

**AN EMPIRICAL ANALYSIS OF THE PRICING BEHAVIOUR  
OF SELECTED 3-DIGIT SECTORS  
IN THE SOUTH AFRICAN MANUFACTURING INDUSTRY (1965-1990)**

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## **ABSTRACT**

While conventional economic theory posits that price is determined by the interplay between the forces of supply and demand, review of literature reveals that the findings of industrial surveys and empirical studies of the pricing behaviour of firms have cast doubts on the validity of this hypothesis.

A close scrutiny of the literature shows that there are two main hypotheses of pricing, namely, the excess demand hypothesis and the mark-up hypothesis. The former is associated with the conventional view that price is determined by the interaction of demand and supply, while the latter hypothesis is often associated with business practice in the real world. A majority of empirical studies lends support to the mark-up hypothesis. However, there is also a sizable number of studies that lend support to the excess demand hypothesis.

This study uses data for the South African manufacturing sector to test the validity and the explanatory power of these hypotheses. The difference between this study and most of the previous studies is the fact that in the present study an attempt is made to use disaggregated data in the actual testing of the hypotheses. While the results of this study demonstrate overwhelming support for the mark-up hypothesis, they also demonstrate that the role played by demand cannot be dismissed.

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## DECLARATION

Except for quotations specifically indicated in the text, and such help as I have acknowledged, this dissertation is wholly my own work and has never been submitted for degree purposes at any other institution.



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## INTRODUCTION

The last two decades saw many countries experiencing soaring inflation rates, and not until recently South Africa has been no exception. Economists around the globe attributed the unprecedented inflation rates to a variety of factors. Some attributed the high inflation rates to unsound monetary and fiscal policies which caused the growth rate of money supply to rise faster than productivity, thus causing an imbalance between aggregate demand and aggregate supply. Others attributed it to certain structural rigidities or bottlenecks obtaining in some economies, particularly in the Third World, which culminated in maladjustments which in turn led to prices that were not only high but were also inflexible. Still others apportioned the blame to soaring input costs in general, and labour costs in particular. There are also those who emphasise the role of expectations in determining or influencing the actual rate of inflation. Inflation, whatever its underlying cause(s), implies a persistent rise in the general price level. In the final analysis this situation arises when there is disequilibrium between (aggregate) demand and (aggregate) supply.

Inflation is the rate of change in the general price level, and the general price level is an important determinant of the standard of living. It is for this reason that policy makers in general, and macroeconomic policy makers in particular seek to ensure price stability. However, for them to be able to accomplish this wonderful goal one would like to believe that they need to have, among other things, a sound understanding of how prices are formed in the first place. Nevertheless, it is not the purpose of this study to examine the different views with regard to the underlying and propagating causes of inflation and how inflation can best be combated. This study will be confined to the analysis, both at the theoretical and empirical levels, of the pricing behaviour of firms. However, the study will place more emphasis on the empirical analysis of pricing behaviour. More specifically, it sets out to establish whether firms, indeed, follow marginal cost pricing or they apply other pricing strategies as one of the theories reviewed in the next chapter posits.



Interest in this study stems, in part, from an understanding of the enormous role that manufacturing has played and will have to continue to play in the economy of South Africa, both in terms of its contribution to gross domestic product (GDP) and employment. The share of manufacturing in gross domestic production is approximately 20 percent and the sector employs approximately 1.4 million people (these estimates are for 1990). Important backward and forward linkages that exist between the manufacturing industry and other industries or sectors of the economy indeed call for a thorough examination of the pricing behaviour of this industry. Given the size of the manufacturing industry (as a share of GDP), and the linkages it has to other sectors, the influence price movements in the manufacturing sector are likely to have on the pricing decisions in other sectors cannot be overemphasised. For this reason a study of pricing behaviour in the manufacturing industry is important, not only as an academic exercise, because such a study is likely to enhance our understanding of the interconnections in the pricing behaviour of the various sectors of the economy, thus contributing to a better appreciation of the role this process plays in the movements in the general price level. A close scrutiny of the micro-foundations of pricing behaviour will enhance our understanding of the macroeconomics of price determination. Hopefully, this will have a positive impact on the efficacy of anti-inflationary policy formulation and related policy issues.

The rest of the discussion is arranged as follows; Chapter 1 outlines the theoretical underpinnings of pricing behaviour of firms and provides a brief overview of how firms behave in the real world *vis a vis* the theory provided at the beginning of the chapter. Chapter 2 gives a comprehensive review of theoretical and empirical studies that have been undertaken in the area. This is coupled with a detailed exposition on the methodologies applied in these studies, focusing specifically on

the *normalisation*<sup>1</sup> techniques and the derivation or construction of demand variables employed by each author or group thereof. Included in this discussion is a detailed summary of the two competing hypotheses that emerge out of the series of empirical studies conducted in this area of study. It is worth noting that the literature on the empirical analysis of the pricing behaviour of firms is fairly limited. Hence the literature survey contained in Chapter 2 rests rather heavily on a handful of studies. One may also stress the fact that the main purpose of this study is not to examine the various theories of inflation and pricing, *per se*, but to focus on the empirical analysis of the pricing behaviour of firms with a view to establish the explanatory power and relevance of these studies for South Africa. In line with the focus of the study, little space and time is devoted to theory, and a substantial proportion (of Chapter 2) of the study is allocated to the review of the empirical studies that form the core of this study. The third chapter looks at the data used in the current study, in particular, the focus is on the techniques used to derive or construct some of the variables used in the analysis. In Chapter 4 the results of the present study are presented, analyzed and discussed in details. The final chapter summarises the findings of the study and draws some conclusions.

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1. *Normalisation* here implies purging series of cyclical fluctuations so that one gets the trend values of the variable over time.

## CHAPTER 1

### PRICE FORMATION

#### 1.1 Economic theory

Conventional economic theory posits that prices are determined by the interplay between demand and supply. Therefore, shifts in or movements of the demand function will, *ceteris paribus*, cause disequilibrium in the market and prices will adjust accordingly (and instantaneously) until equilibrium is restored. When there is deficiency of demand prices decrease, and when there is excess demand prices rise. Firms produce that level of output which equates marginal cost to marginal revenue (which is the same as the demand function in a perfectly competitive market), and charge a price which is equal to marginal cost. Firms, individually or collectively, do not earn abnormal profits.

The equilibrium price thus charged ensures that the quantities traded clear the market, that is, the amount of goods which buyers are willing and able to buy is exactly equal to the quantities which firms offer for sale. In the event of an imbalance between supply and demand the price adjusts instantaneously until equilibrium is restored. The actual process of adjustment is assumed to be facilitated by an auctioneer who calls out bids until the price which buyers are willing to pay converges with the price at which sellers are prepared to sell. The new price will again be equal to the marginal cost. Whether the new price will be equal to, lower or higher than the original price will depend, among other things, on the factors that caused the disequilibrium in the first place.

The pricing mechanism outlined here is referred to as "marginal cost pricing" or "marginalism" which is derived from the fact that price is always equal to marginal cost. Invariably, economic theory links pricing behaviour to market structure. Bain

(1951), for example, claimed that market structure determines the conduct of firms, which in turn determines their performance. This became known as the Structure-Conduct-Performance paradigm (SCP), which posits that firms operating in concentrated markets tend to deviate from the principle of marginal cost pricing (they charge prices that exceed marginal cost - Conduct), as a result they earn abnormal profits (Performance). However, divergent views are held with regard to the validity of the SCP paradigm. For example, the Efficiency School (or Chicago School, as it is sometimes called) argues that it is efficiency that determines the profitability of firms, and hence the market structure. The line of reasoning is as follows, efficient firms charge low prices (as their cost per unit of output is low due to economies of scale), as a result they capture a bigger share of the market, and as a consequence of that the market becomes concentrated. However, the controversy between the two schools falls beyond the scope of this study.

Marginal cost pricing rests on the assumption that the market structure is atomistic. The size of each economic agent is very small relative to the size of the market so that none of them has any market power in the sense of making decisions or acting in a way whose impact reverberates throughout the market and causes market variables such as quantity and price to change. It is also assumed that information and the flow thereof is not only perfect, but is also available to all economic agents at zero cost (or at the same cost). Firms are assumed to know the shape and the location of the demand curve that they are facing. Hence their prices are said to be determined by the interaction of and movements in the demand and supply functions. The analysis does not only assume that economic agents have got vast amounts of information, but that they also make effective use of it in making pricing decisions.

If the assumptions summarised above obtain, then there does not exist room for discretion in the determination of price - economic agents take price as given.

Therefore, it is only logical to expect sellers to undercut one another until price equals marginal cost. In a perfectly competitive setting - price, marginal revenue and demand are the same, and the part of the marginal cost curve above the average variable cost curve is identical to the supply function for the firm. Equality between marginal revenue and marginal cost implies equality of demand and supply. Under these conditions marginal cost pricing thrives.

## **1.2 Business practice**

Economists make extensive use of models when attempting to explain the behaviour of economic agents and relationships among variables. A model simplifies reality, by making assumptions and leaving out "unnecessary" details. The perfectly competitive model summarised in section 1.1 is a good example. However, economic theory does not confine itself to the analysis of perfectly competitive markets only. The various models of oligopoly and monopoly do provide for conditions under which price-setting is possible, that is, where price may not be equal to marginal cost. Under these market structures economic agents are relatively big in size and few in number such that the actions of each would have an impact on variables such as industry supply, demand and hence price. Models such as these tend to give better approximations of the real world. Their assumptions are not very far from reality, and the conclusions they draw are very close approximations of real world outcomes.

Marginal cost pricing, as summarised in section 1.1, was first challenged by Hall and Hitch (1939) subsequent to the findings of their survey of the U.K. manufacturing industry in which they investigated the pricing strategies of firms. When analysing the responses of business people they found that there was a marked difference between the behaviour of firms as postulated in conventional economic theory and actual business practice. From the responses, they concluded that firms apply "mark-up pricing" rather than marginal cost pricing. Mark-up pricing

is a pricing strategy whereby a firm determines the direct unit cost of production, and adds on it a fixed mark-up which makes provision for both profit and overheads. However, a close scrutiny of the results of the Hall-Hitch survey reveals some bias or at least a deliberate disregard of evidence which is consistent with marginal cost pricing. For instance, respondents did mention a number of factors that they take into consideration in deciding on the price at which to sell their output. These include, among others, consideration of the reaction of both current and potential competitors, the effect a price change would have on the market share, passing on of increased costs, yielding the highest profit and meeting a target rate of return on capital employed (Doward, 1987). The structure of the market is also another factor that plays an important role in the determination of price.

According to the responses that were given by businessmen as reported by Hall and Hitch (1939), the mark-up varied in accordance with the conditions of demand. Businessmen even indicated that they were prepared to charge a price below average cost during periods when the economy is going through a depression. However, there are contrasting views as to whether mark-ups increase during booms and decrease during recessions or vice versa.

On the one hand, some economists (Odagiri and Yamashita, 1987) believe that mark-ups increase during expansionary phases of the business cycle due to increased purchasing power which translates into an increase in demand (an outward shift in the demand function), but when there is a recession purchasing power is getting diminished, hence mark-ups will tend to decline. On the other hand, there are economists (Banabou, 1988) who argue that during recessionary phases firms tend to concentrate in producing basic necessities, however, declining demand may force them to operate well below full capacity. Thus causing their cost per unit of output to rise because economies of scale are not exploited to the fullest. Nevertheless, because the goods produced are basic necessities whose price

elasticities are supposedly less than unity firms are able to raise mark-ups substantially to more than compensate for the rising costs. Again, the details of this debate fall beyond the scope of this study.

The above discussion is not aimed at questioning the significance of economic models both in terms of enhancing one's understanding of the real world and informing policy making in the real world. Nevertheless, it is important that, from time to time, theory has to be compared and contrasted with or tested against practice. It is simply on these grounds that section 1.1 and the subsequent sections are included in this study.

## CHAPTER 2

### EMPIRICAL EVIDENCE ON PRICING BEHAVIOUR

#### 2.1 The anti-marginalist attack

The Hall-Hitch attack on marginal cost pricing triggered a series of surveys and econometric studies whose aim was to test the validity or otherwise of the mark-up hypothesis. Important among these was an econometric study undertaken by Neild in 1963 in which he used quarterly data on the British manufacturing industry to analyze the pricing behaviour of that industry. The data he used covered the period from 1950 to 1960. He ran two sets of estimations - one covering the entire period and the other covering the period from 1953 to 1960, that is, excluding what he called the period of the Korean crisis.

