns of demand. Furthermore, only product innovations can lead to the creation of new industries. They are thus more significant than process innovations, which can only lead to the increased efficiency of existing industries.

Schmookler argues that it is the action of market forces, not the availability of all necessary elements of basic-science knowledge, that triggers inventions. He regards science and technology in the modern age as being omnicompetent. Although the availability of basic knowledge may be a necessary condition, it is evidently not a sufficient condition for innovation. Using empirical evidence from several American industries, Schmookler attempts to demonstrate, that demand-side considerations are the major determinant of variations in the allocation of

inventive effort in specific industries and that supply side considerations are subordinate or passive. He concludes that we can treat invention just like any other economic activity. We can analyze inventive activity in precisely the same terms as production and consumption namely, in terms of revenues and costs (Binswanger et al, 1978).

Rosenberg (1974) challenges Schmookler's argument saying that close attention to the growing stock of useful knowledge may explain the historical sequence in which different categories of wants have been satisfied via the inventive process. Rosenberg asserts that although economic forces and motives have inevitably played a major role in shaping the direction of scientific progress, they have not acted within a vacuum, but within the changing limits and constraints of a body of scientific knowledge growing at uneven rates among its component sub-disciplines. Some things were just not able to be invented with the knowledge available at certain times in history. Similarly, industries differ in their capacity to incorporate new innovations into their operations.

Rosenberg concludes that even if demand side forces alone determined the allocation of inventive resources, supply side forces exercise a pervasive influence over the actual consequences of such resource use.

Nelson and Winter's model of technical change (1974), suggests that firms producing with fixed-proportion techniques in any given period of time will start to search for new techniques of production when profits fall below a certain margin. The relative factor prices determine the capital-labour ratios of the firms. The model implies that as demand for the product of an industry increases, research effort in the industry will fall. This is clearly contradictory to the evidence accumulated by Schmookler.

CHAPTER 3

THE SURVEY

3.1 Introduction

As mentioned in Chapter 1, the perceptions of Pietermaritzburg businessmen on the determinants of the choice of technique were collected during a survey carried out in the manufacturing sector from July to September 1990. In this chapter details of the survey and the surveyed region are provided.

The study was conceived as a part of a project being undertaken in the Department of Economics at the University of Natal in Pietermaritzburg to investigate features of the economy of the Pietermaritzburg functional region.

The survey research technique was used to collect the data required for the analysis for two main reasons. The first was that the published data available from the manufacturing census at the regional level does not allow for an analysis by industry of the relationship between relative factor prices, and the capital intensity and scale of operation of firms. In addition, the manufacturing census does not probe interesting issues such as the origin of technology, the influence of the product on the choice of technique and the actual extent of the scope for choice of technique of the firms who have scope to choose their production technique.

The interview and questionnaire research technique which is used here also has weaknesses. The following are some of the weaknesses:

(1) The response given depends on which member of the firm answers the question.

(2) Responses given at one point in time may very well be different to those given at another point in time.

(3) Factors may well prove important to the individual firms, but these may cancel out in the aggregation.

(4) Responses cannot be accepted at face value and should be given further examination

Despite these weaknesses the survey technique unquestionably contributes useful information about the behaviour of firms.

3.2 The Survey Questionnaire

The basis of the survey was a questionnaire presented, during an interview, to a senior representative of each of the responding firms in the sample. The survey questionnaire appears as Appendix A.

A similar research project was carried out in the manufacturing sector in the 1970's by the Department of Economics at the University of Natal in Durban. Although this research project was similar to the current one, there were differences which would make comparisons of the results of the two studies meaningless. Firstly, the earlier project was based on a national sample of firms whereas the current study only focused on the Pietermaritzburg manufacturing sector. In addition the focus of the analysis of data in the two studies differs making direct, meaningful comparisons of the results of the two studies impossible. The questionnaire used in the earlier study was nevertheless used as a guide when the questionnaire to be used in the current study was drawn up.

As mentioned above, this project forms part of a larger project being undertaken in the Department of Economics at the University of Natal in Pietermaritzburg. Questions included in the questionnaire did not only focus on the issues being probed in this particular study. Data which was required from manufacturers in the region for other research projects was also collected during the interviews for

this survey. Questions which will be analyzed in other studies are therefore also included in the survey questionnaire.

The final draft of the survey questionnaire was presented to members of the Economics Department during a seminar held in the Department. 5 pilot interviews were carried out in the sector. In this way any "teething problems" could be picked up before embarking on the larger project.

3.3 Survey Population

3.3.1 A Profile of Pietermaritzburg

To provide some sort of reference platform a brief outline of the surveyed centre is provided.

The Pietermaritzburg municipal area covers 14 218 hectares. At the time of the survey the population within the narrow magisterial boundaries was made up of 66 550 whites, 80 300 asians, 17 200 coloureds and 19 710 blacks. A further 300 000 blacks were living within commuting distance from the city (Pietermaritzburg Publicity Association).

Pietermaritzburg is a designated decentralisation point and therefore industries can, and do, make use of the industrial incentives which apply in such areas.

Pietermaritzburg is well-situated in terms of road, rail and air access. It is on the main arterial route to the Transvaal and the port of Durban. The main road to the Cape Province and the Transkei also runs through the city. Within Pietermaritzburg there is a new, high-tech rail marshalling yard comprising over 200 kilometres of track. Most of the city's industrial land is, or can be, served by rail. The city is also served by its own airport which provides daily flights to all the major centres.

3.3.2 Population of firms

A composite list of all the firms operating within the Pietermaritzburg manufacturing sector was compiled from the list of firms included in the University of South Africa's Bureau for Market Research's Industrial Register for Pietermaritzburg and the Pietermaritzburg Municipal Industrial Register. This sample frame consisted of 247 firms. The UNISA BMR list of manufacturers, although sold as up-to-date, proved to be outdated, hence the supplementary use of the municipal register.

When the list of manufacturers in the various industries had been considered the sample population was stratified into eleven industry groupings using the Standard Industrial Classification (SIC).

For a city of its size, Pietermaritzburg has a wide variety of industries operating within its boundaries. The breakdown of the number of firms operating in each sector at the time of the survey is given in Table 3.1.

TABLE 3.1
BREAKDOWN OF THE NUMBER OF FIRMS IN EACH INDUSTRY OPERATING IN PIETERMARITZBURG

Industry	Number of firms	% of manufacturing sector
Food, Beverage and Tobacco	30	12,1
Textiles and clothing	11	4,5
Leather and footwear	28	11,3
Wood, furniture and fixtures	31	12,5
Paper and printing	14	5,7
Chemicals	17	6,9
Rubber products and plastics	9	3,6
Non-metallic mineral products	8	3,2
Basic metal and metal products	52	21
Machinery and electrical machinery and transport equipment	36	14,6
Miscellaneous	11	4,5
TOTAL	247	100

The sector with the largest number of firms was the basic metals and metal products industry. The smallest sector was the non-metallic mineral products sector. The size of the sectors varied from the smallest with 8 firms to the largest with 52 firms. The largest sector had 6,5 times more firms than the smallest sector.

Comparing the statistics (at the time of the survey) for Pietermaritzburg with those for Natal and the entire South African manufacturing sector reveals interesting statistics.

There were a total of 3 384 industrial establishments in Natal. Pietermaritzburg's industrial sector contributed 7 per cent to this total. Pietermaritzburg

establishments made up 1 per cent of the entire manufacturing sector of South Africa which had 18 640 establishments. (Central Statistical Services, 1990)

Looking at employment figures reveals similar proportions. It is estimated that approximately 25 000 people were employed in the Pietermaritzburg manufacturing sector at the time of the survey (Pietermaritzburg Publicity Association, 1990). The entire South African manufacturing sector employed 1437 026 people, 313 913 of which worked in establishments in Natal. The Pietermaritzburg proportions of these totals were 1,7 per cent and 8 per cent respectively (Central Statistical Services, 1990).

Taking a more detailed look at the employment make-up of the Pietermaritzburg manufacturing sector reveals some astonishing statistics. 44 per cent of the total number of firms in the population employed less than 20 people. 74 per cent employed less than 100 people. There were only 11 firms employing more than 500 people, 3 of which had more than 800 employees.

The sector can also be analyzed according to ownership. In Table 3.2 data on ownership is given. As can be seen, by far the largest proportion of firms were operating as independent units.

TABLE 3.2
OWNERSHIP PATTERNS IN THE PIETERMARITZBURG MANUFACTURING SECTOR

Ownership	Number of firms	Percentage
Head Office	19	7,8
Branch	34	13,9
Subsidiary	35	14,3
Independent unit	154	63,1
Unclassified	2	0,9
TOTAL	244	100

3.4 Sample

A sample of 100 firms was judged to be large enough to be representative of the population, allowing for the inevitable no responses.

Questionnaire research has many pitfalls. Response rates are unpredictable. To ensure there would be a sufficient respondents to guarantee the credibility of the survey results, a sample somewhat larger than the suggested 100 firms was drawn. A quota of 12 firms per industry was applied.

The firm with the largest number of employees in each industry was selected whereafter firms were selected on a random basis, using random digit sampling, until the quota in each cell was reached. Where there were fewer than 12 firms in a particular industry all the firms in the industry were included in the sample.

The final sample drawn consisted of 117 firms of which 88 responded to the questionnaire. This represents a 75,2 per cent response rate. The textiles and clothing and rubber products and plastics industries had a 100 per cent responses rate. The response rate was the lowest in the leather and footwear industry where only 42 per cent of the firms responded to the questionnaire. Table 3.3 provides a detailed breakdown of the response rates of the firms in the various sectors.

TABLE 3.3
QUESTIONNAIRE RESPONSE RATE PER INDUSTRIAL SECTOR

Industry	Number of respondents	Response rate
Food, Beverage and Tobacco	8	66,7
Textiles and clothing	11	100
Leather and footwear	5	41,7
Wood, furniture and fixtures	11	91,7
Paper and printing	7	58,3
Chemicals	8	66,7
Rubber products and plastics	9	100
Non-metallic mineral products	4	50
Basic metal and metal products	10	83,3
Machinery and electrical machinery and transport equipment	10	83,3
Miscellaneous	5	45,4
TOTAL	88	75,2

From the relatively high response rate of 75,2 per cent it is obvious that firms in the sample generally responded favourably to the research project. There is no evidence of non-response bias.

Firms in the chemical industry specifically were, however, initially reluctant to participate in the survey for fear of having to divulge strategic statistics or formulas, and unfortunately, a few companies in the sector could not be convinced that this would not be the case. Firms that refused the interviews on these grounds, were replaced in the sample. The replacements firms were chosen randomly from the remaining firms in the industry.

3.5 Methods Used For Data Analysis

The basis of the empirical analysis is set out in this section. Responses to the questions in the questionnaire were analyzed in terms of:

(i) The industrial classification within which the firms operated.

As mentioned above, using the three digit Standard Industrial Classification (SIC) the firms were coded into the following industry categories:

(a) Food, beverage and tobacco
(b) Textiles and clothing
(c) Leather and footwear
(d) Wood, furniture and fixtures
(e) Paper and printing
(f) Chemicals
(g) Rubber products and plastics
(h) Non-metallic mineral products
(i) Basic metal and metal products
(j) Machinery and electrical machinery and transport equipment
(k) Miscellaneous industries

(ii) The size of the firm was expressed in terms of the number of people employed in the firm. From the responses to the survey it was impossible to derive data concerning the value of firms' capital from which to classify firms by size of capital investment. Some firms were not prepared to divulge these details. Others, especially subsidiary firms, did not have direct access to such information. Still others were unable to accurately calculate their capital figures. Even if all the firms' capital figures had been obtained, the wide range of possible interpretations of the term "capital" and the numerous ways of measuring and reporting the data,

would have handicapped any analysis. Therefore, as a proxy for firm size, the number of employees is used.

Having a closer look at the composition of the sample by firm size reveals the following facts. The five biggest firms in the sample employed 46 per cent of the total labour in this sample! The largest number of employees in any single firm was 2001. The fewest number of employees in any firm was 3. Nineteen firms employed less than twenty employees. These firms, 22 per cent of the sample, employed less than 2 per cent of the total labour in the sample.

For the detailed analysis and comparison of the 77 firms for which employment data was available the firms were divided into 3 categories according to the number of employees.

The first categorisation compared the group of the smallest firms in the sample with the group which included all other remaining firms in the sample. Firms employing less than 20 employees were considered to be small enterprises. There were 19 "small" firms in the sample.

The second categorisation distinguished the largest firms from all the other firms in the sample. Firms employing more than 400 employees were considered large. There were only five such firms in the sample.

The third categorisation identified three firm sizes. The categories were:

(a) The 19 firms employing less than 20 employees - i.e. the smallest firms;

(b) Secondly, the 5 largest firms in the sample; and

(c) The remaining 53 medium sized firms in the sample.

The 3 different categorisations allow for comparisons between the smallest firms and the largest ones, as well as between the small, medium, and large firms.

(iii) The nature of the firm's ownership, distinguishing between:

(a) foreign and local ownership; and
(b) subsidiaries and non subsidiaries.

All the data was captured and processed on a personal computer[5].

5 The VP-Planner computer package was used to code the raw data into spreadsheet files. The data was entered into 11 separate files. Where applicable the responses were coded using the dummy variable "1" for a positive reaction and "0" for a negative reaction. For the statistical analysis of the results, the spreadsheet data files were imported into the Statgraphics statistical package.

CHAPTER 4

AN EMPIRICAL ANALYSIS OF FIRMS WHICH WERE INSENSITIVE TO FACTOR PRICES

4.1 Introduction

Chapter 2 examined the economic theory underlying firms' choices of technique. According to economic theory there are many factors which may determine which techniques firms use. In neo-classical theory specifically, relative factor prices determine firms' choices of technique. The aim of the following two chapters is to establish from the results of the questionnaire survey whether firms in the Pietermaritzburg manufacturing sector were sensitive to factor prices in their choice of technique. This chapter assesses the broad question of the importance of factor prices in the choice of technique and then examines in detail the characteristics of the firms which were insensitive to factor prices in their choice of technique. An investigation of possible explanations why firms were insensitive to factor prices is also carried out.

