PRICE DETERMINATION IN AUSTRALIA -

A DISAGGREGATED APPROACH

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ABSTRACT

The primary aim of this thesis is to obtain estimated sectoral price equations for Australia using quarterly data for the period 1960-61 to 1972-73. The secondary aim of the study is to use the estimated price equations obtained to make a sector by sector comparison of the determinants of sectoral prices and of the lags with which prices respond to these determinants. Aggregate price equations are also estimated and compared with the estimated sectoral price equations in order to determine whether extra information is gained by estimating separate price equations for different sectors. In the first chapter of the thesis some arguments are advanced supporting the view that a sectoral approach to the study of price determination may be necessary to obtain a better understanding of the way in which prices are determined.

Before attempting to accomplish the primary aim of this thesis two chapters are devoted to a brief review of the most important price equations studies carried out for overseas countries and for Australia - Chapter 2 contains a survey of the overseas studies and Chapter 3 contains a survey of the Australian studies. It was found that the Australian work was less extensive than the overseas work both as regards the types of disaggregation used and the types of explanatory variables tested. Chapter 3 concludes with proposals for work to be carried out in this study, these proposals consisting largely of proposals for using alternative types of disaggregation and incorporating variables which have been successfully tested overseas but not
in Australia.

The fourth chapter discusses the data available for carrying out the programme outlined in the preceding chapter. It was found that little of the required data was available and much of the data needed in the regression analysis had to be constructed from available data. As a result of this Chapter 4 contains a rather extensive discussion of the data used and the series constructed are reproduced in an appendix. The discussion of the data revealed that three different types of disaggregation could be used and since the studies reviewed gave little indication as to which type of disaggregation would be the most useful, all three types were experimented with.

The regression results for the final demand type sectors are discussed in Chapter 5, the results obtained for consumer goods sectors are discussed in Chapter 6 and the results for geographical sectors are discussed in Chapter 7. It was found that labour costs were the most important determinant of prices. Various types of labour cost variables were tried. Some were adjusted for changes in short-run productivity to form unit labour cost variables and some for changes in long-run productivity to form "normal" unit labour cost variables. It was found that the labour cost variables unadjusted for productivity (i.e., minimum wage rate and earnings variables) were the most successful. The only other variable which was consistently significant for all sectors for which it was used is the sales tax and excise variable. Materials costs were significant for some sectors only and of the many types of demand variables tried, none were consistently significant although several of the preferred equations included a demand variable.

iv.
In Chapter 8 the results for the three types of disaggregation are compared and it is argued that additional information concerning price determination in Australia is indeed obtained by using a sectoral approach. It is felt that further work in this area is warranted and that the disaggregation by final demand categories and the disaggregation by consumer categories are likely to be more useful than the geographical disaggregation. However, the difficulty of obtaining suitable sectoral data must be balanced against the advantages of using the sectoral approach to the study of price determination.
CHAPTER 1

INTRODUCTION

1.1 Introduction

The primary aim of this thesis is to obtain estimated sectoral price equations for Australia using quarterly data for the period 1960-61 to 1972-73. The secondary aim is to use these estimated price equations for the various Australian sectors to analyse questions of the following type:

(1) Do the determinants of sectoral prices differ from sector to sector?

(2) Do the determinants of sectoral prices differ from those of aggregate prices?

(3) Do the lag structures found to be most appropriate differ from sector to sector?

(4) Do the lag structures found to be most appropriate for the sectoral equations differ from the lag structure found to be most appropriate for the aggregate equation?

From the answers to question of this type we hope to throw some light on the question as to whether prices can be adequately explained by one aggregate price equation or whether it is preferable to explain sectoral prices separately, using sectoral explanatory variables in order to come to a better understanding of the process of price determination in Australia.
Since three different types of disaggregation are to be used in this study, it is hoped that the estimated sectoral price equations will also provide some indication of the type (or types) of disaggregation which ought to form the basis for further work if a disaggregated approach is, in fact, preferable to an aggregate approach.

The next section of this chapter is devoted to a discussion of the disaggregated approach to the study of price determination and the reasons why it might be used in preference to an aggregate approach. Section 1.3 will be concerned with the scope and limitations of this study.

1.2 The Sectoral Approach

While most studies of price and/or wage movements have been conducted at the aggregate level, some authors have pointed out the advantages of using a more disaggregated approach. This section will consider some of the reasons for preferring a sectoral to an aggregate approach to the question of price determination.

Firstly, it may be argued that different sectoral price levels (these will be more clearly defined later in this study) are determined by different factors. If this is the case then an aggregate approach explaining one price variable in terms of aggregate variables will, of necessity, be only a first step in the understanding of the process of price determination in the economy as a whole. Differences in sectoral price equations may be expected both on a priori grounds and on the grounds of empirical findings in other studies. We may expect that if different sectors have different economic structures
(e.g., different industrial concentration, different types of markets, different methods of wage determination) then the behavioural equations used to explain prices in the various sectors will differ. The equations could differ in the types of explanatory variables found to be most appropriate or in the values of the parameters or both. Goodwin argues that the sectoral approach to the problem of inflation allows one to incorporate the "... structure of industry ..." into the "... analysis of inflation ..." resulting in both "... a gain in quality and quantity of information ..."\(^1\) Bowen, after a detailed theoretical analysis of wage and price determination in the individual firm, finds that differences in the process of price determination between different sectors necessitates

"... a less aggregative and more complex model of the general price level that recognizes the existence of various modes of price determination and the interaction of cost and demand considerations within the individual sectors."\(^2\)

Secondly, the existence of different degrees of inflation in different sectors would seem itself sufficient to urge one to adopt a sectoral approach. Eckstein and Fromm pointed out that the inflationary experience of the United States in the period 1957-58 exhibited widely varying changes in sectoral price levels whereas the "average price level" rose by only 2-3%. They argued that this necessitated an analysis of inflation in various "key sectors" rather than an investigation of the general price level.\(^3\)

In the case of the Australian situation, if we examine the price movements for various sectors for the post-war period, there appear to be some significant differences in the rate of price change for certain groups of goods, especially consumer goods. It appears that the trends in the price movements of different goods are sufficiently clear to warrant asking the question why these different trends occur and to attempt to answer this question using estimated sectoral price equations.

Some empirical studies have, in fact, found differences in both the determinants of different sectoral price levels and in the rates of inflation in different sectors. Some, however, have found no differences necessary in structural equations. A further discussion of the findings of price studies for both Australia and overseas countries may be found in Chapters 2 and 3 where an attempt is made to point out some of the differences found.

Thirdly, it has been strongly argued by several economists that a better understanding of the determinants of the aggregate price level may be obtained by using a sectoral approach. Goodwin has argued that with a more disaggregated approach

"... we arrive at a basically improved vision of the process of inflation, i.e. the gradual transmission of inflationary impulses from market to market. In the case of inflation this is not a theoretical refinement but rather very much of its essence."

Schultze also argues along much the same lines and is of the opinion that

"... creeping inflation can only be understood when one goes beneath the aggregates." 1

He argues that simply comparing ex post aggregates is not only dangerous in that

"... they may simply illustrate tautological identities ..."

but also,

"... because they are aggregate, they may hide the basic forces operating during the period." 2

In a discussion of the feasibility of distinguishing cost-induced from demand-induced inflation, Samuelson and Solow are also

"... driven to the belief that aggregate data, recording ex post details of completed transactions may in most circumstances be quite insufficient. It may be necessary first to disaggregate." 3

Finally, it may be argued that sectoral analysis will, in some circumstances, have significant implications for economic policy actions designed to control price movements. The need to go beneath the aggregates for meaningful policy decisions appears to have strongly influenced the Joint Economic Committee price studies of 1959. In one of them Eckstein and Fromm pointed out that there were substantial differences in the percentage changes in the prices of various components of GNP in the period 1953-58 and they state that

"... in an inflation of this sort, concentrated in a few sectors, with the average price level of the economy rising only 2 or 3 percent a year,

2. Ibid., p. 19.
it is particularly difficult to devise proper policies. Where excessive total demand is pulling the entire price structure of an economy upward, policy must clearly seek to bring demand down to the levels matching total supply. But where the imbalances between demand and supply in various markets are uneven and ambiguous, it becomes extremely difficult to wring the inflation out of the system without serious side-effects on the level of employment and the rate of growth." ¹

If the possibility is accepted that aggregate price movements are not necessarily caused by changes in aggregate variables but may be caused by changes in aggregate quantities being unevenly distributed amongst various sectors, then in many cases policies designed to control only the aggregate quantities with no references to sectoral imbalances will fall too heavily on certain sectors and not heavily enough on others.

This discussion may prompt the question as to why aggregate models are then so widely used. One reason is, of course, the relative simplicity of the aggregate model both with respect to its analysis and with respect to its data requirements. Bodkin also argues that in some situations

"... the argument running in terms of macro-variables provides an insight close enough for all practical purposes." ²

1.3 Limitations and Scope

The limitations of this thesis are of two main kinds. Firstly, the empirical work to be discussed in Chapters 5, 6 and 7 was limited by the fact that all reasonable combinations of variables and lags

could not be experimented with. To keep the volume of empirical work to manageable proportions some limitations were placed on the extent of experimentation. These will be discussed in Chapter 5.

In this sense, the results obtained in this study will not be conclusive but it is felt that sufficient equations were estimated to make this only a minor limitation of the thesis. A more important limitation was imposed on the study firstly by the unavailability of certain data and secondly by the doubtful quality of some of the series constructed. Because of this and because of the considerable number of series constructed, the chapter devoted to a discussion of the data used in the empirical analysis is fairly extensive. It is hoped that this rather lengthy discussion of the data will enable the reader to appreciate the limitations placed on the empirical work and the caution with which the results ought to be interpreted.

The structure of the remainder of this thesis is as follows. Chapters 2 and 3 contain a review of the most important overseas and Australian empirical price equation studies which use a disaggregated approach. Chapter 2 contains the review of the overseas studies and Chapter 3 of the Australian studies. Chapter 3 concludes by drawing together the ideas of the studies reviewed in these two chapters which it is felt ought to be tested in this thesis. As mentioned above, Chapter 4 contains a discussion of the data needed to carry out the programme outlined in Chapter 3 and the data which are available or which could be constructed from available data. The next three chapters are given over to an analysis of the regression results; Chapter 5 discusses those obtained using a demand category disaggregation and Chapter 6 those obtained using a consumer category
disaggregation and Chapter 7 those obtained using a geographical
disaggregation. The concluding chapter, Chapter 8, compares the
results discussed in the previous three chapters and attempts to
answer the questions posed in the first section of this chapter.
CHAPTER 2

OVERSEAS SECTORAL PRICE STUDIES

2.1 Introduction

In this chapter we will look at overseas sectoral price studies to see which ideas that have been used in overseas studies ought to be experimented with using Australian data. The next chapter will examine Australian studies of sectoral price determination with the aim of determining which ideas have already been tested for Australia and the success with which they have been used. Chapter 3 will also contain a section outlining the proposals for testing in later chapters.

It will be recalled that in Chapter 1 the main aim of this thesis was stated to be the estimation of sectoral price equations for Australia and, with the help of these estimated price equations, the answering of questions posed in that chapter. Thus in this chapter we are looking for studies containing sectoral price equations. Nevertheless, in the next section of this chapter we shall discuss some early work which embodies a sectoral approach to inflation while not being specifically concerned with estimating sectoral price equations. It is felt that a brief survey of these studies may be worthwhile because of possible insights that will be of use in later parts of this thesis.

The preliminary studies to be dealt with in the next section include the one by Moulton, and the four Joint Economic Committee
studies for 1959 by Schultze, Eckstein and Fromm, Wilson, and Levinson. As far as possible, the studies to be considered in section 2 of this chapter will be discussed according to the type of disaggregation used, the types of variables (both dependent and explanatory) used, the type of lag structure and any special features of the studies.

2.2. Early Work

2.2.1 Moulton

Moulton in his 1958 study of inflation (particularly wartime inflation) argues strongly against two prevailing aggregate views on the origins and causes of inflation. He contends that neither government deficit spending nor a rapid expansion of the money supply were responsible for the World War I inflation and tends to favour less aggregate theories. With this in mind he examines four indexes:

(a) the index of wholesale prices of all commodities,
(b) the index of wholesale prices of sensitive basic commodities,
(c) the cost-of-living index, and
(d) the index of weekly earnings in manufacturing.

He observes that, as expected, prices of sensitive basic materials rose.

by far the most, followed by wholesale prices, then wages and finally the cost-of-living index. He also observes that all prices rose, not only the prices of war-related goods and that this was the

"... inevitable outcome of interactions between prices and costs in the complex financial system." 1

His observations of the World War II experience strengthens his conclusions that

"the price rise typically begins in the war materials and other commodities of impending shortage, and gradually extends, though in varying degree, to all commodities. Involved in this interacting process are rising costs of materials and foodstuffs, rising wages and rising costs of finished products, both civilian and military. The continuing round of cost and price advances proceeds irrespective of the character of the monetary system or of the methods of financing employed; and it proceeds whether there is a budget deficit or a budget surplus. Experience has taught that the progressive rise in prices could be checked only by stabilising wage rates and raw materials prices - the two primary elements of costs." 2

Thus at least for wartime experience, Moulton suggests a disaggregation of the U.S. economy according to stage of production postulating that wages and raw materials costs are the most sensitive to the pressure of demand and that the resulting price increases are passed on, although not necessarily completely, in the following stages of production.

2.2.2 **The Joint Economic Committee Studies**

Now consider the four JEC studies mentioned above, all of

the economy by breaking up GNP into 16 expenditure categories or, in his terminology, "commodity groups". He finds strong correlation between increases in expenditure (a proxy for the pressure of demand) and price increases. But whereas expenditure fell in some sectors, prices rose in all sectors. Specifically, the investment goods sector showed the greatest increase in demand and also the greatest price increases, but sectors with no excess demand and even some with deficient demand did not show stable prices or price decreases. He also uses a second type of disaggregation in terms of the Wholesale Price Index (WPI) which

"... is broken down by economic sectors rather than by commodity groups." 1

He finds that industrial prices rose considerably while output was relatively stable. When he groups these industrial sectors according to stage of production he finds distinct evidence of price rigidities and further, that these rigidities are stronger the more advanced the stage of production. He explains this by saying that

"... in general the more advanced the stage of fabrication of a commodity, the more likely it is to be cost-determined. The closer it is to a raw material, the greater will be the influence of demand." 2

Note that this is very similar to the ideas of Moulton described above. But unlike Moulton who found that (war-induced) increasing raw materials costs were passed on along the production stages, Schultze found that raw materials costs were relatively stable and that finished goods prices generally rose because of

"... cost increases arising out of excess

1. Ibid., p. 106.
2 Ibid., p. 107.
which were concerned with the inflationary experience in the U.S. in the period 1955-58. Let us begin with the paper by Schultze. According to Schultze the period 1955-58 was characterised by generally rising prices despite the absence of aggregate excess demand. Moreover, while most prices were rising, price rises in certain sectors of the economy were greater than average. Schultze has been one of the main proponents of a disaggregated study of inflation and, in fact, his demand shift hypothesis of the inflationary process depends on this type of approach. While his analysis covers more than price determination, it is this aspect of his paper that will be considered here. He asserts that up to 1959 most analysis of inflation had been in aggregate terms but that this type of analysis was not wholly satisfactory for the 1955-57 period since this period was characterised by a marked shift in the composition of demand. The aggregate theory, he states, is based partly on the assumption that prices

"... must be roughly as flexible in a downward direction [as in an upward direction] ... otherwise the prevention of excess aggregate demand will not guarantee price stability if the composition of demand is shifting rapidly."¹

Against this Schultze argues that

"as a general proposition it takes a fairly sizeable decrease in demand, lasting over a significant period to induce price cuts."²

Thus, it is necessary to look at the prices of individual sectors separately in relation to specific sectoral excess demands.

To examine evidence at a sectoral level he first disaggregates

2. Ibid.
demands in the investment goods industries" 1
which gave rise to price rises in semi-fabricated goods and hence
to final goods prices. Consistent with this he notes that increases
in final goods prices were larger in
"... producers durable equipment and
nonresidential construction"
and that
"... prices of finished consumer durable
and nondurable goods rose by a much smaller
amount, and most of the rise in consumer
durable prices was accounted for by automobile
prices." 2

The Eckstein and Fromm study for the JEC is also based on the
conviction that the 1955–58 creeping inflationary period cannot be
satisfactorily explained by an aggregate theory and that special
attention must be given to certain sectors where prices rose faster
than average and to the effects of the price rises in these sectors
on the rest of the economy. The steel industry was chosen as the
subject for particular investigation because the rise in steel prices
was significantly above average 3 and because of the strategic position
of steel in the economy, steel being an important input into many
other sectors. The object of the study was to examine the indirect
as well as the direct effect of steel price rises on the WPI. While
wages are also an important factor in the influence of the steel
sector on the whole economy, the study is concerned almost entirely
with the effects of changes in steel prices on the prices of the

1. Ibid., p. 108.
2. Ibid., p. 107.
3. While Iron and Steel account for only 8% of the WPI, it directly
accounted for 27% of the increase in the index for the period.
output of other sectors. In this context the authors of the study set themselves two main tasks: (a) to measure the extent of cost-push from steel, and (b) to analyse the factors causing the rises in steel prices.

Eckstein and Fromm use the input-output model (and thus an industrial disaggregation) to tackle the first task. Input-output analysis is used to calculate the increase that would have occurred in the WPI in the post war period if the price of steel had behaved in the same way as the average of all other prices in the WPI and this hypothetical increase in the WPI is then compared with the actual increase. To compute the movement of the index that would have occurred if steel had behaved like the rest of the index the n sectoral prices are assumed to be determined by the following input-output based static equation:

\[
(2.1) \quad p_j = a_{1j}p_1 + a_{2j}p_2 + \ldots + a_{nj}p_n + R_j, \quad j = 1, \ldots, n
\]

where \( p_j \) = price of output of sector j,
\( a_{ij} \) = input of industry i per unit output of sector j,
\( R_j \) = (value-added per unit of output of sector j) + (steel cost per unit of output of sector j).

Then \( R_j \) is written as:

\[
(2.2) \quad R_j = a_{sj}p_s + a_{kj}w_j + \pi_j, \quad j = 1, \ldots, n.
\]

where \( a_{sj} \) = unit input of steel per unit output of sector j,
\( a_{kj} \) = labour input per unit output of sector j,
\( p_s \) = price of steel,
\( w_j \) = wage rate for sector j, and
\[ \pi_j = \text{unit profit for sector } j. \]

Hence, (2.1) can be written as:

\[ (2.3) \ p_j = a_1 p_1 + a_2 p_2 + \ldots + a_n p_n + a_s p_s + a_k w_j + \pi_j, \]

\[ j = 1, \ldots, n. \]

It should be noted that equations (2.3) are not price determination equations as envisaged in this study - they are more a statement of the composition of the unit revenue of the various sectors. Recognizing this, Eckstein and Fromm state that

"... as a year-by-year estimate of the influence of steel prices on other prices, the errors are probably substantial... but over a period of 5 or 10 years... prices must move roughly with costs."