The hypothesis Neild (1963) tested was that prices are determined on the basis of a mark-up on costs. He and his successors [Godley and Nordhaus (1972), McFetridge (1973) and Coutts, Godley and Nordhaus (1978)] argued that prices are determined on the basis of *normal* costs. They define normal costs as costs incurred when output is on its trend path, that is, costs purged of cyclical fluctuations. Thus fluctuations of output and costs around the trend do not feature in pricing decisions of firms. Consequently, the mark-up of price over normal costs does not change with respect to short-term and/or temporary changes in the conditions of demand in the product markets, and is independent of the deviations of actual costs from the trend path. The hypothesis, however, does not preclude the possibility of an indirect influence of demand on price. Changes in demand can, in the view of the proponents of the mark-up hypothesis, only have an indirect influence on price via the factor markets.



According to the proponents of the mark-up hypothesis when firms make pricing decisions they assess the direct costs of a product and on this they add a constant margin for overheads and profit, called the mark-up. This does not imply that costs are constant, but that they increase at a steady rate. What is of importance, therefore, are not short-term fluctuations in costs, but the trend which costs follow over time when output is on its trend path. As Eckstein and Fromm (1968, p.1165) put it, "... a common principle of long-term pricing appears to be to set price to earn a target rate of return on capital at a standard or trend volume of output". Hence the authors stress that price will not respond to changes brought about by changing operating rates or capacity utilisation, nor to changes in demand, and claim that price will change if the cost of producing standard output changes. According to Eckstein and Fromm (1968) such changes in the cost of producing the standard level of output can occur as a result of changes either in the price(s) of the main input(s), or due to technological advancement.

Granted the emphasis which the proponents of the mark-up hypothesis place on the role played by normal costs in the determination of price, due regard has to be given to the procedure(s) followed in determining normal values of variables that enter the final estimation equation(s). Various authors, for example Neild (1963), Godley and Nordhaus (1972), McFetridge (1973), Coutts, Godley and Nordhaus (1978), Smith 1982 and Coutts, Godley and Moreno-Brid (1987), have proposed and actually applied different but in some ways often related and/or similar methods of *normalising* the variables that they used to estimate the price equation. Generally, the method employed is largely determined by the data which the researcher has at his disposal as well as the possible causes of the deviations of the variable from its trend path. For now the focus is on the study by Neild.

In testing the mark-up hypothesis Neild started from the proposition that prime costs are comprised of labour and material costs including fuel. His cost equation therefore was:

$$c_t = \beta_1 w_t + \beta_2 m_t$$

2.1

where  $c$  is prime cost per unit of output,  $w$  is the wage rate,  $m$  is the price of materials and  $t$  is time. The coefficients  $\beta_1$  and  $\beta_2$  represent the proportions of the requirements of labour and materials per unit of output, thus they add up to unity. It is worth noting that the equation does not include a demand variable, yet conventional economic theory lays emphasis on the role played by demand in the determination of prices. The omission of the demand variable can be justified on two grounds. First, it can be argued that in many industries full capacity is reached only in boom periods. If one accepts this argument, then it follows that expansion in demand that does not occur when the industry is operating at full capacity will not exert pressure on prices, assuming that everything remains constant. Initially, changes in demand will lead to changes in capacity utilisation not changes in price. This is especially true in oligopolistic industries where firms can afford to hold excess capacity without necessarily suffering losses. Second, in an open economy, the expansion of demand does not necessarily lead to changes in industrial prices even in industries where full capacity is reached, instead it may speed up imports (Sylos-Labini, 1979b).

Neild (1963) proceeded to calculate the mark-up as a proportion of direct costs,

$$p_t = \alpha_0 + \alpha_1 c_t \quad 2.2$$

where  $p_t$  is the final price per unit of output. Two restrictions were imposed on the parameters, namely, that  $\alpha_0 \geq 0$  while  $\alpha_1 \geq 1$ . The author did not provide reasons for imposing these restrictions. However, with the variables (price and costs) in levels,  $\alpha_0$  carries very little or no behavioural meaning. The second restriction, namely that  $\alpha_1$  is greater than or equal to one implies that for gross profit to be positive price per unit has to be greater than cost per unit. This can be expressed in a slightly different way as follows:

$$p_t = (1 + mu_t)(c_t) \quad 2.3$$

Galy, *et al* (1993)

(Note: the constant term has been left out)

$p_t$  is price,  $mu$  is the mark-up and  $c$  is the cost per unit of output and subsumes both labour and material costs. In this case, for gross profits to be positive, it is necessary that the mark-up ( $mu$ ) should be positive and vary depending on the degree of market competition (Galy *et al*, 1993). Accordingly,  $mu$  would differ among sectors.  $mu$  is also likely to be influenced by the degree of competition in the domestic market. Sectors that are sheltered from international competition would probably have high mark-ups relative to sectors that are exposed to international competition.

The restriction that  $\alpha_1$  in equation 2.2 is equal to or greater than 1 or  $mu$  in equation 2.3 should be greater than or equal to zero is another way of saying that the firm

has to be able to, at least, cover its costs if it is to remain in business. Substituting equation 2.1 into 2.2 Neild (1963) produced the final price equation:

$$p_t = \alpha_0 + \alpha_1 \beta_1 w_t + \alpha_1 \beta_2 m_t$$

2.4

The variables in equation 2.4 are still defined as those in 2.1 and 2.2 above. Equation 2.4 was modified by applying a distributed-lag function to both wages and material costs. He justified this modification on two grounds. Firstly, the data used in the study were an aggregation of a wide range of industrial sectors and commodities which he treated as if they were a single firm producing a homogeneous product selling at a uniform price. Therefore, to smooth out differences emanating from variations in productivity, and behavioural and institutional features across the sectors covered time lags were introduced into the model. Secondly, introducing time lags takes account of the fact that the response of price to changes in costs may not necessarily be immediate, since firms are unlikely to incorporate increases in costs into their price equation unless they consider them to be permanent. Transitory fluctuations in costs do not form part of the pricing equation for fear that they may have deleterious effects on consumer confidence, market share and hence profits.

Regarding inertia in the response of prices to changes in costs of labour and materials, Neild (1963) pointed out that it may even take a longer period for changes in the cost of materials to have their full impact on the final price, whereas changes in wages are likely to have the full impact on final prices within a reasonably shorter period. The time differential in the impacts of the cost of materials and wages on price can be attributed, in part, to the fact that wages are often determined by (long-term) contracts between employers or employer associations and employees or trade unions. Hence they are likely to be predictable

to a greater extent, and (nominal) wages hardly move in a downward direction, so once they increase they seldom or never fall again. The cost of materials is determined in the input markets and it changes quite frequently, thus rendering it difficult for the firm to predict it with a high degree of accuracy. Firms may also change sources of materials, and such changes may have important implications for their costs per unit of output.

When lagged values of materials costs are included in equation 2.4 the price equation becomes:

$$p_t = b_0 + b_1 w_t + b_2 m_t + b_3 m_{t-1} + b_4 m_{t-2} \quad 2.5$$

where the  $b_i$ s are "reduced-form" coefficients for  $i = 0, 1, 2, 3, 4$ . The choice of the lag structure was based on estimated time-forms of the distributed lags with respect to wages and materials (Neild, 1963, pp. 17-19). Essentially, the tests revealed that it takes a quarter for the full impact of a change in wages to be reflected on price, while changes in the cost of materials tend to be delayed or their full impact is spread over three quarters. Hence, the appropriate lags are those adopted in equation 2.5. The coefficients of the lagged explanatory variables contain a parameter which introduces the declining weight into the coefficients of the lagged explanatory variable.

In an attempt to test whether pricing decisions in the previous period have a bearing on current pricing behaviour, Neild (1963) added a lagged dependent variable to equation 2.5 as one of the explanatory variables. The final estimation equation became:

$$p_t = b_0 + b_1 w_t + b_2 m_t + b_3 m_{t-1} + b_4 m_{t-2} + b_5 p_{t-1} \quad 2.6$$

where the  $b_i$ s are the same as in 2.5, for  $i = 0, 1, 2, 3, 4$ . The Koyck transformation introduces a new variable,  $p_{-1}$ , and a new coefficient attached to it,  $b_5$ , which is the coefficient of the geometrically declining weight of the lagged explanatory variables.

Regarding the wage variable, Neild (1963) ran three sets of estimations each using a different wage variable. The first one is average wage (labour) cost per unit of output,  $w//$ , where  $w$  is total labour costs and  $/$  is total output. He argued that if short-term variations in labour costs per unit of output are fully compensated for by price changes, then  $w//$  would be the appropriate labour cost variable. This would imply that the mark-up is not on normal (trend) costs, but on average cost, and that prices are flexible in order to compensate for changes in costs, thus making the mark-up and prices cyclical in response to cyclical fluctuations in costs.

The second labour cost variable is based on the hypothesis that prices are determined on the basis of a mark-up on normal costs, so that only the labour productivity trend is relevant rather than fluctuations in labour productivity. At the time Neild conducted his study he estimated that output was increasing at a compound rate of 2.5 percent per annum. If these conditions obtain, then  $w(1.025)^{t/4}$  would be the appropriate labour cost variable to use in the estimation equation (quarterly data were used). However, Rushdy and Lund (1967, p.365) challenged the use of this variable on the grounds that the extraneously determined productivity trend contained in it implicitly introduces the influence of demand into the pricing relationship. Consequently, they claim that the coefficient of the demand variable is likely to be insignificant, not because demand plays a negligible role in the determination of prices, but because the cost variable implicitly incorporates the pressure of demand. They also pointed out that it is possible for output per head to exceed the trend level, thus causing  $w(1.025)^{t/4}$  to be greater than  $w//$  and labour costs to be overstated. Similarly, if output per worker is below the trend level, labour costs per unit will be understated.

The third set of estimations in Neild's study employed a labour cost variable constructed in a way similar to the one in which the second labour cost variable was constructed, but using a statistically determined trend instead of a trend that was determined exogenously. However, Neild (1963, p.20) observed that the labour cost variable constructed in this way "... did not produce any sensible results".

When Neild (1963) ran regressions in which each one of the three labour cost variables mentioned above was used, he observed that the results of the regressions in which prices were assumed to be fixed on the basis of "normal" costs (that is, the second definition with an extraneously determined trend path for output) were of superior quality compared to those in which either average total cost of labour or a labour cost variable constructed using a statistically determined trend was used. These results met all the a priori conditions in terms of their signs, magnitudes and statistical significance. Nevertheless, Rushdy and Lund (1967, p.364) expressed reservations about Neild's results, contending that while they appeared to lend support to the mark-up hypothesis there was marked serial correlation of the residuals which is an indication that there might exist some systematic factor which the model failed to capture.

In an attempt to test for the influence of demand on price the author added a demand variable to the original estimation equation. The proxy of demand he used was an index of excess demand for labour. However, his critics (Rushdy and Lund, 1967) questioned the lag structure of the cumulative demand variable<sup>2</sup> incorporated into the final estimation equation in an attempt to capture the influence of demand on price, claiming that it was inconsistent with the "... orthodox distributed lag structure". Indeed the results of estimations of equation 2.6 were characterised by marked serial correlation indicating that there may be some systematic factor that

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2. Demand at any point in time would be the sum of excess demand for labour up to that particular period.

the model failed to capture. This is a problem which Neild (1963) acknowledged in reporting the results of his study. The results supported the mark-up hypothesis, nonetheless.

The demand variable which was added to the above price equation (equation 2.5) was an index of excess demand for labour in cumulative form ( $cd_t$ ) as a proxy for excess demand. So in each period the index would be the sum of excess demand for labour in the previous periods. The justification for using this proxy is that a given level of excess demand for labour would be associated with a given price level. Put differently, the pressure of demand for goods would manifest itself in increased demand for the labour used to produce the goods. However, it is worth noting that the demand for labour being derived from the demand for products which labour produces is likely to lag behind corresponding market conditions in the product market, thus complicating the relationship between price and demand (measured as excess demand for labour) as well as the interpretation of the results of the distributed lag model. Nevertheless, the introduction of a demand variable into the model "... added nothing to the explanation of prices", implying that the inclusion of the demand variable did not change the conclusions he drew when estimating the equation without a proxy for demand (*ibidem*, p.20). Notwithstanding the problem of serial correlation, the doubts cast by Rushdy and Lund on the normalisation of the labour cost variable and the distributed lag structure adopted in the study, the original hypothesis, namely, that prices are determined on the basis of normal costs - fluctuations in actual costs and changes in demand do not matter was maintained.



## 2.2 A re-examination of the mark-up hypothesis

Subsequent to the study conducted by Neild (1963) a series of other empirical studies [for example, Rushdy and Lund (1967), McCallum (1970), Godley and Nordhaus (1972) McFetridge (1973), Coutts, Godley and Nordhaus (1978), to name but a few] have been conducted in an attempt to test or replicate Neild's hypothesis. Important among these studies is the study which was conducted by Rushdy and Lund (1967) in which the authors used the same data as their predecessor. These authors challenged their predecessor on two grounds. First, they accused him of reversing the acceptable distributed lag form when incorporating demand in his estimation equation. They argued that the distributed lag of demand experience had increasing weights suggesting that the influence of recent excess demand experiences on the current price level is less than the influence of demand experiences of the distant past. Second, they expressed discontent with Neild's introduction of a supposedly unweighted demand variable in the "reduced-form" equation (equation 2.6) instead of introducing it in the structural equation (equation 2.4). They argued that introducing the demand variable (current and lagged) into equation 2.6 does not allow for the possibility of assigning declining weights to the lagged demand variables. Thus suggesting that both current and previous demand experiences are equally important.