4.2 The Importance of Factor Prices

In neo-classical theory relative factor prices are seen to determine firms' choices of technique. It is assumed that if firms were sensitive to factor prices in their choice of technique, they had some scope for choice of technique. A firm sensitive to factor prices could choose to alter the relationship between inputs and outputs in the production process or it could choose between alternative techniques in the available spectrum or alternative techniques, thereby altering its technology. Chapter 2 showed that firms had a choice between moving along a production isoquant, substituting one factor of production for another, or changing their technology and changing to a completely new set of isoquants.

Firms that were sensitive to factor prices had scope for choice of technique, firms that were insensitive to factor prices did not necessarily have no scope for choice of technique. Firms' technique decisions may have been determined by factors other than the price of factors of production.

One of the survey questions (Question 49) asked the respondents to identify from a list of factors those that they considered most relevant to the type of technique chosen by their firm. The responses indicate in various ways whether managers were sensitive to the prices of factors of production when making a decision on the production technique to adopt. The question asked the respondents to tick off as many of the following factors affecting their choice of technique as they saw fit:

(a) Cost and supply of skilled labour
(b) Cost and supply of unskilled labour
(c) Cost and supply of semi-skilled labour
(d) Relative cost of labour and capital intensive techniques
(e) Availability of new techniques
(f) The limited availability/narrow range of alternative techniques
(g) Nature of incentives
(h) Legislation requirements (eg pollution)
(i) Level of interest rates
(j) Cost and availability of finance
(k) Type of product produced
(l) Other - specify

In this question the effect of factor prices on the choice of technique is probed directly in factor (d). Although not as directly, the effect of factor prices on the choice of technique is also probed in factors (a), (b), (c), (i) and (j). In factors (a), (b) and (c), the question deals with the "cost and supply of labour", distinguishing between the levels of skills. Factors (i) and (j) deal with the effect of the "level of interest rates" and the "cost and availability of finance", respectively. Factors

(i) and (j) would affect the cost of capital, while (a), (b) and (c) affect the cost of the labour input.

As is the case with much questionnaire-based research, it is not automatically clear which answers correspond to the theoretical analysis of Chapter 2. Three indicators of whether the relative costs of labour and capital intensive techniques mattered in the choice of production technique are therefore developed. Under each indicator, the terms "insensitive" and "sensitive" will be used to refer to instances where firms were not sensitive to factor prices in the choice of technique and instances where they were sensitive to factor prices in the choice of technique, respectively.

Factor (d), "the cost of labour and capital intensive techniques", will be referred as Indicator 1. Indicator 2 is more broad-based than Indicator 1 and includes positive responses to factor (d), or to any of the cost and supply of labour responses, (a), (b) and (c). The third and broadest indicator of the importance of the relative costs of factors of production in the technique decision includes positive responses to at least one of the factors included in the second indicator, namely (a), (b), (c) and (d), as well as positive responses to (i) and/or (j), "the level of interest rates" and "the cost and availability of finance" respectively. The three indicators are summarized in Box 4.1

Box 4.1

Three Sub-indicators of Sensitivity to Factor Prices

I1 = Yes to "relative cost of labour and capital intensive techniques"

I2 = I1 or yes to any question concerning the cost of labour.

I3 = I2 or yes to "level of interest rates" and/or "cost and availability of finance".

Assessing the responses to the three derived indicators reveals some interesting results about the extent to which managers in the sample claimed their choice of technique depended on the prices of factors of production. Thirty-seven firms (42 per cent) singled out, I1, the relative cost of labour and capital intensive techniques, as a relevant factor when making the choice of production technique. 45 firms responded positively to at least one of the factors (a), (b), (c) or (d). This is nine per cent more firms than responded positively to factor (d) only. Sixteen more firms were included in the sample if the costs of capital are also included in the indicator. This is 18 per cent more of the sample than responded to I2 (see Table 4.1).

TABLE 4.1
FIRMS SENSITIVE TO THE COST OF FACTORS OF PRODUCTION

Indicator	Number of firms	Percentage
I1	37	42
I2	45	51,1
I3	61	69,3
TOTAL	88	100

If it is assumed that firms that were sensitive to factor prices had scope for choice of technique, then from the broadest definition of being sensitive to the relative

costs of factors of production relevant to their choice of technique, it is evident that 69 per cent of the firms were sensitive to factor prices in their choice of technique and therefore had some scope for choice of technique. When sensitivity is most narrowly defined from the responses, there were still 42 per cent of the firms with scope for choice of technique.

4.3 The Analysis of Firms Which Were Insensitive to Factor Prices

4.3.1 Introduction

In the remaining part of this chapter firms that reported that, when choosing a production technique, they were insensitive to factor prices are investigated. The investigation probes how the firms that were insensitive to factor prices in their choice of technique differed from those firms which were sensitive to factor prices in their choices of technique. It investigates whether the firms were foreign- or locally-owned, whether they belonged to specific industries, and whether the size of the firm in any way determined a firm's sensitivity to factor prices. Possible explanations for the firms' insensitivity towards factor prices are also sought.

4.3.2 Foreign Versus Local Ownership

The question which is considered in this section is the relationship between the ownership of the firm and the choice of technique. Did foreign-owned firms tend to be less "sensitive" to factor prices than locally-owned firms? Further, did the dependence on foreign technologies affect foreign-owned firms less than locally-owned firms when considering the resulting scope for choice of technique? Did foreign-owned firms have standardised technologies which they employed in every country regardless of factor prices?

Of the foreign-owned firms, 83 per cent were insensitive to Indicator 1, 75 per cent were insensitive to Indicator 2 and 58 per cent to the all-encompassing Indicator 3. Even for Indicator 3, there were more than half of the total number

of the foreign-owned firms that were insensitive to the relevant indicator of factor price sensitivity. Lower percentages of locally-owned than foreign-owned firms were insensitive according to the three indicators. The percentages for the locally-owned firms were 54, 45 and 26 respectively (See Table 4.2).

TABLE 4.2
INSENSITIVITY TOWARDS THE PRICES OF FACTORS OF PRODUCTION - ANALYZED BY FIRM OWNERSHIP

Ownership	Indicator 1	Indicator 2	Indicator 3
Foreign-owned	10 (83,3%)	9 (75%)	7 (58,3%)
Locally-owned	41 (53,9%)	34 (44,7%)	20 (26,3%)

* Percentages represent the proportion of firms in the category concerned.

Foreign-owned firms were more likely to be insensitive to factor prices as shown by a Chi-square test for I3, which revealed this difference to be significant at the $p = 0.05$ level[6]. Similar differences emerged for the other indicators, although the Chi-square tests were significant only at the $p = 0.10$ level[7].

These differences in sensitivity towards factor prices need to be explained. One hypothesis pertains to the importation of technology as well as capital.

Meth (1990) concludes that the manufacturing sector is the major user of imported capital goods in South Africa. He does point out though that industries vary in their dependence on imported capital goods. Meth's assertion that the manufacturing sector uses large amounts of imported capital goods can be tested against the results of the Pietermaritzburg survey. In Question 21 of the questionnaire firms were asked whether their "core" equipment in use in the production process was predominately imported. 67 firms (76 per cent) said yes. In Question 46 the source of plant and machinery was also probed. Firms were

6 χ^2 value = 4.99528. Df = 1

7 Indicator 1: χ^2 value = 3.67270. (Df = 1)
Indicator 2: χ^2 value = 3.79861. (Df = 1)

asked whether their latest investment in plant and machinery in general was imported or locally produced. 53 firms (60 per cent) said their latest plant and machinery was imported.

The results of both questions analyzed in the previous paragraph indicate that the firms in the sample were biased towards the use of imported capital goods. The question of whether foreign-owned firms made greater use of imported techniques than locally-owned firms will now be investigated. If foreign-owned firms are found to have made greater use of imported techniques the question is then, did their use of imported techniques limit their scope for choice of technique of production and perhaps make them insensitive to relative factor prices?

To speculate on how ownership affects firms' sensitivity to factor prices, the inclination of a firm to use imported techniques is initially considered against the firm's ownership. The proportion of imported content in techniques used by firms as well as whether the imported proportion differed according to ownership is also explored.

To find out whether ownership did affect firms' reliance on foreign technologies the responses to Question 46 are assessed. As set out earlier, the question probed the origin of the latest plant and machinery invested in by the firms.

TABLE 4.3
THE SOURCE OF PLANT AND MACHINERY PURCHASED BY FIRMS - ANALYZED BY FIRM OWNERSHIP

Ownership	Purchased imported plant and machinery		Purchased both locally- and foreign produced plant and machinery	
	Number	% of respondents*	Number	% of respondents*
Foreign-owned	6	50	2	16,7
Locally-owned	47	61,8	3	3,9

* Percentages represent the proportion of firms in the category concerned.

Table 4.3 shows that more locally-owned firms used only imported plant and machinery than foreign-owned firms. (62 per cent compared with 50 per cent). 17 per cent of foreign-owned firms and only 4 per cent of locally-owned firms purchased both locally- and foreign-produced plant and machinery. When the proportions of firms which were using any measure of imported plant and machinery are totalled, the difference between the foreign- and locally-owned firms is negligible. 67 per cent of the foreign-owned versus 66 per cent of the locally-owned firms imported at least some of their plant and machinery.

Not surprisingly, there is no significant statistical difference between the number of foreign-owned firms compared with locally-owned firms that imported their plant and machinery[8]. Thus the insensitivity of foreign-owned firms to factor prices cannot be linked solely to the use of imported techniques.

A subsidiary question of importance is whether the proportion of imported plant and machinery used by the foreign-owned firms was larger than that used by locally-owned firms. Question 56 asked the respondents what proportion of the new technology embodied in the machinery used for production and the methods of production, was developed domestically to meet local conditions, and what proportion was imported.

The cumulative frequency distribution of the foreign technology embodied in the machinery being used by firms is compared in Table 4.4.

The comparison of the use of foreign-developed techniques by the foreign- and locally-owned firms, reveals that proportionately more locally-owned firms compared with foreign-owned firms made use of production techniques with more than 80 per cent foreign content. 57 per cent of locally-owned firms' techniques contained 100 per cent foreign technology. The percentage of foreign-owned firms whose technology was 100 per cent foreign was 50 per cent. 64 per cent of locally-

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8 χ^2 value = 3.11533. Df = 1. This is not significant at the p = 0.10 level.

owned firms' and 50 per cent of foreign-owned firms used technologies which contained at least 90 per cent foreign technology. For techniques with 80 per cent or less foreign technology the picture changes. 83 per cent of foreign-owned firm, compared with 78 per cent of locally-owned firms, employed production techniques with at least 50 per cent foreign content. Eleven locally-owned firms (14 per cent), compared with 1 foreign-owned firm (8 per cent), used techniques with no foreign content.

TABLE 4.4
CUMULATIVE FREQUENCY OF THE PERCENTAGE OF FOREIGN TECHNOLOGY EMBODIED IN TECHNIQUES IN USE - ANALYZED BY FIRM OWNERSHIP

% of foreign technology	Locally-owned firms		Foreign-owned firms	
	Number	% of respondents*	Number	% of respondents*
100	41	56,9	6	50
95	43	59,7	6	50
90	46	63,9	6	50
85	47	65,3	6	50
80	51	70,1	9	75
70	52	72,2	9	75
60	54	72,2	9	75
50	56	77,8	10	83,3
40	58	80,5	10	83,3
30	58	80,5	11	91,7
25	60	83,3	11	91,7
20	61	84,7	11	91,7
0	72	100	12	100

* Percentages represent the proportion of the firms in the category concerned.

From this analysis it is seen that a larger proportion of locally-owned firms were reliant on techniques with greater than 80 per cent foreign content. 47 locally-owned firms (62 per cent) compared with 6 foreign-owned firms (50 per cent)

used techniques with more than 80 per cent foreign content. Foreign-owned firms' insensitivity to factor prices cannot be directly attributed to the fact that foreign-owned firms made use of imported technologies.

Another factor, also stemming from the importation of technology, might explain foreign-owned firms' insensitivity to factor prices. Foreign firms may have been more likely to have had standardized technologies which they employed in every country regardless of factor prices. Could it be that these firms' technologies were "given" from the point of view of local managers? To check this hypothesis the responses to Question 12 of the questionnaire are considered. The question asked firms that were subsidiaries of larger companies whether they had any discretion on the decision of the choice of technique in the manufacturing process. Did the price insensitive firms tend to answer yes?

Question 12 did not give a list of responses from which respondents could choose. It required the interviewer to record the responses, which were coded after the interview. The responses were coded into three categories. Those firms which had complete autonomy in their choice of technique were coded as having "full" discretion. Those firms which had a constrained choice of technique due to their having to follow guidelines from a head office were categorized as having "limited" discretion. The discretion of firms whose techniques were prescribed to them was regarded as "none".

There were seven foreign-owned firms who said their technique decisions were insensitive to relative factor prices, i.e. they did not respond positively to any one of the three indicators I1, I2, and I3.

Of these seven foreign-owned firms, five were subsidiaries of larger companies. The remaining two operated independently. Three of the subsidiary firms reported full discretion with respect to the choice of technique. The other two subsidiary firms said they had limited discretion on their choice of technique. None of the firms said they had no discretion on the choice of technique. Thus,

foreign-owned firms that were insensitive to the relative cost of factors of production did not face "given" technologies.

If the foreign-owned firms that were insensitive to relative costs were not constrained by the fact that they faced "given" technologies nor by their use of imported "inappropriate" techniques, how else could their behaviour be explained?