Having calculated the increase in the WPI that would have occurred if the price of steel (assumed exogenous) had moved like the rest of the index and compared this with the actual increase Eckstein and Fromm conclude that

"... if steel had behaved like the rest of the index, the total rise from 1947 to 1958 would have been 14 points instead of the actual increase of 23 points, that is, the extraordinary behaviour of steel accounted for 40% of the rise over the 11 years. Most of the divergence has occurred since 1951."

Turning now to the part (b) of the study, which was concerned with the main causes of the observed rise in steel prices, Eckstein and Fromm found firstly, that wage costs rose much faster in the steel sector than in other sectors; secondly, that while wages were increasing sharply, profit margins were being maintained if not increased;

2. Ibid., pp. 7, 8.
and thirdly, that while demand was not strong enough to "explain" the price rises it was sufficiently strong

"... to permit these increases to occur without immediate and telling decline in the demand for steel." 1

Wilson's study of the U.S. machinery sector resembled that of Eckstein and Fromm in adopting a sectoral approach to inflation and in being concerned with a specific industry. The study has two main aims:

(a) to investigate whether demand pressures were responsible for the large rises in machinery prices in the 1955-58 period, and
(b) to analyse the effects of the machinery price rises on the general price level.

To examine the first question Wilson analyses various time series for the machinery sector. These series include wage costs, material costs, plant and equipment expenditures, capital appropriations, overtime hours worked, capacity and output relative to peak and, finally, orders data. An examination of these series provides some support for the hypothesis that the inflation in the machinery sector was caused by strong demand in that sector. In addition, Wilson estimates various equations explaining the change in machinery prices. For comparison, similar equations are also estimated for the steel sector. The preferred equation arising from the regression analysis was of the form:

\[
\Delta P_t = f \left[ \left( \frac{NO - S}{P} \right)_{t-1}, \left( \frac{GNP - GNP^*}{GNP^*} \right)_t, \left( \frac{UFO}{S} \right)_{t-1}, \Delta W_t \right]
\]

1. Ibid., p.34.
where \( f \) is linear and
\[
\Delta P = \text{the change in price},
\]
\( NO = \text{new orders}, \)
\( S = \text{sales}, \)
\( GNP* = \text{trend GNP}, \)
\( UFO = \text{unfilled orders, and} \)
\( W = \text{wages}. \)

The equations were fitted by Least Squares using data for the period III 1953 to II 1959. Beta coefficients were used to compare the importance of the variables in the regressions. The results of the regression analysis support the hypothesis that excess demand was an important causal factor in the price rises observed in the machinery sector. The variable \((NO-S)/P\) (representing excess demand) was found to be significant for the machinery sector but not for the steel sector. The coefficient of \((GNP-GNP*)/GNP^*, \text{reflecting the level of business activity, was found to be significantly positive for both sectors. While the estimated coefficient of the wage change variable was found to be significant and positive for both sectors, the relationship was found to be stronger in the case of steel. The variable UFO/S was not significant for either sector.}

The second aspect of Wilson's study of the machinery sector is concerned with determining the effect of the greater than average increases in machinery prices on the general price level. Wilson distinguishes between direct and indirect effects. Measuring the direct effect by
\[
\frac{\text{change in the index (actual)} - \text{change in the index (excluding machinery)}}{\text{change in the index (actual)}},
\]
he finds that for the period 1954-58

"...nearly one-fifth of the recent inflation in the industrial wholesale price index, and over one-fifth of the inflation in the wholesale price index for finished industrial goods are due to the greater than average price rise in machinery." 1

Partly because of the unavailability of suitable data, he is unable to quantify the indirect effects.

Hence, while Wilson has not presented a sectoral study of price determination for the entire U.S. economy, he has presented an analysis of one important industrial sector, and has also provided estimated price equations using sectoral explanatory variables with some success for two sectors.

Finally, consider the fourth JEC study by Levinson. Levinson does not set out to test any specific hypothesis but rather to present an analysis of price and wage data for the pre-1959 period. He considers only manufacturing industries and disaggregates them according to the Standard Industrial Classification, considering 19 2-digit manufacturing industries. His study consists mainly of cross-section regression analysis of wage and price changes on employment, productivity, output, profits and concentration ratios. In the analysis no strong relationship between price change and productivity or concentration ratios was found. The strongest relationships were found to be between price changes and profit levels and, particularly after 1951-52, between price changes and changes in gross hourly earnings.

Levinson's analysis is also concerned with the examination of trends within specific manufacturing industries. The main tool

1. Wilson, op.cit., p.56.
for this analysis are the ratios of various indexes for an individual industry to the same index for manufacturing as a whole. This analysis shows significant differences between industries. Common trends were found among some industries when classified according to concentration and degree of unionisation.

To sum up, these preliminary studies have shown that a sectoral approach to the study of price determination may well be fruitful - in many cases differences between sectors in price determination methods appear to warrant the use of this type of analysis. While price determination equations were not usually presented, the studies do give some indication of the types of disaggregation and the types of variables which may be useful. We will now consider other overseas studies which, unlike those just considered, have been concerned specifically with the estimation of disaggregated price equations.

2.3 Price Equation Studies

2.3.1 Neild

We will consider here only that part of Neild's study dealing with price determination. Here his major objective is to estimate an equation explaining the prices of manufacturing goods (excluding food, drink, and tobacco) in terms of wage and materials costs using quarterly British data for the periods 1950-60 and 1953-60 (the latter sample period being used to exclude the effects of the Korean War). The statistically "best" equation for 1950-60 was found to be:

\[ (2.5) \quad p_t = 0.044 + 0.141 \frac{w_t}{(1.025)^t} + 0.106 m_t + 0.065 m_{t-1} - 0.037 t_{-2} + 0.603 p_{t-1}, \quad R^2 = 0.998 \]

where \( p \) = index of manufacturing prices (excluding food, drink and tobacco),
\( w \) = index of wage rates,
\( w/(1.025)^t \) = index of wage rates adjusted for the long-term growth in the index of labour productivity estimated at 2\( \frac{1}{2} \)% p.a., and
\( m \) = index of material costs.

Results for the 1953-60 period were similar except that the coefficient of \( m_t \) was less well determined. In an attempt to remove the serial correlation evident in the above equation, a demand variable was included but it proved to be insignificant.

Separate equations for five industries (Paper, Chemicals, Timber, Textiles, and Food) were also estimated using revised data for the period 1957-61. Thus Neild's disaggregated analysis does not consist of disaggregating the economy or even the manufacturing sector into industries. Rather, the results of the analysis of the aggregate case are used to estimate equations for the five separate industries. Equation (2.5) with two changes are estimated for all five industries. Firstly, the productivity trend is "internally estimated" rather than being put in advance at 2\( \frac{1}{2} \)% per annum as in equation (2.5). Thus the variable \( w_t/(1.025)^t \) is replaced by \( w/(1+q)^t = w(1-qt) = w - q(wt) \) and both \( w \) and \( wt \) are included as explanatory variables, the estimated coefficient of \( wt \) providing an
estimate of \( q \). Secondly, \( m_{t-2} \) is dropped in the equations for the separate industries. The dependent variable used in all equations is the industrial price for the particular sector and the explanatory variables are all "sectoral" ones, i.e., they pertain to the sector for which the equation is being estimated. As suggested by the form of (2.5), it is assumed that prices and wages are related by a geometrically declining distributed lag and that materials costs are related to prices by a distributed lag the weights of which decline geometrically from the third weight onwards. The average lags implicit in the estimated coefficients of the lagged dependent variable vary from sector to sector. The lowest average lag of 0.136 quarters was for the Timber sector and the highest of 2.135 quarters was for Food.

The variables in the individual industry equations were often insignificantly different from zero. Thus the wage rate has a significant coefficient in only two of the five equations and in one of these it enters with a negative sign. Similarly, the "internally estimated" productivity factor, \( q \), (the coefficient of \( wt \)) is significant in only two cases (at 10%), in one of which it is negative and the other positive. The results for materials costs are somewhat better: current materials costs are always highly significant except in the Chemicals equation where it is significant at the 10% level only; but lagged materials costs are significant in only one case (Food) where it has a negative sign.

Comparing the results for all manufacturing with those for the five individual industries, Neild concludes that

"... in contrast to the results for all manufacturing, the coefficient of labour cost [in the individual industry equations]
is poorly determined compared with that of materials prices. As might be expected, the materials prices for individual industries are more variable than for total manufacturing and also contribute more to the variations in final prices." 1

2.3.2 Schultze and Tryon2

Schultze and Tryon are mainly concerned with estimating a wage-price subsystem for the Brookings model. In contrast with the two Australian studies to be discussed in the next chapter, industrial disaggregation is used rather than disaggregation by final demand category and the SIC categories are later converted by Fisher, Klein and Shinkai3 to conform with the final demand categories of the other parts of the model. Disaggregation is by industry because

"... the basic data and decision-making framework in the area of costs, factor prices, and demand for factors, relate primarily to an industry structure." 4

The price subsystem for the model consists of price equations for the following industrial sectors:

(a) Durable manufacturing,
(b) Nondurable manufacturing plus mining of crude petroleum and natural gas,
(c) Wholesale and retail trade,
(d) Regulated industries,

1. Ibid., pp. 24, 26.
(e) Contract construction, and

(f) Residual industries.

Separate equations are also estimated later for most of the SIC 2-digit industries, but this, obviously, was not the main part of the study.¹

Generally wholesale price levels, where available, were used as dependent variables. In some cases value-added prices were used and for the contract construction industry an implicit deflator was used. Regression equations were also reported using first differences one quarter apart as the dependent variable but the equations incorporated into the model were all of the price level type. Most of the equations for the 2-digit industries used WPI levels as the dependent variable.

All explanatory variables used were sectoral ones and were chosen on the basis of the following three-part pricing hypothesis:

(i) Prices are largely determined by markup on standard costs, i.e., costs at some "normal" level of operations,

(ii) Short-run cost changes have some effect on prices but this effect is smaller than that of standard cost changes.

(iii) Markup is influenced by demand relative to supply.

In addition Schultze and Tryon test whether the response of prices to positive and negative excess demand is asymmetrical.

For standard costs the variable used is:

¹ Schultze and Tryon point out that "... a number of industries are missing, and only a few of the possible combinations of variables were tried." (ibid., p. 310)
ULCN = \frac{RWSS}{X}

where ULCN = normal (or standard) unit labour costs, RWSS = compensation per manhour, and \( \bar{X} \) = a 12-term moving average of output per manhour.

except in the equations for the regulated industries where the trend value of depreciation per unit of output was used. This variable was not used in most other cases because of the difficulty of obtaining meaningful and accurate data. To represent raw materials costs at normal capacity a 4-quarter moving average of the materials price index was used.

To test whether prices reacted to short-run fluctuations of actual unit labour costs (ULC) about standard unit labour costs the variable (ULC - ULCN) was also included in the regression equations. To test the validity of part (iii) of the pricing hypothesis (i.e., the effect of demand pressure on markup) the following variables were experimented with:

(a) A capacity utilisation index used in the form of deviations from trend.

(b) In some cases the deviations of capacity utilisation from trend of the supplying industries,

(c) Deviations from trend of the ratio of inventories to output.

Finally, to test the asymmetry hypothesis the deviations of the capacity utilisation index were split up into positive and negative deviations and entered into the equations as two separate variables. A finding that the estimated coefficients of these two variables were signifi-
cantly different would support the hypothesis.

Having considered the structure of the equations experimented with let us turn to the results. First consider the estimation results for the six industry groups. As noted previously, different dependent variables were used for these groups. For durable and nondurable manufacturing the WPI for these two groups is used, for contract construction an implicit deflator is used and for the remaining three groups the dependent variable is a value-added price. Hence, for these last three groups materials prices are not relevant as an explanatory variable and therefore a comparison of materials prices vis-a-vis, say, ULCN cannot be made. Comparing the results for durable manufacturing, nondurables manufacturing, and contract construction, we find that in all equations ULCN is the most important variable (being consistently highly significant both in level and first difference equations). In the durables case the deviation of ULCN from ULC is found to be only marginally significant while in the nondurable equation it usually has the wrong sign and is insignificant. For construction this variable is significant but with a smaller coefficient than in the durables case (this is so in both the level and first difference form of the equations). Looking at materials costs, they were found to

"explain a substantial part of the variance not accounted for by normal unit labour costs." \(^1\)

In the price level equations reported materials costs were insignificant (and generally of the wrong sign) in the durables case and

\(^1\) Ibid., p. 305.
generally significant for the nondurables and the construction sectors. Where the equations were in the first difference form, results with the materials costs variables were similar for nondurables and construction and improved for the durables sector, the estimated coefficient usually being significantly positive. For the groups for which value-added prices were used the most important variable was ULCN although in the trade sector the coefficient of \((ULC-ULCN)\) was not consistently smaller than the coefficient of ULCN. The variable for depreciation costs added to the regulated industries equations was found to be significant. In the residual industries \((ULC - ULCN)\) and ULCN were again found to be of equal importance.

The results of experimentation with demand variables were very mixed. Generally, Schultze and Tryon found the performance of the capacity utilisation variable disappointing and they remark that this may well be the result of the poor data used to measure this variable. It did prove to be significant in some cases but, on the whole, the ratio of inventories to output proved significant in more cases. In most cases it was found that where capacity utilisation appeared to have some effect on prices, positive deviations had a larger coefficient than the negative deviations, thus providing some support for the asymmetry hypothesis.

Turn now to the estimated equations for the SIC 2-digit industries. These equations were not as fully experimented with as were the equations for the six industry groups discussed above. ULCN or a variable combining ULCN and depreciation costs is again the most consistently significant. As might have been expected, materials prices proved to be more important in the equations for some of
the 2-digit industries than in the equations for the six groups discussed above. The problem of multi-collinearity between materials and labour costs was encountered in many of the equations making the parameter estimates somewhat unreliable. There appeared to be weak evidence of the asymmetrical effect of demand on prices.

Sophisticated distributed lags were not used by Schultze and Tryon. However, various combinations of short lags were experimented with. Unlagged variables were almost always used in preferred forms since

"... the regressions obtained [using lagged variables] had poorer fits than the unlagged versions, and, almost without exception, the standard errors of the regression coefficients were larger." 1

2.3.3 Eckstein and Fromm 2

The main purpose of this study by Eckstein and Fromm is to test the validity of two competing pricing hypothesis:

(a) the competitive hypothesis, and

(b) the full-cost or target-return hypothesis.

For this purpose they estimate equations for the U.S. manufacturing sector as a whole and disaggregating this sector along industry lines, they also estimate separate equations for the durables and nondurables sectors. Wholesale prices in three different forms (the price level, the first difference in the price level, and the percentage change in the price level) were used to represent the dependent variable. As in other studies, equations with the dependent variable in the

1. Ibid., p. 307.

first difference form had lower $R^2$'s than the price level equations. The $R^2$'s associated with the equations having the dependent variable in percentage change form generally fall in between.

Eckstein and Fromm argue that the competitive hypothesis suggests that the following explanatory variables should be used:

(a) the backlog of unfilled orders - both level and change,
(b) the deviation of inventories from their optimal level,
(c) changes in unit labour costs,
(d) changes in unit materials costs, and
(e) the industry operating rate.

On the other hand, they argue that the target-return hypothesis suggests the following explanatory variables:

(a) changes in standard unit labour costs,
(b) changes in standard unit materials costs,
(c) changes in the standard capital/output ratio, and
(d) changes in the target rates of return, standard markup or standard volume.

In addition to the above nine variables, the deviation of ULC from ULCN was used as an explanatory variable to allow for a mixture of the two methods of pricing. Finally, asymmetry of price reaction to positive and negative cost changes was tested using two different tests. Firstly, (ULC-ULCN) was split up into positive and negative deviations which were used to form two separate variables. The second test involved two steps, the first of which was to identify the quarters in which, according to the estimated price equation, prices should have fallen and then to re-estimate the equation using data for the quarters in which prices should have risen (the equation
could not be re-estimated for the quarters in which prices should have fallen because there were too few observations). If the estimated coefficients for the cost variables in the re-estimated equation are larger than those in the original equation a bigger than average price reaction to cost increases is suggested. Only weak evidence for the asymmetry hypothesis was found using these tests.

The result of estimating equations with the above explanatory variables suggest that, in general, a mixture of the two competing pricing hypotheses provides the best explanation of price levels and price changes. The results for all manufacturing show that, on the basis of Beta coefficients, ULCN and lagged ULCN are more important than (ULC - ULCN) which is, however, significant. Materials costs are also important. Similarly, demand variables are less important than cost variables although both the operating rate and the ratio of unfilled orders to sales are significant. The estimated first difference and percentage change equations generally confirm these conclusions. When separate equations for durables and nondurables are estimated it is found that results for durables are similar to those for all manufacturing except that ULCN appears to be more important in the durables equation. In the equation for nondurables fewer variables prove to be significant but materials costs are more important. Of the demand variables, the industrial operating rate was found to be most useful.

Finally, consider the results of experimentation with lags. Some of the individual variables were introduced with one period lags, ULCN proving to be the most important. The lagged dependent variable was also tried in many equations. In the price level form of the
equation for all manufacturing the coefficient of the lagged dependent variables was high and highly significant. $R^2$ increases when this variable is introduced into the equation. But Eckstein and Fromm note that

"... of course, it is not satisfactory to rest so much of the statistical explanation on the lagged dependent variable." ¹

Thus they consider the result of including the lagged dependent variable in the first difference form of the equation and find that it has a smaller estimated coefficient and a smaller t-ratio suggesting that the

"... lags in the other variables ... account for most of the dynamics in the process. Thus this equation argues that prices adjust rather promptly to changes in demand and cost conditions, with the largest part of the adjustment occurring within a few months." ²

In the first difference form of the equation for durables, the lagged dependent variables has a large coefficient but again substantially smaller than in the level form of the equation for all manufacturing.

2.3.4 Evans³

As with many of the other studies so far considered the work by Evans to be discussed now is concerned with estimating price equations for a macro-econometric model, in this case for the U.S. economy. His study is included because, to some extent, he uses a disaggregation into sector by stage of production although he also

1. Ibid., p. 1173.
2. Ibid.
disaggregates by final demand sector. Both price level and price change equations are used in the same model. Evans' "basic" equation is the one explaining the level of manufacturing prices measured by the WPI. He then estimates price change equations (based largely on the change in manufacturing prices) for the following final demand sectors:

(a) consumer nondurables and services,
(b) consumer durables except autos and parts,
(c) autos and parts,
(d) fixed business investment,
(e) residential construction, and
(f) exports.