According to Rushdy and Lund (1967), the correct demand variable to include in the price equation is the cumulative index of demand,  $cd_t$  (as defined in footnote 1), if and only if the dependent variable is the price level. However, if the dependent variable is the change in the price level the appropriate variable is the current level of excess demand, which can be denoted as  $d_t$ . They pointed out that it is not surprising that Neild found the coefficient of the demand variable to either be statistically insignificantly different from zero or have a negative sign. They attributed this to the fact that the lag structure of the demand variable that Neild used was incorrect. However, this was later correctly refuted by McCallum (1970)

on the grounds that Rushdy and Lund's argument is "... misplaced and misleading". He supported Neild for using a distributed lag of excess demand experience with increasing weights, since this provides for "... an orthodox decreasing geometric lag relationship between the relevant variables" (McCallum, 1970, p.149).

Rushdy and Lund (1967) also questioned the appropriateness of the labour cost variable which Neild (1963) used in his final estimation on two grounds. In the first place they claim that it was not *normalised*, implying that it was not purged of cyclical fluctuations. Therefore, in their view the model did not test the hypothesis it purported to test (namely, the mark-up hypothesis). Their second objection was directed at the exogenously determined trend included in the labour cost variable,  $w/1.025)^{1/4}$ , which according to them is likely to be positively correlated with demand, thus causing the influence of demand on price to be spuriously insignificant when both variables are included in the same regression equation.

In an attempt to provide some empirical evidence to support their criticisms, Rushdy and Lund (1967) conducted a study that was meant to replicate Neild's study using the same data that he had used, but modifying the model somehow. They ran a series of estimations using alternative labour cost and demand variables in addition to those used by their predecessor. For instance, in attempting to deal with the problem of a labour cost variable which they claimed was not normalised in Neild's model, Rushdy and Lund (1967, p.365) replaced the labour cost variable with its distributed lag. The justification being that "... a distributed lag of previous experiences is an alternative way of estimating the normal value of a variable ..." (Rushdy and Lund, 1967, p.365). The additional labour cost variables they used were  $w_a/q$  which is an index of actual earnings divided by output, and  $w_s$ , standard labour cost, that is labour costs excluding overtime. The authors expressed reservations about the former labour cost variable due to its potential sensitivity to the pressure of demand. Firms are likely to employ labour on an overtime basis

during periods of high demand, thus causing  $w_a/q$  and demand to be highly collinear. This may render  $w_a/q$  an unreliable measure of normal labour costs. However, Rushdy and Lund (1967) observed that  $w_a/q$  and  $w_s$  moved quite closely during the period covered by their study.

Regarding demand, Rushdy and Lund (1967) tried the following alternative indicators of the pressure of demand:

- (i)  $d_t$
- (ii)  $d_{t-1}$
- (iii)  $d_t$  and  $d_{t-1}$
- (iv)  $d_{t-1}$  and  $d_{t-2}$
- (v)  $d_t$ ,  $d_{t-1}$  and  $d_{t-2}$
- (vi)  $d_t^h$  - the highest level of demand observed in periods  $t$ ,  $t-1$  and  $t-2$  ( $d_t$  is current excess demand measured by an index of excess demand for labour)

Regressions of equations which included demand variables (iii), (iv) and (v) were plagued by collinearity. Of all the alternative demand variables (ii) produced better results, in the sense that the demand variable had a coefficient that had both a positive sign and was statistically significantly different from zero, thus enabling Rushdy and Lund (1967) to dismiss the claim by Neild that demand does not have any direct influence on prices. However, it is worth noting that the performance of the demand variable demonstrated sensitivity to the specification of the labour cost variable. For instance, in the case of Rushdy and Lund's study the demand variable ( $d_{t-1}$ ) had a positive coefficient which was statistically significantly different from zero only when it was paired with  $w_a/q$  as the labour cost variable.

Extending the analysis further by subjecting the mark-up hypothesis to an additional test, the authors estimated an equation with a change in price instead of the price

level as the dependent variable. The equation they estimated had all variables in first differences:

$$\Delta p_t = p_t - p_{t-1} = \alpha_1 \beta_1 \Delta w_t + \alpha_1 \beta_2 \Delta m_t$$

2.7

(Rushdy and Lund, 1967, p.366)

In accordance with their criticism against Neild, the demand variable which Rushdy and Lund (1967, p.366) incorporated into equation 2.7 was the current level of demand ( $d_t$ ). Equation 2.7 does not have a constant term. However, if the results produced by estimating equation 2.7 show a constant term which is significantly different from zero that will be an indication that prices have a tendency to change even after allowing for the impact of changes in costs and demand. The question of whether prices tend to rise or fall can be inferred from the sign of the constant term.

When estimating equation 2.7, Rushdy and Lund (1967) used alternative lag distributions for both the index of demand and the cost variables. The maximum lag for costs was two periods while the maximum lag for the demand variable was three periods. A few aspects of their results are worth noting. First, they observed that the problem of autocorrelation was reduced or even eliminated in the first difference equations. Since equation 2.7 is an equation in first differences this result should not come as a surprise as differencing is one of the methods of reducing or eliminating autocorrelation (Gujarati, 1988, p.381-2). Second, it was evident from the results that recent demand pressure has some influence on price changes. Regressions with current and lagged values of the cost variable exhibited better explanatory power, thus confirming that the impact of changes in costs on prices is, indeed, not contemporaneous. The delay in the impact of changes in costs on industrial prices is partly attributable to imperfections in the flow of information. It

is also attributable to the fact that firms would want to ascertain that the change in costs is not transitory before they begin to pass it on to the consumers.

Regarding the coefficients of the current and lagged demand variables, results of Rushdy and Lund's study indicated that the appropriate lag is one period, that is, one quarter. They pointed out that when the demand variable is lagged by more than one period the coefficient of the second period tends to be negative. This is probably due to some feedback mechanism. Further periods in the distant past have coefficients that are insignificantly different from zero.

The constant term was positive and significant indicating that prices have a tendency to rise even after allowing for the influence of costs and demand. This may be attributed to inflationary expectations which often have a self-fulfilling effect. If economic agents expect the inflation rate to accelerate their negotiated outcomes will tend to follow their expectations and inflation will rise.

The results of Rushdy and Lund's study led them to a conclusion that the role played by demand in explaining pricing behaviour cannot be dismissed as being insignificant, even after its indirect effects on costs have been accounted for. Evidence of this was borne out of the magnitudes and the statistical significance of the coefficient of the demand variable that they used in their study.

A study by McCallum (1970) challenged the criticism by Rushdy and Lund (1967) that Neild (1963) reversed the acceptable distributed lag structure when introducing lagged values of both costs and demand in his price equation. McCallum (1970) argued that it was the latter authors' formulation which, in essence, reversed the acceptable distributed lag structure. He also pointed out that the hypothesis tested by his predecessors was out of step with "the standard theory of competitive market

price dynamics" which suggests that price changes are brought about by excess demand alone (McCallum, 1970, p.151).

In dealing with the aspect of testing a wrong hypothesis, an accusation McCallum (1970) levelled against his predecessors, he decided to test for the relationship between changes in price and excess demand. His argument was that his predecessors failed to test the relation between price and demand. This criticism was based mainly on the structure of the models employed in earlier studies. The studies regressed price on costs (and demand) or changes in the said variables. McCallum thought that regressing changes in price directly on excess demand would produce a better result. To this end, he used the following simple relation:

$$\Delta p_t = \gamma e_t \quad 2.8$$

(McCallum, 1970, p.151)

where  $\Delta p$  is a change in price,  $\gamma$  is the coefficient of excess demand which is greater than zero and  $e$  is excess demand (still measured as the excess demand for labour). The data McCallum (1970) used were also those used by Neild (1963) and Rushdy and Lund (1967). Taking cognisance of the possibility of time lags between  $\Delta p$  and  $e$ , McCallum introduced lagged values of  $e$  in equation 2.8. Nevertheless, as he noted, the results of his study were inconclusive.

The studies reviewed so far have something in common, namely, they use aggregated data. This is the issue which McFetridge (1973) addressed by undertaking a study of the Canadian cotton textile industry using quarterly data for the period 1958-1969. His analysis included a test of the alleged asymmetric relationship between price and changes in demand. The latter was tested for by first estimating the mean level of demand in any given period, and then calculating the difference or the deviations of demand from the mean. Positive and negative deviations, respectively, gave indications of excess demand and deficient demand,

thus creating "dichotomised demand variables". If the difference between the absolute values of the coefficients of the positive and the negative deviations is statistically significantly different from naught, then the hypothesis that the relationship between changes in price and demand is asymmetric would be rejected. For such a result would suggest that prices are flexible in all directions depending on the conditions of demand.

McFetridge (1973, pp.147-152) found that changes in the demand variable played an important role in the determination of price. Thus refuting the Hall-Hitch hypothesis, and supporting the Rushdy-Lund hypothesis. Further, the asymmetry hypothesis was rejected. Therefore, McFetridge (1973, p.150) concluded that "... the rate of price change responds equally to excess or deficient demand". However, one may hastily add that this is hardly a universally accepted observation.

It is worth noting that both the proponents of the mark-up hypothesis [Neild (1963), Eckstein and Fromm (1968), Godley and Nordhaus (1972), to name but a few], and the proponents of the excess demand hypothesis [Rushdy and Lund (1967), McFetridge (1973) and Smith (1982)] agree on the role played by normal costs in explaining changes in prices. The former, nevertheless, argue that demand is not important, while the latter argue that demand also plays a crucial role in the determination of price. So the debate is not about the role of normal costs. The debate revolves around the role played by (changes in) demand in the determination of prices. Subsequent sections take the debate a few steps further.

### **2.3 The mark-up hypothesis rediscovered**

From the discussion in section 2.2 it is abundantly clear that *normalisation* of variables that enter into the estimation equation(s) used to test the mark-up hypothesis is at the core of every empirical study of pricing behaviour. Recall that *normalisation* (detrending) here implies purging the various series used in the

analysis of all cyclical fluctuations. The main purpose of this section is to examine alternative methods that have been employed in studies subsequent to those reviewed in the previous sections.

The main focus here is on procedures followed in the studies conducted by Godley and Nordhaus (1972), Coutts, Godley and Nordhaus (1978), Smith (1982) and Coutts, Godley and Moreno-Brid (1987). These studies sort to test the same hypothesis as those reviewed in the previous section; namely the mark-up hypothesis. However, their approach or methodology is slightly different from those followed by their predecessors in the following respects. Firstly, it is in these studies that more sophisticated and elaborate techniques of *normalising* costs are employed. Secondly, the cost variables used in the analysis were derived in ways which were different from those used in some of the previous studies. Thirdly, these studies did not use excess demand for labour as a proxy of excess demand for goods, instead they used a demand variable constructed using actual output. The manner in which such a proxy was constructed will be explained in greater details in chapter 3. The following discussion sheds light on the three aspects which comprise the core of the differences between these studies and those discussed in the previous sections.

### **2.3.1 The derivation of normal costs**

As it was pointed out above, this section will give a detailed exposition on alternative ways by which costs can be *normalised*. These are methods which were employed in the studies by Godley and Nordhaus (1972); Coutts, Godley and Nordhaus (1978); Smith (1982), and Coutts, Godley and Moreno-Brid (1987). Each one of these studies introduced some modification(s) to the models that preceded it, with increased sophistication in the models.



Recall that the mark-up hypothesis asserts that when firms determine prices, they first assess the direct variable costs of a product and add a margin for overheads and profit, that is, the mark-up. Firms are assumed to measure costs by reference to a normal level of capacity utilisation. The normal level of capacity utilisation is defined as the level of capacity utilised when output is on its trend path. Accordingly, the normal level of capacity utilisation is non-cyclical. Hence the mark-up added to normal costs will also be non-cyclical. Short-term fluctuations in costs, according to the mark-up hypothesis, do not affect pricing decisions. However, firms are assumed to continually assess their costs so that any discernible permanent changes in direct costs can be incorporated into normal costs, and hence form part of the pricing decision-making process. It is also argued that firms continually assess their capacity utilisation and they make the necessary adjustments when new products or improvements to old products are introduced so that any permanent changes in costs can be incorporated into the cost structure to avoid understatement of normal costs [Godley and Nordhaus (1972), p.586; Coutts, Godley and Nordhaus (1978), p.22-4].