To cast some light on "other factors" which might have limited firms' scope for choice of technique, the responses of the seven foreign-owned firms that were insensitive to the relative cost of factors of production in their choice of technique to Question 59 of the survey questionnaire are examined. The responses of the "insensitive" locally-owned firms are then analyzed to check whether the responses differ depending on the firm ownership.

The question asked the respondents whether they were aware of more modern, up-to-date methods of production or equipment employed by competing firms in their industry locally or in other countries. If the respondents were aware of such techniques of production, they were asked to give reasons why they had not incorporated the techniques into their operations. The respondents could choose reasons for their decisions not to use the latest technique from the following list:

(a) Technique not available in South Africa
(b) Price of labour relative to capital
(c) Scale of output too small
(d) Supply constraints
(e) Other, where respondents were asked to give details

Four of the five foreign-owned firms not using the latest technique gave reasons for their decision. All four firms ascribed their decisions not to use the latest technique to the fact that their scale of output was too small to warrant their employing the up-to-date technique. Three of the five firms said that cost considerations also influenced their choice of technique.

Analyzing the locally-owned firms which were insensitive to factor prices in their choice of technique to determine what "other factors" might have limited their scope for choice of technique, reveals the following: Twelve of the "insensitive" locally-owned firms were not using the latest technique. Of those twelve, 7 ascribed their decisions not to use the latest technique to their scale of output. Their output was too small to warrant the firm employing the up-to-date production technique. Only one of the locally-owned firms said that the price of labour relative to capital deterred them from employing the latest technique.

Although foreign-owned firms were less sensitive to factor prices than locally-owned firms, no single reason can be found to explain this tendency.

4.3.3 Industry Differences

The likelihood that firms whose technique decisions were insensitive to the prices of production factors belonged to specific industries is considered in this section. Were the decisions of firms in certain industries regarding the choice of technique more or less sensitive to factor prices than firms in other industries?

Table 4.5 contains the answers. The first thing to notice is that within each of the 11 categories of industries, some firms were "insensitive" and some were "sensitive" as measured by each of the three indicators. This means that industry-based assumptions will be at best, gross and misleading. Sub-industry factors also affect a firm's sensitivity to factor costs, and thus their scope for substituting labour for capital.

The three indicators of sensitivity indicate firms in the chemical industry were the most insensitive to factor prices in their choice of production techniques. Even the broadest measure of sensitivity, I3, reveals that 62,5 per cent of the industry did not regard the relative factor prices as relevant when making decisions on the choice of technique. The percentages for the other 10 industries for I3 varied from 0 to 50 per cent.

TABLE 4.5
FIRMS WHOSE TECHNIQUE DECISIONS WERE INSENSITIVE TO THE PRICES OF FACTORS OF PRODUCTION - ANALYZED BY INDUSTRIAL SECTOR

Industry	Indicator 1	Indicator 2	Indicator 3
Food, beverage and tobacco	6 (75%)	6 (75%)	3 (37,5%)
Textiles and clothing	5 (45,4%)	4 (36.4%)	3 (27,3%)
Leather and footwear	2 (40%)	2 (40%)	0 (0%)
Wood, furniture and fixtures	6 (54,5%)	6 (54,5%)	5 (45,4%)
Paper and printing	4 (57,1%)	4 (57,1%)	1 (14,3%)
Chemicals	7 (87,5%)	6 (75%)	5 (62,5%)
Rubber products and plastics	4 (44,4%)	3 (33,3%)	1 (11,1%)
Non-metallic mineral products	2 (50%)	2 (50%)	2 (50%)
Basic metal and metal products	5 (50%)	5 (50%)	4 (40%)
Machinery and electrical machinery and transport equipment	6 (60%)	3 (30%)	2 (20%)
Miscellaneous	4 (80%)	2 (40%)	1 (20%)
TOTAL	51	43	27

* Percentages represent the proportion of firms in the specific industry.

The food and beverage industry was insensitive to Indicators 1 and 2. Three firms considered the capital costs included in I3 relevant in the technique decision. As a result of these firms' responses the industry's "insensitivity" decreased. When considered against the broad-based I3, only 37,5 per cent of firms in the industry were insensitive towards factor prices.

As a group, firms in the leather and footwear and rubber products and plastics industries, were the most sensitive to the prices of the factors of production. In the leather and footwear industry no firms were insensitive to Indicator 3. Firms in the paper and printing industry and the rubber products industry also revealed a greater than average sensitivity towards factor prices when assessed in the broadest terms. Only one firm in each of these two industries was insensitive to I3.

A possible reason for the chemical industry being so insensitive to factor prices was its reliance on unalterable techniques of production, given the nature of the product being produced. To check how reliable such an assumption is, the responses to Question 17 in the questionnaire are examined. The question asked firms whether the specific nature of the product/s they were producing directly affected their choice of technique. One might expect the firms in the chemical industry to have answered yes, and those in the leather and footwear and rubber products and plastics industries to have a higher proportion of firms which answered no.

Table 4.6 does not support the hypothesis that specific industries were more constrained in their choice of technique than others, due to the specific nature of the product they produced. An overwhelming 70 per cent of the total number of firms in the sample said their techniques of production were directly affected by the product/s they produced. The largest proportion of firms in the paper and printing industry (86 per cent) felt that the product/s they produced directly affected their production technique. Firms in the chemical industry were no more affected by the product they produced than firms in a number of other industries. A Chi-square test run on these results finds the differences among industries are not statistically significant at conventional levels[9], although this result cannot be accepted unconditionally as the Chi-square test is not powerful when only one or two of 11 industries is "different".

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9 χ^2 value = 8.05464. Df = 10. This is not significant at p = 0.10 level.

TABLE 4.6
FIRMS WHOSE TECHNIQUE WAS AFFECTED BY THE NATURE OF THE PRODUCT BEING PRODUCED - ANALYZED BY INDUSTRIAL SECTOR

Industry	Number of Firms	Percentage*
Food, beverage and tobacco	5	62,5
Textiles and clothing	9	81,8
Leather and footwear	3	60
Wood, furniture and fixtures	7	63,6
Paper and printing	6	85,7
Chemicals	6	75
Rubber products and plastics	7	77,8
Non-metallic mineral products	1	25
Basic metal and metal products	7	70
Machinery and electrical machinery and transport equipment	8	80
Miscellaneous	3	75
TOTAL	62	70,4

* Percentages represent the proportion of firms in the specific industry.

However, rethinking this question, it can be concluded that its meaning is open to several interpretations. First, within each of the 11 industry groupings the products produced were not identical. In some industries a wide range of products were produced. The variations amongst firms in each industry could account for the high positive response to Question 17. Second, firms could have interpreted the term "technique" in the question in many ways. This is illustrated in the following hypothetical example.

A firm in the paper and printing industry could carry out a job that requires it to print on single sheets of paper, while another job may require that it print onto sheets of paper and then bind those loose pages into book form. Depending on

its interpretation of the term "product", the firm could have responded that, yes, the specific nature of the product (book or loose sheet of paper) did affect the choice of technique. The binding of the sheets of printed paper into a book requires additional techniques to simply printing on loose sheets of paper.

Firms may have interpreted "technique" as different for the two processes outlined in the example above, and hence have responded that yes the product that they produce did affect the choice of technique. A printing press cannot bind books. And so, depending on how the firm interpreted the term "product" someone could say that their product did determine their technique but still be sensitive to factor prices or another could say their product did not determine their technique and still be insensitive to factor prices.

Therefore there must have been other factors in addition to the nature of the product being produced that affected the industries' sensitivity to factor prices. Here the scale of output and the availability of techniques could be important.

As described earlier, Question 59 asked firms whether they were using the latest technique available and if not, why not. The firms were asked to select from the following list the reasons for not employing the latest technique of production:

(a) Technique not available in South Africa
(b) Price of labour relative to capital
(c) Scale of output too small
(d) Supply constraints
(e) Other, where respondents were asked to give details

Responses to this question do overlap to an extent with those investigated in Question 49, from where the three indicators of sensitivity to factor prices were derived. Reason (b) in the list above is the price of labour relative to capital which is what is measured by the three indicators of price sensitivity, I1, I2 and I3. Consistency in the responses can thus be verified.

Of the 59 firms that were not using the latest technique 29 (49 per cent) said that their scale of output did not warrant them changing their production technique to incorporate the latest technique. The price of labour relative to capital was only considered by 12 per cent of respondents a reason for their decision not to use the latest technique, whilst only 7 per cent regarded the fact that the latest technique was not available in South Africa a reason for their non-implementation of the technique.

TABLE 4.7
REASONS WHY FIRMS WERE NOT USING THE LATEST TECHNIQUE AVAILABLE - ANALYZED BY INDUSTRIAL SECTOR

Industry	Price of labour relative to capital	Technique not available in SA	Scale of output
Food, beverage and tobacco	1 (33,3)	1 (33,3)	2 (66,7)
Textiles and clothing	0	0	3 (37,5)
Leather and footwear	0	0	2 (50)
Wood furniture and fixtures	1 (14,3)	1 (14,3)	3 (42,9)
Paper and printing	0	0	0
Chemicals	0	0	3 (60)
Rubber products and plastics	2 (33,3)	0	3 (50)
Non-metallic mineral products	1 (25)	0	3(75)
Basic metal and metal products	1 (11,1)	0	5 (55,6)
Machinery and electrical machinery and transport equipment	1 (16,7)	1 (16,7)	4 (66,7)
Miscellaneous	0	1 (33,3)	1 (33,3)
TOTALS	7	4	29

* Bracketed figures represent percentages of responding firms in each industry.

As was discovered earlier, firms in the chemical industry showed the least responsiveness to relative factor prices. This conclusion is borne out by the results of Question 59 analyzed in Table 4.7. None of the firms in the chemical industry indicated that relative prices of factors of production were important when

considering their technique of production. The rubber products and plastics industry also shows responses which correspond with those derived from the price sensitivity indicators. Firms in this industry once again reported a sensitivity towards the price of factors of production. Compared with the rest of the sector, the largest number of firms in the rubber products and plastics industry said that the price of labour relative to capital was a reason for them not to employ the latest techniques.

Surprising, however, is the fact that no firms in the leather and footwear industry mentioned relative factor prices as a reason for not using the latest technique. This result is not consistent with the earlier finding. Reasons other than factor prices weighed heavier on the decision not to employ the very latest techniques in this industry.

When the number of firms that said their scale was too small to make the latest techniques viable is specifically considered, it is observed that the non-metallic mineral products industry had the highest proportion of responding firms not using the latest available technique due to the scale of output. Of those firms in the chemical industry that gave a reason for them not using the latest technique, all said their scale of output precluded them employing the latest technique successfully.

The results of a Chi-square test across all industries, however, show that the difference between industries in their response to the scale factor was not of significance[10]. Once again, this result must not be accepted unconditionally as the Chi-square test is not powerful when only one or two of 11 industries is "different".

Firms in the various industries were found to differ in their sensitivity towards factor prices in their choice of technique. Analyzing the firms that were insensitive

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[10] χ^2 value = 9.94485. Df = 10.

to factor prices reveals that no specific industry was insensitive to factor prices because the product they produced determined their production technique. The scale of firms' operations was the most prominent reason why firms insensitive to factor prices were not using the latest technique.

4.3.4 Size of Firm

In this section the size of firms is considered to see whether it affected the firm's sensitivity towards factor prices. As explained in Chapter 3, the number of employees in the firm was used as a proxy for the size of the firm. In this section the aim is to answer questions such as: were small firms more or less sensitive to factor prices in their choice of technique than large firms?

In Box 4.2 the average size (mean) of the firms and the standard deviation are given for the responses to the three indicators, I1, I2, and I3.

Box 4.2

The Average Employment Size and Standard Deviation of the Firms Responding to the Three Indicators

	Yes	No
Indicator 1:		
Mean	127.5	141.5
Standard Deviation	206.6	318.3
Indicator 2:		
Mean	128.8	142.3
Standard Deviation	213.8	328.2
Indicator 3:		
Mean	121.2	167.0
Standard Deviation	187.1	410.2

One way to assess whether the size of the firm significantly affected its sensitivity to factor prices in its choice of technique would be to carry out t-tests of significance on the responses to the three derived indicators against the size of the firms.

These tests were indeed run and showed that the size of the firm, for all three indicators, is an insignificant determinant of a firm's sensitivity to factor prices in their choice of technique. The results are given in Box 4.3 below:

Box 4.3

T-Statistics of the Importance of I1,I2 and I3 by Size of the Firm

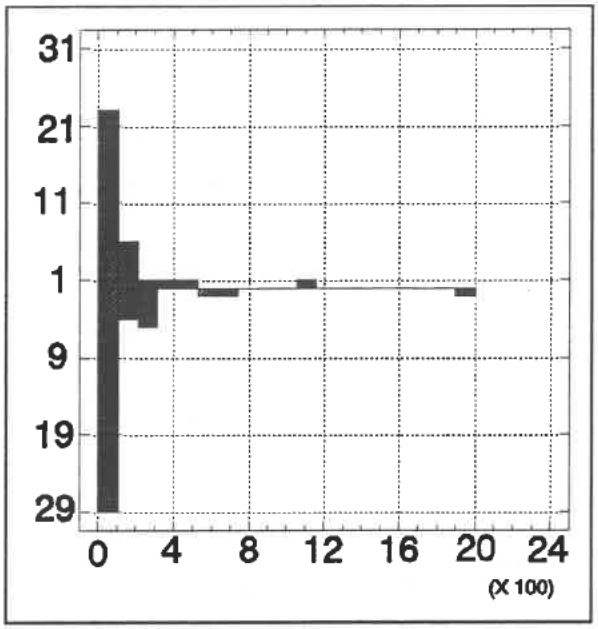
Indicator 1: Computed T-statistic = -0.267654

Indicator 2: Computed T-statistic = -0.214761

Indicator 3: Computed T-statistic = -0.675375

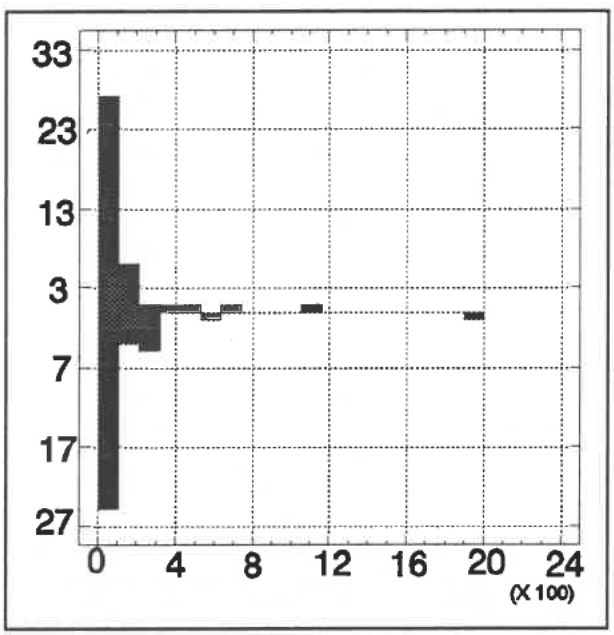
The size distribution of the firms according to their responses to the three indicators is set out in the histograms in Figure 4.1, below. Figure 4.1 (i) is the histogram of the responses to I1, Figure 4.1 (ii) the histogram of responses to I2, and Figure 4.1 (iii) the histogram of responses to I3.