The manufacturing price equation explains the level of manufacturing prices measured by the WPI. The sectoral price equations for (a)-(f) above use implicit deflators in first difference form as the dependent variable. The preferred form\(^1\) of the estimated equation explaining manufacturing prices has the following explanatory variables:

(i) unit labour costs - \(\frac{\text{total wage bill for the manufacturing sector}}{\text{total output originating in the manufacturing sector}}\),
(ii) capacity utilisation index,
(iii) the lagged dependent variable in the form of the average level of manufacturing prices in the previous four quarters, and
(iv) a dummy variable for the Korean War.

The sectoral price change equations are explained largely by changes in manufacturing prices, this form being based on the argument that

\(^1\) For the theory underlying the form of the equation see Evans, *op.cit.*, pp. 290-300.
"... the prices of service industries are almost entirely determined by wage rates in these industries; the prices of trade industries are usually determined by a certain percentage markup of manufactured goods. Thus if one can explain wage rates and prices of manufactured goods, prices of service and trade sectors can be easily determined."

Thus, the three consumer goods price changes and the change in export prices are explained by the change in manufactured goods prices and the lagged change in manufacturing prices. In the equation for nondurables and services the change in farm prices is also included as an explanatory variable (a wage rate variable is not included). The equations explaining the two investment implicit deflators have a somewhat different form. The change in the implicit deflator for fixed business investment is explained by the change in the implicit deflator for GNP and the ratio of fixed business investment to GNP, the latter term being used to represent the inelasticity of fixed business investment with respect to price. The change in the residential construction deflator is explained by the change in the GNP deflator and the change over two quarters of the sum of fixed business investment and investment in residential construction.

As noted previously, the manufacturing price equation includes the lagged dependent variable among the explanatory variables. This variable is derived from an adjustment process of the form:

\[
\Delta p = \delta (p^* - p_{-1}),
\]

where \( p^* \) = the equilibrium price, and \( p \) = actual price.

1. Ibid., p. 291.
The lagged dependent variable on the right-hand-side of the equation is used in 4-quarter moving average form for statistical reasons because

"... otherwise the parameter estimate of the lagged term is likely to be severely biased upward."

Evans warns that despite this precaution

"... the importance of this term should not be overrated. Firms are likely to adjust prices quickly to changes in unit labour costs and capacity utilisation." 1

As previously noted, some of the sectoral price change equations have one period lags.

2.3.5 Phipps 2

Phipps, in his study of the effect of productivity and demand on prices in the U.K., estimates various price equations for four U.K. industries: (i) Chemicals, (ii) Textiles, (iii) Timber, and (iv) Paper. All equations estimated have the price level as the dependent variable. The explanatory variables are arrived at in the following manner:

Prices are assumed to be determined by markup over unit costs:

\[ P = K_0 + K_1C \]

where \( P \) = price of final output,

\( C \) = Unit prime costs,

and \( K_0, K_1 \) are constants.

1. Ibid., p. 297.

Writing unit prime costs as a weighted sum of wage earnings and raw materials price (2.7) becomes:

\[ P = K_0 + K_1 (B_1W + B_2M) \]  

where \( W \) = hourly wage earnings, and \( M \) = raw materials price.

An equation of this form is used to test the effect of labour productivity on the prices of the four sectors by specifying \( B_1 \) in two different ways. The first form which Phipps uses is:

\[ B_1 = \frac{X}{N_t} - 1 \]

where \( X \) = output per week at constant prices, and \( N \) = the number of hours worked per week.

Use of this form implies that prices are influenced by short-run productivity changes, and that the relevant labour costs variable is \( B_1W \) which is similar to the actual unit labour cost (ULC) variable used in some studies discussed earlier. The second form is similar to the one used in Neild's study and is given by

\[ B_1' = \left[ \frac{X}{N_o} \cdot (1 + \frac{n}{100})^t \right]^{-1} \]

where \( \frac{X}{N_o} \) = "full" capacity labour productivity in some base year, and \( n \) = the rate of growth of labour productivity (% per six months).

Use of this form implies that prices are influenced by long-run movements in productivity trend and that the relevant labour cost variable is \( B_1'W \) which can be thought of as a ULCN variable.

To test the role of demand in the pricing process a demand
variable, $D$, for which Kuh's "demand ratchet"\(^1\) is used, is added to the preferred estimated equation for each sector.

It is assumed that both labour costs and materials costs enter into the pricing equations with a distributed lag. To make the estimation of these lags manageable Phipps assumes that full adjustment of prices to these two costs is completed within two periods. This assumption is used in preference to a Koyck-type distribution of the lag weights because the statistical problems inherent in the estimation of geometrically declining lags are thus avoided and also because the estimation of the equations under the above assumptions shows that the lag coefficients do not always decline geometrically. The demand variable is used only in the current form.

Thus the estimated equations for each of the four sectors are of the form:

\[(2.9) \quad P_t = a_0 + a_1 (B_1 W)_t + a_2 (B_1 W)_{t-2} + a_3 M_t + a_4 M_{t-1} + u_t\]

These equations are first estimated for each sector using the two alternative specifications for $B_1$ to test the two assumptions made about productivity. The preferred forms resulting from these regressions are then used to test the importance of demand in the pricing process, equations of the following form being estimated for each sector:

\[(2.10) \quad P_t = a_0 + a_1 (B_1 W)_t + a_2 (B_1 W)_{t-2} + a_3 M_t + a_4 M_{t-1} + a_5 D_t + u_t\]

---

Finally, in an appendix Phipps reruns the regressions using a Koyck-type distributed lag so that he may compare his results with those obtained by Neild who also uses this type of lag.

Consider firstly, the results of the labour productivity test. Phipps notes that the choice between the competing hypotheses concerning the specification of $B_1$ will be made mainly on the basis of the t-statistic for the labour cost variable rather than on the basis of $R^2$ since

"... we are not concerned with producing an equation which yields the best predictive estimates but with choosing between hypotheses which deal specifically with the role of labour productivity in the pricing process."

The regression results showed that actual unit labour costs ($B_1W$) provided the best results for the Paper and Timber sectors and that $B_1W$ was preferable for the other two sectors. Current materials prices were always significant but lagged materials prices were generally insignificant. The Durbin-Watson test for serial correlation was generally indeterminate at the 5% level. When the demand variable was included it proved to be significant at the 5% level only for the Paper sector. At the 15% level the demand variable was also significant in the Timber equation.

The results of lag estimation were mixed. Lagged materials prices tended, on the whole, to be insignificant. Lagged unit labour costs were often significant and in some cases the coefficient of lagged wage costs was greater than that for current wage costs. The results of re-estimating the equations using a Koyck-type lag

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were markedly different from those obtained using the lags described above. As has previously been the case with price level equations, the lagged dependent variable is always highly significant and the size of the estimated coefficient varies between 0.346 and 0.657. Because of the marked difference between the results of the regression using the two different lag formulations Phipps is of the opinion that

"... Neild's conclusions may stem from the fact that he uses a Koyck-type distributed lag which is inappropriate and/or produces biased estimates when OLS are used."  

2.3.6. Agarwala and Goodson

As the title of this study suggests, Agarwala and Goodson are interested in consumer goods prices. Their study of consumer prices in the U.K. is policy-oriented. Specifically, they set out to analyse the effects of the Selective Employment Tax (SET) and indirect taxes on consumer prices. For this purpose they feel that a disaggregated approach is necessary.

Two types of disaggregation are used. In the first instance an industrial classification based on a 13-sector input-output table for the U.K. for 1963 is used. Prices based on this classification are later converted to prices for 10 consumer commodity groups. Their basic hypothesis is that unit prime costs and taxes are the primary factors determining prices. The input-output model is used to compute unit prime costs. Noting that unit prime costs are defined

1. Ibid., p. 296.

as the sum of unit labour costs and unit import prices, their reason for using the input-output model is given as follows:

"It is ... important to remember that the relevant labour (or import) cost is not just the direct cost at the final stage of production but the direct and indirect labour and import cost entering into the commodity at various stages of its production. In this situation it is virtually impossible to work out the effects of changes in particular wage rates (or import prices) on particular commodities by the usual time-series regression ... The only plausible approach is to utilize extraneous empirical information to form a hypothesis about the importance of a particular cost item in the price of a particular commodity and then see if the price movements predicted on the basis of these a priori constraints agree with the observed movements of prices."  

The "extraneous empirical information" which they find most useful for their purposes is the input-output model.

All equations are estimated with the price level as the dependent variable. As regards the explanatory variables and the lags used in the equations finally estimated consider first the derivation of the unit prime costs series using the input-output model. Unit prime costs are assumed to be related to unit labour costs and import prices in the following way:

\[(2.11) \quad C = A.C + D.W + E.M\]

where \( C \) = a vector of unit prime costs
\( A \) = the input-output matrix,
\( D \) = a diagonal matrix showing the proportion of unit costs formed by wages,
\( E \) = a diagonal matrix showing the proportion of unit costs formed by unit import costs,

1. Ibid., p. 57.
\[ W = \text{a vector of unit labour costs, and} \]
\[ M = \text{a vector of unit import costs.} \]

Using results obtained by Godley and Rowe\(^1\) for the aggregate case one-period lags are introduced into this equation to get:

\[ (2.12) \quad C_t = A.C_{t-1} + D.W_{t-1} + E.M_{t-1} \]

As noted previously, the input-output matrix used (and hence the above equation) is in terms of industrial sectors but Agarwala and Goodson are interested in consumer prices. This equation is therefore converted to one in terms of consumer goods sectors by methods used by Brown and Fisher, Klein and Shinkai\(^2\). The equation used for conversion is:

\[ (2.13) \quad C_{ct} = R.C_{t} + B.M_{t} \]

where \( C_c \) = a vector of prime costs for consumer goods,
\( R \) = a matrix for converting industrial categories into consumer goods categories, and
\( B \) = a matrix showing the direct import content by industry of final consumer goods expenditure.

By repeated substitution of (2.12) into (2.13) the following expression is obtained:

\[ (2.14) \quad C_{ct} = B.M_{t} + R.E.M_{t-1} + R.A.E.M_{t-2} + R.A^2.E.M_{t-3} + \ldots + R.D.W_{t-1} \]

\[ + R.A.D.W_{t-2} + R.A^2.D.W_{t-3} + \ldots \]

---

Lags of up to eight periods were used in this expression to obtain series for unit prime costs.

Using these prime costs figures, Agarwala and Goodson propose to estimate equations of the following form for each sector \( i = 1, \ldots, 10 \)

\[
(2.15) \quad P_{it} = \alpha_i + \beta_i C_{cit} + \delta_i D_{it} + \gamma_i T_{it} + u_{it}
\]

where \( P_{i} \) = price of consumer good \( i \),

\( C_{ci} \) = the elements in the unit prime cost vector obtained from (2.14),

\( D_{i} \) = the pressure of demand for good \( i \),

\( T_{i} \) = the indirect tax on good \( i \), and

\( u_{i} \) = the error term for the \( i^{th} \) equation.

Thus all explanatory variables are sectoral ones.

In their statistical analysis Argarwala and Goodson assume that indirect taxes are fully passed on to consumers and so the dependent variable in the equations actually estimated becomes price net of tax, i.e.,

\[
(2.16) \quad P_{it}^e = \alpha_i + \beta_i C_{cit} + \delta_i D_{it} + u_{it}
\]

is the form of the equation actually estimated. Indirect taxes are later added on to the estimated equations to obtain final prices.

The regressions were run using both annual and quarterly data. The unit labour costs component incorporated into the prime cost series discussed above was used in three different forms:

(i) Current unit labour costs,

(ii) A 4-quarter moving average of unit labour costs, and
(iii) An 8-period moving average of unit labour costs.

These different forms were tried in order to test whether prices are more sensitive to short-run or long-run changes in unit labour costs. The 4-period moving average proved to be superior and is used in preferred equations and also in the quarterly estimates. The prime cost variable proved to be highly significant in all equations reported. No suitable sectoral data were available to measure the influence of demand so that the rate of growth of quantity demanded was used as a proxy in the annual equations. In the regressions it consistently had a negative sign (contrary to expectations) and significantly improved the fit of only one of the sectoral equations. It was therefore dropped from the equations in subsequent policy analysis.

In the regressions using quarterly data prime costs based on a 4-period moving average of unit labour costs was again used. Two variables were used as a measure of demand pressure: (i) the ratio of the quantity consumed in the current quarter to the quantity consumed in the same quarter a year ago, and (ii) the ratio of the quantity consumed in the current quarter to the moving average of quantities consumed in the previous four quarters. Both variables, however, were omitted from the preferred equations for reasons similar to those for dropping the demand variable from the annual equations.

As mentioned previously, one period lags were incorporated into the calculations of unit prime costs. The length of these lags was based on the aggregate study by Godley and Rowe and no other experimentation with lags is reported.
2.4 Conclusions

This chapter has surveyed some important empirical studies on sectoral price determination for overseas countries. In the discussion the studies were divided into two groups: (i) those early studies which were concerned with a sectoral approach to inflation but which did not contain rigorous statistical tests of price equations, and (ii) those studies containing statistical tests of disaggregated price equations. Different types of disaggregation were used and many types of explanatory variables were used. In the concluding section of this chapter an attempt will be made to draw together the main ideas emerging from the discussion of these studies. A more detailed discussion of which of the hypotheses suggested by these studies (which ought to be tested for Australia) will be deferred to the following chapter. As most of the explanatory variables used in these studies appear relevant to most types of disaggregation (with the possible exception of geographical disaggregation) variables will not generally be described in relation to any particular type of disaggregation.

Four different types of disaggregation have been used in the studies reviewed above. Moulton, Schultze and Evans have all used a state-of-production-type of disaggregation. Moulton and Schultze both used this type of disaggregation to show the effects of price increases spreading through the economy mainly by way of materials costs, while Evans used it in conjunction with sectors defined by final demand categories. All these studies indicate that the determinants of prices may well differ according to the stage of production.
Most of the other studies have used sectors defined by industry. One of the reasons for this is probably the availability of WPI numbers in the U.S. and industrial prices in the U.K. The study of Schultze and Tryon appears to be the only one which discusses its choice of method of disaggregation. In this case the industrial classification is used partly for reasons of data availability and also because it corresponds more closely to decision-making areas. Besides this there are two studies using input-output analysis the disaggregation in which is largely by industrial classification. Two other types of disaggregation have been used, viz., final demand categories by Schultze and by Evans and consumer goods categories by Agarwala and Goodson.

The type of dependent variable used in the studies has usually corresponded to the type of disaggregation used. Thus, when the final demand type of disaggregation has been used an implicit deflator has been the dependent variable, and when industrial disaggregation has been used industrial prices have usually been the dependent variable. Schultze and Tryon were the exception. They used an industrial disaggregation with three types of price variables: (i) industrial prices, (ii) implicit deflators, and (iii) value-added prices. The most common forms which the dependent variable has taken have been the price level and the change in the price level. Eckstein and Fromm also used percentage changes. Using variables in the level form invariably gives the highest $R^2$ but multi-collinearity often becomes a problem and the importance of the lagged dependent variable if used becomes suspect (see the studies by Phipps, Evans, Eckstein and Fromm). Use of the dependent variable in the first
difference form brings with it possible errors of observation.

As many types of explanatory variables have been used in the various studies, it is not proposed to consider them all here, but merely to mention the ones which have proved to be the most useful. A more complete discussion is contained in Chapter 3. With little doubt the variable which has contributed most to the variation in price levels or price changes has been unit labour costs. This variable has been used in various forms and it appears that some type of normal labour cost variable has been the most useful. However, for various sectors actual unit labour cost has also been found significant (see, e.g., Phipps) and therefore this variable ought not to be rejected a priori. (One of the advantages of a disaggregated approach is that different types of variables can be used for different sectors where necessary.) Another cost variable frequently used especially in the more disaggregated studies is materials costs. There appears to be strong evidence that the materials-costs variable is far more likely to be significant in disaggregated than in aggregate studies although it will not necessarily be significant for all sectors. This variable has almost always been used in "actual" form rather than in "normal" form but there does not seem to be any obvious reason for this.

On the demand side, many different variables have been used most of them relating to the product market rather than to the labour market. Schultze, in his 1959 JEC study used the change in expenditure for various categories of goods to gauge the extent of excess demand in various sectors. Eckstein and Fromm in their 1959 study
also used changes in output of the steel sector to measure demand but state that the rate of capacity utilization is a better indicator of demand (especially in relation to supply) and also used the backlog of orders. However, neither of the studies have tested the variables empirically in price determination equations. Wilson used two variables successfully in his equations for the machinery and steel sectors, viz., 
\[(\text{NO} - \text{S})/\text{P}\] and a variable, 
\[(\text{GNP} - \text{GNP}^*)/\text{GNP}^*\], representing the general level of business activity. Turning now to the price equation studies, we find that Neild found that an index of excess demand for the labour market was insignificant in his aggregate equations. He does not give any indication that demand variables were used in his disaggregated equations. Schultze and Tryon found that the capacity utilization index performed disappointingly, being significant in only a few cases and that the ratio of inventories to output which was used to represent demand in some cases, proved to have a stronger influence. Eckstein and Fromm in their 1968 study found the ratio of unfilled orders to sales and the industrial operating rate to be significant measures of demand. Evans experimented with various measures of demand in his manufacturing price equation but found that the capacity utilization index was the most satisfactory. Phipps examined Neild's negative conclusions on the importance of demand and feels that the use of a labour market proxy for demand in the product market is not very satisfactory and that this may have resulted in Neild's conclusion. As an alternative, Phipps uses Kuh's "demand ratchet" variable (defined previously) but finds it to be significant in only one of the four industries which he considers and marginally significant in another. Finally,
Agarwala and Goodson used the rate of growth of quantity demanded without success to represent the pressure of demand.

When we consider the lag structure, we find that only one or two period lags on the individual variables or Koyck-type lags have been used in these studies. Studies using Koyck lags by the introduction of the lagged dependent variable on the right-hand-side of the equation, have generally warned against the importance of this variable especially in a price level equation (see the studies by Evans, Phipps, Eckstein and Fromm). Hence, in general, the studies indicate that short lags are the most appropriate.

Finally, various authors have tested the importance of asymmetrical price reactions to demand and cost changes. The evidence in favour of this hypothesis does not appear to be very strong but it has been found to be important in some sectors and will be worth experimenting with in Australian equations.
CHAPTER 3

SECTORAL PRICE STUDIES FOR AUSTRALIA

3.1 Introduction

Having examined sectoral price studies carried out using data for overseas countries in the previous chapter, let us now turn to the Australian work which has been done in this area. We find only two important studies both of which are concerned with estimating disaggregated (in the second case only slightly disaggregated) price equations for incorporation into macro-econometric models of the Australian economy. First the price equations for the Reserve Bank of Australia (RBA) model will be considered and then we will look at the price equations for the Treasury - Australian Bureau of Statistics (T-ABS) model.