The studies by Godley and Nordhaus (1972) and Coutts, Godley and Nordhaus (1978) started off by engaging in a step-by-step process of purging each cost component of any tractable cyclical fluctuations. To this end, the authors first identified the factor(s) which could cause costs to deviate from their trend path. Thereafter, they proceeded with the process of systematically "removing" the cyclical effects of these factors on costs.

In deriving normalised labour costs, for example, Godley and Nordhaus (1972), Coutts, Godley and Nordhaus (1978) and Smith (1982) started off from the proposition that labour costs are a function of employment, the number of hours worked, hourly wage rates and the size of the overtime premium. The next step was to purge each one of these components of cyclical fluctuations. Employment was

normalised by relating it to the *normal* level of output, while at the same time using an appropriate time trend to trace out the level of output that would have obtained had output not deviated from its trend path. *Normalised* output here refers to fitted values of output derived/constructed by regressing actual output on an exponential trend. The product of *normalised* average earnings and *normalised* employment is *normalised* total labour costs. Godley and Nordhaus (1972) and Coutts, Godley and Nordhaus (1978) divided normalised total labour costs by normalised output to get an approximation of normalised labour costs per unit of output. This can be put in an equation form as:

$$ULC_N = \frac{AE_N L_N}{X_N} \quad 2.9$$

where ULC is unit labour costs, AE is average earnings, L is employment, X is actual output and the subscript N implies that the variable has been *normalised*. Equation 2.9 can be modified to make provision for other costs incurred by employers in favour of labour such as fringe benefits, etc. The actual manner in which these factors are accounted for would depend on the way in which they are paid or transferred to employees as well as the way in which they affect each cost component.

After the normal unit labour costs have been derived, the next step in the construction of the cost series is to add "other (non-labour) costs". These costs may include the cost of materials, fuel, services and indirect taxes paid by the manufacturer during the various stages of manufacturing. Godley and Nordhaus (1972, p.861-2) assumed that the volume of materials and services used per unit of output did not change during the period they considered. This assumption makes it possible to attribute any changes in cost per unit of output to changes in the price of inputs alone.

Another important difference between the study by Neild (1963) and that of Coutts, Godley and Nordhaus (1978) is in the way in which labour and material costs enter the cost function. In the former study, account was taken of the fact that the response of product prices to changes in the prices of inputs may not be instantaneous. Neild's formulation, on the one hand, recognised that there may be a difference between the time it takes for changes in the costs of labour and materials to have a full impact on the final price with that of the latter being shorter than that of the former. Coutts, Godley and Nordhaus (1978, p.33), on the other hand, assumed that the response of price to changes in costs is instantaneous.

After the costs of production have been normalised (or detrended) following the procedure outlined above, and after all the variables have been purged of cyclical fluctuations the next step is the actual testing of the hypothesis.

### **2.3.2 Testing the hypotheses using the nested hypotheses testing procedure**

The preceding section outlines the methods by which researchers can and have derived and normalised the variables that they used in the estimation of the pricing model. This section will focus mainly on the actual process of estimating the price equations as applied in the studies under review. There are basically two alternative ways that can be employed in testing these hypotheses. The section that follows examines each one of these techniques in detail.

Price equations can take one of three forms. Some have a cost variable as the only explanatory variable (or costs variables in the case of aggregated data), others a demand variable only, and still others have both costs and demand as explanatory variables. The latter is referred to as the nested hypotheses testing method. The nested hypotheses testing procedure in this instance would entail the simultaneous testing of both the mark-up hypothesis and the excess demand hypothesis. This is

done by including excess demand, or a proxy thereof, and the normal cost variable(s) in the same estimation equation. When this method is applied emphasis is placed on the magnitude and statistical significance, or otherwise, of the coefficients so as to establish whether one of the variables or both of them play an important role, in a statistical sense, in the determination of prices. This is determined solely on the basis of the statistical significance or otherwise of the coefficients attached to the variables included in the model.

In testing the hypotheses, Godley and Nordhaus (1972) and Coutts, Godley and Nordhaus (1978) preferred the following equation:

$$\Delta \ln p_t = \alpha_0 + \alpha_1 \Delta \ln \hat{p}_t + \alpha_2 \Delta \ln \left( \frac{X}{XN} \right)_t \quad 2.10$$

[Godley and Nordhaus (1972, p.869) Coutts, Godley and Nordhaus 1978, p.29]

where  $p_t$  is the price level,  $\hat{p}_t$  is the predicted price,  $X$  is actual output and  $XN$  is trend output. It is important to note that  $\hat{p}_t$  in the above equation is derived independently of actual price. Equation 2.10.1 (see below) is not a regression equation, but a mathematical expression used to derive a predicted price series. Consequently, even the sum of the differences between the two (the predicted price and the actual price) should in no way be expected to be equal to naught as is normally the case with residuals of an ordinary least squares regression. Hence  $\hat{p}_t$  is included in equation 2.10 as an "instrumental variable" subsuming all cost components. The predicted price series ( $\hat{p}_t$ ) is derived from the various cost components including normalised unit labour costs. Godley and Nordhaus (1972) and Coutts, Godley and Nordhaus (1978) used the following formulation to construct a predicted price series:

$$\hat{p}_t = (1 + \mu) \left[ \sum_{i=0}^n a_i PC(t-i) + b_i IC(t-i) \right] \quad 2.10.1$$

PC = progressively-added unit costs derived using the following equation,

$$PC(t) = \alpha_w w(t) + \alpha_m (1 - \beta) m(t) + \alpha_{ser} ser(t) + \alpha_{ut} ut(t)$$

$\hat{p}_t$  = predicted price

w = normal unit labour costs (which are the same as  $ULC_N$ )

m = the cost of materials

ser = the cost of services

ut = unit intermediate taxes

$\mu$  = mark-up in the base year

$a_i$  = coefficients of progressively-added inputs, lagged i quarters

$b_i$  = coefficient of initial-entry inputs, lagged i quarters

n = the (integer) number of quarters which make up the production period.

IC = initial entry unit costs

$IC(t) = \alpha_m \beta m(t)$  where  $\beta = 2/3$

They used the above expression to derive a series of raw predictions of prices. Each component of the above expression is an index number series (Coutts, Godley and Nordhaus, 1978).

The ability of  $\hat{p}_t$  to predict  $p_t$  was tested by regressing the latter on the former:

$$\Delta \ln p_t = \alpha_0 + \alpha_1 \Delta \ln \hat{p}_t + u_t \quad 2.10.2$$

If  $\alpha_1$  equals unity, then the model predicts prices perfectly. This in turn would give tentative support to the mark-up hypothesis in that it would imply that prices can be predicted with some degree of accuracy by simply looking at the supply side (cost

structure) without any consideration of the conditions of demand. Godley and Nordhaus (1972) and Coutts, Godley and Nordhaus (1978) then used the predicted price series as a proxy for normal costs in the final estimation equation. They estimated equation 2.10.2 in first differences so as to overcome the problem of serial correlation of the residual between predicted and actual price.

Godley and Nordhaus (1972) and Coutts, Godley and Nordhaus (1987) found the coefficient of the predicted price to be consistently below unity, in four out of seventeen industries quite significantly so. While this might be misconstrued to be a refutation of the mark-up hypothesis, one has to be mindful of the fact that strict interpretation of this coefficient requires fulfilment of certain conditions. The first of these conditions is that the data used have to be completely accurate. The second condition is that the lags imposed have to be the true lags. The last condition is that the mark-up has to be either constant or change smoothly over time. Sylos-Labini (1979, p.161) attributed deviations of the coefficient of the predicted price series from unity more to wide fluctuations in the mark-up than to the other two factors. This, he pointed, was especially true in the studies under review as the mark-up for the United Kingdom manufacturing showed a downward trend during the period covered by these studies.

In equation 2.10,  $(X/XN)$  is an index of deviations of output from its trend level (it could represent either excess or deficient demand). However, the demand variable was not dichotomised in the study under review as no tests of the alleged asymmetric relation between changes in demand and price were undertaken.  $\alpha_0$  is the constant term, and if this term is significantly different from zero it would imply that prices do change even if both demand and costs remain unchanged or that price are also influenced by other factors in addition to demand and costs. This could imply many things, for example, it could imply that there is (are) a factor(s) which influence price, but are not captured by the model. The coefficient  $\alpha_1$  attached to the predicted price variable gives some indication of how accurate the predicted

price series (calculated using the mathematical relation in equation 2.10.1) predicts the actual movement in prices. In the study by Godley and Nordhaus (1972, p.869) this coefficient was equal to 0.625. For reasons mentioned above, this did not discourage the authors from proceeding with their analysis. Instead, they concluded that the predicted price series was fairly reasonably successful in predicting the movement in actual prices.

The coefficient  $\alpha_2$  measures the responsiveness of price to changes in demand. Technically, it is the elasticity of price with respect to changes in demand. On estimating equation 2.10, Godley and Nordhaus (1972) and Coutts, Godley and Nordhaus (1978) observed that  $\alpha_2$  was very small in magnitude and statistically insignificant. The implication being that the demand variable played a negligible role in the determination of prices. Hence the authors concluded that there was nothing in their findings which indicated that changes in demand have a discernible influence on price (Coutts, Godley and Nordhaus, 1978, pp.60-61).

Smith (1982, p.214) challenged the way in which Coutts, Godley and Nordhaus (1978) derived their normal cost variables. He contended that in spite of the emphasis the latter authors placed on normal variables (in the statement of the hypothesis), the "normal" employment variables they employed in their studies were derived independently of the trend path of output. As a result their studies fell short of testing the very hypothesis which they purported to test. He suggested an alternative procedure for the derivation of normal variables. Further, he questioned the use by Rushdy and Lund (1967) of first differences of price, costs and excess demand instead of percentage rates of change. Smith's reservations about the use of first differences emanated from the fact that prices and costs are generally known to have rising trends, while excess demand is generally trendless (generally, demand fluctuates widely over time). On these grounds he cautioned that the use

of first differences in the final estimation equation may obscure the "real" relationship between these variables.

In an attempt to address the shortcomings of his predecessors, Smith (1982) derived normal output by regressing the logarithm of seasonally adjusted output ( $X_t$ ) on a time trend ( $t$ ),

$$\ln X_t = \alpha_0 + \alpha_1 t + u_t \quad 2.13$$

Smith (1982, p.214).

He then went on to define the predicted value of the dependent variable as the logarithm of normal output,  $\ln XN$ :

$$\ln XN_t = \hat{\alpha}_0 + \hat{\alpha}_1 t \quad 2.14$$

Godley and Nordhaus (1972, p.856) and Coutts, Godley and Nordhaus (1978, p.23) suggested that it is the deviations of real output from its trend and standard nationally negotiated hours that determine the desired average hours worked per week. However, the long-run trends may also be important. It is probably for that reason that Smith (1982) chose the following desired hours function:

$$H_t^* = \beta_0 \gamma + \beta_1 HS_t + \beta_2 \gamma \ln \left( \frac{X}{XN} \right)_t + \beta_3 \gamma t + (1 - \gamma) H_{t-1} + u_t \quad 2.15$$

Smith (1982, p.215)

where  $H_t^*$  is desired average hours worked per week,  $HS_t$  denotes the standard nationally negotiated hours worked per week,  $\ln(X/XN)_t$  represents the residuals



from estimating equation 2.13,  $t$  is a time trend,  $H_t$  is actual average hours worked per week and  $u_t$  is a random variable.

In estimating earnings, Smith (1982) used the same approach as Coutts, Godley and Nordhaus (1978). Nevertheless, the final hypothesis testing equation was different from that which was employed by his predecessors. He began from the hypothesis that firms set the price level as a mark-up over costs, that is:

$$P_t = \alpha_0 M_t^{\alpha_1} \cdot NP_t^{\alpha_2} \quad 2.16$$

Smith (1982, p.231)

$P_t$  is the output price level,  $NP_t$  is the predicted normal price, and  $M_t$  is the multiplicative mark-up. Moving from the premise that there is a positive relationship between the mark-up and the level of demand the logarithm of the mark-up is given by,

$$\Delta \ln M_t = \beta_1 \Delta \ln \left( \frac{X}{XN} \right)_{t-i} \quad 2.17$$

(where  $\beta_1 > 0$ )

To arrive at the final estimation equation, Smith (1982, p.232) took logarithmic first differences of equation 2.16, and into that he substituted equation 2.17 to get:

$$\Delta \ln P = \Delta \ln \alpha_0 + \alpha_1 \beta_1 \Delta \ln \left( \frac{X}{XN} \right)_{t-i} + \alpha_2 \Delta \ln NP_t \quad 2.18 (i)$$

Equation 2.18 (i) can be rewritten as:

$$\Delta \ln P = \Delta \ln \alpha_0 + \gamma \Delta \ln \left( \frac{X}{XN} \right)_{t-1} + \alpha_2 \Delta \ln NP_t \quad 2.18 \text{ (ii)}$$

where  $\gamma = \alpha_1 \beta_1$ .