In each of the histograms, frequency is measured on the vertical axes and the size of the firms on the horizontal axes. Two outlier points in the range of firm sizes (1100 and 2001 employees) are clearly visible in the figures. Disregarding the two outlier points, the histograms show that there was no clear link between firm size and sensitivity to factor prices. The size of the firm did not determine the firm's sensitivity to factor prices.



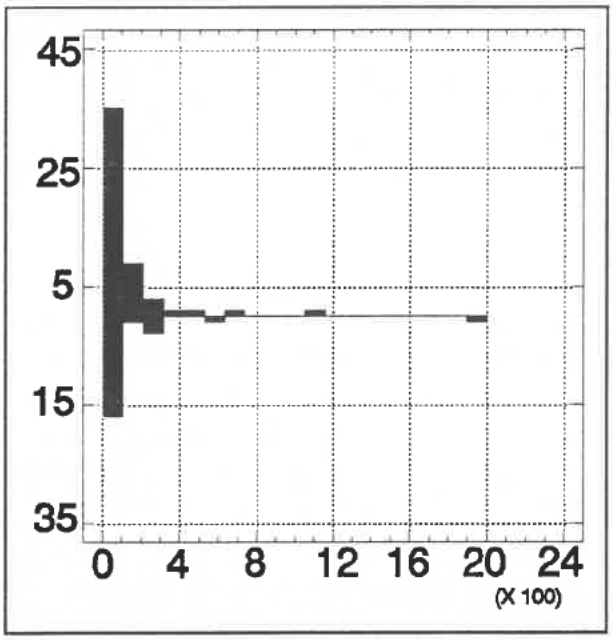
Histogram of Responses to I1 by Firm Size

Figure 4.1(i)



Histogram of Responses to I2 by Firm Size

Figure 4.1(ii)



Histogram of Responses to I3 by Firm Size

Figure 4.1(iii)

The results of the t-tests must not be accepted as unconditional evidence of the fact that the size of the firm did not affect the firm's sensitivity towards the relative cost of factors of production in the technique decision. The existence of two outlier points in the range of firm sizes reduces the credibility that can be attached to the results of these tests. The t-tests need to be supplemented with further evidence before any firm conclusions can be drawn.

As explained in Chapter 3, the firms were divided into three categories to facilitate the analysis of the data according to size of the firm. The "largest firms" refers to the firms that employed more than 400 people. There were five such firms in the sample. The "smallest firms" refers to the firms in the sample that employed fewer than 20 employees. There were 19 such firms.

The sensitivity of firms to factor prices is assessed on the basis of whether they were large or small. Table 4.8 records the results.

TABLE 4.8
FIRMS WHICH WERE INSENSITIVE TO FACTOR PRICES - LARGEST FIVE FIRMS COMPARED WITH THE REST OF THE SAMPLE

Firm Size	Indicator 1	Indicator 2	Indicator 3
Five largest firms	3 (60%)	2 (40%)	2 (40%)
The rest of the sample	41 (56,9%)	36 (50%)	22 (30,6%)

* Percentages represent the proportion of firms in the category concerned.

The five largest firms were slightly more insensitive to factor prices than the rest of the sample for the derived indicators, I1 and I3. For Indicator 2 the rest of the sample were marginally more insensitive than the five largest firms. The result indicates that the largest firms were more insensitive to factor prices, but the differences between the group of the large firms and the group of the rest of the sample were not statistically significant[11].

In order to explore the question of size of the firm further, the firm sizes were broken down into a group containing the 19 firms employing fewer than 20 employees, and another group of the rest of the firms in the sample.

Comparing the two categories of firms: The proportion of firms that were insensitive to factor prices diminishes rapidly moving from I1 to the broadest measure of sensitivity, I3. The group of the rest of the firms did not exhibit as dramatically falling insensitivity to factor prices. 31,6 per cent of the smallest firms were insensitive to factor prices as measured by I3. The percentage of the firms in the rest of the sample was only marginally less at 31 per cent. The differences are not statistically significant[12]. Table 4.9 sets out these results.

11 The χ^2 values are 0.0178241, 0.187045, and 0.194383 for I1,I2, and I3 respectively. Df = 1. These values are not significant at the p = 0.10 level.

12 The χ^2 values are 0.372656, 0.529752, and 0.00197754 for I1, I2, and I3 respectively. Df = 1. These values are not significant at the p = 0.10 level.

TABLE 4.9
FIRMS WHICH WERE INSENSITIVE TO FACTOR PRICES - SMALLEST NINETEEN FIRMS COMPARED WITH THE REST OF THE SAMPLE

Firm size	Indicator 1	Indicator 2	Indicator 3
Nineteen smallest firms	12 (63,2%)	8 (42,1%)	6 (31,6%)
The rest of the sample	32 (55,2%)	30 (51,7%)	18 (31%)

* Percentages represent the proportion of firms in the category concerned.

If the firms are divided up into three categories according to size, the insensitivity towards the three derived indicators for the different sizes can be assessed. The results for the small firms can be compared with those for the medium and also the large firms.

In Table 4.10 the results of this analysis are extended to the three firm size groupings. Once again the differences are not statistically significant[13].

TABLE 4.10
FIRMS WHICH WERE INSENSITIVE TO FACTOR PRICES - ANALYZED BY SIZE OF THE FIRM

Firm size	Indicator 1	Indicator 2	Indicator 3
Small (3 - 20)	12 (63,2%)	8 (42,1%)	6 (31,6%)
Medium (21 - 400)	29 (54,7%)	28 (52,8%)	16 (30,2%)
Large (401 - 2001)	3 (60%)	2 (40%)	2 (40%)

* Percentages represent the proportion of firms in the category concerned.

The largest firms were the most insensitive to factor prices when assessed in terms of the broadest measure of sensitivity, I3. The medium-sized firms appear to have been the least insensitive to the derived indicators I1 and I3. Of the three

[13] The χ^2 values are 0.424727, 0.830649, and 0.206984 for I1, I2, and I3 respectively. Df = 2. These values are not significant at the p = 0.10 level.

groupings, the smallest firms were the most insensitive to I1. The message is once again: firm size was not an important determinant of sensitivity to factor prices.

Comparing the degree of insensitivity to factor prices with the size of the firm, it is found that although the larger firms were marginally more insensitive to factor prices than other firms, the difference between theirs and other firms' insensitivity is not statistically significant.

4.4 Synopsis

In this chapter the results of the questionnaire survey were assessed to establish firms' sensitivity to factor prices in their choice of technique. The firms that reported that they were insensitive to factor prices in their choice of technique were analyzed to determine whether they had any specific characteristics. The findings of the analysis are summarised in Chapter 7. The firms that reported that they were sensitive to factor prices in their choice of technique are analyzed in the chapter which follows.

CHAPTER 5

AN EMPIRICAL ANALYSIS OF FIRMS WHICH WERE SENSITIVE TO FACTOR PRICES

5.1 Introduction

The characteristics of the firms that claimed their choices of technique were insensitive to factor prices have been examined. The investigation aimed out to find out whether these firms had specific characteristics and whether there were specific factors other than factor prices which determined their choice of technique. The firms that were sensitive to factor prices are now assessed to find out whether they, as a group, had any specific characteristics.

Firms which indicated that relative factor prices were important in their choice of technique are all assumed to have had some scope for choice of technique. They did not necessarily all have the same degree of scope for choice of technique. Some firms may have had unlimited scope while others' scope may have been limited in some way.

Did those firms which were sensitive to factor prices tend to be large or small, foreign- or locally-owned, or in particular kinds of industries, and how did the extent of scope for choice of technique vary within these groupings?

5.1.1 Indicators of Scope for Choice of Technique

As set out in an earlier section, Question 49 asked respondents to tick off from a list those factors which they considered most relevant to the type of technique chosen by their firms. Included as one of the possible factors was (f), "limited availability/narrow range of alternative techniques".

To be able to identify from those firms with scope for choice of technique, those firms whose scope was restricted scope, factor (f) is introduced to the analysis.

First the subset of firms that responded positively to the three indicators, I1, I2, or I3 was selected. Then their response to factor (f) was examined. If a firm did not consider factor (f) relevant in its choice of technique, but was sensitive to factor prices, as measured by I1, I2, and I3, the firm was not limited in its scope for choice of technique. It was a "not limited scope" firm. If factor (f) was relevant, then the firm is said to have had limited scope. It was a "limited scope" firm.

The indicators of the extent of firms' scope for choice of technique are summarized in Box 5.1

Box 5.1

Sub-indicators of Sensitivity to Factor Prices

$I1^0$	=	Yes to I1 but not to factor (f)
$I2^0$	=	Yes to I2 but not to factor (f)
$I3^0$	=	Yes to I3 but not to factor (f)
$I1^1$	=	Yes to both I1 and factor (f)
$I2^1$	=	Yes to both I2 and factor (f)
$I3^1$	=	Yes to both I3 and factor (f)

Before continuing, a conceptual issue needs to be clarified. Why it is important to distinguish between firms whose scope for choice of technique was in some way limited and those whose technique choice was not limited at all? The reason can be set out in an example.

As was argued in Chapter 2, factor substitution can occur in several ways. First, a firm may decide to substitute one factor of production for another within the

bounds of a specific technique of production. Hence, a *given* technology but different possible capital/labour ratios. Second, even if in each technique no substitution, as suggested above, is possible, firms may be able to substitute actual production technologies for one another. Firms may be able to change from using one production method to another.

Scope for choice of technique may therefore mean different things to different firms. The "limited scope" firms may have been limited in choices between technologies or, given a technique, limited in the ways in which the technique was operated. The firm's decisions could also have been limited in both situations. The "not limited scope" firms may have had choices within a technique, as well as choices between technologies. As stated earlier, the survey results cannot be used to isolate factor substitution that occurred as a result of choices between technologies and substitution that occurred as a result of choices within a technology.

The next three sections investigate whether the sensitivity to factor prices of those firms that were sensitive to factor prices, differed according to the firm's ownership, the industry within which the firm operated, or the size of the firm, respectively.

5.1.2 Foreign Versus Local Ownership

Consider first how the type of ownership affected the scope for choice of technique. The issues which must be considered are: Did foreign-owned firms tend to have unlimited scope for choice of technique or was their scope somehow constrained? How did this scope compare with the locally-owned firms? How wide was their scope for choice of technique?

To be able to draw conclusions about the ownership of "not limited scope" firms the responses to sub-indicators $I1^0$, $I2^0$, and $I3^0$ are analyzed.

It is interesting to see from the unbracketed figures in Table 5.1, that of the foreign-owned firms that did have scope for choice of technique all of the firms were "not limited scope" firms as measured by indicators $I1^0$ and $I2^0$. 80 per cent of these firms had scope as measured by $I3^0$. The figures for the locally-owned firms for the three indicators $I1^0$, $I2^0$, and $I3^0$ were 66 per cent, 64 per cent, and 71 per cent respectively. From these results it can be seen that of the firms that were sensitive to factor prices most were "not limited scope" firms.

TABLE 5.1
"NOT LIMITED SCOPE" FIRMS - ANALYZED BY FIRM OWNERSHIP

Ownership	Indicator 1^0	Indicator 2^0	Indicator 3^0
Foreign-owned	2 (16,7%) 100%	3 (25%) 100%	4 (33,3%) 80%
Locally-owned	23 (30.3%) 65,7%	27 (35,5%) 64,3%	40 (52,6%) 71,4%

The proportion of firms in each of the ownership categories that were sensitive to factor prices are given in brackets in Table 5.1. It is clear that as a proportion of the number of firms in each category, a larger proportion of the locally-owned firms were "not limited scope" firms. The difference is such that measured by the broadest based indicator $I3^0$, only marginally more of the foreign-owned firms were "not limited scope" firms compared with the narrowly-based indicator $I1^0$ for the locally-owned firms. Because the proportion of foreign-owned firms is so small, the statistical power of the Chi-square test is highly limited. Not surprisingly, the differences in Table 5.1 are not statistically significant[14].

No two of the foreign-owned "not limited scope" firms were from the same industry. It is interesting to note that none of these firms were in the leather and footwear industry, the industry that was the most sensitive to the prices of the

[14] The χ^2 values are 0.3242, 0.0343068, and 0.399207 for I1, I2, and I3 respectively. Df = 1. These values are not significant at the p = 0.10 level.

factors of production. The firms sensitive to factor prices also varied in size from one employing 40 people to one employing 388 people.