3.2 Survey

3.2.1 The RBA Equations

The published material on the RBA equations consists of two papers.1 Paper 3F, which will be considered first, briefly describes the theoretical basis of the equations and some experimentation carried out with alternative forms. Paper 3G contains later versions

of the preferred estimated equations as included in the model RBAl. The two papers will be considered separately because of some differences in the equations estimated and in the variables used. Both papers are, however, concerned with estimating price level equations for various sectors for the purpose of incorporation into the Bank's macro-econometric model. Apart from data restrictions this is probably the main reason for the use of sectors defined by categories of final demand and implicit deflators to measure the various price levels.

Firstly, consider Occasional Paper 3F. The authors of this paper attempt to construct price equations which include both cost and demand influences on prices. They find that price theory suggests the following type of equation for the equilibrium price level:

\[(3.1) \quad p^* = f(X, ULC, pim, R),\]

where \(p^*\) = the equilibrium price level,
\(X\) = the pressure of demand,
\(ULC\) = unit labour cost,
\(pim\) = import prices, and
\(R\) = the rate of sales tax.

Following a suggestion by Eckstein and Fromm\(^1\) that in the oligopoly case prices are influenced not by short-run productivity changes as reflected in actual unit labour cost but by long-run productivity changes as reflected in a "normal" unit labour cost variable (ULCN), ULC is replaced by ULCN. Equation (3.1) then becomes:

(3.2) \[ p^* = f(X, ULCN, pim, R). \]

Eckstein and Fromm's method\(^1\) is used to calculate the ULCN series. To cast the equation in terms of actual rather than equilibrium prices, it is postulated that these two variables are related by the following distributed lag:

\[
(3.3) \quad p_t = w_0p^*_t + w_1p^*_{t-1} + \ldots + w_kp^*_{t-k},
\]

where \( k \) is some positive integer. Assuming that for \( k = \infty \) the coefficients \( w_0, \ldots, w_k \) in this equation have been generated by a general Pascal probability distribution, a result by Jorgenson\(^2\) may be used to write equation (3.3) as:

\[
(3.4) \quad V(L)p_t = U(L)p^*_t
\]

where \( U(L) \) and \( V(L) \) are polynomials in the lag operator, \( L \), of degree \( m \) and \( n \) respectively. Experimentation with various cases of \( U(L) \) and \( V(L) \) showed that because of statistical problems\(^3\), they could be of no greater order than zero and one respectively. Hence, equations (3.1) and (3.2) become:

\[
(3.5) \quad v_0p_t + v_1p_{t-1} = u_0f(X_t, ULC_t, pim_t, R_t).
\]

\[
(3.6) \quad v_0p_t + v_1p_{t-1} = u_0f(X_t, ULCN_t, pim_t, R_t).
\]

These equations are estimated in the form:

1. Ibid., pp. 1168-1169.
3. The dependent and explanatory variables showed autocorrelation and there was evidence of collinearity between them.
(3.5')  \[ p_t = g(X_t, ULC_t, pim_t, R_t) + v'_0 p_{t-1}, \]

(3.6')  \[ p_t = g(X_t, ULCN_t, pim_t, R_t) + v'_0 p_{t-1} \]

where  \[ g(x) = \left(\frac{u_0}{v_0}\right)f(x), \]  \[ x \]  some vector of explanatory variables, and  \[ v'_0 = -v_1/v_0. \]

These equations are estimated for the following implicit deflators:

(a) the implicit deflator for GNE,

(b) the implicit deflator for personal consumption expenditure on purchases of motor vehicles,

(c) the implicit deflator for personal consumption expenditure on other durables,

(d) the implicit deflator for personal consumption expenditure on non-durables,

(e) the implicit deflator for private investment in dwellings,

(f) the implicit deflator for private investment in equipment,

(g) the implicit deflator for private investment in construction.

Before discussing the estimated equations it should be noted that mainly aggregate explanatory variables are used. The exception is the sales tax rate and, of course, the lagged dependent variable. As regards the explanatory variables the following points should be noted. First, since direct measures of demand pressure in the product market in Australia are not readily available, labour market proxies were used in the empirical analysis. Both total unemployment and total vacancies were experimented with separately and with the exception of the equation for consumer durables, these variables were also used with one period lags. Secondly, to represent unit labour costs...
the following different variables were used in the reported estimated equations:

(i) Current unit labour costs = \textit{wages, salaries and supplements\non-farm GNP at constant prices},
(ii) normal unit labour costs calculated using Eckstein and Fromm's method as noted above, and
(iii) average weekly earnings.

Further, again following Eckstein and Fromm, the variable \((ULC-ULCN)\) was used as well as \(ULCN\)

"... so as to allow for a mix of competitive and oligopolistic influences." 1

Thirdly, for import prices the implicit deflator for imports of goods and services was used. This variable was used only in the GNE equation.

Fourthly, for the two consumer durables equations (motor vehicles and other durables) the appropriate percentage rate of sales tax was used.

In the equation for (a) (the implicit deflator for GNE) \(ULCN\) was found to be far superior to \(ULC\) (in terms of the significance of the estimated coefficient) but was not superior to the average earnings variable. The coefficient of the current unemployment variable was found to be significant whereas the coefficient of the same variable lagged one period was found to be insignificant. The results obtained using vacancies (both current and lagged) were similar to those using current unemployment. The import prices variables has a significant coefficient only in some cases and the coefficient of \((ULC-ULCN)\) is highly insignificant.

In the equations for (b), (c) and (d) explaining the implicit

deflators for consumption expenditure similar explanatory variables were used except that import prices were dropped and in the motor vehicles equation and the equation for other durables the relevant sales tax rates were added to the explanatory variables. The equations reported for motor vehicles and other durables had somewhat lower associated $R^2$'s than the equation for GNE and the equations for motor vehicles showed significant serial correlation in the disturbances. ULCN did not prove to be much superior to ULC in the durables equations but it was superior in the non-durables equations. Average earnings were again significant in all cases reported and, as in the case of the GNE equations, did not prove to be inferior to ULCN. Sales tax rates were always highly significant. The demand pressure variables were not generally significant in the durables equations but both unemployment and vacancies (current and lagged) proved to be significant in the non-durables equations.

In the equations for (e), (f) and (g) ULC performed poorly and ULCN was significant for construction and investment in equipment. Average earnings were significant only in the construction equation. The demand pressure variables had significant coefficients in all equations reported for dwellings, in none of the equations reported for equipment and in only two out of eight for construction. The construction equations showed evidence of serially correlated disturbances.

Hence, on the whole, the sectoral equations reported in Paper 3F were quite successful in using aggregate explanatory variables. In most cases it can be said that both costs (in the form of ULC, ULCN or average earnings) and demand (represented by unemployment or
vacancies) significantly influenced price levels and that using some combination of these variables as well as the lagged dependent variable (which was, of course, always significant) and dummy variables to account for seasonal influences in the data series, suitable equations explaining the implicit deflators were obtained. $R^2$'s were generally very high and in only two of the equations did serial correlation of the disturbances prove to be a problem.

Turning now to the price equations of RBAI (Occasional Paper 3G) we have separate equations for:

(a) the implicit deflator for personal consumption expenditure on non-durables,
(b) the implicit deflator for personal consumption expenditure on household durables,
(c) the implicit deflator for personal consumption expenditure on purchases of motor vehicles,
(d) the implicit deflator for gross fixed capital expenditure on dwellings,
(e) the implicit deflator for gross fixed capital expenditure on construction,
(f) the implicit deflator for gross fixed capital expenditure on equipment,
(g) the implicit deflator for government expenditure: current,
(h) the implicit deflator for government expenditure: capital, and

(i) the Consumer Price Index.

Comparing these equations with those in Occasional Paper 3F we find that three new equations have been added, viz., those for the implicit
deflators for government expenditure and an equation explaining the CPI.

Consider, firstly, the equations explaining the implicit deflators (a)-(f) above. In all these equations the total vacancies variable experimented with in Paper 3F has been dropped and unemployment has been used to represent demand pressure. This is probably for two reason: firstly, in the equations reported in Occasional Paper 3F the vacancies variable was not consistently superior to unemployment and secondly, unemployment is explained by the RBA1 model whereas vacancies are not. The unemployment variable is used without a lag and only in equations for non-durables, investment in dwellings, investment in construction and investment in equipment. Its coefficient is significant in the first two of these equations. Another change in equations for (a)-(f) which is worth noting is that the average earnings variable is used exclusively to represent labour costs. The reasons for this are probably similar to those advanced above in the case of vacancies and unemployment. The average earnings variable is used in all the equations but its coefficient is insignificant in the two consumer durables equations. In contrast to the results in the previous paper, the sales tax rate variable in the motor vehicles equation is not significant in this case. In fact, in the equation for this sector only the lagged dependent variable has a significant coefficient. A new variable was introduced into the consumer goods and investment goods equations except the motor vehicles equation. The new variable is the expected change in the CPI and is defined by equation (27) of RBA1 as:

\[(3.7) \quad \text{PCPI}_t = 100.\text{JW}(\text{J}_t\text{P}(\text{PCPI}_t))\]
where PCPICE = the expected change in the CPI,
JW = a 12-period weighted moving-average operator,
J4P(PCPI) = a 4-quarter percentage change of the CPI.

This variable is significant in only two of the five equations in which it was introduced. The R^2's associated with the equations range from 0.860 to 0.998 and there is little evidence of serially correlated disturbances.

Turning now to the remaining price equations in the model we find that both government expenditure deflators are explained in terms of the implicit deflator of GNP, the equation for capital expenditure also including two seasonal dummy variables. The R^2's for these two equations show a good fit but the Durbib-Watson statistics indicate serially correlated disturbances. Finally, the CPI is explained by the CPI lagged one period and a complex variable involving current and lagged values of (a), (b), (c) and (d) above.¹ Thus while the price equations in RBA1 are obviously founded on the more detailed work of Occasional Paper 3F they have been changed in some cases to suit the purposes of the model and possibly also in the light of further experimentation.

Summing up briefly, the RBA equations present some support

1. The estimated equation for the CPI is as follows:
\[ PCPI = 0.008 + 0.991 PCPI_{-1} + \frac{\sum_{j=1}^{14} w_{ji} P_j}{\sum_{j=1}^{14} w_{ji}} P_{i-1} - 1 \]
\[ (77.37) \]
\[ Se = 0.0039, R^2 = 0.996, DW = 2.11, CV = 0.004 \]

where PCPI = the CPI
\[ P_1, P_2, P_3, P_4 = (a), (b), (c), (d) \] above respectively, and
\[ w_{ji} = \text{exogenous weights}. \]
for the arguments in favour of a sectoral approach to price determination. The estimated equations reported showed significant differences in the equations for different sectors. Thus, even though aggregate explanatory variables were used, both the size and the significance of the coefficients in different equations varied. Differences were also evident in both the average lengths of the distributed lags implicit in the estimated coefficient of the lagged dependent variable and in the lags of specific variables although most explanatory variables were used in current form. Somewhat surprising in relation to the arguments advanced in Chapter 1 is the apparent success of aggregate explanatory variables in the estimated sectoral equations especially as evidenced by the usually satisfactory $R^2$'s. However, the favourable values for $R^2$ should be seen in the light of the fact that the equations were in the level form and the presence of the lagged dependent variable on the right-hand-side of the equations. Unfortunately, no estimated equations excluding the lagged dependent variable from the right-hand-side are reported in the studies (except the price equations for government expenditure). Further, some of the t-ratios for the estimated coefficients may be improved by the use of sectoral explanatory variables.

3.2.2 The T-ABS Equations

The studies to be discussed here are in many ways similar to

1. See pp. 2-6, supra.
the Reserve Bank studies discussed above. Firstly, the equations form part of an econometric model of the Australian economy. Secondly, they also use a disaggregation of the Australian economy into final demand sectors and sectoral price levels are represented by implicit deflators of expenditure classes of GNP. Thirdly, the main theoretical background is developed in the two first-mentioned papers by Higgins and slightly more disaggregated equations are given in the full model contained in the Higgins-Fitzgerald report. So the procedure will be as above, i.e., to consider the Higgins papers first and then the price equations as incorporated into the March 1973 version of the model.

Initially, Higgins concentrates on one price variable, viz., the implicit deflator for home-produced GNE (denoted PHG) since it is felt to be the

"... deflator of broadest scope which reflects domestic influences on domestic prices." ¹

Equations are also estimated for the consumption deflator, PC, since it is used as an explanatory variable in some wage equations. The

"... preferred forms arising from the investigation of PHG are used to estimate equations for PC." ²

In specifying the equations Higgins considers cost influences, demand influences and the influences of indirect taxes on prices.

Cost influences taken into account are restricted to unit labour costs partly for data reasons. Normal unit labour costs (ULCN) are used in preference to actual unit labour costs and are calculated

². Ibid.
by a method based on the Canadian RDX2 model which uses a production function to estimate normal labour requirements which, in turn, are used to calculate ULCN. In relating ULCN to PHG Higgins prefers the distributed form:

\[(3.8) \quad PHG = W(L)ULCN\]

to the simple mark-up form:

\[(3.9) \quad PHG = (1+k)ULCN\]

since previous studies have found significant lags between labour costs changes and price changes to exist. As in the RBA equations, the variable \((ULCN - ULC)\) was experimented with to "... allow for the possibility of a mixed system of pricing."

Secondly, consider the form of indirect tax rates as an explanatory variable. In the case where indirect tax increases are passed on completely the price equation takes the form:

\[(3.10) \quad P = (1+ITR)W(L)ULCN\]

where \(ITR\) = the rate of indirect tax.

To fit the equation the price variable is expressed net of tax and equation (3.10) becomes:

\[(3.11) \quad \frac{P}{(1+ITR)} = W(L)ULCN\]

Where indirect tax increases are partly absorbed, the equation takes the form:

\[(3.12) \quad P = (1+B.ITR)W(L)ULCN\]

where \(B\) = the proportion of indirect tax passed on.
Since B would probably have a dynamic structure, difficulties of non-linear parameters would occur if (3.12) were written in the same form as (3.11). To overcome this problem two alternative forms are proposed:

\[(3.13) \quad P = W_1(L)ULCN + W_2(L)ITR\]

or, following RDX2:

\[(3.14) \quad \frac{P}{(1+ITR)} = W_1(L)ULCN + W_2(L)ITR\]

Finally, to include demand pressure in the pricing equations, the ratio of total vacancies to the number of unemployed was used as a proxy. The rate of change of this ratio was also experimented with in initial estimations but was found to be insignificant.

Now consider the estimation results. The equations originally estimated were of the form:

\[(3.15) \quad \begin{cases} \frac{P}{(1+ITR)} = W_1(L)ULCN + W_2(L)ITR + W_3(L)\frac{V}{U} + a\frac{V}{U} + b(ULC-ULCN) + C \\ \end{cases}\]

Three estimated equations were reported with PHG as the dependent variable and two with PC as the dependent variable. As indicated in equation (3.15) distributed lags were used for ULCN, ITR and V/U in all equations. They were not successful for V/U but 7-period lags proved useful for the other two variables. Neither of \(\frac{V}{U}\) and \((ULC-ULCN)\) proved useful. In the equation where PHG is the dependent variable the weights on both ULCN and ITR are positive and declining. The coefficient of the demand pressure variable, V/U, is not
significant at the 10% level of significance. Serial correlation of the disturbances was found to be a problem in this equation as in all the other equations reported in the Higgins (1971b) paper. All equations reported in this paper have, however, been corrected for first order serial correlation. In the serially uncorrected equations for PHG, V/U was often significant. Despite V/U being insignificant in the serially corrected equations, it was retained in the preferred form because

"... the sums of the weights on lagged indirect taxes, where V/U is included, are generally more realistic than when V/U is excluded."

Thus when an equation of the form:

(3.16) \[ \text{PHG} = a + b(V/U) + W_1(L)\text{ULCN} + W_2(L)\text{ITR} \]

is estimated the weights on ITR are positive and declining as expected \textit{a priori}. But when V/U is dropped and the equation estimated is of the form:

(3.17) \[ \text{PHG} = a + W_1(L)\text{ULCN} + W_2(L)\text{ITR} \]

the weights on ITR are V-shaped and all negative except the first which seems an unacceptable pattern. As expected, in the equation with \( \text{PHG}/(1+\text{ITR}) \) as dependent variable the weights on ITR are all negative and decline in absolute value. But

"... in general the tax variable was insignificant at conventional levels." 2

The weights on ULCN in all equations are positive and decline monotonically. The preferred PHG equation incorporated into the July 1971

1. \textit{Ibid.}, p.29.
2. \textit{Ibid.}, p.29.
version of the T-ABS model was of the form of (3.16) above with the average lag on ULCN being 2.7 quarters and the average lag on ITR being 2.2 quarters.

Turning now to the estimated equations for the price of consumption, we find that again, in both the equations the demand pressure variable V/U is insignificant. In the equations with PC as the dependent variable the weights on ULCN are positive and declining and the weights on ITR are V-shaped with the first two weights being positive and the remainder being negative. In the equation with PC/(1+ITR) as the dependent variable the weights on both ULCN and ITR are positive and declining. The preferred form of this equation retains V/U and has PC as the dependent variable.

Now consider the price equations in the paper by Higgins and Fitzgerald. This study contains the estimated price equations explaining the following variables:

(a) the implicit deflator for consumption less imports,
(b) the implicit deflator for non-consumption, non-inventory national expenditure less imports, and
(c) the implicit deflator for non-farm inventory investment.

Other price equations are included but these are identities and will not be considered here. Consider firstly, the consumption less imports equation. It is similar to the consumption equation discussed above - the dependent variable is the price level and the explanatory variables are the rate of sales tax, the ratio of vacancies to unemployment and normal unit labour costs. In this case the demand pressure variable, V/U, is significant and both the other explanatory variables are used with a distributed lag. The weights on the sales
tax variable are all positive and declining and the weights on ULCN first increase and then decrease. The implicit deflator for non-consumption, non-inventory national expenditure less imports is explained solely by ULCN and a trend variable. The equation is of the form:

\[(3.18) \quad PBLD = (a+bQTIM)W(L)ULCN\]

where \(QTIM\) = a dummy variable representing time

\[\begin{align*}
100 & \text{ in 1958III} \\
101 & \text{ in 1958IV} \\
102 & \text{ in 1959I} \\
\ldots \ldots
\end{align*}\]

The weights on ULCN are all positive and declining. The equation explaining non-farm inventory investment is estimated in the ratio form:

\[(3.19) \quad \frac{PSNN}{PSNN_{-1}} = a + b \frac{PDHE}{PDHE_{-1}},\]

where \(PSNN\) = the price of non-farm inventory investment,

\(PDHE\) = the price of national expenditure on home-produced, non-inventory goods and services.