The variables in the above equations are in effect percentage changes which takes account of the potential shortcoming which Smith (1982) had identified in the studies conducted by his predecessors. Two alternative predicted normal price variables, NP1 and NP2 were used. NP1 was generated on the assumption that the proportion of materials entering at the beginning of the production process is two-thirds. Unfortunately, neither theoretical nor practical reasons were given as justification for this assumption. NP2 was formed as a distributed lag of current average cost, the lag distribution having geometrically declining weights summing up to unity and being estimated by maximum likelihood.

When estimating equation 2.18, Smith (1982, p.234) found  $\gamma$ , the coefficient of the excess demand proxy, to have the *a priori* expected sign and significant at 5 per cent level of significance. The coefficient was equal to 0.0072 and 0.0063 when the demand variable was paired with NP1 and NP2, respectively. The respective t-values were 2.45 and 2.39. The coefficient of the predicted normal price variable was significant in both sets of estimations. It is quite striking that even though the coefficients of the demand variables (NP1 and NP2) were statistically significant in this instance they were of very small magnitudes. Nonetheless, they have the correct sign and are statistically significant, thus allowing Smith (1982) to dismiss the claim by Neild (1963), Godley and Nordhaus (1972) and Coutts, Godley and Nordhaus (1978) that demand does not play any direct role in the determination of price while at the same time acknowledging that normal costs are important. It is important to observe that the statistical significance, or otherwise, of the coefficient of the demand variable; hence the acceptance or rejection of the mark-up

hypothesis seems to depend, to a large extent, on the choice and the specification of the demand variable.

A study by Coutts, Godley and Moreno-Brid (1987) explored the possibility of using cointegration techniques to estimate the relationship between price and costs and demand. They used annual data for the British Manufacturing industry covering the period from 1967 to 1985. In testing for unit roots, the authors found that there existed a long-run relationship between the dependent variable (price) and the explanatory variables (costs and demand). This permitted the application of cointegration analysis in testing for the relationship between the said variables. However, in this study no attempt shall be made to explain the technique they used in detail, suffice to mention that the results they produced supported the conclusions made by Neild (1963), Godley and Nordhaus (1972) and Coutts, Godley and Nordhaus (1978); namely that prices are determined, to a large extent, by changes in normal costs, while the influence of demand is either negligible or non-existent (Coutts, Godley and Moreno-Brid, 1987, p.31).

At a theoretical level, and on the basis of the literature reviewed thus far, one would be inclined to conclude that the mark-up hypothesis receives more support than the excess demand hypothesis. There may be two reasons for this. It is either that the mark-up hypothesis does, indeed, explain the manner in which firms price their products or it could be that the methodology employed to test the two hypotheses is biased in favour of the mark-up hypothesis. These are issues which this study seeks to explore in the subsequent chapters.

## CHAPTER 3

### DATA AND SOURCES

#### 3.1 Notes on the data used in the study

The purpose of this chapter is to give a detailed account of the sources of the data used in this study. This will include an explanation as to how certain series were derived or constructed, and where necessary and applicable reasons will be given as to why certain techniques were chosen instead of others. The methods employed in the present study will be compared to and contrasted with those reviewed in chapter 2.

Data series employed in this study are drawn from two main sources, namely, the manufacturing census data published by the Central Statistical Services (CSS) in the South African Statistics and Sectoral Data Series supplied by the Industrial Development Corporation of South Africa Limited. The latter will, hereafter, be referred to as the IDC. All data series published in the South African Statistics are on an annual basis from 1945 to 1962, biennial for the period between 1962 to 1972, and triennial beyond 1972. The last manufacturing census carried out by the CSS was in 1985, hence for some of the variables that are of interest in this study there is no information available for the period beyond that covered by the last census.

The manufacturing industry of South Africa consists of numerous and varied sectors or major groups (as they are referred to by the Central Statistical Services, hereafter, referred to as CSS). The number of these sectors has varied between 19 and 27 during the period between 1946 and 1990. These variations are due both to the establishment of new sectors and reclassification of already existing sub-

groups into separate sectors. The combined effect of these changes is to make the analysis of trends in prices, costs, and other variables for each sector and comparisons among the various groups comprising the industry a fairly difficult task. Consideration of these factors led to the choice of four sectors for this study. The four sectors chosen are Fabricated Metal Products, Machinery (which includes Electrical Machinery), Textiles, and Wearing Apparel. The choice of sectors is based on their size in terms of both employment and the gross value of output. In 1990 the IDC estimated that together these sectors produced approximately 24 percent of total manufacturing output, and they employed approximately 34 percent of the labour force engaged in manufacturing. Some sectors which are important in terms of either criterion were left out on the grounds that their prices are sometimes subject to control by the government, for example, Food, Beverages, etc. Admittedly, some of the sectors left out play quite an important role in the determination of the price indexes in the country, for example, the Food sector is one good example. Food inflation has been one of the main contributing factors to the persistently high inflation rate in this country in the past.

It is apparent from the previous chapter that data requirements of a study of factors that drive prices are enormous. Both the availability and quality of data do not only influence the quality of the results, but also determine the level of confidence one can attach on the results and thus the robustness of the conclusions that flow from such results. At the same time wide variations in the kind of data used in different studies inhibit the extent of comparability of the results.

Disaggregated data of the type which sophisticated and elaborate models of pricing behaviour like those used by Godley and Nordhaus (1972), Coutts, Godley and Nordhaus (1978) and Coutts, Godley and Moreno-Brid (1987) are not available for the manufacturing sector of South Africa. Consequently, some of the sophisticated normalisation techniques that were applied in those studies could not be emulated.

Again, rendering the results of this study not strictly comparable to those that have been produced in the said studies.

The outline given in the preceding section gives rise to two issues that are of practical importance in this study. The first one is with regard to the unavailability, in the CSS manufacturing census, of data for the odd years for the period between 1962 and 1985, and complete absence of data (from the CSS sources) for the period beyond 1985. The question is whether there are any alternative sources of data that could be explored or scientific ways by which one could interpolate and extrapolate in order to produce continuous and consistent series covering a period reasonably long enough to enable some rigorous econometric analysis.

The second issue is with regard to the fact that only annual data are available for the South African manufacturing sector whereas most of the studies that have been conducted elsewhere made use of quarterly data. This is not a problem save for the fact that it may reduce the comparability of the results of the current study with those of previous studies. In fact, as Sylos-Labini (1979b, p.155) puts it, "... the use of annual data is the simple solution to the *normalisation problem*". This assertion is based on the practically feasible and theoretically plausible reason that firms do not change the prices of their products in relation to intra-year fluctuations in output.

Missing data for every odd year between 1962 and 1972 were obtained by taking the average of the observations for the two years for which data were available (that is, adding the observation for the year preceding and the year following the year for which there is a missing observation and dividing by 2). The effect of this method on the results and conclusions is likely to be negligible<sup>3</sup>. However, for the period

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3. The effect was tested for by running regressions using the original data with observations for the odd years missing. The results produced were in line with the results for the entire period, with interpolations included. Further, when one looks at the trend of each of the variables in the model by plotting each against time, they tend to

1972-1990 where more than one observation is missing this method could not be applied.

Regarding missing observations for the period from 1972 through 1990 where more than one consecutive observations were missing two options could be explored. The first method would be to splice<sup>4</sup> the CSS and the IDC series. After the missing observations for the period between 1962 and 1972 were generated by means of averages, the CSS series were continuous from 1946 to 1972 while the IDC series covered the period from 1972 to 1990. Therefore, splicing the two sets of data produces a continuous and consistent series for the entire period of study.

The second alternative method entails making use of the available data to estimate the trend of each one of the variables in question; and use the estimated trend to both interpolate between 1972 and 1985, and extrapolate from 1985 to 1990<sup>5</sup>. Both methods were explored in the present study. Unfortunately, the results of the estimations in which the latter method was used were of extremely poor quality in the sense that they either had inappropriate signs or were of unrealistically high magnitudes. In instances where they had the appropriate signs they were statistically insignificant. Consequently, they were abandoned and in the next chapter only the results of the alternative method are displayed and analyzed.

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follow a smooth trend. Hence the similarity in the results is to be expected.

4. To splice the two data sets, one has to work out the ratio of the IDC to the CSS series. Then, multiply CSS series by the ratio to get consistent series for each variable. It is worth noting that the two sets of data were overlapping by five observations.

5. Extrapolation would be undertaken by using available data to work out the trend which each variable follows over time. Then, the estimates obtained from the data at hand can be used to estimate the missing observations. This procedure works well if and only if the variables do not fluctuate violently.

The following section concentrates on explaining the construction and the *normalisation* of individual variables used in the final estimations. The variables to be considered are the price, (*normal*) costs and demand.

### **3.2 The derivation and construction of variables used in the model**

#### **3.2.1 Price**

The study examines the relationship between price and *normal* costs and demand for each sector studied. Price is the dependent variable, while costs and demand, however measured, are the explanatory variables. Given that each sector is comprised of a large number of sub-groups each of which is made up of relatively smaller units engaged in different but related productive activities, it is unquestionable that there is a high level of aggregation involved in the whole analysis. It is also inconceivable that one would find a single ruling price per unit within a particular sector (as the products produced and sold are not homogeneous). Consequently, one cannot refer to price as though one is talking about the price at which homogeneous units of a particular commodity are sold. Similarly, when one talks about output in terms of units produced one would be referring to a range of different but related sets of products which are neither of the same size nor measured in terms of a common numeraire. Therefore, at any point in time there would be a range of prices for the different products produced, and in some instances for the different sizes of the same product. One way around this particular problem is the use of index numbers. Each index would be some weighted measure of the different prices and quantities (and even different sizes of the same product) of the different items produced by the sub-groups comprising a particular sector. Unfortunately, such statistics are not always available. For the manufacturing sector, for instance, the CSS does provide an index of the physical volume of production for the entire period, but until 1974 price indices are not available on a sector by sector basis. Food is the only sector for which such



information is available for longer periods. Unfortunately, for reasons mentioned earlier, the latter sector does not constitute a good subject of study for the analysis of pricing behaviour.

The unavailability of price series for individual sectors immediately prompts one to think of alternatives that can be explored in an attempt to either construct a price series for each sector or to find a reliable proxy. Again, the CSS does provide information on the value of sales although such information covers the period from 1965 up to 1990 (and beyond; however, for this study we consider the period up to 1990), thus rendering it impossible to include periods prior to 1965 in the study. The alternative would be to use the gross value of output (GVO) instead of sales if one is interested in the period prior to 1965. This possibility was explored and the results of estimations in which GVO was used are presented in the Appendix.

The sales series and the index of the physical volume of production constitute very useful pieces of information that can be used to find some plausible approximation of the price series for each sector. Hence, the price series used in the final estimations were constructed by dividing the nominal value of sales in each year by the corresponding index of the physical volume of production. It is the nominal value of sales that is relevant here because it is through it that the actual fluctuations in the price level can be captured. When this is fitted in the model one can then ascertain the extent to which the pressure of demand and/or rising costs exert inflationary pressures on the price level in the South African manufacturing sector.

It is worth noting that the price series does not have to be normalised before it enters the estimation equation. The reason for this can be found in the statement of the hypothesis itself. The relationship we are testing for is between price and *normal* costs. Therefore, it is the cost series that have to be *normalised*.

### 3.2.2 Costs

A review of the literature reveals that there is some consensus regarding the fact that all costs, except cost of materials, should be *normalised* (detrended). Nevertheless, there are also some differences with regard to which *normalisation* technique is the best. Some researchers (Neild, 1963 and Smith, 1982) *normalise* costs by regressing them on appropriate time trends, while others (Coutts, Godley and Nordhaus, 1978 and Coutts, Godley and Moreno-Brid, 1987) elected to identify specific factors that cause individual cost components to deviate from their trend level, and removing such deviations one by one until the normal value of a variable is obtained. Examples of factors that cause costs to deviate from their trend path are overtime hours and remuneration thereof.

Sophisticated and elaborate *normalisation* techniques employed in recent studies [see Godley and Nordhaus (1972); Coutts, Godley and Nordhaus (1978) and Coutts, Godley and Morino-Brid (1987)] of pricing behaviour require that one should have knowledge of average earnings per worker, standard hours worked, overtime hours, overtime wage rate, etc.. Most of this information is not available for the manufacturing sector of South Africa. What one could obtain on labour costs are series on total salaries and wages. There are also series on total employment for each major group. Together these two pieces of information can be used to derive the labour cost per unit of output. However, each had to be normalised before normalised unit labour cost series could be constructed.

While employment seems to show some sensitivity to the business cycle, the results did not show any sensitivity to the functional form of the trend used to normalise employment. However, a linear trend produced a better fit<sup>6</sup>, hence employment was

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6. Various time trends were tried, and the linear time trend produced better results.

normalised by regressing total employment on a linear trend. The following equation was used:

3.1

$$I = \alpha_0 + \alpha_1 t + u_t$$

where  $I$  is employment,  $t$  is a linear time trend and  $u_t$  is an error term.