5.1.3 Industry Differences

The next issue to be tackled is to what extent the scope for choice of technique varied between industries. When comparing the industries to determine which of them was the most insensitive to factor prices, it was found that the chemical industry had the highest proportion of "insensitive" firms. The leather and footwear and rubber products and plastics industries were the most sensitive to factor prices. The paper and printing industry also showed an above average sensitivity to factor prices.

If the sensitivity to factor prices indicates scope for choice of technique, how broad was the scope within the industries? Did some industries have wider scope than others? Table 5.2 sets out the results.

The percentages in brackets in Table 5.2 represent the proportion of the firms in the specific industry that were "not limited scope" firms. The unbracketed percentages represent the proportion of firms in each industry that were sensitive to factor prices that were "not limited scope" firms.

TABLE 5.2
"NOT LIMITED SCOPE" FIRMS - ANALYZED BY INDUSTRIAL SECTOR

Industry	Indicator 1	Indicator 2	Indicator 3
Food, beverage and tobacco	1 (12,5%) 50%	1 (12,5%) 50%	4 (50%) 80%
Textiles and clothing	4 (36,4%) 66,7%	5 (45,5%) 71,4%	6 (54,5%) 75%
Leather and footwear	1 (20%) 33,3%	1 (20%) 33,3%	3 (60%) 60%
Wood, furniture and fixtures	2 (18,2%) 40%	2 (18,2%) 40%	3 (27,3%) 50%
Paper and printing	2 (28,6%) 66,7%	2 (28,6%) 66,7%	5 (71,4%) 83,3%
Chemicals	0 (0%)	1 (12,5%) 50%	1 (12,5%) 33,3%
Rubber products and plastics	4 (44,4%) 80%	4 (44,4%) 66,7%	6 (66,7%) 75%
Non-metallic mineral products	1 (25%) 50%	1 (25%) 50%	1 (25%) 50%
Basic metal and metal products	5 (50%) 100%	5 (50%) 100%	6 (60%) 100%
Machinery and electrical machinery and transport equipment	4 (40%) 100%	5 (50%) 71,4%	5 (50%) 62,5%
Miscellaneous	1 (20%) 100%	3 (60%) 100%	4 (80%) 100%
TOTAL	25 (28,4%)	30 (34,1%)	44 (50%)

All of the firms in the basic metal and metal products industry and the miscellaneous industry that were sensitive to factor prices, were "not limited scope" firms as measured by $I1^0$, $I2^0$, and $I3^0$. The industry with the second most "not limited scope" firms was the paper and printing industry where 83 per cent of the firms that were sensitive to factor prices were "not limited scope" firms.

Of the two industries which had a greater than average sensitivity to factor prices, more firms in the rubber products and plastics industry than in the leather and footwear industry were "not limited scope" firms.

The industry with the smallest proportion of "not limited scope" firms was the chemical industry. Firms in this industry were earlier found to be the most insensitive to factor prices. The wood, furniture and fixtures industry also had proportionately few "not limited scope" firms.

For all of the sub-indicators, differences between industries in the number of "not limited scope" firms were not statistically significant at the $p = 0.10$ level[15]. But for the reasons mentioned earlier, the Chi-square test tells only part of the story.

Table 5.3 gives the proportion of "limited scope" firms in each of the industries. Comparing the proportion of the "not limited scope" firms in each industry in Table 5.2 with the proportion of "limited scope" firms in each industry in Table 5.3 provides some interesting discussion.

The wood, furniture and fixtures industry and the non-metallic mineral products industry showed no clear-cut tendency to either "not limited scope" or "limited scope" firms. The firms in these industries which did have scope for choice of technique were evenly spread between "not limited scope" and "limited scope" firms. The leather and footwear industry also did not show any marked tendency in scope for choice of technique.

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[15] χ^2 values for $I1^0$, $I2^0$, and $I3^0$ are 9.539209, 10.9085, and 15.9707 respectively. Df = 10.

Firms in the rubber products and plastics, textiles and clothing, paper and printing, and machinery and electrical machinery industries had a higher tendency to be "not limited scope" firms. Firms with scope in the chemical industry tended to be more constrained in their choice of technique.

TABLE 5.3
"LIMITED SCOPE" FIRMS - ANALYZED BY INDUSTRIAL SECTOR

Industry	Indicator 1	Indicator 2	Indicator 3
Food, beverage and tobacco	1 (12,5%)	1 (12,5%)	1 (12,5%)
Textiles and clothing	2 (18,2%)	2 (18,2%)	2 (18,2%)
Leather and footwear	2 (40%)	2 (40%)	2 (40%)
Wood, furniture and fixtures	3 (27,3%)	3 (27,3%)	3 (27,3%)
Paper and printing	1 (14,3%)	1 (14,3%)	1 (14,3%)
Chemicals	1 (12,5%)	1 (12,5%)	2 (25%)
Rubber products and plastics	1 (11,1%)	2 (22,2%)	2 (22,2%)
Non-metallic mineral products	1 (25%)	1 (25%)	1 (25%)
Basic metal and metal products	0 (0%)	0 (0%)	0 (0%)
Machinery and electrical machinery and transport equipment	0 (0%)	2 (20%)	3 (30%)
Miscellaneous	0 (0%)	0 (0%)	0 (0%)
TOTAL	12 (13,6%)	15 (17%)	17 (19,3%)

* Percentages represent the proportion of firms in the specific industry.

A Chi-square test showed the differences between the industries in the number of "limited scope" firms to be statistically insignificant at the $p = 0.10$ level[16].

The firms' scope for choice of technique can be verified. Did some industries perhaps have few techniques from which to choose? Was the choice in other industries wide? A correlation between the industries' range of production processes and their scope for choice of technique would be expected. Lots of production processes to choose from, lots of scope for choice of technique as measured by the derived indicators.

Responses to Question 22 are analyzed in the investigation into the number of techniques that firms had from which they could choose. The question asked firms if there was a wide variety of core processes that could be used to produce their product.

All firms in the leather and footwear industry said that there were a wide variety of core processes which could be used to produce their product. Firms in the textiles and clothing industry could also choose between various processes to produce their product. 73 per cent of the textiles and clothing industry said there were a wide variety of core processes to produce their product.

A large proportion of firms in both these industries reported sensitivity to factor prices. By the assumption they had scope for choice of technique. This correlates with this latest finding on the variety of core production processes.

None of the firms in the non-metallic mineral products industry reported a wide variety of core production processes from which to choose. In the rubber products and plastics industry 22 per cent of firms reported a wide variety of core production processes. The result in the rubber products and plastics industry does not correlate with the data on sensitivity to factor prices. Firms in this industry

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16 χ^2 values for $I1^1$, $I2^1$, and $I3^1$ are 11.2444, 7.40317, and 8.23922 respectively. Df = 10.

were predominantly sensitive to factor prices. They were found to be "not limited scope" firms. This would point to a wide variety of production processes which is not what the answers to Question 22 reflect.

The chemical industry's results do correlate with their responses to the sensitivity to factor prices. Only 37 per cent of the firms said there were a variety of core processes from which to choose. Their scope for choice of technique was clearly restricted.

The results of the investigation into the variety of production processes are reported in Table 5.4.

TABLE 5.4
FIRMS WHICH CHOSE FROM A WIDE VARIETY OF PRODUCTION PROCESSES - ANALYZED BY INDUSTRIAL SECTOR

Industry	Number of firms*
Food, beverage and tobacco	3 (37,5%)
Textiles and clothing	8 (72,7%)
Leather and footwear	5 (100%)
Wood, furniture and fixtures	5 (45,4%)
Paper and printing	3 (42,9%)
Chemicals	3 (37.5%)
Rubber products and plastics	2 (22,2%)
Non-metallic mineral products	0 (0%)
Basic metal and metal products	7 (70%)
Machinery and electrical machinery and transport equipment	7 (70%)
Miscellaneous	2 (40%)
TOTAL	45 (51,1%)

* Percentages represent the proportion of firms in the specific industry.

The industries varied from 100 per cent of the leather and footwear industry to 0 per cent of the non-metallic mineral industry who faced a wide variety of core processes to produce their product. The differences between industries is significant at the p = 0.10 level[17].

5.1.4 Size of Firm

The last variable which must be investigated to see if firms differed in their sensitivity to factor prices and therefore the extent of their scope for choice of technique, is the size of the firm.

Did the five very large firms in the sample have less constrained scope for choice of technique than the rest of the firms in the sample? What about the small firms? Did they have more or less scope for choice of technique when judged against the rest of the sample? From earlier discussion it was observed that the largest firms reported more insensitivity towards factor prices than the rest of the sample. This difference was not, however, significant. Their scope for choice of technique can still be expected to have been somewhat more constrained than the rest of the firms in the sample.

TABLE 5.5
"NOT LIMITED SCOPE" FIRMS - LARGEST FIVE FIRMS COMPARED WITH THE REST OF THE SAMPLE

Firm size	$I1^0$	$I2^0$	$I3^0$
Five largest firms	0 (0%)	0 (0%)	0 (0%)
The rest of the sample	22 (71%)	26 (72,2%)	38 (76%)

* Percentages represent the proportion of "sensitive" firms in the category concerned.

From Table 5.5 it is clear that the five largest firms were more constrained in their choice of technique than firms in the rest of the sample. None of the five

[17] χ^2 value = 46.3018. Df = 10.

largest firms responded positively to $I1^0$,$I2^0$, or $I3^0$. A large proportion of the rest of the sample responded positively to the three sub-indicators. More than 75 per cent of the rest of the sample were "not limited scope" firms as measured by the broad-based $I3^0$.

Although fairly large, the differences between the number of firms in the two size groups that were "not limited scope" firms are not statistically significant for $I1^0$ and $I2^0$ [18]. They are, however, significant at the p = 0.10 level for $I3^0$ [19].

When the firms are divided into a group comprising the 19 firms with fewer than 20 employees, and another group of the rest of firms in the sample, as is done in Table 5.6, a larger proportion of the smallest firms are found to have been "not limited scope" firms. 77 per cent of the small firms were "not limited scope" firms compared with 70 per cent of the rest of the firms in the sample as measured by $I3^0$. The result also holds for the two narrower based sub-indicators. The differences between the groups is not statistically significant. The Chi-square values vary between 0.237941 and 0.488976. These are not significant at the p = 0.10 level.

TABLE 5.6
"NOT LIMITED SCOPE" FIRMS - SMALLEST NINETEEN FIRMS COMPARED WITH THE REST OF THE SAMPLE

Firm size	$I1^0$	$I2^0$	$I3^0$
Nineteen smallest firms	5 (71,4%)	8 (72,7%)	10 (76,9%)
The rest of the sample	17 (65,4%)	18 (64,3%)	28 (70%)

* Percentages represent the proportion of "sensitive" firms in the category concerned.

The proportion of "not limited scope" firms in each of the groupings is compared by dividing the firms up into three categories according to size.

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[18] χ^2 values for $I1^0$ and $I2^0$ are 1.30286 and 1.73842. Df = 1.

[19] χ^2 value = 4.14545. Df = 1.

As is found in Table 5.7, once again the group of the smallest firms had the largest proportion of "not limited scope" firms. As noted earlier, not a single one of the largest five firms were "not limited scope" firms.

TABLE 5.7
"NOT LIMITED SCOPE" FIRMS - ANALYZED BY SIZE OF THE FIRM

Firm size	$I1^0$	$I2^0$	$I3^0$
Small (3 - 20)	5 (71,4%)	8 (72,7%)	10 (76,9%)
Medium (21 - 400)	17 (70,8%)	18 (72%)	28 (75,7%)
Large (401 - 2001)	0 (0%)	0 (0%)	0 (0%)

* Percentages represent the proportion of "sensitive" firms in the category concerned.

Chi-square tests showed these differences to be statistically insignificant at the p = 0.10 level[20].

What can explain these differences between firm size and their scope for factor substitution? Why did larger firms have more constrained scope for factor substitution than other firms?

As explained earlier in this section and in Chapter 2, the technique decision is made up of two distinct choices. Firms can substitute one factor for another within the bounds of a specific technique or they can substitute one technology for another.

It could be that smaller firms had all the choices that the larger firms had to substitute within a technique, but they may have had the additional option of substituting one technology for another to produce larger outputs. The larger firms, due to sheer size, may have surpassed many such options to change technologies. Large firms may only have had choices within a technique. These

[20] χ^2 values for $I1^0$, $I2^0$, and $I3^0$ are 1.68964, 2.04380, and 4.20 respectively. Df = 2.

choices may also have been limited as techniques used to produce large scale outputs may have been less adaptable than those used to produce at smaller scales. The bigger the large firms were in comparison to the other firms, the more significant this difference in scope for choice of technique may have been.

5.2 Synopsis

Firms that reported that they were sensitive to factor prices when choosing a production technique were analyzed in this chapter. These "sensitive" firms were assumed to have had varying degrees of scope for choice of technique. The results were analyzed to determine whether there were any specific discernable patterns of sensitivity to factor prices according to a firm's ownership, its size, or the industry in which it operated. The summarised findings of the analysis are set out in Chapter 7.

CHAPTER 6

RESEARCH AND DEVELOPMENT

6.1 Introduction

As the theory outlined in Chapter 2 suggests, there are many factors which may determine or at least affect which production technique a firms chooses to employ. So far the analysis of the results of the questionnaire survey has focused on the sensitivity of firms to factor prices in their choice of technique. In this chapter the results of survey questions concerning firms' investment in research and development (R & D) are analyzed to ascertain whether firms which invest in R & D have certain characteristics since the decision to invest in R & D may affect firms' choices of technique. This may ultimately influence the amount of labour a firm absorbs.