The estimated equation does not appear very satisfactory with an \(R^2\) of 0.224 and showing evidence of serially correlated disturbances at the 5% level. The coefficient of \(PDHE/PDHE_{-1}\) is significant at 5%.

3.3 Conclusions

The two disaggregated models of price determination for Australia discussed in the previous section of the chapter have many similarities which appear to be the result of both being designed to
form price "submodels" of larger econometric models of the Australian economy. Besides considerations of data availability, this purpose of the equations influenced to some extent the types of price variables used (implicit deflators) since these are in terms of final demand categories and can therefore be used in conjunction with constant dollar expenditures estimated elsewhere in the model. Another feature of the equations (probably also influenced by their purpose) is that the explanatory variables are, on the whole, aggregate ones. Thus aggregate unit labour costs and aggregate demand pressure variables are used. In the RBA equations, however, "sectoral" indirect sales tax variables are used in some equations.

Comparing the price equations of the two models, the Bank "submodel" shows more disaggregation. However, Higgins and Fitzgerald promise a

"considerable disaggregation of prices and a more elaborate treatment of the effects thereon of import prices using input-output data for extraneous specification of some parameters." ¹

Both models appear to have much the same theoretical basis, i.e., prices are determined by unit costs (only labour costs being used), the pressure of demand in some cases and indirect taxes where applicable. In addition, the Bank also experimented with import prices (these being dropped in the model in Occasional Paper 3G) and the expected change in the CPI.

Comparing the lag structure of the two studies we find that in the Bank equations it is assumed that the coefficients of

equation (3.3) above are generated by a general Pascal distribution (for the case \( k = \infty \)). Hence each of the explanatory variables are assumed to enter into the equations with coefficients generated by this distribution. A result by Jorgenson on rational distributed lags is then used to transform the equation into the form of (3.4) and this is truncated to give an equation with the dependent variable of the left-hand-side and the explanatory variables (not in the distributed lag form) plus the dependent variable lagged one period on the right-hand-side. This form is used in both papers 3F and 3G. In the estimated equations the lagged dependent variable is usually found to be highly significant (as expected). Estimation results showed significant differences between the estimated coefficients of the lagged dependent variable. If this variable is considered to be the result of a "Koyck transformation" applied to a geometrically declining distributed lag, the average lag implied in the estimated value of the lagged dependent variable varies from \( \frac{1}{4} \) quarter to 6 years.

In the T-ABS equations we find that the Almon method of estimating the coefficients of the distributed lag has been used. In the estimated equations presented in these studies we find that often the weights decline monotonically but that this is not always the case (especially in the case of the weights on the tax variable). Further the method employed in the T-CBCS model allows for the use of different lag structures for different explanatory variables. If some of the results are compared we find that the average lags are not as long in the Higgins-Fitzgerald equations. Thus in the equations
for consumption less imports the average lag on the tax variable is 1.76 quarters and on unit labour costs it is 3.69 quarters. Similarly, in the "investment" equation the average lag on ULCN is 1.53 quarters.

Thus having surveyed the two important studies of price determination in Australia, we find that only one of the various methods of disaggregation used in overseas studies (see Chapter 2) has been used. We have seen that different types of disaggregation have been used in the overseas studies surveyed in the previous chapter and the next section of this chapter will contain proposals for using these types of disaggregation for Australia. It will also be proposed to carry out further work using the demand-type disaggregation since the overseas studies have used some explanatory variables which have not been used in the Australian studies.

3.4 Proposals for further testing

In this section we shall draw on the discussion of the preceding part of this chapter and of the previous chapter in order to prepare a programme for the econometric work to be carried out in the following chapters. This programme will be built up in stages. First, we will consider the type of disaggregation to be used. Secondly, we will consider the form and type of the dependent variable. Thirdly, the various explanatory variables to be tested will be discussed and finally the proposals for the testing of lag structures and any other features will be described.
3.4.1 Types of Disaggregation

In the sectoral studies discussed in Chapter 2 disaggregation by industry was commonly used. Two of the studies used this type of disaggregation in conjunction with the input-output model. The two British studies by Neild and Phipps appear merely to have selected several industries for which data were available and used data for these industries for their analysis. In the U.S. study by Schultze and Tryon, on the other hand, there has been an attempt to disaggregate the entire economy or, at least, a large part of it. It is felt that, data permitting, the latter approach is preferable for the purposes of this thesis since the object is to analyse price determination in the Australian economy using a disaggregated approach rather than to study price determination in several Australian sectors. The possibility of using the input-output model will be discussed below when the explanatory variables are considered. Of the studies using the industrial disaggregation only Schultze and Tryon appeared to have discussed the reasons for their choice of type of disaggregation. They state that an industrial disaggregation was used (i) because the "decision-making framework" corresponds more closely to sectors defined by industry, and (ii) because most of the available data relate to this type of disaggregation. Since this type of disaggregation has been used with some success in overseas studies and has not been used in Australian studies it is felt to be worth experimenting with here.

The second type of disaggregation to be considered is

1. See the studies by Eckstein and Fromm (1959) op.cit., and Agarwala and Goodson, op.cit.
disaggregation by categories of consumer goods. It should be noted
that this type of disaggregation is not a disaggregation of the
entire economy but of that part of the economy producing consumer
goods, the disaggregation being by consumer goods categories. The
only study in which sectors defined in this way have been used is the
one by Agarwala and Goodson for the U.K. Agarwala and Goodson used
consumer goods sectors because their object was to examine the effects
of certain economic policy actions on consumer goods prices and they
expected these policy actions to have different effects on different
sectors. An investigation of consumer prices in Australia would be
of interest for two reasons - firstly, because the CPI is most commonly
used as a measure of the rate of inflation, and secondly, because
the CPI often features in wage demands based (partly at least) on
past and likely future increases in the CPI.

The third type of disaggregation to have been used in overseas
studies is disaggregation according to the stage of production. In
his discussion of inflation, Moulton suggests that this type of dis-
aggregation may be useful to show the spread of price rises from
demand sensitive basic raw materials through to final goods. Schultze
also used this type of disaggregation by regrouping sectors as de-
 fined by the WPI and found that the further advanced the stage of
production the more cost-determined is the price of the commodity.
Evans' equations for the Wharton model also imply this type of hypo-
thesis, i.e., that retail prices are largely determined by manufactur-
ing prices (the prices of output of the previous stage of production).
In fact, the study by Evans is the only one which contains estimated
price equations based on this type of disaggregation. The form of
Evans' equations, however, appears to be based on a priori reasoning only (see above, p. 20., Ch. 3) with no testing of alternative forms reported. Therefore the question remains as to whether retail prices are largely determined by manufacturing prices or whether both are perhaps influenced by similar factors or by different factors moving in a similar way. However, the a priori reasoning by Evans and also by Schultze and Moulton, and the results obtained do give the ideas sufficient plausibility to warrant some attempt to test them.

The fourth type of disaggregation to be considered is disaggregation according to final demand categories. As noted previously, this type of disaggregation has been used in the two Australian studies discussed in the previous section of this chapter and in the study by Evans considered in Chapter 2. As indicated, further work will be carried out using this type of disaggregation.

Finally, the fifth type of disaggregation mentioned in Chapter 1 is disaggregation by geographical sectors. This type of disaggregation was not used by any of the Australian or overseas studies reviewed. The most obvious way of disaggregating the Australian economy by geographical sectors is to consider each State as a separate sector. This type of definition also appears the most promising as regards data availability.

Considering the type of sectors defined and discussed earlier in this thesis it appears feasible to combine a geographical disaggregation with one of the other types of disaggregation already discussed. Thus, we could first disaggregate the economy into sectors defined by States and then further disaggregate each State
into, say, industrial or final demand sectors. Apart from considerations of data availability this type of "double disaggregation" will be considered to be outside the scope of this thesis. Hence, geographical disaggregation will be taken to mean that each Australian state is equivalent to a sector. From this definition the question arises as to what type of price to use to represent the price level of each sector. Theoretically, we could consider industrial prices, consumer prices or implicit deflators but it is anticipated that data availability will limit the choice so that this matter will be deferred till later.

When considering the estimation results it will be important to take into account whether the measure of the price level used for each State is a measure of the prices paid by residents of the State or a measure of the prices of the products produced within the State. If the former definition is used we would expect inter-sectoral dependence where some goods consumed within a State are produced within another State (or States), and hence the measure of the sectoral price level used will be important when we consider the questions which will be asked of the estimated sectoral price equations. We would not expect this type of interdependence if a measure of the price of the goods produced within a State is used.

3.4.2 The Dependent Variable

The studies reviewed in the previous chapters suggest that the type of dependent variable used is usually determined by the type of disaggregation used. Thus the two Australian studies discussed in this chapter used the final demand type of disaggregation and used
implicit deflators to represent sectoral prices. Schultze also used implicit deflators to represent sectoral prices when considering sectors defined by final demand categories. When an industrial disaggregation was used an industrial price index (e.g., the WPI for the U.S.) was used to represent the sectoral price levels. The exception to this rule is the study by Schultze and Tryon in which three types of price variables are used within the framework of an industrial disaggregation, viz., WPI numbers, value-added prices and implicit deflators. In the present study we will follow the studies which allow the type of price variable to be determined by the type of disaggregation used.

The form of the dependent variable also varied between the studies. Three different forms are to be found in the studies reviewed, viz., the price level, the first difference in the price level and the percentage change in the price level. As noted, Eckstein and Fromm use all three forms of the dependent variable and note that there are (statistical) problems associated with the use of all three. They state these as follows:

"Equations for price levels are vulnerable to multicollinearity introduced by common time trends, and are uncomfortably close to the identity of value, that is, price equals the sum of unit costs and unit profits. One-quarter differences show less of these difficulties, but given the small changes in the variables which occur from one period to the next, the errors of measurement are large compared to the actual price movements. Indeed, since the indexes are quoted to the nearest tenth of a point, rounding alone loses considerable quarterly variation. The four-quarter differences are a good compromise in these regards, but suffer from the autocorrelation induced by overlapping data." 1

Wilson, using first differences, considers possible errors of observation and taking the following example,

<table>
<thead>
<tr>
<th>Index level</th>
<th>125.7 ± 0.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical first difference</td>
<td>1.5 ± 0.2</td>
</tr>
</tbody>
</table>

notes that

"... errors of observation account for 20 percent of the variance in first differences ..." ¹

Since the relative importance of these problems is not known in advance, the most desirable course would have been to experiment with all three forms and make a choice if necessary, after such experimentation had been carried out. Unfortunately, however, this course of action is impossible if only for reasons of time and it was decided to estimate only price level equations.

3.4.3  **Explanatory Variables**

We will now consider the explanatory variables which have been used in the studies reviewed in this and the previous chapter. The discussion will proceed variable-by-variable, reference being made to the different form the variable has taken in different studies and to the success with which it has been used. Variables which appear to have been successful in the studies reviewed will be used in several different ways. First the explanatory variables which have proved successful in the Australian studies will be tried in price equations based on types of disaggregation other than the final demand type. Secondly, the sectoral counterparts of successful Australian

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¹ Wilson, *op.cit.*, p.65.
variables will be used with Australian data disaggregated by demand categories. Thirdly, variables which have proved to be successful in any one of the overseas studies discussed in Chapter 2 will be tried in equations based on all types of disaggregation, not merely the type used in the study concerned.

Most, if not all, of the studies considered, both the Australian and overseas, have found labour costs the most important variable in the cost group and, in fact, the most important of all explanatory variables. In most cases the emphasis has been on unit labour costs rather than, say, a wage rate or earnings variable. In the early work discussed in the first section of the previous chapter where, generally, no price equations were estimated, wage variables were often used although in most cases the effect of productivity was also mentioned. In the price equation studies the wage cost variable is usually adjusted for productivity and the method of adjustment used gave rise in many studies to a distinction between actual unit labour costs (ULC) and "normal" unit labour costs (ULCN). In these studies ULC was usually a wage or earnings variable adjusted for short-run changes in productivity and ULCN was obtained by adjusting the wage or earnings variable only for long-run productivity movements or standard or normal labour requirements. In the majority of cases ULCN was used in preferred equations. However, this was not always the case. Thus the studies by Schultze and Tryon and by Eckstein and Fromm found ULCN to be significant but Evans found a ULC variable to

1. A discussion of the problem of measuring the relative importance of explanatory variables in regression equations in this study will be found in the discussion of empirical results in Ch. 5.
be significant. Phipps, in his disaggregation study for the U.K., experimented with two types of labour costs and found both to be significant but for different sectors. If we look at the Australian studies we also find mixed results. In RBA paper 3F the authors reported that the substitution of ULCN for ULC in the regression equations generally led to an improvement in the fit of the equations and to an improvement of the t-ratio associated with the estimated coefficient. It should be noted, however, that this was not the case for all equations and that if equations using ULCN to represent labour cost are compared with the same equations using average earnings to represent labour cost the reported improvement in the estimated equations (in terms of $R^2$ and the t-ratio) is not generally apparent. In fact, in the RBA1 model reported in Paper 3G average earnings are used to represent labour cost in all the equations. The T-ABS studies used ULCN in the preferred equations since the

"... use of normal unit labour costs, which abstracts from short-term productivity movements, generally provides a more accurate simulation result." ¹

Thus, on the whole, the empirical results seem to favour ULCN rather than ULC but they also indicate that average earnings and ULC ought not to be rejected in advance. Further in contrast with the Australian studies, it is proposed to use sectoral labour cost variables rather than aggregate ones.

Given that ULCN will be experimented with in the equations, it must be decided how to calculate ULCN. Again, various methods

have been used with no testing of alternative methods in the same study. The simplest method has been to divide a wage or earnings variable by a long-term moving average of productivity or by an externally estimated constant rate of increase in productivity.¹ More complicated methods were used by Eckstein and Fromm, by the RBA who used Eckstein and Fromm's method, and by Higgins. With respect to the first two methods, it is felt that long-run changes in productivity should be taken into account and that, therefore, ULCN should be computed using a long-term average of productivity. Further, it is felt that the simplest method ought to be experimented with first. If this is unsuccessful other methods could then be tried if data permit.

In the equations where ULCN was used, a variable ULC - ULCN was also often used to test for the presence of both oligopolistic and competitive pricing. The results obtained using this variable were mixed. Eckstein and Fromm generally found it significant while in the study by Schultze and Tryon it was found to be significant in some cases only. In both Australian studies it was not significant.

Thus concerning the labour cost variable, many different variables have been used and there appear to be few general conclusions to be drawn with respect to their success. However, it appears that ULCN is likely to be more successful (in terms of $R^2$ and the significance of the estimated coefficient) than ULC or a wage or earnings variable and that ULC - ULCN could enter the equations with a significant but small coefficient. The Australian studies (see also

¹. See the studies by Neild, *op.cit.*, and Phipps, *op.cit.*
Pitchford and Nieuwenhuysen and Norman\(^1\) indicate that wage or earnings variables ought to be tested, especially in a disaggregated study where it might be expected that different variables are important for different sectors. Since labour costs enter into the costs of production for each sector irrespective of the way in which the sector is defined, it appears that these comments are applicable to all types of disaggregation to be used, the definition of the sectoral wage and productivity variables depending on the type of disaggregation.

The second variable to be considered in the cost group is materials costs. As has been noted earlier, it appears from empirical research overseas that materials costs tend to become more important in pricing equations when they are estimated at a disaggregated level. Almost invariably, the materials cost variables have been found to be less important than labour costs variables in price determination equations and, perhaps as a result of this, less experimentation with the form of this variable has been carried out. Materials cost variables are not used at all in the two Australian studies reviewed in this chapter but have been found to be important in overseas studies and hence will be tested in this study. Several points emerge from overseas studies. Firstly, the materials price variable has usually taken the form of a quarterly index, though the Schultze-Tryon study has used both this form and a 4-quarter moving average of materials prices. The latter was found to be significant in some

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cases and the former in others. Secondly, from Evans' study it appears that farm prices may be important in a price equation for non-durables. Thirdly, if a stage-of-production disaggregation is used we would expect materials prices to be important. Finally, the results obtained by Agarwala and Goodson using materials (and labour) costs within an input-output framework indicate that this hypothesis ought to be tested.

The only study so far reviewed which has stressed the importance of overhead costs is the 1959 study by Schultze. He split overhead costs up into overhead employment costs and the costs of capital consumption, and he argued that overhead costs were particularly important causal factors in the 1955-57 inflation in the U.S. He also argues that the increasing proportion of total costs accounted for by overhead costs accentuated the downward rigidity of prices since most overhead costs are relatively fixed and are, therefore, difficult to reduce if output falls short of the projected output on the basis of which overhead costs were incurred. However, none of the other studies so far discussed have attached importance to the independent effect of overhead costs on prices and an overhead costs variable has therefore not been tested in any price determination equations. Nevertheless, when considering labour cost variables in the regressions in this thesis it may be interesting to test whether the effects of overhead labour costs on prices is the same as that of non-overhead labour cost.

Another variable which has been used only rarely is profits. Eckstein and Fromm in their 1959 study of the U.S. steel sector found some evidence of the importance of profits. In their 1968 study
they also included a profits variable, viz., the after-tax rate of return on real capital corrected by the operating rate to test whether changes in the target rate of return have any influence on prices. Since this variable was not included in any of the estimated equations reported in their study it may be assumed to have been unsuccessful. It is, therefore, not proposed to test this variable especially in the light of Wilson's comments that increases in profit margins are probably the result of strong demand.

The only remaining cost variable which appears to have been important in several studies is the rate of sales tax. This is especially true for the Australian studies and it is, therefore, proposed to test this variable in sectoral price determination equations to be presented later in this thesis.

We will now consider the second group of explanatory variables, viz., the demand variables of which two types will be distinguished: (i) variables measuring the pressure of demand or excess demand in the product market, and (ii) proxy variables measuring the pressure of demand or excess demand in the labour market. In general we find that, with the exception of the study by Neild, all the overseas studies discussed in Chapter 2 have used variables of type (i) and both the Australian studies have used labour market proxies which fact is due mainly to the unavailability of suitable product market demand variables in Australia. Considering the type (i) variables first, we find that several different variables have been used. The most important of these are capacity utilization, orders data, and the inventory/sales ratio. A capacity index has been the most favoured and would appear to give the best indication of demand relative to
supply though it has been unsuccessful in some cases possibly because of poor data.\(^1\) Hence we would expect this variable to be important if suitable data could be found. Cruder measures of capacity utilization have been used by Phipps (Kuh's demand ratchet) and Wilson (output relative to previous peak output) and these could be used if satisfactory capacity utilization series are unavailable. One other measure used by several studies is the change in output or expenditure (used by Schultze, Eckstein and Fromm (1959), Wilson, Agarwala and Goodson).