Regarding labour costs, total salaries and wages seem to rise at an exponential rate over time, and the causes of such a trend are open to speculation. One possible explanation lies in the growing unionisation and bargaining power of unions which characterised the period under consideration, especially the last two decades. There is no doubt that during this period workers, through their unions, have succeeded in obtaining high (money) wages for themselves. These wage demands may have been linked to the soaring levels of inflation which the country experienced during the period in question as well as attempts by some employers to close the earnings differentials between black and white employees. Granted the behaviour of costs, it was clear that regressing total salaries and wages in normal scale on a linear time trend would not be appropriate in normalising the labour costs, hence a log-linear functional (exponential) form was adopted. The functional form used was:

3.2

$$\ln tsw = \alpha_0 + \alpha_1 t + u_t$$

where  $\ln tsw$  is the logarithm of total salaries and wages,  $t$  is a linear trend and  $u_t$  is an error term. When the antilogarithm of the predicted total salaries and wages was calculated, it produced a good fit in the sense that it traced the original series reasonably well.

Employment for all sectors studied was normalised by regressing total employment ( $L$ ) on a linear time trend, that is:

$$L = \alpha_0 + \alpha_1 t + u_t$$

where  $L$  is total employment,  $t$  is a linear trend,  $u_t$  is an error term. After both total labour costs and employment had been normalised in the manner outlined above, a series of normalised labour cost per unit of output was constructed by dividing normalised total salaries and wages by normalised employment. Since both the numerator and the denominator are normalised<sup>7</sup>, the resulting labour cost per unit of output is free of cyclical fluctuations.

Regarding the cost of materials, the CSS provides series on total cost of materials for each major group. These series, together with the index of the physical volume of output, allow one to derive the cost of materials per unit of output by dividing the former by the latter. It is generally accepted that normalisation is not required in the case of material costs. The reason behind this convention is that the prices of materials are determined by forces beyond the control of manufacturers - they are determined by the interaction of the forces of demand and supply as well as other conditions obtaining in the factor markets, hence manufacturers take input prices as given.

### 3.2.3 Demand

In Chapter 2, mention was made with regard to the fact that excess demand is hardly observable or measurable. This is especially so for industries that do not produce on order. For in the case of industries that produce on order, unfilled orders would constitute a good measure or proxy of excess demand. While for industries

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7. Fitted values of both labour costs and employment were used to work out *normalised* unit cost of labour.

that maintain certain levels of inventories one has to find an appropriate proxy. Studies conducted in the U.K. [see Neild (1963), Rushdy and Lund (1967) and McCallum (1970)] used the index of excess demand for labour which is a statistic published by their National Institute in its *Economic Review*. There is no such index for South Africa.

Fedderke (1992) in a similar study, in which he examines pricing behaviour of 2-digit<sup>8</sup> manufacturing industry as a whole, used expenditure on gross domestic product at both current and constant prices. The use of this proxy is sensible and can be justified on reasonable grounds for a study like the one he undertook in which aggregated data are used. It is plausible to expect the demand for manufactured goods to move closely with or to be closely correlated with aggregate demand. In fact, Fedderke (1992) did test the level of correlation between manufacturing sales and gross domestic output by regressing one on the other and found an  $R^2$  "in the vicinity of 0.98". This is an indication of how closely the two trace one another over time. However, the present study employs more disaggregated data compared to Fedderke's study. Consequently, it is necessary in this particular case to find a sector-specific proxy of demand. The value of sales for each sector would give an indication of demand for each sector's output. Therefore, sales are used to construct a proxy for demand. An alternative to this would be the gross value of sales. The only limitation to the latter option is the fact that some firms keep a certain level of inventory. So that the value of output produced may not necessarily reflect demand for the industry's output. While the two options are explored in this study, the results of the latter option have been relegated to the appendix.

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8. The 2-digit (3-digit in the title) industrial classification is a Standard Industrial Classification which is based on the degree of homogeneity or diversification of the industry. The number of digits varies with the degree of diversification.

The derivation of the demand variable in this study follows a procedure similar to the one used in the studies reviewed in the second chapter. The nominal value of sales is normalised by regressing it on a time trend. The procedure followed is as follows:

$$\ln S = \alpha_0 + \alpha_1 t + u_i \quad 3.4$$

where  $\ln S$  is the logarithm of the nominal value of sales,  $t$  is a linear time trend and  $u_i$  is an error term. The demand variable is derived by dividing the actual value of sales by the normalised value of sales. Therefore, the variable thus produced is purged of cyclical fluctuation. Sales series for each one of the sectors studied could be obtained for the period from 1965 to 1990, thus producing a sample of 26 observations. While this sample is not very large it still contains a reasonable number of observations to allow one to perform some statistical and econometric tests, and produce sensible results.

In an attempt to check for the sensitivity of the results to the derivation or the choice of the proxy of demand, an alternative demand variable was constructed using the gross value of output (see more on this and the results of regressions in which this demand variable was used in the Appendix).

The above discussion explains how each one of the variables that enter into the estimation equation or model was derived. The next logical step is the actual testing of the hypotheses which is the main topic of chapter four.

## CHAPTER 4

### TESTING THE HYPOTHESES

#### 4.1 The basic model

The preceding chapters laid the foundation for the empirical test of the mark-up and the excess demand models of pricing behaviour. In this chapter the basic model used to test these hypotheses is presented. This is followed by a step by step presentation of results of estimations of the various versions of the basic model.

In Chapter 2 mention is made of the two alternative methods of testing the two competing pricing hypotheses; namely, the mark-up hypothesis and the excess demand hypothesis. The first method entails testing the two hypotheses separately, while the second method, namely the nested hypotheses testing method, entails testing the two hypotheses simultaneously. Apparently the latter method is the most popular, and has been used quite widely in empirical studies of pricing behaviour. Reasons for the popularity of this procedure are open to speculation. It is possible that most researchers prefer this procedure because it reduces the possibility of misspecification in the form of an omitted variable. This is borne out of the criticism levelled by Rushdy and Lund (1967) against Neild (1963) that the latter author did not only leave out a separate demand variable, but that the labour cost variable he used implicitly incorporated the influence of demand. Rushdy and Lund's argument is that the extraneously determined trend contained in the labour cost variable which Neild (1963) used in his final estimation equation is highly correlated with demand, that is, when demand is high the trend level of output will tend to rise. This may lead to a spuriously insignificant coefficient for the demand variable.

The nested hypothesis testing method as it is applied in this study implies putting together in the same estimation equation, explanatory variables for both

hypotheses. More specifically, this entails having a cost variable and a demand variable in the same estimation equation.

Hence, the final basic estimation equation is:

$$P = \beta_0 + \beta_1 C + \beta_2 D + u_t$$

4.1

where P represents price, C is total variable cost per unit, and D is demand. The special feature of this procedure becomes apparent in the analysis of results. Acceptance or rejection of either or both of the hypotheses tested depends on the statistical significance of the effect each variable has on price as reflected by the magnitude and the statistical significance of the coefficient attached to it. In the present study, for instance, one is testing for the null hypotheses that  $\beta_1$  or  $\beta_2$  or both are equal to zero. However, in applying the nested hypotheses testing procedure it is imperative that the variables included in the model should not be highly collinear. For if they happen to be highly collinear, the nested hypotheses testing procedure will produce high standard errors, thereby making the t ratios spuriously "insignificant". Consequently, a wrong null hypothesis may be accepted, that is, the probability of committing type II error becomes higher (Gujarati, 1988, pp.290-5). Hence extra caution has to be exercised in applying this procedure. In the present study tests for multicollinearity were conducted<sup>9</sup> and they did not reveal high collinearity between the cost and the demand variables in the model.

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9. The informal test of correlation coefficients did not show any evidence of multicollinearity.



## 4.2 Empirical tests of the excess demand and mark-up hypotheses: An application to South African data

Having decided on the estimation procedure to be employed, and established from the preliminary tests undertaken that the data do satisfy the requirements of the methodology, the next step is to undertake the estimations. In the first sub-section the results of the estimations of the model with all variables in level form<sup>10</sup> are displayed and discussed. This is followed by a discussion of the results of the same model with all variables in first differences.

### 4.2.1 Results of the model with variables in level form

Before estimations were undertaken the variables in equation 4.1 were transformed into logarithmic scales, so that the estimation equation becomes:

$$\ln P = \beta_0 + \beta_1 \ln C + \beta_2 \ln D + u_t \quad 4.2$$

where  $\ln P$  and  $\ln C$  are, respectively, price and costs in natural logarithms.  $\ln D$  is the logarithm of demand constructed by dividing sales by normalised sales ( $S/SN$ ). Expressing the variables in logarithmic scales has the advantage of allowing for the direct estimation of the respective short-run elasticities of the dependent variable with respect to changes in the explanatory variables. Logarithms also reduce the possibility of producing coefficients of unrealistically high magnitudes. The latter problem was evident in the study by Fedderke (1992, p.182). He observed that the literature on pricing behaviour reports elasticities of price with respect to normalised unit variable cost between 0 and 1. Hence short-run elasticities that are

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10. By variables in level form it is meant that the variables used in the regression are simply in levels, be they in natural logarithms or normal scale, but there has not been *differencing* of any variable.

substantially larger than unity should be treated with caution, especially if the industry studied is not monopolised.

**a. Ordinary Least Squares (OLS) regression results**

*Table 1: Regression results of estimations of equation 4.2*

Dependent Variable $\ln P$				
26 observations used for estimation from 1965 to 1990				
Sector	$\beta_0$	$\beta_1$	$\beta_2$	Diagnostic Statistics
Fabricated Metal Products	1.503 (0.133) [11.33]	0.885 (0.014) [63.59]	0.659 (0.087) [7.51]	Adj. $R^2 = 0.993$ F-statistic = 2069 DW-statistic = 1.49
Machinery	-0.12 (0.162) [-0.75]	1.016 (0.016) [63.61]	0.762 (0.094) [8.07]	Adj. $R^2 = 0.993$ F-statistic = 2062 DW-statistic = 1.89
Textiles	-0.048 (0.12) [-0.45]	1.058 (0.012) [88.57]	0.689 (0.093) [7.407]	Adj. $R^2 = 0.994$ F-statistic = 1903 DW-statistic = 1.609
Wearing Apparels	3.06 (0.101) [30.36]	0.688 (0.011) [61.69]	0.635 (0.062) [10.23]	Adj. $R^2 = 0.994$ F-statistic = 2083 DW-statistic = 1.51

(a) The figures in (.) brackets are standard errors

(b) The figures in [.] brackets are  $t$  ratios

(c) \* Durbin Watson statistic falls within the zone of indecision

The results of ordinary least squares estimations of equation 4.2 for all four sectors studied as displayed in Table 1 are generally satisfactory. Annual data covering the period from 1965 to 1990 are used. It is important to note that estimations of equation 4.2 were also undertaken with data excluding the odd years for which no data are available. The results of the latter set of estimations did not show any marked difference from those displayed in Table 1. Nevertheless, one may add that one does not have to attach too much importance to results alluded to here. They were simply used as a test of the sensitivity of the results of the entire sample to the splicing of the CSS and the IDC sets of data. It is for this reason that they are not presented here.

Before discussing the results in greater detail, a summary of the diagnostic statistics is provided. The summary gives an overview of the quality of the results in terms of the statistical significance or otherwise of each. These summary statistics help one determine the level of confidence one can attach on the results and the robustness of the conclusions that flow from the results.

Starting with the r-squares, they all depict high explanatory power. All of them are in the vicinity of 0.9. While it is generally accepted that high r-squares are a good indicator of the explanatory power of a model, very high r-squares tend to breed suspicion. Hence it becomes necessary for one to look at the r-squares in conjunction with other diagnostic statistics. Such statistics would include, among others, the Durbin-Watson statistics, F values, etc.. Looking at these statistics in Table 1 there is no reason to have any reservations about the quality of the results. For two sectors - Machinery and Textiles - the Durbin-Watson statistics lead to an unambiguous conclusion that autocorrelation is not a problem, while for the other two - Fabricated Metal Products and Wearing Apparel - the Durbin-Watson statistics fall within the zone of indecision. Therefore, based on the Durbin-Watson statistics one can conclude that there is generally no problem of autocorrelation, thus

reaffirming the good quality of the results. However, in the case of the results of regressions in which the gross value of output was used to construct the demand variable the problem of autocorrelation did show up for one of the sectors; namely, Fabricated Metal Products (see Table A1 in the Appendix). As a result of this problem, the estimation of the same equation with variables in first difference form was undertaken in an attempt to eliminate it. An alternative way of eliminating autocorrelation that could be used is the Cochrane-Orcutt iterative procedure (for more on this see Appendix). The problem of autocorrelation is attributable, in part, to the common time trends used in the derivation of normal variables, an observation also made by Eckstein and Fromm (1968, p.1170).