The choice of technique facing firms that either carry out their own R & D and/or invest in imported R & D may be determined by different factors to those facing firms which do not invest in any form of R & D. Firms which invest in some form of R & D may be less constrained in their choice of technique than firms which have to choose their techniques "from the shelf". Investment in R & D may also affect firms' sensitivity to factor prices in their choice of technique. Firms with access to R & D may be able to adapt techniques to suit changing factor prices, whilst firms with no access to R & D, for whatever reason, may be more constrained in their choice of technique.

In order to ascertain whether firms that invested in R & D had specific characteristics this chapter investigates questions such as: What proportion of the firms in the sample invested in R & D? Did a larger proportion of the large firms invest in R & D than the smaller firms? Did ownership affect whether a firm invested in R & D or not - i.e. did foreign-owned firms' greater access to overseas R & D through parent companies affect the proportion of foreign-owned firms

which invested in R & D and did managers of firms think that they could import the results of R & D more cheaply than they could develop them themselves?

6.2 The Extent of Investment in Research and Development

In this section the extent of investment in R & D by firms is investigated so that the number of firms that may have been affected in their choice of technique by investment in R & D can be established.

Question 55 in the survey asked firms whether they invested in R & D expenditures or not. Firms that did invest in R & D expenditures were asked the money value of their annual investment in R & D. However, many firms would not give an estimate of their annual expenditure on R & D, probably because they experienced difficulty in isolating what could be considered R & D in monetary terms. For this reason the amount of R & D invested in by a firm cannot be expressed as a monetary proportion of, for example, the firm's capital or fixed asset figure. Such proportions would have been valuable when making comparisons between firms.

Firms were also asked in what area of their operation they chose to invest in R & D. They could select from a list of four possible areas, those areas in which they had chosen to invest in R & D. The list included investment in product promotion, management training, new production techniques and royalties on patents.

The results of the survey show that more than half of the firms in the sample, namely 49 firms (56 per cent) reported that they invested in R & D expenditures. Of these 49 firms almost half, i.e. 23 (47 per cent), invested in R & D specifically for the development of new production techniques. These figure do not reveal an overwhelming tendency to invest in R & D. A significant proportion of the firms did not invest in any form of R & D.

The possibility that the fact that firms did not invest in R & D affected their sensitivity to factor prices is now probed. Were significantly more firms which did invest in R & D sensitive to factor prices in their choice of technique? In other words, does R & D make firms any more or any less sensitive to factor prices in their choice of technique.

Although the difference in proportions are not significant, it appears from the results in Table 6.1 that more firms that did invest in R & D were sensitive to factor prices in their choice of technique. Considering the sensitivity of firms as measured by the broadest indicator I3: 57 per cent of the firms that invested in R & D were sensitive to factor prices whilst 52 per cent of the firms that were insensitive to factor prices invested in R & D. This result is confirmed when comparisons are made when sensitivity to factor prices is measured by the narrow-based I1. Of the firms that invested in R & D 65 per cent were sensitive and 49 per cent were insensitive to factor prices as measured by I1. As would be expected, investment in R & D therefore widens the range of technical choices in the production function.

TABLE 6.1
FIRMS' SENSITIVITY TO FACTOR PRICES AND THEIR INVESTMENT IN R & D

Invested in R & D	Indicator 1		Indicator 2		Indicator 3	
	Sensitive	Insensitive	Sensitive	Insensitive	Sensitive	Insensitive
Yes	24 64,9%	25 49%	27 60%	22 51,2%	35 57,4%	14 51,8%
No	13 35,1%	26 51%	18 40%	21 48,8%	26 42,6%	13 48,1%

* Percentages represent the proportion of firms in each "sensitivity" category.

These results cannot, however, be taken as conclusive evidence that investment in R & D made firms more sensitive to factor prices as there may have been many reasons why firms invested in R & D and these reasons may in themselves have affected firms' sensitivity to factor prices. Attention is now focused on the

size of the firm and the firm ownership respectively, to investigate whether such characteristics affected whether firms invested in R & D or not.

6.2.1 Size of Firm

Brown (1975) argues that large firms are better able to carry out R & D into new techniques. An investigation of whether a larger proportion of the large firms in the Pietermaritzburg manufacturing sector invested in R & D is now conducted.

Table 6.2 shows the proportion of firms in each of the firm size categories that said that they did invest in R & D. The proportion of firms in each of the firm size categories that invested in R & D specifically into new production techniques is also shown. expenditures, and the firm size concerned.

TABLE 6.2
FIRMS WHICH INVESTED IN R & D - ANALYZED BY SIZE OF THE FIRM

Firm size (no of employees)	Overall R & D		R & D into new techniques	
	Number	% of respondents*	Number	% of respondents*
Small (3 - 20)	8	42,1	4	21
Medium (21 - 400)	29	54,7	10	18,9
Large (401 - 2001)	4	80	3	60

* Percentages represent the proportion of firms in the category concerned.

There is a positive correlation between the proportion of firms that responded that they invested in R & D (overall R & D) and the size of the firm. Eight of the small firms (42 per cent), 29 medium-sized firms (55 per cent) and 4 of the large firms (80 per cent) invested in R & D. The proportions for investment in R & D specifically into new production techniques are 21 per cent, 19 per cent, and 60 per cent respectively. Although not as distinctively positively correlated, the results do indicate a similar positive correlation between the size of the firm and its investment in R & D into new production techniques.

Although these results appeared to confirm Brown's argument, chi-square tests showed the differences for both overall R & D and for R & D specifically into new production techniques to be statistically insignificant at the p = 0.10 level[21].

The positive correlation between the firm size and investment in R & D could be explained by the fact that large firms are more able to carry the costs of R & D than the smaller firms. Specific reasons for the positive correlation between the size of the firm and investment in R & D are not sought in this study although the opinion of firms on the costs of R & D are investigated in the next section.

6.2.2 Foreign Versus Local Ownership

Concerning the effect that the ownership of a firm might have on the firm's investment in R & D, Brown (1975) suggests that foreign-owned firms, being subsidiaries of larger, foreign-based corporations, should have easier access to the results of foreign R & D and may therefore be less likely to invest in R & D themselves, and will be more likely to maintain that it is cheaper to import such results. These suggestions are tested for the Pietermaritzburg manufacturing sector.

The first thing to notice from Table 6.3 is that the suggestion that foreign-owned firms are less likely to invest in R & D does not hold when the results of the survey are assessed. A larger proportion of foreign-owned firms compared with locally-owned firms invested in R & D (67 per cent compared with 54 per cent). There is, however, no significant statistical difference between the number of foreign-owned firms compared with locally-owned firms that invested in R & D[22].

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21 χ^2 values = 2.43096 and 4.50866 respectively. Df = 2.

22 χ^2 value = 0.679428. Df = 1. This is not significant at the p = 0.10 level.

TABLE 6.3
INVESTMENT IN R & D - ANALYZED BY FIRM OWNERSHIP

Ownership	Overall R & D		R & D into new techniques	
	Number	% of respondents*	Number	% of respondents*
Foreign-owned	8	66,7	4	33,3
Locally-owned	41	53,9	19	25

* Percentages represent the proportion of firms in the category concerned.

It can also be established from Table 6.3 that proportionately more foreign-owned firms invested in R & D into new production techniques than locally-owned firms. The proportions for the two ownership categories were 33 per cent and 25 per cent respectively. The differences were, however, also not statistically significant at the $p = 0.10$ level[23]. The tendency to invest in R & D, whether it was overall investment in R & D or R & D specifically into new production techniques, cannot be linked conclusively to the firm's ownership.

The next issue to be probed is the suggestion that foreign-owned firms would be more likely to consider it cheaper to import the results of R & D rather than develop them themselves. The results of Question 57 which asked firms whether they thought that they could import the results of R & D more cheaply than they could develop them themselves are analyzed. The question required firms to give responses for investment in R & D for both minor and major research. The responses of firms are given in Table 6.4.

A significantly larger proportion of foreign-owned firms considered it cheaper to import the results of R & D for major research[24]. An overwhelming 92 per cent of foreign-owned, compared to 58 per cent of locally-owned firms, considered it cheaper to import the results of R & D for major research. These results confirm the suggestion that foreign-owned firms will be more likely to consider it cheaper to import the results of R & D rather than develop them themselves.

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23 χ^2 value = 0.372798. Df = 1.

24 χ^2 value = 4.64615. Df = 1. This is significant at the $p = 0.05$ level.

TABLE 6.4
FIRMS' OPINIONS ON THE COST OF IMPORTING THE RESULTS OF R & D - ANALYZED BY FIRM OWNERSHIP

Ownership	Cheaper to import results for major research		Cheaper to import results for minor research	
	Number	% of respondents*	Number	% of respondents*
Foreign-owned	11	91,7	4	33,3
Locally-owned	44	57,9	26	34,2

* Percentages represent the proportion of firms in the category concerned.

Only 30 firms in the whole sample (34 per cent) considered it cheaper to import the results of R & D for minor research. Of these 30 firms 4 were foreign-owned and 26 locally-owned (33 and 34 per cent of the respective categories). The difference between the foreign- and locally-owned firms that considered it cheaper to import the results of R & D for minor research was not statistically significant[25].

6.3 Synopsis

In this chapter the results of the research survey were analyzed to see whether firms which invested in research and development had any specific characteristics. The link between investment in R & D and sensitivity to factor prices in the choice of technique was also investigated. The results of the analysis are summarised in Chapter 7.

[25] χ^2 value = 0.0035491. Df = 1. This is not significant at the p = 0.10 level.

CHAPTER 7

SUMMARISED FINDINGS AND POLICY IMPLICATIONS

7.1 Introduction

As outlined in Chapter 2, there are many factors which may determine which production technique a firm chooses to employ. According to neoclassical theory relative prices of the factors of production determine a firm's choice of technique from a wide spectrum of techniques. Other theories suggest a more limited range of choices of techniques, and that factors such as the scale of the firm's operation or the product which the firm produces are most likely to determine which production technique a firm utilizes. In this thesis the results of a questionnaire survey carried out in the Pietermaritzburg manufacturing sector were analyzed to ascertain the importance to the Pietermaritzburg manufacturer of certain factors in their choice of technique.

The study investigated the importance of factor prices in the choice of technique. It established what proportion of the sampled firms were sensitive, and what proportion were insensitive, to factor prices in their choice of technique. These results were then analyzed to determine whether the firms that were either sensitive, or insensitive, to factor prices in their choice of technique, had specific characteristics - were they large or small, foreign- or locally-owned, or did they operate in certain industries?

The results of the survey questionnaire were also analyzed to determine whether firms which invested in research and development had certain characteristics, since the decision to invest in research and development may affect a firm's choice of technique.

The findings of the analysis are summarised below.

7.2 Summarised Findings

7.2.1 The Importance of Factor Prices

When the data was analyzed to assess whether firms were sensitive to factor prices when making decisions on production techniques it was found that when sensitivity was most broadly defined, 61 firms (69 per cent of the sample) were sensitive to factor prices. Using the narrowest definition of sensitivity to factor prices, 37 firms (42 per cent of the sample) choices of technique were sensitive to factor prices.

7.2.1.1 Insensitivity to Factor Prices

The firms which said that making their choice of technique they were insensitive to factor prices were analyzed to ascertain whether they had any specific characteristics.

(a) Considering the firm's **ownership** as a possible determinant of sensitivity to factor prices reveals that foreign-owned firms were less sensitive than locally-owned firms to factor prices in their choice of technique. 58 per cent of foreign-owned firms were insensitive to factor prices as defined by the broadest indicator I3. The percentage for locally-owned firms was only 26 per cent. The difference was statistically significantly at the $p = 0.05$ level for the derived indicator I3 and significant at the $p = 0.10$ level for indicators I1 and I2. (See Section 4.2 above for the definitions of the derived indicators I1, I2 and I3.)

These results were investigated further to explore possible reasons for the foreign-owned firms being less sensitive to factor prices in their choice of technique than locally-owned firms.

It was found that there was no significant statistical difference between the number of foreign-owned firms compared with locally-owned firms that imported their plant and machinery. 67 per cent of the foreign-owned firms and 66 per cent of the locally-owned firms imported at least some of their plant and machinery. Considering too the proportion of foreign technology embodied in techniques in use reveals that a larger proportion of locally-owned firms than foreign-owned firms made use of production techniques with more than 80 per cent foreign content. Foreign-owned firms' insensitivity to factor prices could not therefore be explained by their greater reliance on largely foreign-made techniques.

The assertion that foreign-owned firms have standardised technologies which they employ in every country regardless of factor prices was then explored. Foreign-owned firms reported a substantial amount of discretion in choosing a technique. Not one of the five foreign-owned subsidiary firms which were insensitive to factor prices reported that they had no discretion on the choice of technique. The foreign-owned firms did not therefore face given technologies and were thus not insensitive to factor prices due to them having to employ standardised technologies.

The responses to a survey question which asked firms whether they were aware of more up-to-date methods of production available but not in use in their production were analyzed to further test whether ownership affected a firm's sensitivity to factor prices. Of the firms that were not using the latest technique of production four out of five foreign-owned firms said that was so because their scale of operation did not warrant them using the latest technique. Seven of the twelve locally-owned firms not using the latest technique ascribed their decision to their scale of output. Only one of the locally-owned firms which were insensitive to factor prices said that the price of labour relative to capital deterred them from employing the latest technique. Factor prices were not the most important, nor the only determinant of production techniques.

In all tests of possible reasons why foreign-owned firms compared to locally-owned firms were less sensitive to factor prices in their choice of technique, no single reason was found for foreign-owned firms' insensitivity to factor prices, in fact, factor prices were neither the only, nor the most important determinant of technique amongst the firms in the sample.

(b) The firms that were insensitive to factor prices were then considered to see whether the **industry** that the firm operated in significantly influenced its sensitivity to factor prices.

Industries varied in sensitivity towards factor prices. There were differences within each industry as well as between the 11 industries as to the sensitivity to factor prices.