Let us now turn to the labour market variables which have been used as proxies for demand pressure in the product market. As mentioned earlier, the study by Neild is the only overseas study in which this type of measure (in this case the Dow-Dicks-Mireaux index of excess demand in the labour market) has been used. Neild found the variable highly insignificant and concluded that

"... this rejection of demand influence seems fairly decisive, but it remains possible that a more complex formulation or a different indicator might lead to a different conclusion." \(^2\)

The measure was not tested in the disaggregated equations. Rushdy and Lund,\(^3\) in a re-examination of Neild's conclusions found some support for the inclusion of the Dow-Dicks-Mireaux index in the aggregate pricing equation. The conclusion is not very strong and

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1. See Schultze and Tryon, *op.cit.*
they state that

"... the level of demand cannot be dismissed as being an insignificant factor in the explanation of the price changes of manufactured goods, even after its effects on costs (wages and materials) have been accounted for."

Both the Australian studies used labour market proxies to represent demand pressure in the product market. The RBA studies used both the number of unemployed and the number of vacancies (both for the whole economy) separately and found that both variables performed satisfactorily. Only the level of unemployment was used in the RBA1 model. It was found to be significant in only two equations suggesting either that the pressure of demand is important in some sectors only or that the proxy is not a very satisfactory measure of demand pressure, or both. Thus, it appears that further experimentation is necessary with (i) sectoral rates or levels of unemployment and/or vacancies, and (ii) other demand variables. The studies by Higgins and Higgins and Fitzgerald for the T-ABS model also used labour market variables. It will be recalled that in the paper by Higgins the ratio of vacancies to unemployment was used in both the PC and PHG equations but that in all equations reported it was insignificant. This variable is also used in the consumption less imports equation in the paper by Higgins and Fitzgerald. Another formulation of this variable used by Pitchford in aggregate equations is the ratio of vacancies less unemployment to the sum of employment and unemployment which he uses as a measure of percentage excess demand in the labour market. This form appears consistently significant in his equations and, intuitively, appears to be the most suitable form. Another measure of

demand pressure in the labour market is overtime hours worked used by Wilson and this will be tested in this thesis.

A final variable which does not fall into either the cost or demand categories is price expectations. Only one of the studies reviewed in the previous two chapters has used a variable representing expected prices (or price changes), viz., the RBA paper 3G. The neglect of price expectations in price determination equations is probably due to two main factors: (i) price expectations are not likely to be very important in the process of price determination if the rate of price increase fluctuates irregularly between zero and, say, 3 or 4% p.a. as it has done in Australia for much of the post-war period, and (ii) expected price is very difficult to quantify and hence there are significant problems in testing the importance of price expectations. If price expectations do, in fact, have a significant effect on price changes, it would appear that a large part of this effect would occur indirectly by way of the effect of expectations on wages and demand, both of which already enter as explanatory variables.

Apart from the question of whether price expectations are likely to have an effect on price independent of their effect on wages and demand, there is the question of the measurement of expectations. In the absence of a directly observable price expectations variable, expectations have almost always been measured by a combination of past prices and if this type of variable has a significant coefficient in a price equation one cannot be sure whether this means that

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the cost and demand variables should enter into the equation with an infinite distributed lag. In view of these uncertainties, it has been decided not to experiment with an expectations variable in this study.

3.4.4 Lag structures and other features

In general, the studies reviewed in Chapter 2 have shown that the greater part of the adjustment of prices to the explanatory variables used is accomplished within two quarters. Several of the studies have used a distributed lag resulting in the inclusion of the lagged dependent variable on the right-hand-side of the equation. Neild estimates equations of this type which result from the imposition of a geometrically declining lag on both materials and wage costs and finds the coefficient of the lagged dependent variable to be always highly significant in his aggregate equations. He also performs tests on alternative lag specifications for both wage and materials costs the results of which tend to confirm that geometrically declining lags were, in fact, appropriate. As mentioned above, Phipps is rather sceptical of the validity of the results obtained by Neild using this type of lag structure. Further, experimentation was carried out only with aggregate equations and no separate experimentation is reported for the sectoral equations which all have the lagged dependent variable on the right-hand-side. The other studies to use the lagged dependent variable on the right-hand-side were the ones by Evans and Eckstein and Fromm, both of which expressed doubt as to the conclusions which could be drawn from the estimated coefficients of that variable especially in price level equations and both of
which stated that adjustment of prices to cost changes is likely to be rather quick.

When we consider the two Australian studies reviewed in this chapter, we find that more sophisticated lags were used. The RBA studies assumed that actual prices were related to equilibrium prices (and hence the explanatory variables) by a distributed lag, the weights of which are generated by a general Pascal probability distribution. Under various simplifying assumptions equations are obtained and estimated which have the current values of the explanatory variables (in some cases also with a one period lag) plus the lagged dependent variable on the right-hand-side of the equation and those are to be viewed with the same caution as the Koyck-type equation. As has been the case in previous studies, the coefficient of the lagged dependent variable is almost always highly significant and often large. The T-ABS equations, on the other hand, use Almon distributed lags on ULCN and indirect taxes. In all equations reported the weights on ULCN are positive and declining. On the tax variable (which is usually insignificant) there is no consistent trend. Commenting on the preferred equations for PC and PHG Higgins says

"Although some of the preferred equations seem reasonable no emphasis is placed on the implied estimates of the extent to which indirect tax changes are reflected in prices."\(^1\)

Thus, in conclusion, it appears that short one or two period lags will be the most useful (and also the easiest to experiment with) but that longer lags ought to be experimented with (especially Almon-type lags) in the light of the results of the T-ABS equations.

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The only remaining aspect of the studies discussed to be considered for testing with Australian data are the various tests carried out to ascertain whether the response of prices to demand and cost changes is asymmetrical.

The asymmetry hypothesis appears to have been first suggested by Schultze in his 1959 JEC study and, in fact, much of his explanation of the 1955-57 U.S. inflation was based on the hypothesis that firms increased prices more readily (and by a greater amount) in the face of excess demand than they reduced prices in the face of deficient demand. Schultze finds some evidence for this for the 1955-57 period.

A more thorough test of this hypothesis was carried out by Schultze and Tryon. It will be recalled that to represent the pressure of demand on prices, they used, *inter alia*, the deviation of capacity utilization from normal. To test the asymmetry hypothesis they split this variable up into positive and negative deviations and enter these as two separate variables in the price equation. If the hypothesis is correct we would expect the coefficient of the positive deviations to be greater than the estimated coefficient of the negative deviations. The hypothesis was tested using both the six broad industry groups and the 2-digit industries and was found to be supported in many industries.

As mentioned previously, Eckstein and Fromm used two different methods to test for the asymmetry of price change to cost change. In the first the variable ULC - ULCN was split into two variables, *viz.*, one for positive deviations and one for negative deviations. If the asymmetry hypothesis is correct we would expect the estimated
coefficient of the positive deviations to exceed the estimated coefficient of the negative deviations. In the second, quarters during which prices should have risen according to the estimated equation were indentified, the equation was re-estimated for these quarters and we would expect the coefficient of the cost variables in the re-estimated equation to be greater than the corresponding coefficients in the original equation. The results of both these tests provide only weak evidence of asymmetry. But Eckstein and Fromm note that part of any downward price rigidity is already accounted for by the use of "normal" unit labour costs which are not affected by short-run productivity changes.

Thus, overall, it appears that overseas studies provide some evidence (although weak) of asymmetrical response of prices to cost and demand changes. Furthermore, Schultze and Tryon's more disaggregated study found this factor to be important for certain sectors and since this thesis is to be concerned, inter alia, with investigating sectoral differences in price determination, it is felt that the hypothesis should be entertained.
CHAPTER 4

DATA

4.1 Introduction

Having outlined the proposed programme of work for this thesis in the final section of the previous chapter, it is now necessary to consider the data which are required to carry out this programme. This will be the first task to be undertaken in this chapter; it will be contained in section 4.2. Section 4.3 will deal with the question of the availability of the data shown to be required in section 4.2. It will transpire from the discussion of this section that some of the required data which are not available in the proper form can be constructed from available data. In section 4.4 we will discuss this data in some detail together with the methods used to construct it. All constructed series will be reproduced in Appendix 4.2. The final section of this chapter (section 4.5) will contain an evaluation of the data to be used.

4.2 Data Required

This section will contain a discussion of the data required to represent the following six types of variables: prices (dependent variable), labour costs, materials costs, sales tax, product market demand variables and labour market demand variables (explanatory variables).
4.2.1 Prices

Data are required to represent price levels for sectors defined according to the following types of disaggregation:

(1) Industrial disaggregation,
(2) Disaggregation by expenditure categories,
(3) Disaggregation by stage of production,
(4) Disaggregation by consumer categories, and
(5) Geographical disaggregation.

In the case of sectors defined by disaggregation of types (1), (3) and (5) above we require for each sector a price index measuring the price levels of the goods produced in that sector and in the case of sectors defined by disaggregation of types (2) and (4) we require for each sector a price index measuring the price level of the particular class of goods covered by the sector.

4.2.2 Labour Costs

It will be recalled that in the previous two chapters a distinction was made between actual and normal unit labour cost. To compute actual unit labour cost (ULC) for a particular sector we require both wage-rate (or earnings) data and short-run productivity data for that sector. ULC ought to be based on the wage-rate if it is expected that a firm adjusts its prices only for changes in the wage-rate it pays its employees (after taking productivity into account) and on earnings if it is thought that prices are also adjusted to, e.g., changes in overtime earnings. To compute normal unit labour cost (ULCN) for each sector we require data representing
long-run productivity for each sector in addition to wage-rate or earnings data. It will be recalled that long-run productivity will be calculated as a moving average of short-run productivity. Hence to calculate both ULC and ULCN, data for wage-rates, earnings and short-run productivity will be required for each sector. In the case of disaggregation of types (1), (3) and (5) the wage data for a particular sector should relate to those employed in the sector whereas in the case of disaggregations of types (2) and (4) it should relate to those employed in making the goods covered by that sector.

Besides ULC and ULCN, it was stated in the previous chapter that it would be worthwhile experimenting with an earnings variable on its own, unadjusted for productivity or with productivity as a separate variable. This will obviously not require extra data. Similarly, if we wish to experiment with a wage rate variable on its own with productivity as a separate variable no extra data will be required.

In addition it was suggested in the last section of the previous chapter that the effects of overhead and non-overhead labour costs should be tested for separately. For this we would require that the three types of series mentioned above be available for both overhead and non-overhead labour for each sector.

4.2.3 Materials Costs

In the case of materials cost the materials cost variable for an industrial, stage-of-production or geographical sector would be required to measure the cost of materials used by that sector. For an expenditure or consumer sector the materials cost data would be
required to represent the cost of materials used in the manufacture of the goods covered by the sector.

It was further suggested in the previous chapter that materials costs and labour costs could alternatively be calculated for each sector by the input-output method used by Agarwala and Goodson. To ascertain the data requirements for the use of this method of computing unit prime costs it is necessary to examine the method in more detail than was done in Chapter 2 and for this reason the task has been deferred to subsection 4.2.7.

4.2.4 Sales Tax

The final cost variable to be discussed is the sales tax rate. For sectors defined by expenditure and consumer goods classes this variable will be taken to be the weighted average of the rates applying to the goods in the class since sales tax is generally levied on classes of goods rather than on, say, specific firms or industries. In the case of sectors defined by industry, stage-of-production or geographical area, the rate-of-sales-tax variable for a particular sector will be the weighted average of the rates applicable to the principal goods produced by the sector. Thus, to test the importance of the sales tax variable we require an index of the rate of sales tax for each sector (as described above) for which sales tax is likely to be important.

4.2.5 Product Market Demand Variables

Several variables representing the pressure of demand in the product market were suggested in the previous chapter. If all these
are to be experimented with we require data for each sector for each of the following variables.

(1) Capacity utilization;
(2) Orders data;
(3) Inventory levels;
(4) Sales;
(5) Output;
(6) Expenditure.

In connection with item (1), it should be noted that "capacity utilization" is usually associated with a particular industry. It may, therefore, be difficult to define for a sector defined by disaggregations of types (2) and (4) and also for a stage-of-production sector where the same firm may be involved in the production covered by two different sectors. For these sectors capacity utilization will be thought of as the level of capacity utilization of those firms or industries principally engaged in the production of the goods which they cover. In the case of item (6) we face the difficulty of defining "expenditure" for an industrial sector since expenditure is usually disaggregated by type of purchaser (e.g., private, government) and by type of good (e.g., capital goods, consumer goods). Expenditure corresponding to an industrial sector will be taken to be the expenditure on the principal output of the sector by all types of purchasers. A similar difficulty arises in the case of the disaggregation of types (3) and (5) and it will be dealt with in the corresponding way.
4.2.6 Labour market Demand Variables

To implement the proposals outlined in the previous chapter regarding the importance of labour market demand variables in price equations, data for each sector for each of the following variables are required.

(1) Unemployment;
(2) Vacancies;
(3) The Dow-Dicks-Mireaux index of excess demand in the labour market;
(4) Overtime hours.

It is likely that difficulties will be faced in defining unemployment for sectors since it is unlikely that each sector will have its own isolated labour market where unemployment may be measured except, perhaps, in the case of geographical sectors. Hence an aggregate unemployment variable will be used in equations for expenditure, consumer, stage-of-production and industrial sectors and sectoral unemployment variables will be used in equations for geographical sectors. The same difficulties are not likely to be faced in the definition of vacancies and hence sectoral variables will be required for all sectors, vacancies for expenditure and consumer sectors being defined as vacancies in the principal forms or industries producing the goods covered by each sector. What was said in relation to unemployment applies also to the DDM index of excess demand in the labour market since this index is based, inter alia, on the rate of unemployment. Finally what was said in relation to vacancies applies also to the overtime hour variable.
4.2.7 Unit Prime Cost

Finally in this section we consider the data requirements for the calculation of unit prime cost using the input-output-balanced method proposed by Agarwala and Goodson in their study for the U.K.

It will be recalled that Agarwala and Goodson's initial equation was of the form:

\[(4.1) \quad C = A.C + D.W + E.M\]

where \(C\) = a vector of unit prime cost for industrial sectors, 
\(A\) = the input-output matrix (transposed), 
\(D\) = a diagonal matrix showing the proportion of unit cost formed by wage cost, 
\(W\) = a vector of unit labour cost, 
\(E\) = a diagonal matrix showing the proportion of unit cost formed by import cost, and
\(M\) = a vector of unit import cost.

It will also be recalled that in the actual calculation of unit prime cost the three vectors \(C\), \(W\) and \(M\) on the right-hand-side of equation (4.1) were lagged one period. This will not be done in this section since the data requirements are not effectively different in the case where the unlagged version is used.

Equation (4.1) implies a prime cost equation for the \(i^{th}\) sector of the following form:

\[(4.2) \quad C_i = a_{i1}C_1 + a_{i2}C_2 + \ldots + a_{im}C_m + d_{i1}W_1 + e_{i1}M_1\]

It should be noted that Agarwala and Goodson are primarily interested in the policy question of the effect of changes in import prices and wages on final goods prices via changes in prime cost. For the
purposes of this thesis, where the primary object is to explain final goods prices, it appears to be preferable to change equation (4.2) (and hence equation (4.1)) to

\[(4.3) \quad c_i = a_{1i}P_1 + a_{2i}P_2 + \ldots + a_{mi}P_m + d_iW_i + e_iM_i \]

where \(P_j\) is the price of the output of sector \(j\). This implies that unit prime cost for industry \(i\) is a weighted average of material input prices and wage rates. The use of equations of this type rather than equations similar to equation (4.2) to generate the successive \(C\) vectors will, of course, necessitate extra data, viz., time series data for \(P_1, \ldots, P_m\) but this matter will be further discussed in the following section of this chapter.

If equations of the form (4.3) are used to derive unit prime cost series for each sector for the sample period the following data would be required:

(a) An input-output matrix.
(b) A vector of prices of the outputs of the sectors defined in the input-output matrix for each quarter of the sample period.
(c) A diagonal matrix whose diagonal elements are the proportions of unit cost formed by wage cost for each sector defined by the input-output matrix. This matrix would be fixed for the sample period, as would the input-output matrix.
(d) A diagonal matrix whose diagonal elements are the proportions of unit cost formed by import prices for each sector defined by the input-output matrix. This matrix would also be fixed for the sample period.
(e) A vector of unit labour cost corresponding to each sector
defined by the input-output matrix for each quarter of the sample period.

(f) A vector of unit import prices for each sector defined by the input-output matrix for each quarter of the sample period. In their empirical application of this model Agarwala and Goodson took the $i^{th}$ element of this vector for period $t$ to be the price index of imports in period $t$ used by the $i^{th}$ sector. In fact, they used a 14-sector input-output matrix and found that import prices were available for only four different categories of imports so that they had to

"... allocate these four import price categories to our input-output industrial categories on the basis of subjective judgement."

1. Agarwala and Goodson, _op.cit._, p. 61.

Having now considered the data requirements for the computation of unit prime cost for the industrial sectors defined by the input-output matrix, let us consider the data required to permit conversion of the unit prime cost for industrial sectors into unit prime cost for other types of sectors. We will specifically consider only the conversion to consumer sectors. The conversion to other types of sectors (except geographical sectors) is achieved in an identical manner. Again, Agarwala and Goodson's description of the matrices used for conversion is very brief so that their method will have to be examined in more detail before we can decide what data are necessary.

It will be recalled that the equation used for conversion is:

1. Agarwala and Goodson, _op.cit._, p. 61.
\[(4.4) \quad C_c = R.C + B.M \]

where \( C_c \) = a vector of unit prime cost for consumer sectors, \( R \) = a conversion matrix, and \( B \) = a matrix showing the direct import content by industries of final consumption goods expenditure.