The constant term has a negative sign for two sectors and a positive sign for the other two sector. For a model with variables in levels, the constant term is of little explanatory value. The more important coefficients,  $\beta_1$  and  $\beta_2$ , which indicate the relationship between the dependent variable and the explanatory variables the coefficients of the cost and demand variables, respectively, have the *a priori* signs for all sectors. Both  $\beta_1$  and  $\beta_2$  have a positive sign showing that there exists a positive relationship between price and costs and demand. For purposes of interpretation, it is important to remember that both these coefficients are elasticities.

The standard errors of the individual estimates are fairly low. The coefficient of the cost variable ( $\beta_1$ ) is statistically significant for all sectors at the 5 percent level of significance, and it is of an acceptable magnitude. For two sectors - Machinery and Textiles - the coefficient is greater than unity, and for Fabricated Metal Products and Wearing apparel sectors it is less than unity. The two coefficients that are greater than unity were subjected to a further test in order to establish whether they are significantly greater than unity. The test showed that for Textiles,  $\beta_1$  is statistically significantly different from one. This is an important observation because South

Africa's Textile industries are said to be highly protected from international competition. This is evident from the percentage share of domestic consumption of textiles supplied by domestic producers which is around 90% (Levy, 1992, p.31). Protection against international competition enables domestic Textiles producers to more than shift increases in costs onto consumers. A given percentage change in the cost structure of the textiles industry leads to a proportionately higher percentage change in the domestic price of textile goods.

The  $\beta_1$  coefficients are statistically significant for all the sectors studied. This suggests that costs play a significant role in the pricing decisions of South African manufacturing firms. These results serve to confirm the findings that have been made in some of the preceding studies reviewed in Chapter 2 that firms determine prices by adding a mark-up on normal costs.

In contrast with the results of some of its predecessors [Neild (1963); Godley and Nordhaus (1972); Coutts, Godley and Nordhaus (1978) and Coutts, Godley and Moreno-Brid (1987)], in this study all of the coefficients of the demand variable are statistically significantly different from zero, thus refuting the null hypothesis that  $\beta_2$  equals naught. This result is striking, for while economic theory emphasises the direct role played by movements of the demand function in the determination of price, some of the empirical studies reviewed in Chapter 2 claim that the role played by demand is limited to the indirect influence demand has on input costs. However, as it was pointed out earlier on (see Section 3.1), the results of this study are not necessarily strictly comparable to those of studies reviewed in chapter 2. On the one hand, previous studies either used an index of excess demand for labour or a demand variable derived from the value of output as a proxy for demand. On the other hand, the present study used a demand variable constructed using sales (or the gross value of output in the case of the results contained in the Appendix). The question then becomes - which one of these proxies is more appropriate?

In answering the question raised in the above paragraph, one would like to point out that the index of excess demand used in studies conducted in the United Kingdom is for the economy as a whole while the gross value of sales used in the present study is sector-specific. Therefore, one would like to believe that the latter actually captures movements in demand in a specific sector much better than an index of excess demand for labour. Intuition would make one believe that there is a closer link between demand for a good and the sales of that good than the index of demand for labour used to produce the good. Labour cannot be hired and fired as and when employers wish. Consequently, the time lag between changes in the demand for goods and demand for labour should be relatively longer, thus creating complications in the interpretation of the relationship between price and demand as measured by the index of excess demand for labour. Unless one assumes a fixed capital labour-ratio, it does not make sense to suggest that every time demand for goods increases it will lead to a corresponding increase in the demand for labour. It is for these reasons that the statistical insignificance of the demand variable measured as an index of excess demand may not necessarily imply that demand does not play an important role in the pricing decisions of firms.

The coefficients of both costs and demand variables that are contained in Table 1 give an indication of the relationship - whether it is positive or negative - between the dependent variable and the individual explanatory variables. Nevertheless, these results as presented do not allow for direct comparisons of the coefficients, that is, one cannot make inferences from them as to which one of the two explanatory variables is more important in explaining movements in the price level. The following section sheds light on this aspect.

### *b. Standardised coefficients*

Unless the coefficients contained in Table 1 are standardised<sup>11</sup> one does not know the relative importance of the individual independent variables in explaining movements in the dependent variable.

*Table 2: Standardised coefficients*

Sector	$\beta_1$	$\beta_2$
Fabricated Metal Products	0.986	0.117
Machinery	0.988	0.125
Textiles	0.993	0.083
Wearing Apparel	0.963	0.159

The standardised coefficients in Table 3 give better approximations of the relationship between price and costs and demand. They allow one to compare the coefficients on the basis of their magnitudes. The magnitude of the coefficients demonstrates unambiguously that prices are determined mainly on the basis of cost considerations. Again for the Textiles sector, demand seems to play a very limited role in the determination of price with the standardised coefficient equal to 0.083. This could be related to the high levels of protection (limited international competition) alluded to in the preceding section.

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11. The standardised coefficient is equal to the unadjusted (OLS) coefficient adjusted by the ratio of the standard deviation of the independent variable to the standard deviation of the dependent variable (Pindyck and Rubinfeld, p.85). The generalised procedure is represented by:

$$\hat{\beta}_j^* = \hat{\beta}_j \frac{s_{x_j}}{s_y}$$

The coefficient of the cost variable for each sector is consistently greater than 0.9, thus suggesting that every unit standard deviation change in costs will lead to a 0.9 standard deviation change in price. However, in the case of demand the coefficient of the cost variable varies from 0.083 to 0.159. This marked difference in the magnitudes of standardised coefficients could be attributed to the fact that changes in direct costs are relatively easy to measure, and their effect on cash flows and hence profits is immediate and obvious. Therefore, it is relatively easy for those involved in making pricing decisions to establish a change in costs - ascertain that it is not transitory and incorporate it in their pricing decisions. This result is quite revealing, in that it shows clearly that while both cost and demand matter, the influence of cost on price is more important. The influence of demand is probably attenuated by the fact that the South African manufacturing sector often operates below full capacity. So it is possible for firms to meet seasonal and cyclical peaks in demand without incurring enormous costs. This is especially plausible given the fact that the structure of the sector leans more toward oligopoly which makes the holding of unused capacity feasible. Under such conditions the pressure of demand would be reflected more in changes in output, and less on prices. Further, in an (relatively) open economy some of the increase in demand might be met by an increase in imports instead of an increase in price (Sylos-Labini, 1979b, p.157).

The response by firms to changes in demand is always characterised by a lot of uncertainty arising partly from the fact that demand is hardly measurable, and also due to the fact that in the real world the possible consequences of a change in price are never known with a high degree of certainty. Firms hardly know the demand function that they are facing. However, once firms are aware that the demand curve they are facing is not perfectly elastic, they tend to be cautious about raising prices. Furthermore, movements in the demand function are likely to have a limited effect on profits until the pressure of demand in the product market filters through to the factor market. Indeed, the low standardised coefficients seem to bear testimony to



this assertion. The coefficients of lagged demand variables did not confirm this assertion, nonetheless.

#### 4.2.2 Transforming the model into an autoregressive model by Koyck approach

Transforming equation 4.2 by the Koyck approach in order to incorporate the influence of the previous price level on current pricing decisions (price level), the model becomes,

$$\ln P = \alpha_0 + \alpha_1 \ln C + \alpha_2 \ln D + \alpha_3 \ln P_{-1} + v_i \quad 4.3$$

where  $\alpha_0 = \beta_0(1-\lambda)$

$$\alpha_1 = \beta_1$$

$$\alpha_2 = \beta_2$$

$$\alpha_3 = \lambda = \text{coefficient of the geometrically declining weight of the lagged explanatory variables}$$

$$v_i = u_i - \lambda u_{i-1}$$

The results of the autoregressive model are contained in Table 3 below. Again, judging from the summary statistics - the r-squares, the Durbin's h statistic and the F values - the results demonstrate satisfactory quality. Also contained in Table 3 are the estimated long-run responses of price to the combined effect of changes in both costs and demand. Of major interest in the results displayed in Table 3 are the long-run responses and  $\alpha_3$  which is the coefficient of the lagged dependent variable  $P_{-1}$ . Here little will be said about the short-run responses, suffice to observe that all of them are statistically significantly less than unity, except  $\alpha_2$  in Machinery (the significance was tested for using the t statistic). It is also apparent from the results

that the inclusion of a lagged dependent variable tends to reduce the magnitude of coefficient of the cost variable. However, the coefficients drop by a negligible fraction.

*Table 3: A Summary of the results of the autoregressive model (Equation 4.3)*

Dependent Variable lnP 25 observations used for estimation from 1966 to 1990					
Sector	Long-Run Responses <sup>12</sup>	$\alpha_1$	$\alpha_2$	$\alpha_3$	Diagnostic Statistics
Fabricated Metal Products	1.67	0.654 (0.095) [6.86]	0.576 (0.097) [5.94]	0.262 (0.108) [2.42]	Adj. R <sup>2</sup> = 0.995 F-statistic = 1543 D's h-stat.=0.75
Machinery	1.82	0.819 (0.149) [5.47]	0.648 (0.136) [4.68]	0.195 (0.146) [1.31]	Adj. R <sup>2</sup> = 0.994 F-stat. = 1258 D's h-stat.=0.621
Textiles	1.76	0.788 (0.074) [10.63]	0.512 (0.092) [5.59]	0.262 (0.071) [3.68]	Adj. R <sup>2</sup> = 0.999 F-stat. =3692 D's h-stat.=0.665
Wearing Apparel	1.33	0.490 (0.109) [4.51]	0.433 (0.144) [3.00]	0.313 (0.174) [1.79]	Adj. R <sup>2</sup> = 0.995 F-stat. = 1514 D's h-stat. = 0.61

(a) The figures in (.) brackets are standard errors

(b) The figures in [.] brackets are *t* ratios

12. The long-run responses are estimated using the formula;

$$\frac{\alpha_1 + \alpha_2}{1 - \alpha_3}$$

(Pindyck and Rubinfeld, 1991, p.205).

Regarding costs, an inference that can be drawn from this is that firms do not incorporate the full effect of changes in costs in their prices in the short-run. This suggests that firms are either aware or just believe that they are facing elastic demand functions. Therefore, shifting changes in the cost structure onto consumers via changes in price is a process which they undertake cautiously in order to attenuate the potential negative effects such changes are likely to have on demand and revenue.

Again looking at the diagnostic statistics, the Durbin's h-statistic which is the relevant test of serial correlation in the case of autoregressive models has an absolute value which is substantially less than 1.96 for all sectors, thus indicating absence of serial correlation at the 5 percent level. The r-squares demonstrate that the inclusion of a lagged dependent variable does not have any discernible effect on the explanatory power of the model.

The coefficient of the lagged dependent variable,  $\alpha_3$ , is statistically significant at the 5 percent level of significance for Fabricated Metal Products and Textiles sectors. For Wearing Apparel and Machinery,  $\alpha_3$  is statistically significant at 8 percent and 20 percent, respectively. From these results it can be concluded, at least tentatively, that the pricing decisions at any point in time (t) are influenced by pricing decisions in the previous period (t-1). Longer time lags were tried and the coefficient either becomes statistically insignificant or its sign changes.

The long-run responses give the total effect costs and demand have on price in the long-run. It is obvious from figures displayed in Table 3 that the long-run response is greater than unity for all four sectors, thus giving an indication that in the long-run the combined effects of costs and demand lead to greater than proportionate changes in prices. This is plausible, for it makes sense to suggest that firms need time to adjust to any changes in the environment in which they operate. If there is

a change in their cost structure, for example, they have to establish its magnitude, estimate its potential impact on their profitability, study their competitors' responses to the change before they can be able to incorporate such a change in their pricing decisions. However, as the regression results presented in Tables 1, 2 and 3 show, it is still possible for firms to shift part of the change in the cost structure in the short-run. Nevertheless, the proportion shifted should be such that its impact on the final price is negligible, otherwise it may have deleterious effects on the market share of the firms in question.

#### 4.2.3 Regression results of the model with variables in first differences

While this study is essentially aimed at examining and explaining the relationship between price and costs and demand, it is also interesting to study and get to understand the relationship between changes in these variables. This can be achieved by modifying equation 4.2 by expressing all variables in first differences. This was done in spite of the fact that there did not exist any strong signs of the presence of autocorrelation. This is a step which was first introduced by Rushdy and Lund (1967), and subsequently emulated by Godley and Nordhaus (1972) and Coutts, Godley and Nordhaus (1978). Estimating the price equation in first differences also helps to show if changes in price are explained more by changes in costs and demand and less by the levels of these variables. The first difference equation estimated is,

$$\Delta \ln P = \beta_0 + \beta_1 \Delta \ln C + \beta_2 \Delta \ln D + u_i \quad 4.4$$

In equation 4.4  $\beta_0$  will be equal to zero if on average prices do not change when costs and demand are constant. However, if  $\beta_0$  is significantly different from zero, then that would imply that on average prices tend to change even when both costs and demand remain unaltered.