Overall, the chemical industry was the least sensitive to factor prices. When measured against the broad-based I3, 62,5 per cent of firms in the chemical industry reported that they were insensitive to factor prices when choosing a technique. The insensitivity to factor prices of the other 11 industries as measured by the broad-based indicator I3 varied from 0 per cent of the firms in the leather and footwear industry to 50 per cent of the firms in the non-metallic mineral products industry.

Firms in the leather and footwear industry's choices of technique were the most sensitive to factor prices. Firms in the paper and printing industry and rubber products and plastics industry also reported an above average sensitivity to factor prices in their choice of technique.

A further item in the questionnaire was assessed to establish whether the product that the firm was producing determined the choice of technique and therefore made some industries more sensitive to factor prices than others. 70 per cent of the firms in the sample said that their product determined their choice of technique. Most firms in the paper and printing

industry (86 per cent) said the nature of their product affected their choice of production technique. Firms in the chemical industry were no more affected by the products they produced than firms in a number of other industries. It was noted however, that the interpretation of the term "product" was very wide. This would have affected firms' responses to the question being analyzed and therefore the results.

Industry sensitivity to factor prices was analyzed further with an assessment of the responses to a question which asked the firms whether they were using the latest technique available, and if not, why not. 59 firms in the sample were not using the latest technique available. 29 firms (49 per cent) ascribed this to the fact that their scale of output was too small to warrant using the latest technique. Only 12 per cent of the firms in the sample were not using the latest technique because of the relative prices of factors of production. The industry with the greatest proportion of firms that gave the factor price ratio as the reason for them not using the latest technique was the rubber products and plastics industry with 2 firms (33 per cent of the firms in the industry). 7 per cent of the sample said the fact that the technique was not available in South Africa prohibited them using the latest technique. In all instances there were no statistically significant differences between industries in their reasons for not using the latest technique.

It can be noted that in no single industry were relative factor prices the most important factor determining firms' choices of technique. The scale of a firm's operation was the most prominent reason why firms insensitive to factor prices were not using the latest technique.

(c) The last variable to be tested for its affect on firms' sensitivity to factor prices was the **size of the firm**. T-tests of significance revealed that the size of the firm was not a significant determinant of the firm's sensitivity to factor prices. There were, however, two outlier points in the range of firm

sizes which reduced the credibility that could be attached to the results of the t-tests. For this reason, the results were analyzed further by dividing the firms into categories according to the number of employees.

The five largest firms in the sample were most insensitive to factor prices as defined by I3. The sensitivity to factor prices did not differ significantly between firm size categories. 40 per cent of the large firms compared with 32 per cent of the smallest firms and 30 per cent of the medium-sized firms were insensitive to factor prices as measured by I3. Firm size was therefore not an important determinant of sensitivity to factor prices.

7.2.1.2 Degrees of Sensitivity to Factor Prices

Firms that were sensitive to factor prices in their choice of technique were assumed to have had some scope for choice of technique. This scope for choice of technique may have differed between firms. An additional variable, namely "the limited availability of alternative techniques", was introduced into the analysis to facilitate an investigation of the extent of the firms' scope for choice of technique. Firms were categorised as either "limited scope" or "not limited scope" firms depending whether or not they responded positively to the new variable introduced into the analysis. The results were once again analyzed to ascertain whether firms' properties affected the extent of their scope for choice of technique.

(a) Analyzing the **ownership** of the firm revealed that of the foreign-owned firms which were sensitive to factor prices and therefore had scope to choose their technique, all of the firms were "not limited scope" firms as measured by indicators $I1^0$ and $I2^0$, whilst 80 per cent of the foreign-owned firms were "not limited scope" firms as measured by the derived indicator $I3^0$. The figures for the locally-owned firms for the three indicators $I1^0$, $I2^0$ and $I3^0$ were 66 percent, 64 per cent and 71 per cent respectively. (See Section 5.1.1 for the definitions of the derived indicators $I1^0$, $I2^0$ and $I3^0$.)

Considering the number of firms that were sensitive to factor prices in their choice of technique as proportions of the two ownership categories reveals that a larger proportion of the locally-owned firms than the foreign-owned firms were "not limited scope" firms. 33 per cent of the foreign-owned firms and 53 per cent of the locally-owned firms were "not limited scope" firms as measured by the broad-based indicator $I3^0$.

(b) When the extent of the scope for choice of technique was assessed by **industry** it was found that all firms in the basic metal and metal products industry and the miscellaneous industry that were sensitive to factor prices were "not limited scope" firms as measured by $I1^0$, $I2^0$ and $I3^0$. 83 per cent of firms in the paper and printing industry that were sensitive to factor prices were "not limited scope" firms.

The industry with the smallest proportion of "not limited scope" firms was the chemical industry. The wood, furniture and fixtures industry also had proportionately few "not limited scope" firms. The differences between industries in the proportion of firms that had wide scope for choice of technique were not statistically significant.

Firms in the wood, furniture and fixtures industry and the non-metallic mineral products industry showed no clear-cut tendency to either "not limited scope" or "limited scope" firms. The firms in these industries which did have scope for choice of technique were evenly spread between "not limited scope" and "limited scope" firms. The leather and footwear industry also did not show any marked tendency in scope for choice of technique.

Firms in the rubber products and plastics, textiles and clothing, paper and printing, and machinery and electrical machinery industries had a higher tendency to be "not limited scope" firms. The differences between industries was, however, not statistically significant.

Firms' scope for choice of technique was verified by considering the results of a questionnaire item which probed how wide the choices were that firms had between core processes.

All firms in the leather and footwear industry said that there were a wide variety of core processes which could be used to produce their product. 73 per cent of the textiles and clothing industry said there were a wide variety of core processes to produce their products. None of the firms in the non-metallic mineral products industry reported a wide variety of production processes from which to choose. Only 22 per cent of firms in the rubber products and plastics industry and 37 per cent of firms in the chemical industry said they had a wide variety of processes from which to choose.

In all instances, except that of the rubber products and plastics industry, the results correlate with the data on sensitivity to factor prices. Firms that were sensitive to factor prices reported a wide variety of core processes from which they could choose their technique.

(c) When **the size of the firm** was considered it was found that the large firms were more constrained in their choice of technique than firms in the rest of the sample. 77 per cent of the smallest firms and 76 per cent of the medium sized firms in the sample were "not limited scope" firms as measured by the broad-based $I3^0$. None of the largest five firms were "not limited scope" firms.

The largest firms may have been restricted in their choice of technique due to the sheer size of their operations. Large firms may have only had choices within techniques not across technologies. The choices within techniques may also have been limited as techniques used to produce large scale outputs may have been less adaptable than was the case for small scale operations.

7.2.2 Investment in Research and Development

The results of the analysis of investment in research and development show that 56 per cent of firms in the sample invested in R & D. Of these firms, 47 per cent invested in R & D specifically for the development of new techniques. There was no conclusive link between the sensitivity of a firm to factor prices in their choice of technique and investment in R & D - of the firms that were sensitive to factor prices in their choice of technique as measured by I3, 57 per cent invested in R & D, whilst 52 per cent of the firms that were insensitive to factor prices by the same measure I3, invested in R & D.

It was also found that there was a positive correlation between investment in R & D and the size of the firm. Proportionately more large firms (80 per cent) invested in R & D than the small (42 per cent) and the medium-sized (55 per cent) firms. The proportions of firms that invested in R & D specifically into new techniques were 21 per cent, 19 per cent and 60 per cent respectively for the small, medium and large firms. Proportionately more of the foreign-owned firms (67 per cent) than the locally owned firms (54 per cent) invested in overall R & D. 33 per cent of the foreign-owned firms and 25 per cent of the locally-owned firms invested in R & D specifically into new techniques. The differences in investment in R & D between the ownership categories and also between the size of firm categories were not, however, statistically significant.

What was significantly different though was the difference between the proportion of the foreign-owned firms compared with the locally-owned firms that considered it cheaper to import the results of R & D for major research rather than to develop them themselves. A much larger proportion of foreign-owned firms (92 per cent) than locally-owned firms (58 per cent) said they considered it cheaper to import the results of R & D for major research. Only 30 firms in the whole sample considered it cheaper to import the results of R & D for minor research.

7.3 Policy Implications

As pointed out at the outset, in order to avert an economic catastrophe, South Africa needs to create as many job opportunities as possible within the economy. The manufacturing sector will have to play a leading role in any attempt at job creation. The results of the survey point to possibilities for policies aimed at job creation in the manufacturing sector, and they also alert policy-makers to the limitations of certain policies.

Policy prescriptions for South Africa's problem of unemployment range over a wide spectrum embracing options such as lowering real wages, using "appropriate techniques" and changing demand patterns. The results of this study of the manufacturing sector in the Pietermaritzburg region show that exclusive reliance cannot be placed on a single strategy.

When the results of the survey were analyzed it was found that at least 37 (42 per cent as measured by I1), but as many as 61 (69 per cent as measured by I3), of the firms in the sample were sensitive to factor prices in their choice of technique. Changes in factor prices will have an effect on labour absorption in certain cases.

However, the findings of the research also showed that differences between and within industries in firms' sensitivity to factor prices and therefore the possible effect on employment levels, given changes in real wage rates, will be affected by factors such as:

(a) The variance between industries in capital/labour ratios brought about by the nature of the product produced.

(b) The nature of the product the firm produces. Besides the differences which may occur between industries, because of the broad 3-digit classification of industries, products produced by different firms in a single industry may vary in nature substantially and therefore require different production techniques.

(c) The size of the firm. From the survey results, large firms were less sensitive to changes in factor prices than smaller firms. Firms of different sizes within an industry may also operate with different capital/labour ratios. This, as well as the size of the firm, may affect a firm's sensitivity to factor prices.

(d) The firm ownership. Foreign-owned firms were less sensitive to factor prices than locally-owned firms.

Production functions estimated for the various industries and elasticities of substitution between factors of production would provide more direct answers to questions posed on the effects of changes in the real wage rate on employment levels in the manufacturing sector. It must be borne in mind, however, that the elasticities may not be perfectly accurate as the existence of unused capacity within the production process may distort the results of any such calculations. Data from the manufacturing census precluded the estimation of production functions and the calculation of elasticities of substitution for the various industries, for the Pietermaritzburg region.

A constraint on the efficiency of manufacturing firms has been the limited size of the South African market and limited penetration of export markets. If firms can extend their markets they will reap economies of scale, but the results of the research suggest that their increased scale of production may limit their choice of technique, and their freedom to respond to relative factor prices in South African factor markets.

Policy-makers must remember that in the long run changing factor prices will not only affect the choice between available production techniques, they may also inevitably shape the direction of technological development and hence will ultimately affect the nature of the whole spectrum of techniques from which firms can choose their technique.

Policies which affect the amount of R & D firms invest in will essentially affect the behaviour of firms over a long period since investment in R & D will, given time, broaden the range of technical choices in the production functions available to firms. This may make firms more sensitive to factor prices in their choice of technique. The increased sensitivity to factor prices may then ultimately alter firms' short-run behaviour following changes in real wage rates. Policies which affect the employment behaviour of firms in the short-run will have to be dove-tailed to policies on the promotion of R & D since the policies will feed on one another.

Firms in the survey sample which invested in R & D were inclined to be more sensitive to factor prices in their choice of technique than those that did not invest in R & D. The results of the survey also pointed to the fact that proportionately more large firms invested in R & D than was the case with the small and medium-sized firms in the sample.

The South African manufacturing sector is a large importer of foreign plant and machinery. Policies devised to promote local R & D may make firms less dependent on foreign technologies. The decreased dependency holds advantages for the local economy. First, by reducing the dependency on foreign technologies the demand for imported plant and machinery will fall. This will provide relief on the balance of payments. Second, investment in local R & D may encourage firms to adapt techniques to suit local economic conditions. By adopting more appropriate production techniques firms could automatically absorb more labour.

From the results of the survey it can be suggested that in order to reap these possible benefits of increased local R & D, policies to promote R & D, especially amongst small firms, need to be adopted in order to encourage more firms to invest in R & D.

APPENDIX A

SURVEY OF MANUFACTURING TECHNIQUE

DETERMINANTS IN THE PIETERMARITZBURG

ECONOMIC REGION

July 1990

1. NAME OF COMPANY: .....

2. STREET ADDRESS: .....

.....

.....

4. TELEPHONE NUMBER: .....

5. POSITION OF RESPONDENT IN COMPANY: .....

6. Please indicate the industry (or industries) within which the firm operates (eg. food, chemicals).

(a)	Food, Beverage and Tobacco	
(b)	Textiles	
(c)	Clothing and Footwear	
(d)	Wood, Paper and Paper Products	
(e)	Furniture and Fixtures	
(f)	Printing and Publishing	
(g)	Rubber Products and Plastics	
(h)	Chemicals and Chemical Products (including petroleum and coal)	
(i)	Non-metallic Mineral Products	
(j)	Basic Metal Industry	
(k)	Metal Products	
(l)	Machinery and Electrical Machinery and Equipment	
(m)	Transport Equipment	
(n)	Miscellaneous	

7. How long has your firm been operating in Pietermaritzburg?

.....

8. Is the firm foreign-owned?

YES	NO

What is the extent of the foreign interest? Please specify.

80 - 100%	50 - 80%	< 50%

9. What form does the ownership of the firm take?

Private Company		Public Co.		Close Corporation	
Sole Proprietor		Partnership		Other	

10. Ownership by race

White	Black	Coloured	Indian

11. Is your firm:

(i) Independent .....

(ii) A Subsidiary .....

12. If a subsidiary, how much discretion does your firm have with respect to:

(i) The decision of choice of technique in the manufacturing process

.....

.....

.....

.....

(ii) The decision on wage payments

.....

.....

.....

.....

13. Does your firm make use of:

(i)	mass production	
(ii)	production in job lots	

14. Is/are your product(s):

(i)	intermediate product/s	
(ii)	final product/s	

15. What segment of the market do you service with your products?

.....

.....

.....