Previously it was assumed that there are \( m \) industrial sectors (i.e., the input-output matrix is \( m \times m \)); further assume that there are \( n \) consumer sectors. Then the equation derived from (4.4) for the \( j \)th consumer sector is as follows:

\[(4.5) \quad C_{cj} = r_{j1}C_1 + \ldots + r_{jk}C_k + \ldots + r_{jm}C_m + b_{j1}M_1 + \ldots + b_{jm}M_m \]

Although the elements of the \( R \) and \( B \) matrices are only loosely defined by Agarwala and Goodson, it would appear that the typical element \( r_{jk} \) is the proportion of consumer expenditure on commodity class \( j \) which is devoted to the output of industrial sector \( k \). Similarly, \( b_{jk} \) would appear to be the proportion of consumer expenditure on commodity class \( j \) which is met out of imports of goods similar to the output of industrial sector \( k \). If this is the case then:

\[(4.6) \quad \sum_{k=1}^{m} (r_{jk} + b_{jk}) = 1 \quad \forall j = 1, \ldots, n \]

Then, to obtain the data necessary to carry out the conversion of the \( C \) vector into the \( C_c \) vector we would need estimates of all the \( r_{jk} \) and \( b_{jk} \) in addition to the \( C \) vector (for each period) which will be generated by equation (4.3) and the \( M \) vector for each period which will have been needed for the generation of the \( C \) vectors.
Two aspects of equation (4.5) will be remarked upon. Firstly, consider the definition of the $b_{jk}$ elements. The definition of these elements given above is not given by Agarwala and Goodson but inferred from their definition of the $B$ matrix which is as follows:

"... matrix showing the direct import content by industries of final consumer goods expenditure." 1

It is difficult to understand, however, why Agarwala and Goodson first allocate direct import prices to the industries defined by the input-output matrix and then proceed by means of matrix $B$ to convert these categories to consumer expenditure categories. It would appear far simpler to make $B$ a diagonal $(n \times n)$ matrix $(b_{ij})$ ($b_{ij} = 0$ if $i \neq j$) and define a new $n$-component vector, $M^*$, whose elements, $M^*_i$, are import prices corresponding to consumer goods categories.

The second aspect of the conversion equation to be mentioned concerns the purpose of the second term in equation (4.4). Agarwala and Goodson make no mention of its purpose but point to the studies by Brown 2 and Fisher, Klein and Shinkai. 3 The study by Brown suggests that the second term is designed to take account of consumer goods expenditure on goods which are directly imported. While this seems reasonable for Brown's study which is concerned with expenditure, it appears unsuitable for inclusion in a prime cost equation of the type envisaged in this thesis since direct imports, by definition, do not

1. Ibid., p.58, my emphasis.
2. Brown, op.cit.
undergo further production before being sold to consumers and therefore do not form part of the prime cost of Australian producers. This is not to deny that the prices of direct imports do not affect prices for consumer goods but it seems preferable to test for this effect separately.

Finally, we must return to a brief discussion of equations (4.2) and (4.3) and their relation to data requirements. As mentioned above, use of equations of type (4.2) rather than (4.3) make the data requirements for the calculation of the C vectors for each period less rigorous. However, the use of (4.2) instead of (4.3) does not affect the data required to convert the C vector to the \( C_c \) vector.

Thus, in conclusion, there are several ways in which the data requirements may be simplified should certain data be unavailable. Firstly, if data for the \( P_j \) in equation (4.3) should be unavailable, equation (4.2) could be used instead of (4.3). Secondly, if data for the matrix \( B \) is unavailable \( B \) could be changed to a diagonal matrix (provided \( M \) also can be changed) as described above, or, alternatively, equation (4.4) could be simplified to:

\[
(4.7) \quad C_c = R.C
\]

4.3 Data Availability

This section will discuss the availability of the data shown to be necessary in the previous section. Where the data are available in the form required the data actually to be used will be described. In cases where the data are unavailable in the required form but can...
be constructed from available data this is pointed out but a description of the method which is to be used is deferred to section 4.4. Where the required data are not available and cannot be constructed this will also be stated.

Unless stated otherwise all data to be used is quarterly and has been collected for the period 1959-60 to 1972-73. The regressions will be run using quarterly observations for the 13-year period 1960-61 to 1972-73. Since quarterly data are to be used, seasonal influences on prices must be considered. If prices vary seasonally, there are two methods of taking this into account. The first method is to seasonally adjust all price data and the second to introduce seasonal dummy variables into the regression equations. Neither of these methods have been used in this study for two reasons. Firstly, seasonal influences on prices are not likely to be marked and they have seldom been taken into account in price equation studies presumably for this reason. Secondly, the only price study mentioned in this thesis which has used seasonal dummy variables and hence made some attempt to measure seasonal effects on prices is the one by Pitchford¹ and in the equations reported in his study the estimated coefficients of the seasonal dummy variables are insignificant in all but one case.

The discussion in this section will proceed in the same order as that in the previous section so that a comparison of the data available with the data required will be facilitated.

4.3.1 Prices

Price data are unavailable for two of the five types of

1. See Pitchford, op.cit.
disaggregation listed above in 4.2.1, namely, industrial sectors and stage-of-production sectors. No price index is currently published for Australia for industrial sectors. Furthermore, it appears impossible to find data from any source for even the majority of the broadest categories of the Australian Standard Industrial Classification.\(^1\) Consequently in the remainder of this chapter we will be concerned only with the three remaining types of disaggregation — by expenditure (disaggregation type A), by consumer categories (disaggregation type B), and by geographical categories (disaggregation type C).

To obtain implicit deflators to represent prices for expenditure sectors the current price estimates of the various classes of expenditure were divided by the corresponding constant price estimates.\(^2\) The availability of published quarterly constant price estimates limit the expenditure categories for which implicit deflators could be obtained to the following:

(a) Final private consumption expenditure (sector A1),

(b) Final government consumption expenditure (sector A2),

(c) Private gross fixed capital expenditure: dwellings (sector A3),

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2. The source of statistics is: A.B.S. *Quarterly Estimates of National Income and Expenditure*, (Canberra), various issues. Note that while this discussion of the construction of the implicit deflators ought to be contained in the next section, it is, in fact, contained in this section so that the sectors to be used in this study may be defined before proceeding with the discussion of the data for the explanatory variables.
(d) Private gross fixed capital expenditure: other buildings and construction (sector A4),
(e) Private gross fixed capital expenditure: all other (section A5),
(f) Public gross fixed capital expenditure (sector A6), and
(g) Gross National Expenditure \(^1\) (sector A7).

Sectoral prices for consumer categories are provided by the indexes for the following five groups of the Consumer Price Index:\(^2\)

(a) Food (sector B1),
(b) Clothing and drapery (sector B2),
(c) Housing (sector B3),
(d) Household supplies and equipment (sector B4),
(e) Miscellaneous (sector B5), and
(f) The CPI for the aggregate case (sector B6).

Thus, using this type of disaggregation five sectors are distinguished. As in the previous case, aggregate equations explaining the CPI will also be experimented with.

The final disaggregation to be considered is the geographical disaggregation. Since constant price estimates of GNE are not available separately for the States, the CPI for each capital city had to be used to represent the price level in each geographical sector. Thus, the following sectors are distinguished:

1. For all three types of disaggregation to be used in this study an "aggregate" equation (in this case one explaining the implicit deflator of GNE) will be estimated for the purpose of comparing the performance of the aggregate equation with the performance of the sectoral equations.
(a) New South Wales (sector C1),
(b) Victoria (sector C2),
(c) Queensland (sector C3),
(d) South Australia (sector C4),
(e) Western Australia (sector C5), and
(f) Tasmania (sector C6).

As the aggregate price variable in this case would be the same as in the previous case (since both use CPI figures), no separate aggregate equations will be estimated for the geographical disaggregation.

4.3.2 Labour Costs

As mentioned in the previous section, both wage-rates and earnings variables are to be used to test the importance of labour costs in the price equation. They will be used separately, with productivity as a separate variable, in the form of ULC and in the form of ULCN. However, following discussion in the previous section we need only consider the availability of sectoral wage-rate data, sectoral earnings data and sectoral short-run productivity data. Let us consider firstly, the availability of sectoral earnings and wage-rate data. Both minimum hourly wage-rates (actual wage-rates and indexes) and minimum weekly wage-rates are available in A.B.S. publications. Minimum hourly wage-rates were discarded because they are available only from 1962 onwards whereas data for the period 1959-60 to 1972-73 are required as pointed out above. Minimum weekly wage-rate data are available for the whole of the 1959-60 to 1972-73 period, but only for industrial and geographical sectors. Thus, the required wage-rate data for type A and type B disaggregations are unavailable.
However it was constructed by taking weighted averages of the indexes for industrial sectors and a discussion of the procedure used is contained in section 4.4. Although minimum wage-rate indexes are available on a State basis, the indexes used for type C sectors were constructed from the State data so as to correspond as closely as possible with the dependent variable and a description of the method used is also contained in the following section.

Consider, now, earnings data. Data for average weekly earnings are published only for Australia as a whole and for the States separately and hence sectoral data for sectors defined by disaggregations of type A and type B could not be obtained or constructed. Hence it was decided to use the same series, viz., the series for Australia as a whole in the equations for each of the sectors $A_1, \ldots, A_7$ and $B_1, \ldots, B_6$ and to use the series for the States in the equations for sectors $C_1, \ldots, C_6$. A seasonally adjusted average weekly earnings series is also published by the A.B.S. and will be experimented with. It is, however, available only for Australia as a whole and will, therefore, only be experimented with as an alternative to the original series for Australia as a whole.\(^1\)

Finally in this section on labour costs we will consider the availability of data to be used to represent productivity movements. Since there is no published information on productivity for the sectors defined in sub-section 4.3.1, data on productivity, where used, were obtained by dividing the series for the output of a sector by

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the series for employment in that sector. Even this proved not to be as straightforward as envisaged and the problems faced and the series constructed will be discussed in section 4.4.

The final aspect of labour costs mentioned in the previous section of this chapter is overhead labour costs. In relation to this it was felt worthwhile to test as separate explanatory variables overhead and non-overhead labour costs. After examining the published time series, however, it appears that this will not be possible. The only source of data available is the A.B.S. surveys of wage rates, earnings and hours but data for these surveys are available only from 1963 onwards and only annual observations (at October of each year) are published. For these reasons the surveys have been disregarded as a source of data.

4.3.3 Materials Costs

As should be clear from the discussion in sub-section 4.3.1, there is a serious lack of quarterly price data in Australia. This was amply evident also in the search for materials prices, although in the area of materials price indexes the A.B.S. has started to remedy the situation by extending the number and scope of its materials price indexes. The outdated index "Wholesale Price (Basic Materials and Foodstuffs) Index" (hereafter denoted WPI) which ceased to be published after December 1970, is in the process of being replaced by the "Price Index of Materials used in Manufacturing" (which is yet to be published), the two building materials price indexes

1. The "Price Index of Materials used in House Building" and the "Price Index of Materials used in Building other than House Building".
the "Price Index of Metallic Materials". The indexes already published in this new series are, unfortunately, of limited use since the two building materials price indexes are available only from 1966-67 onwards and the remaining indexes from 1968-69. Apart from these indexes there are various indexes of unit values of primary products but these are, on the whole, available only at annual intervals and thus of little use. Hence all materials price indexes used in this study had to be constructed, the data used for this construction coming from various sources but mainly from the Export Price Index published by the A.B.S. and the Import Price Index published by the R.B.A. The methods used will be further discussed in section 4.4.

4.3.4 Sales Tax

Sales tax rate indexes are not available and had to be constructed from information published by the Commissioner of Taxation. Further discussion of these indexes will also be found in the following section.

4.3.5 Product Market Demand Variables

In the previous section six different types of product market demand variables were listed. Of these there are only two, namely (5) and (6) for which series are available or could be constructed from available data.

All output data had to be constructed or proxies used so that discussion of the output data will be deferred to the next section.

For sectors A1, ..., A7 the choice of expenditure data was straightforward since these sectors are defined by expenditure
categories. Seasonally adjusted constant price estimates were used for type A sectors. The data used for sectors B1, ..., B6 and C1, ..., C6 had to be constructed and is therefore discussed in the next section.

4.3.6 Labour Market Demand Variables

The availability of data for the four types of labour market demand variables listed in section 4.2.6 will now be discussed.

They are unemployment, vacancies, the Dow-Dicks-Mireaux index of excess demand in the labour market and overtime hours. Since the DDM index to be considered is the one developed for Australia by Hagger\(^1\), the index for excess demand in the product market developed by Hagger and Rayner\(^2\) will also be discussed here in conjunction with the series for the labour market although it should properly be included in the previous sub-section dealing with product market demand variables.

Consider, firstly, unemployment and vacancies. Both are available for Australia as a whole, for the States and for occupational groups.\(^3\) Although vacancies are now published by the Department of

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3. The source of statistics for both unemployment and vacancies is the Department of Labour, *Monthly Review of the Employment Situation*, (Melbourne), various issues with the exception that seasonally adjusted series for both aggregate unemployment and aggregate vacancies were obtained from A.B.S., *Seasonally Adjusted Indicators, 1973*, op.cit. The original series obtained from the Department of Labour publications were all seasonally adjusted by the ratio-to-trend method (see P.H.Karmel, *Applied Statistics for Economists*, (Melbourne: Sir Isaac Pitman & Sons, 1963), Ch.10).
Labour for industrial groups, these data are available only from July 1972 onwards and cannot, therefore, be used in the construction of sectoral data for sectors of type A and type B. The occupational groups for which both unemployment and vacancies are available are:

1. Rural,
2. Professional and semi-professional,
3. Clerical and administrative,
4. Skilled building and construction,
5. Skilled metal and electrical,
6. Other skilled, n.e.i.,
7. Semi-skilled,
8. Unskilled manual, and
9. Service occupations.

With one exception, it is impossible even roughly to allocate these occupational groups to the final demand and consumer categories for which price determination equations are to be estimated. Hence it will be impossible to construct series for these types of sectors but unemployment and vacancies for Australia as a whole will be experimented with. The exception mentioned above is that vacancies and unemployment for occupational group (4) above could be used to represent the pressure of demand for sectors A3, A4 and B3 (the three building sectors). The use of vacancies or unemployment for this occupational group would omit any effect of the unemployment or vacancies of the semi-skilled and unskilled workers in the building industry on prices. Besides this consideration, the data for unemployment and vacancies for this occupational group are available only from 1962-63 onwards while data are required for the period 1959-60.
onwards. For these reasons the series for unemployment and vacancies for the skilled building and construction occupational group were not used in the regressions.

For the geographical sectors C1, ..., C6 the figures for unemployment and vacancies for the States will be used. For unemployment the series to be used are those for "Persons registered for employment with the Commonwealth Employment Service" and following the precedent set by the RBA, the absolute numbers of unemployment and vacancies will be used.

Now consider the availability of data to represent overtime hours for the sectors to be used in this thesis. Only quarterly observations on factory overtime hours are available and they were obtained from Department of Labour publications. The data available are disaggregated by industry and by State. Hence the required data are available for geographical sectors but not for consumer and expenditure sectors. Series for sectors of type A and type B will be constructed from the data available for industrial sectors and this will be discussed in more detail in the following section.

Finally, consider the two types of indexes calculated by Hagger and Hagger and Rayner. Both are available for Australia as a whole. The Hagger index for excess demand in the labour market is also available for the States separately but the Hagger-Rayner index is not. Neither are disaggregated in any other way. Hence it will not be possible to construct series of either type for type A and type B sectors and it will not be possible to construct product

1. See Department of Labour, *op.cit.*
market series for geographical sectors. Besides these considerations, the data are unavailable for the full period 1959-60 to 1972-73 and thus could not be used in the equations to be estimated in this study. It would be interesting to experiment with these series using a truncated sample period especially so that their performance could be compared with the performance of more readily available series. However, this would not further the object of this study which is to estimate sectoral price equations for various Australian sectors for the period 1960-61 to 1972-73. These series were, therefore, not used in this study.

4.3.7 Unit Prime Costs

Since all the data needed to compute unit prime costs (UPC) using Agarwala and Goodson's input-output-based method are not available the data actually used are discussed in the following section. Briefly, data representing prices for industrial sectors are not available so that Agarwala and Goodson's original equation was used. The input-output and related coefficients were obtained from the 1962-63 input-output tables for Australia but the 105 sector input-output matrix presented in these tables was aggregated to a 14 sector one because of the lack of labour cost and import cost data. Not all the data required for the conversion matrices for type A and type B sectors were available and some had to be constructed using suggestions provided by the Deputy Commonwealth Statistician, Hobart. Finally, the import cost data used was far from satisfactory and some arbitrary allocations of import prices to various aggregated input-

output sectors had to be made.

4.4. **Data Construction**

This section will contain a discussion of the methods used to construct the required time series where these were not available in the proper form. Before getting down to the detail it may be helpful to explain a procedure which was used repeatedly to obtain the series required for the various type A and type B sectors.

Frequently where data were not available for type A and type B sectors they were available for industrial categories. Where this was the case the procedure used was to choose an industrial sector which was similar to the type A or type B sector for which the series was required and use the series for this industrial sector to represent the appropriate variable for the type A or type B sector in question. Alternatively, if there was no such industrial sector the procedure was to combine the series of several industrial sectors by means of weighted averages. This may be illustrated by the following example. Consider the expenditure sector A1, i.e., private final consumption expenditure, and assume that we wish to obtain a series representing the minimum wage-rate for this sector. As stated in the previous section, minimum weekly wage-rates are available for industrial and geographical sectors only. Since none of the industry groups for which wage-rates are available corresponds at all closely with expenditure sector A1, a weighted average of the series for the following groups was used:

1. All manufacturing,
2. Wholesale and retail trade,
(3) Public authority (n.e.i.) and community and business services, and
(4) Amusements, hotels and personal services.

The weights used were derived from the weights used by the A.B.S. in the calculation of the wage-rate indexes for all industry groups. The groups included in the All manufacturing group are (a) Engineering, vehicles, etc., (b) Textiles, clothing and footwear, (c) Food, drink and tobacco, (d) Sawmilling, furniture, etc., (e) Paper, printing, etc., and (f) Other manufacturing. The minimum wage-rates for all these groups were chosen since it was difficult to exclude any one or more of them on the grounds that their wage-rate would not affect prices of consumer goods. The other groups chosen are obviously relevant to sector A1. It will be noted in the above and in what follows that the exclusion or inclusion of any one group is often somewhat arbitrary as it is bound to be if an industrial sector contributes to more than one type A or type B sector. In some cases it was impossible to make even a rough allocation of industrial category variables to type A or type B sectors. In these cases either the corresponding aggregate variable was used or the variable was excluded from the regression equation for the particular sector.

4.4.1 Labour Costs

In this section we will consider the minimum weekly wage-rate indexes used for sectors of type A, B and C and the data used to construct short-run productivity series for sectors of type A and B.

1. See A.B.S., Labour Report, 1970, (Canberra, 1971), p.97. The weights used for (1),(2),(3),(4) above were 0.7173, 0.2087, 0.0367, and 0.0373 respectively.
For reasons given below, short-run productivity series could not be constructed for geographical sectors.

Consider, firstly, the minimum weekly wage-rate indexes used for sectors A1, ... A7. Where a weighted average of several indexes was used to give a minimum weekly wage rate index for a particular sector, the weights used were taken from the same source as in the example given above.

(a) For sector A1 we used a weighted average of the weekly wage-rate indexes for:
   (1) All manufacturing,
   (2) Wholesale and retail trade,
   (3) Public authority (n.e.i.) and community and business services, and
   (4) Amusements, hotels and personal services.