*Table 4: Regression results of the model with variables in first differences*

Dependent Variable $\Delta \ln P$				
25 observations used for estimation from 1966 to 1990				
Sector	$\beta_0$	$\beta_1$	$\beta_2$	Diagnostic Statistic
Fabricated Metal Products	0.098 (0.018) [5.57]	0.218 (0.102) [2.14]	0.837 (0.075) [11.12]	Adj. $R^2 = 0.836$ F-statistic = 62.09 DW-statistic = 2.11
Machinery	0.098 (0.023) [4.21]	0.296 (0.126) [2.35]	0.801 (0.128) [6.27]	Adj. $R^2 = 0.643$ F-statistic = 22.58 DW-statistic = 2.09
Textiles	0.054 (0.014) [3.73]	0.537 (0.097) [5.57]	0.661 (0.116) [5.68]	Adj. $R^2 = 0.743$ F-statistic = 35.61 DW-statistic = 1.73
Wearing Apparel	0.028 (0.014) [1.95]	0.424 (0.105) [4.06]	0.647 (0.143) [4.51]	Adj. $R^2 = 0.54$ F-statistic = 15.11 DW-statistic = 2.48

*(a) The figures in (.) brackets are standard errors*

*(b) The figures in [.] brackets are t values*

Table 4 presents the results of estimations of the model with variables in first differences. The results are quite satisfactory, save for the fact that the r-squares are a little lower than in the previous estimations ranging from 0.54 to 0.83, still depicting fairly high explanatory power. The Durbin-Watson statistics are even better than those in Table 1. All of them indicate absence of autocorrelation. This

result comes as no surprise, as first differences are often considered to be one of the ways of reducing or eliminating autocorrelation (Gujarati:1988).

The constant term is positive and statistically significantly greater than zero in all instances, thus allowing one to conclude, perhaps with some qualification, that on average prices tend to rise even after allowing for the effects of both costs and demand.  $\beta_1$  and  $\beta_2$  both bear the a priori expected signs, that is, they are positive and statistically significantly different from zero, thus consolidating the maintained hypothesis that both costs and demand are important in the determination of prices, and changes thereof. What conclusion(s) can one draw from these results? This question is answered in the next section. Again, the coefficients of the first difference equation are standardised.

Table 5: *Standardised Coefficients of the first difference equation*

Sector	$\beta_1$	$\beta_2$
Fabricated Metal Products	0.179	0.928
Machinery	0.287	0.765
Textiles	0.580	0.591
Wearing Apparel	0.576	0.640

The magnitudes of some of the coefficients of equation 4.4 show a reversal of the observation made above, namely, that costs play important role than demand in the determination of price. This trend is more evident in the case of Fabricated Metal Products and Machinery, and less so for Textiles and Wearing apparel. The change in the magnitudes holds true for both the OLS results and standardised coefficients. While both the price level and changes therein are important, one is inclined to

believe that the latter is more important than the former. The results that are contained in Table 5 lend support to this assertion. This is unequivocally so for Fabricated Metal Products and Machinery sectors.

## CHAPTER 5

### SUMMARY AND CONCLUSIONS

This study begins by contrasting economic theory with business practice. The findings of the survey by Hall and Hitch (1939) marked the beginning of a series of empirical studies all of which were aimed at testing the validity of those findings.

Literature review (in chapter 2) from the Hall-Hitch survey through the recent studies subsequent to the survey reveals that two competing hypotheses emerged out of these studies, namely, the mark-up hypothesis and the excess demand hypothesis. Differences are also evident, both with regard to the methodology and the actual econometric techniques used in the analysis. Contentious issues revolve mainly around the best procedure(s) to be used in *normalising* costs. It is also worth noting that as more studies are conducted in the area the analytical techniques are increasingly becoming sophisticated. Notably, the application of cointegration techniques by Coutts, Godley and Moreno-Brid (1987) is commendable. However, data limitations did not permit emulation of such techniques in this study.

A close scrutiny of these studies also reveals that, while the two hypothesis may be seen to start from separate premises, they are not necessarily mutually exclusive, as some authors seem to suggest. Evidence of this is the assertion by some authors (Odagiri and Yamashita, 1987) that mark-ups tend to rise with demand. This is an important assertion which can be supported by means of a mathematical derivation (see Bilas, 1967, pp.210-211). For, if it is true that mark-ups and demand are positively correlated, then the empirical testing of the hypotheses in question may be hindered by the problem of multicollinearity. However, statistical tests did not reveal any problem of multicollinearity.



Most of the studies covered by the literature review of chapter 2 lend support to the mark-up hypothesis. However, there is a handful of empirical studies that do not only question the validity of the mark-up hypothesis, but have also demonstrated that demand also plays an important role in the determination of prices (for example, McFetridge, 1973 and Smith, 1982).

Data requirements are discussed at length in chapter three. From the discussion it is apparent that the form in which data on South African manufacturing are published does not allow one to emulate the most recent, and sophisticated techniques (for example cointegration techniques), thus making strict comparisons of the results of the current study with those of previous studies difficult if not impossible.

The results of the present study have, on the whole, demonstrated satisfactory quality not only in terms of all the diagnostic statistics supplied, but also with regards to the magnitudes and the signs of the coefficients. The coefficients do not only have the expected signs, their magnitudes are also credible. The coefficient of the cost variable is in all instances, except two, less than unity, implying that the manufacturing industry is incapable of fully shifting changes in its cost structure, at least in the short-run. It can be deduced from this that the manufacturing industry of South Africa is either aware or operates on the belief that the demand function it faces is not perfectly inelastic. Hence it bears some proportion of the change in the cost structure.

The relationship between costs and prices is striking, and it has got important implications not only for anti-inflationary policy, but for the international competitiveness of South African manufactured goods as well. Remuneration costs per unit of output in the South African manufacturing industry are higher than those of the country's major trading partners. The major trading partners referred to here

are Germany, Japan, the United States of America and Taiwan. This, together with the fact that output per worker in South African manufacturing is the lowest compared to the same group of countries poses serious challenges for this industry. Pressure is mounting on South African firms to be internationally competitive. The country is now a member of the World Trade Organisation [(formerly known as the General Agreement on Tariffs and Trade (GATT))]. This is both good news and bad news for South African manufacturing in particular, and the country in general.

The good news is that international markets are opening up to South African manufactures. This will enable certain sectors to expand and to take full advantage of economies of scale. Exposure to international competition will, hopefully, provide an incentive to become efficient. However, all of this can be achieved if South African producers can find ways of reducing their costs per unit of output. As the results of this study have shown, as long as costs continue to escalate, prices are likely to continue to rise if the firms are to remain in business. It is, however, worth noting that the abolition of non-tariff barriers and reduction of tariffs may contribute toward the reduction of manufacturing costs in South Africa. The cost of imported inputs may drop, thus leading to a reduction in the cost per unit of output.

What is the bad news regarding membership of the WTO? The bad news is that South Africa also has to open up her markets to foreign manufactures. This will be done by first replacing all non-tariff barriers by their tariff equivalents, and then reducing all tariffs by an average of 30 to 37% over five years up to 1999 (Ahmad, *et al*, 1994, p.11). When this happens South African manufacturers will be exposed to stiff competition. It is only those firms which will be able to improve their productivity and reduce their costs which will be able to survive. Inefficient firms will be forced out of the market. Consequently, jobs will be lost and unemployment may rise.

While the results of this study lend support to the mark-up hypothesis, they also demonstrate unequivocally that it is unrealistic and misleading to dismiss the role played by movements in demand in price determination. The standardised coefficients of estimation results of the model with variables in level form and first differences contained in Tables 2 and 5, respectively, lead to contradicting conclusions as to whether costs or demand play the most important role in the determination of pricing behaviour.

The results of this study have made it clear that manufacturing prices are substantially driven by changes in the cost structure of the industry, as much as they are influenced by changes in demand. Therefore, it is safe to conclude that inflation in South Africa is due partly to both cost-push and demand-pull factors. However, one may also add that this is not an attempt to reduce the role played by other factors in determining the general price level in the economy at a macro level. Nonetheless, the assertion that demand and supply factors reinforce one another in influencing the general price level is reiterated. An important conclusion that flows from this is that for any anti-inflationary policy to be efficacious it has to embody elements of both demand and supply side management.

## APPENDIX

### Results of regressions in which GVO was used to construct the demand variable

The results presented in this section are those in which an alternative definition (derivation) of the demand variable was used; namely  $GVO/GVO_N$ . Where  $GVO$  is the gross value of output and  $GVO_N$  *normalised* gross value of output. In the case of the results presented in Tables 1 to 5 the proxy for the demand variable was constructed using sales. This additional exercise was undertaken in order to see whether the results and hence the conclusions of the study would be sensitive to the specification and/or the manner in which the demand variable was constructed. It must be noted that the sample periods for the two sets of results are different. The sample period for the results discussed in Chapter 4 is 1965 to 1990, while the sample period for the results discussed in the Appendix is 1946 to 1972. Therefore, the results displayed in the Appendix are not strictly comparable to those discussed in chapter 4. It is precisely for this reason that they have been relegated to the Appendix. The equation estimated was,

$$\ln P = \beta_0 + \beta_1 \ln C + \beta_2 \ln D + u_t \quad 4.2(A)$$

The results are contained in Table A1 below. Note that in Table A1 there are two sets of results for the Fabricated Metal Products sector. The results marked by an asterisk were produced using the Cochrane-Orcutt iterative procedure. This was necessitated by the fact that the results of ordinary least squares displayed autocorrelation. Generally, these results are in line with the results discussed in Chapter 4 in which the demand variable was derived using sales. Consequently, the conclusions that were drawn from the earlier results are maintained. Nevertheless,

for two sectors - Machinery and Textiles - the coefficient of the demand variable is negative and statistically significant.

*Table A1: Regression Results of Equation 4.2(A)*

Dependent Variable is $\ln P$ 27 observations used for estimation from 1946 to 1972				
Sector	$\beta_0$	$\beta_1$	$\beta_2$	Diagnostic Statistics
Fabricated Metal Products	3.588 (0.333) [10.79]	0.525 (0.037) [14.37]	1.272 (0.086) [14.85]	Adj. $R^2$ = 0.907 F-statistic = 128 DW-statistic = 0.559
Fabricated Metal Products	3.384 (0.689) [4.91]	0.545 (0.734) [7.42]	1.105 (0.049) [22.62]	Adj. $R^2$ = 0.971 F-statistic = 204 DW-statistic = 2.157
Machinery	0.967 (0.081) [12.00]	0.979 (0.048) [94.07]	-0.076 (0.021) [-3.61]	Adj. $R^2$ = 0.997 F-statistic = 5179 DW-statistic = 1.659
Textiles	0.725 (0.146) [4.97]	0.972 (0.018) [51.55]	-0.096 (0.028) [-3.46]	Adj. $R^2$ = 0.992 F-statistic = 1518 DW-statistic = 1.675
Wearing Apparel	1.556 (0.217) [7.16]	0.881 (0.027) [33.31]	0.011 (0.008) [1.34]	Adj. $R^2$ = 0.981 F-statistic = 678 DW-statistic = 1.726

Again the equation was transformed into first differences, and the results of the of the first difference equation are presented in Table A2.

$$\Delta \ln P = \beta_0 + \beta_1 \Delta \ln C + \beta_2 \Delta \ln D + u_t \quad 4.4(A)$$

Table A2: Regression Results of Equation 4.4(A)

Dependent Variable is $\ln \Delta P$ 26 observations used for estimation from 1947 to 1972				
Sector	$\beta_0$	$\beta_1$	$\beta_2$	Diagnostic statistics
Fabricated Metal Products	0.101 (0.059) [1.687]	-0.549 (0.598) [-0.919]	0.0976 (0.102) [9.59]	Adj. $R^2 = 0.943$ F-statistic = 190 DW-statistic = 1.204
Machinery	-0.009 (0.007) [-1.395]	1.059 (0.066) [16.053]	-0.238 (0.077) [-3.101]	Adj. $R^2 = 0.95$ F-statistic = 171 DW-statistic = 2.219
Textiles	0.008 (0.006) [1.25]	0.764 (0.076) [10.39]	0.098 (0.076) [1.28]	Adj. $R^2 = 0.914$ F-statistic = 133 DW-statistic = 2.23
Wearing Apparel	0.2804E-3 (0.004) [0.066]	0.844 (0.058) [14.54]	0.001 (0.076) [0.013]	Adj. $R^2 = 0.919$ F-statistic = 130 DW-statistic = 2.439

While the general impression is that the results are not very sensitive to the specification of the demand variable, there are instances in which the signs of the coefficients changed. Therefore, one could not unequivocally conclude that results are not sensitive to the manner in which the demand variable is derived.

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