16. Does the serviced market segment affect your technology choice through quality which can only be obtained using certain technologies?

YES	NO

Please elaborate.

.....

.....

.....

.....

17. Does the specific nature of the product/s being produced directly affect the choice of technique? Please explain in detail.

.....

.....

.....

.....

.....

18. Please give a brief description of the production processes used in the manufacture of your product.

.....

.....

.....

.....

.....

.....

.....

.....

.....

19. Can you distinguish "core" from "ancillary" processes?

YES	NO

If so, what proportion of plant and machinery and capital assets is in the categories:

Core	%
Ancillary	%

20. To what extent can machinery used in ancillary processes be sourced locally?

.....

.....

.....

.....

21. Is the "core" equipment primarily sourced overseas?

YES	NO

If so, are you aware why this is the case? Please explain.

.....

.....

.....

.....

22. Is there a wide variety of core processes that can be used to produce the products?

YES	NO

Please elaborate.

.....

.....

.....

.....

23. At what capacity is the plant and machinery in your firm operated?

.....%

24. Are any of your employees required to work shifts?

YES	NO

If so, how many shifts and of what duration operate daily?

.....

.....

.....

.....

25. What is the employment structure of your total work force?

(a)

	WHITES		BLACKS		COLOUREDS		INDIANS	
	M	F	M	F	M	F	M	F
UNSKILLED								
SEMI-SKILLED								
SKILLED								

Skill Level Definitions

Unskilled	-	Labourers/Menial Workers etc.
Semi-Skilled	-	Clerical/Secretarial/Sales/Apprentices/ Operators etc.
Skilled	-	Professional/Technical/Managerial/ Administrative/Artisans etc.

(b)

	Part time	Full time
UNSKILLED		
SEMI-SKILLED		
SKILLED		

26. What proportion of total costs, during the last financial year, was accounted for by labour and what was the average wage in each case?

	% of total costs	average wage
Unskilled labour		
Semi-skilled labour		
Skilled labour		

27. At what rate per annum do you expect total employment to grow in the next five years?

Negative growth	
No change	
1 - 2% per annum	
3 - 4% per annum	
5 - 6% per annum	
Above 6% per annum	

28. What are the major factors accounting for the change in employment referred to above?

.....

.....

.....

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.....

.....

29. If your firm grows, will you alter your method/s of production?

YES	NO

If so, how will your production technique be altered?

.....

.....

.....

30. Have any of the productivity campaigns in South Africa had any affect on your firm's attitude towards productivity related issues?

YES	NO

Has any particular body/group's campaign had particular influence on your firm's productivity actions? If so, please specify.

.....

.....

.....

31. Has your firm made any conscious attempts to increase productivity?

YES	NO

Please elaborate on these attempts.

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.....

32. Please explain how these productivity related attempts have affected production in your firm, if at all?

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33. Has the productivity drive had any implication on staffing in your firm? Please elaborate.

.....

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.....

34. Did your firm move to Pietermaritzburg from elsewhere?

YES	NO

If so, where did your firm move from?

.....

35. Has your firm relocated within the Pietermaritzburg economic region.

YES	NO

If so, please give details.

.....

36. Please indicate the following in order of importance in determining your decision to locate your firm in Pietermaritzburg.

	Imp.	Unim	Rank
(a) Availability of unskilled labour...			
(b) Availability of semi-skilled labour			
(c) Availability of skilled labour....			
(d) Availability of ancillary services			
(e) Regional Development Incentives...			
(f) Proximity of market.....			
(g) Availability of Indian labour			
(h) Proximity of supply of materials .			
(i) Power supply			

OTHER (Please specify)

(j) .....

(k) .....

(l) .....

37. If the incentives offered under the Regional Development Strategy introduced in April 1982 persuaded you to invest in Pietermaritzburg, please indicate the relative importance of the incentives.

	Imp.	Unim	Rank
(a) Labour incentives			
(b) Interest subsidy			
(c) Rental subsidy			
(d) Housing subsidy			
(e) Relocation costs			
(f) Railage rebate			
(g) Transport rebates			
(h) Tender price preference			
(i) Training rebate			
(j) Price of land			

OTHER (Please specify)

(k) .....

(l) .....

(m) .....

38. Which incentives is your firm claiming - list details.

.....

.....

.....

39. Do you have a recognition agreement with Union/s?

YES	NO

40. If the answer to 39 is in the affirmative, with which union/s do you have such an agreement?

.....

.....

41. Has investment in fixed assets, purchased or leased, been necessary to compensate for:

	Yes	No
(a) A shortage of unskilled labour		
(b) The rising cost of unskilled labour ...		
(c) A shortage of semi-skilled labour		
(d) The rising cost of semi-skilled labour		
(e) A shortage of skilled labour		
(f) The rising cost of skilled labour		
(g) Poor labour productivity		

42. Has the lack of reliability in attendance of the labour force caused your firm to alter its investment decisions at all?

YES	NO

43. How have the investment decisions been affected?

.....

.....

.....

.....

44. What is the current value of the plant and machinery in use in your operations?

(i)	Owned.....	
(ii)	Leased.....	

45. Roughly estimate the total cost of your last major investment in plant and machinery. Include outright purchases and leased equipment. In which year was the investment made?

(i)	Purchased	R
(ii)	Leased	R
(iii)	Year	

46. Was the plant and machinery invested in:

(i)	Imported	
(ii)	Locally produced	

47. How many additional workers were employed because of the expansion?

	WHITE	COLOURED	INDIAN	BLACK	TOTAL
UNSKILLED					
SEMI-SKILLED					
SKILLED					

48. Was this new investment project more machinery oriented (capital intensive) than existing techniques of production?

YES	NO

If yes, state why.

	Imp.	Unim	Rank
(a) Cost and supply of skilled labour			
(b) Cost and supply of unskilled labour			
(c) Cost and supply of semi-skilled labour			
(d) Relative cost of labour and capital intensive techniques			
(e) Availability of new techniques			
(f) Reliability of labour			

OTHER (Please specify)

(g) .....

(h) .....

(i) .....

49. What factor/s were most relevant to the type of manufacturing technique chosen by your firm? ("Type" refers to the capital-intensity of the technique chosen.)
Rank the following factors in terms of their relative importance.

	Imp.	Unim	Rank
(a) Cost and supply of skilled labour...			
(b) Cost and supply of unskilled labour.			
(c) Cost and supply of semi-skilled labour.....			
(d) Relative cost of labour and capital intensive techniques			
(e) Availability of new techniques			
(f) The limited availability/narrow range of alternative techniques			
(g) Nature of incentives			
(h) Legislation requirements (eg pollution).....			
(i) Level of interest rates			
(j) Cost and availability of finance ...			
(k) Type of product produced			

OTHER (Please specify)

(l) .....

(m) .....

(n) .....

50. Did your location specifically in Pietermaritzburg affect your decision on the type of production technique to invest in?

YES	NO

If so, how was your decision affected?

(a) More labour intensive techniques ..... | |

(b) More capital intensive techniques ..... | |

OTHER (Please specify)

(c) .....

(d) .....

(e) .....

51. If the "relative cost of alternative techniques" was "unimportant" (Question 49), specify why this was so.

(a) No alternatives existed ..... | |

(b) Other constraints alone determined choice | |

(c) Other constraints in addition to lack of alternatives determined choice ..... | |

OTHER (Please specify)

(d) .....

(e) .....

(f) .....

52. What was the nature of the "other constraints"? (Question 51)

(a) .....

(b) .....

(c) .....

53. Please indicate the relative importance of the following factors in generating proposals for new investment in fixed assets or the leasing of new fixed assets.

	Imp.	Unim	Rank
(a) Increasing your share of your present product markets.....			
(b) Introducing new product ranges into existing product markets.			
(c) Expanding sales of existing products into new markets.....			
(d) Introducing new product ranges into entirely new markets.....			
(e) The desire to obtain control over the supply of essential inputs.....			
(f) The desire to obtain additional marketing outlets.....			
(g) To maintain your share of an existing market that is growing			
(h) To incorporate new techniques of production over and above the normal replacement investment.....			

OTHER (Please specify)

(i) .....

(j) .....

(k) .....

54. Please indicate the relative importance of the following factors in generating proposals for new investment in fixed assets or the leasing of new fixed assets. (Please leave blank if the factor is irrelevant to investment decisions).

	Imp.	Unim	Rank
(a) Cost and availability of labour			
(b) Availability of capital goods ...			
(c) Government policy now and in the future			
(d) Relatively high interest rate structure			
(e) Lack of internal finance.....			
(f) Lack of external finance			
(g) Competition from local and imported goods			
(h) Nature of the product being produced			
(i) Legislation requirements (eg pollution)			
(j) Sanctions pressures (investment backup).....			
(k) Regional unrest situation			
(l) Development region incentives ...			
(m) Expected growth in demand			

OTHER (Please specify)

(n) .....

(o) .....

(p) .....

55. Does the company invest in research and development (R & D) expenditures?

YES	NO

Approximately, how much per annum?.....

State the nature of such expenditure:

(a)	Product promotion	
(b)	Management training	
(c)	New production techniques	
(d)	Royalties on patents	

OTHER (Please specify)

(e) .....

(f) .....

(g) .....

56. To what extent is new technology, as embodied in the machinery used for production:

(a) Developed domestically to meet local conditions?

.....%

(b) Imported? .....%

To what extent is new technology, as embodied in the methods of production:

(a) Developed domestically to meet local conditions?

.....%

(b) Imported? .....%

57. Do you think that you can import the results of R & D more cheaply than you can develop it?

(a) For major research

YES	NO

(b) For minor research

YES	NO

58. Do you feel that there should be more government support for local R & D work aimed at developing machinery and methods of production suitable for local conditions?

YES	NO

If yes, please state what form it should take.

.....

.....

.....

59. Are you aware of more modern, up to date methods of production or equipment employed by competing firms in your industry here and in other countries?

YES	NO

If yes, why do you not switch to incorporate such methods and/or equipment in your own operation? (please give details)

	Imp.	Unimp	Rank
(a) Technique not available in South Africa			
(b) Price of labour relative to capital			
(c) Scale of output too small			
(d) Supply constraints			
Specify:.....			
.....			
.....			

OTHER (Please specify)

(e) .....

(f) .....

60. Do you feel you have adequate access to information on alternative techniques and equipment (including the availability of second hand equipment which may reduce total costs)?

YES	NO

If no, please elaborate.

.....

.....

61. Would you make use of second hand plant and machinery should it be available?

YES	NO

If no, please elaborate .....

.....

.....

.....

62. Will future investment decisions determining the choice of technique of manufacture in your firm be affected by the recent spate of violence in the Pietermaritzburg and surrounding areas?

YES	NO

Please give reasons for your answer.

.....

.....

.....

63. If your answer to question 62 was in the affirmative, how will your decisions be affected?

.....

.....

.....

64. Is your plant and machinery serviced in;

Pietermaritzburg	South Africa	Abroad

65. Has the lack of service back-up affected your production?

YES	NO

Please give details.

.....

.....

.....

66. Please give a breakdown of inputs into your production process.

RAW MATERIALS	PROCESSED	MANUFACTURED

TOTAL 100%

67. Can you give an approximate percentage breakdown of the source of your firm's major material inputs on the following basis?

SOURCE	RAW MATERIALS % BREAKDOWN	PROCESSED % BREAKDOWN	MANUFACTURED % BREAKDOWN
Pietermaritzburg			
Durban/Pinetown			
Rest of Natal - Industrial			
Rest of Natal - Agriculture & Mining			
Rest of South Africa			
International			
TOTAL	100%	100%	100%

Definitions of Supply forms.

RAW MATERIALS: Extracted products that have had no form of processing e.g. mineral ore, agricultural produce, etc.

PROCESSED : Processed products requiring further processing by your or any other firm e.g. steel, leather, wood etc

MANUFACTURED : Products requiring no further processing e.g furniture, motor spares etc.

68. If the source of the firm's processed and manufactured inputs is in Pietermaritzburg or Durban/Pinetown, give a percentage break - down of the sectors from which the inputs are obtained.

	PMB	DBN/PTN
(a) Food, Beverage and Tobacco		
(b) Textiles		
(c) Clothing and Footwear		
(d) Wood, Paper and Paper Products		
(e) Furniture and Fixtures		
(f) Printing and Publishing		
(g) Rubber Products		
(h) Chemicals and Chemical Products ...		
(i) Non-metallic Mineral Products		
(j) Basic Metal Industry		
(k) Metal Products		
(l) Machinery and Electrical Machinery and Equipment		
(m) Transport Equipment		
(n) Miscellaneous, including Leather Products, petroleum and coal		
TOTAL	100%	100%

69. Please give a breakdown of the outputs of your firm.

PROCESSED	MANUFACTURED
%	%

Total 100%

70. Can you give an approximate percentage breakdown of where your firm's products are sold, on the following basis?

MARKET	PROCESSED % BREAKDOWN	MANUFACTURED % BREAKDOWN
Pietermaritzburg		
Durban/Pinetown		
Rest of Natal- Industrial		
Rest of Natal- Agriculture and mining		
Rest of South Africa		
International		
TOTAL	100%	100%

For definitions of Processed Products and Manufactured Products see question 67.

71. If your firm's products are sold in Pietermaritzburg, to which sector/s are they sold?

(a) Retail or Wholesale	
(b) Construction	
(c) Food, Beverage and Tobacco	
(d) Textiles	
(e) Clothing and Footwear	
(f) Wood, Paper and Paper Products	
(g) Furniture and Fixtures	
(h) Printing and Publishing	
(i) Rubber Products	
(j) Chemicals and Chemical Products	
(k) Non-metallic Mineral Products	
(l) Basic Metal Industry	
(m) Metal Products	
(n) Machinery and Electrical Machinery and Equipment	
(o) Transport Equipment	
(p) Miscellaneous, including Leather Products, petroleum and coal	
(q) Other eg. government, municipality etc. ..	

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