(b) For sector A2 the data used are identical to those used for sector A1.2

(c) For sectors A3 and A4 the index for the Building and Construction industry was used. It should be noted that both sector A3 and sector A4 are building and construction sectors, sector A3 covering dwellings and sector A4 other buildings and construction. The wage-rate indexes available do not make this

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1. The source of the data are A.B.S. 'Monthly Bulletin of Employment Statistics,' (Canberra), various issues to 1962 and A.B.S., 'Wage Rates and Earnings,' (Canberra), various issues after 1962.

2 This has been the practice for most of the explanatory variables, i.e., to use the same data for sectors A1 and A2. This was done because it was difficult to allocate any particular industrial category to the final government consumption expenditure sector and it was felt that in the absence of such an index the index derived for sector A1 was the most suitable alternative.
distinction so that the same index was used for both. This seems a suitable procedure since there is no obvious reason why employees working on dwellings should be paid a different minimum wage-rate than those working on other buildings.

(d) For sector A5 the index for the industrial group Engineering, metals, vehicles, etc., was used since this appeared to be the only industry resembling the investment in equipment sector.

(e) For sector A6 a weighted average of the indexes used for sectors A3 and A5 was used. This was done because sector A6 includes all public gross fixed capital expenditure and is not disaggregated into gross fixed capital expenditure on dwellings, other buildings and construction and equipment as is private gross fixed capital expenditure. Thus, in general, the data used for private consumption expenditure was also used for government consumption expenditure and a weighted average of the data used for the three private gross fixed capital expenditure sectors was used for the public gross fixed capital expenditure sector.

(f) For sector A7 the weighted index for all industry groups was used.

Consider now the data to be used for sectors B1, ..., B6.

The following are the series used for type B sectors:

(a) For sector B1 a weighted average of the minimum weekly

1. Where the series used to represent the minimum wage rate for a sector was a weighted average of the indexes for more than one industry group the weights used were derived from the same source as those used for the type A categories and were calculated in the same way. It will be noted in the following that for most type B sectors the index to be used is a weighted average of the index for the manufacturing sector (or sectors)
wage-rate indexes for the following two industrial sectors was used: (1) Food, drink and tobacco,
   (2) Wholesale and retail trade.

(b) For sector B2 a weighted average of the indexes for the following two industrial sectors was used:
   (1) Textiles, clothing and footwear,
   (2) Wholesale and retail trade.

(c) For sector B3 the wage-rate index for the Building and Construction industry was used.

(d) For sector B4 a weighted average of the indexes for the following two industrial sectors was used:
   (1) Sawmilling, furniture, etc.,
   (2) Wholesale and retail trade.

(e) For sector B5 a weighted average of the indexes for the following three sectors was used:
   (1) Engineering, metals, vehicles, etc.,
   (2) Public authority (n.e.i.), community and business services,
   (3) Amusements, hotels and personal services.

While the index for Engineering, metals, vehicles, etc., is obviously too broad for a consumer sector, it was nevertheless included because of the importance of the motoring item in the price index for sector B5.

(f) For sector B6 a weighted average of the following indexes was used: (1) The index calculated for sectors A1 above,
(2) The index for the Building and Construction industry.

The index for B6 is somewhat broader than the sum of those used for sectors B1, ..., B5. This index was used for B6 because, while it is difficult to allocate two of the indexes for manufacturing industries to any one of the consumer sectors, there appeared to be no reason why they should be excluded from the index for all consumer goods. The index for the Building and Construction industry was included in the index constructed for sector B6 and excluded from the index constructed for sector A1 because housing is included in the CPI but not in the final private consumption expenditure sector. In what follows this will be seen to be the general pattern, i.e., the index used or constructed for sector B6 is a weighted average of the series used or constructed for sectors A1 and A3.

Turn now to sectors C1, ..., C6. As mentioned in the previous section, minimum weekly wage-rate indexes are available separately for the States. However, since the price level in each State is to be represented by the CPI for the capital city of the State, the wage-rate indexes used were constructed so as to correspond as closely as possible to the dependent variable. Hence, for sectors C1, ..., C6, a weighted average of the indexes for each of the following industrial sectors for the State in question was used:

(1) All manufacturing,
(2) Building and construction,
(3) Wholesale and retail trade,
(4) Public authority (n.e.i.) and community and business services,
(5) Amusements, hotels and personal services.

It will be noted that these indexes are similar to the one used for sector B6. This was the reason for choosing a weighted average of these particular industrial sectors. The weights used are different for each State and are derived from the same source and calculated in the same way as those described above for type A sectors.

Finally, in this section on labour costs, we will consider the data used to represent productivity movements. Since there is no statistical information on productivity published on a sectoral basis, data on productivity, where used, were obtained by dividing output or production (these terms will be used interchangeably) of a sector by employment in that sector. Unfortunately, this was not as straightforward as envisaged at first. Firstly, where disaggregated data on output and employment are available, they are usually disaggregated on an industrial basis thus causing the same problems as were faced with the minimum wage-rate data discussed above. These problems were overcome in the same way as before, i.e., either by choosing an industrial sector which seemed reasonably close to the sector in question or by combining (by a weighted average) the series for more than one industrial sector in the case where more than one industrial sector appeared to correspond to part of the sector for which data are being sought. Secondly, although both production and employment, where available at a sectoral level, were both usually disaggregated on an industry basis, the actual industries for which each was available often did not correspond. Hence, sectoral productivity figures were used in the calculation of sectoral labour costs only for those sectors where industries for which employment figures
were available and industries for which output figures were available appeared to correspond closely. For the sectors for which it was not possible to find closely corresponding employment and output data no short-run productivity series were calculated and ULC and ULCN variables could not be tested for these sectors. Thirdly, added to these difficulties was the fact that the employment and output categories chosen for a particular type A or type B sector did not always correspond to the wage-rate data chosen for that sector. Little could be done about this since, if productivity (and hence ULC and ULCN) had been computed only for those sectors where wage-rate, employment and output data correspond closely it would have been possible to test these variables for few, if any, sectors. In relation to this it should be noted that ULC and ULCN are also calculated using average weekly earnings as the numerator. For type A and type B sectors data for average weekly earnings for Australia as a whole were used and in this case there was no correspondence between the sectors covered in the numerator and those covered in the denominator of ULC and ULCN.

Let us now turn to a consideration of the data used to represent output for each sector. Generally, only factory production figures could be obtained and these were used. The A.B.S. publishes production statistics for various classes of goods but these are all in terms of physical units which could not be combined to obtain production statistics for the sectors defined by type A and type B disaggregation. Hence, rather than using expenditure figures from

the National Accounts as proxies for production, the various ANZ Bank Indexes of Factory Production\(^1\) were used for both type A and type B sectors with some exceptions to be noted below. Since quarterly production figures show marked seasonable variations which are unlikely to be reflected in price movements, seasonally adjusted figures were used.\(^2\) Now consider the data used to represent output for type A sectors.

(a) For sector A1 a weighted average\(^3\) of the ANZ Bank Indexes of factory production for the following industries was used:

1. Furniture and furnishings,
2. Textiles, clothing and footwear,
3. Food, drink and tobacco,
4. Gas, and
5. Electricity.

When considering the reasons for including certain indexes

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1. These indexes were obtained from ANZ Bank, *Quarterly Survey*, various issues.

2. The *Quarterly Survey* contains seasonally adjusted as well as original indexes for broad commodity groups and original data only for the more disaggregated groups. Thus, a seasonally adjusted index as well as an original index is published for the Fuel and power group but only original data are published for the four Fuel and power sub-groups: P1 Coal and coke, P2 Gas, P3 Electricity, and P4 Petroleum products. Since the indexes for some of the sub-groups were used it was decided not to use any of the seasonally adjusted data published in the *Quarterly Surveys* but rather to take the original data even where seasonally adjusted data are available and to seasonally adjust them all by the same method, viz., the ratio-to-trend method mentioned above.

3. Where a weighted average of more than one series was used to represent output for any one sector, unless otherwise stated, the weights were derived from the weights used by the ANZ Bank to obtain the index for all groups. (For a description of the ANZ Bank Indexes and the weights used see the *Quarterly Survey* for October 1967.) It should be noted that weights are published only for the groups and not for the sub-groups. Where a weight for a sub-group was required the proportion of the weight of the group to which the sub-group belongs accounted for by the sub-group was calculated using data on Australian production obtained from the 1962-63 input-output tables.
and excluding others, it ought to be recalled that only indexes which had reasonably closely corresponding employment indexes were included. Hence Furniture and furnishings is only a sub-group of the Furniture and household goods group. The rest of this group was excluded because suitable corresponding employment series could not be obtained.

(b) Following the procedure outlined in the case of minimum wage-rates, the output index calculated for sector A1 was also used for sector A2.

(c) For Sector A3 there is no suitable production index available so that the number of new houses and flats completed was used. This series was changed to an index with base 1966-67=100. This was done because the ANZ Bank data are all in the form of indexes and the wage-rate data are in the form of indexes. The employment data used which is to be described later was also changed to index form (base 1966-67=100). Thus all the data to be used in the calculation of ULC and ULCN is in index form and the resulting series for ULC and ULCN will also be in index form.

(d) For sector A4 the value of other buildings and construction completed rather than the number completed was used since, while houses and flats may be sufficiently homogeneous for their number to be meaningful, this is not the case for other building and construction. Besides this consideration, the number of other building and construction completed is not published, probably for the above reason. Since the value

1. The source of these data is A.B.S., Building Statistics, (Canberra), various issues.
2. Source as above for sector A3.
series reflects cost changes as well as quantity changes, the series was deflated by the implicit deflator for sector A4. Both the series used for A3 and the series used for A4 were seasonally adjusted by the ratio-to-trend method.

(e) For sector A5 a weighted average of the ANZ Bank indexes for the following groups was used:

(1) Metals, machinery and apparatus,

(2) Transport equipment,

(3) Chemicals and allied industries.

(f) Following the procedure used for sector A6 in the case of minimum wage-rates described above, a weighted average of the output indexes used for sectors A3, A4 and A5 was used for sector A6. The weights used for the three indexes were derived from the Australian production figures given in the input-output tables. Sector A3 was assumed to be equivalent to input-output sector E1 (Residential building), sector A4 was assumed to be equivalent to input-output sector E2 (Other building and construction) and sector A5 was assumed to be equivalent to the sum of the remaining sectors contributing to Private Gross Fixed Capital Expenditure. This was the same allocation used in the calculation of UPC series by the input-output method.

(g) For sector A7 seasonally adjusted non-farm product at constant prices was used to represent production. This series was chosen to correspond to the total employment series which

1. Source of this series is A.B.S., Quarterly Estimates of National Income and Expenditure, (Canberra), various issues.
excludes employment in agriculture.

Now consider the data used to represent output for sectors B1, ..., B6.

(a) For sector B1 the ANZ production index for the Food, drink and tobacco industry was used.

(b) For sector B2 the index for the Textiles, clothing and footwear group was used.

(c) For sector B3 the index described above for sector A3 was used.

(d) For sector B4 we used a weighted average of the indexes for the following groups: (1) Furniture and furnishings,

(2) Gas, and

(3) Electricity.

The weights used were derived from the weights published by the ANZ Bank in the same way as described above for type A sectors.

(e) For sector B5 no suitable production data could be found for which corresponding employment data was available so that short-run productivity (and hence long-run productivity and ULC and ULCN) could not be calculated for this sector.

(f) Following the procedure used in the calculation of a minimum wage-rate index for sector B6, a weighted average of the production indexes calculated for sectors A1 and A3 was used to represent the production for sector B6. The weights used were those used for the construction of the CPI$^1$, the weight assigned to the index for sector A3 being the weight of the

housing group in the CPI and the weight assigned to the index for sector Al being the sum of weights for the other four groups.

Finally, in the case of production or output figures for the States (sectors C1, ..., C6) it was not possible to find suitable sectoral information. Firstly, in nearly all cases manufacturing production was available but only on an annual basis. Secondly, since the industrial disaggregation used above for sectors Al, ..., A7 and Bl, ..., B6 is not available on a State basis, the output data which could be obtained for the States would not correspond very closely to the wage-rate data used. Thus it was decided not to test productivity, ULC and ULCN in the price equations to be estimated for the geographical sectors.

Consider now the second group of data required for the calculation of productivity series, viz., employment figures. As explained previously, both production and employment data were chosen so as to correspond as closely as possible. Hence for the sectors for which no suitable statistical information on production was available, employment data will be omitted in the lists below. The data used are based on the number of civilian employees published for industrial categories by the A.B.S. Where the series used for a particular sector is a combination of the series for more than one industry the numbers employed in the various industries are added for each quarter and the resulting series is then changed to index form with base

1. The source of the data is A.B.S., Employment and Unemployment, (Canberra), various issues, except for data used for sectors A3, A4, B3 which were taken from A.B.S., Building and Construction, op.cit.
1966–67=100 for reasons discussed previously. Consider firstly, the data used for sectors A1, ..., A7.

(a) For sector A1 an index of the employment in the following industries was used: (1) Furniture and fittings,
(2) Yarns and textiles,
(3) Clothing and knitted goods,
(4) Boots, shoes and accessories,
(5) Food, drink and tobacco, and
(6) Gas and electricity.

(b) For sector A2 the series calculated above for sector A1 was used.

(c) For sector A3 the series for Building and construction – houses and flats was used.

(d) For sector A4 the series for Building and construction – other was used.

(e) For sector A5 an index of the employment in the following industries was used: (1) Founding, engineering, metal working,
(2) Ships, vehicles, etc.,
(3) Chemicals, dyes, explosives, paints, etc.

(f) For sector A6 a weighted average of the series for A3, A4 and A5 was used.

(g) For sector A7 an index of the total number of persons employed in all industry groups was used.

Now consider the employment data used for sectors defined by type B disaggregation.

(a) For sector B1 an index of the number employed in the Food,
drink and tobacco industry group was used.

(b) For sector B2 an index of the number employed in the following industries was used: (1) Yarns and textiles, (2) Clothing and knitted goods, (3) Boots, shoes and accessories.

(c) For sector B3 the index calculated above for sector A3 was used.

(d) For sector B4 an index of the number employed in the following two industries was used: (1) Furniture and fittings, and (2) Gas and electricity.

(e) For sector B6 a weighted average of the number employed in the two industries covered by sectors A1 and A3 was used.

4.4.2 Materials Costs

As noted in the previous section, data for materials costs are not readily available and the series used were constructed from data obtained from a variety of sources. The main sources of raw data were the Export Price Index (EPI) and the Import Price Index (IPI). Both of these indexes are disaggregated to some extent — both of them by commodity groups. It was also decided to link the two building materials indexes recently published by the A.B.S. to the building materials section of the WPI and to experiment with the linking of the "Price Index of Metallic Materials used in the Manufacture of Fabricated Metal Products" (part of the "Price Index of Metallic Materials") to the metals and coal section of the WPI as an alternative

1. The source of the EPI is A.B.S., Quarterly Summary of Australian Statistics, (Canberra), various issues; the source of the IPI is R.B.A., Statistical Bulletin, (Sydney), various issues.
to the use of the index to be constructed for sector A5.\textsuperscript{1} The validity of the use of EPI, IPI and the three linked indexes will be further discussed in the next section of this chapter which is devoted to an evaluation of the data used.

Consider first the data used to represent materials costs for sectors defined by type A disaggregation.

(a) For sector Al a weighted average of the indexes for the following EPI groups was used: (1) Wool, (2) Meats, (3) Dairy produce, (4) Cereals, (5) Dried and canned fruit, (6) Sugar, and (7) Hides and tallow.

The weights used were based on the input-output tables for 1962-63. This was felt to be preferable to deriving them from weights used by the A.B.S. to calculate the aggregate EPI since the latter are based on the composition of exports. One (and in one case two) input-output sector was allocated to each of (1) to (7) above. The value of the output of each of these input-output sectors which was absorbed by other Australian industries was then obtained from the input-output tables and the weight for any one sector was calculated as the proportion of its value of output absorbed by other Australian

\textsuperscript{1} The two building materials price indexes and the "Price Index of Metallic Materials" are all published by the A.B.S. in mimeographed bulletins having the same title as the name of the index.
industries to the total for the sectors used.\(^1\) The use of intermediate usage figures rather than total Australian production figures is felt to be preferable because it is likely that a large part of the output of the sectors used is exported and the resulting weights would not express the relative importance of the different materials prices for Australian producers.

(b) For sector A2 the index calculated above for sector A1 was used.
(c) For sector A3 the "Price Index of Materials used in House Building" linked to the building materials section of the WPI was used. The linked index was constructed firstly by changing the base of the building materials section of the WPI to that of the "Price Index of Materials used in House Building" and then joining the two indexes at the point for which the earliest observation on the new index was published. There did not appear to be any noticeable break in the linked series at the point of linkage.
(d) For sector A4 the "Price Index of Materials used in Building other than House Building" linked to the building materials section of the WPI was used. The two series were linked in that same way as those used for sector A3 and again there was no noticeable break in the linked index at the point of linkage.

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1. The input-output sectors allocated to (1) to (7) above are: (1) input-output sector A1, (2) input-output sector A4, (3) input-output sector A5, (4) input-output sectors A2 and A3, (5) input-output sector A7, (6) input-output sector C7, and (7) input-output sector C64. A list of the input-output sectors is contained in Appendix 4.1 to this chapter. It is felt that the weights thus derived for (5) and (7) are the least suitable as the correspondence between the input-output sectors and the indexes to which they are allocated is poor.
(e) For sector A5 it was intended to use the weighted average of the indexes for the following two IPI groups:

(1) Crude materials, inedible,

(2) Chemicals.

However, data for these two groups are available only from 1965-66 onwards, prior to which the disaggregation of the index is somewhat different although some classes in the old classification are similar to classes in the new classification.¹ There is, however, no equivalent for either (1) or (2) above so that it was decided to assume that (1) and (2) above combined (by a weighted average, the weights being derived from the weights used by the RBA in the calculation of the aggregate IPI) were equivalent to the indexes for (1) Basic materials and (2) Base metals combined in the old classification and these two combined indexes were linked in the same manner as the indexes for Sectors A3 and A4 were linked. As noted previously, another linked index (the metals and coal groups of the WPI linked to the "Price Index of Metallic Materials used in the Manufacture of Fabricated Metal Products") will be experimented with as an alternative to the linked IPI based index.

(f) For sector A6 the weighted average of the indexes derived for sectors A3, A4 and A5 will be used. The weights to be used are derived from the input-output tables and are the same as those used to weight the output series for sector A6 described

above. Since two alternative series are to be experimented with for sector A5 there will also be two alternative series for sector A6.

(g) For sector A7 the IPI was used to represent materials costs.

Consider now the materials cost data used in the equations for the consumer sectors.

(a) For sector B1 a weighted average of the indexes for the following EPI groups was used: (1) Meats,

(2) Dairy Produce,

(3) Cereals,

(4) Dried and canned fruit, and

(5) Sugar.

The weights used to combine these indexes were derived in the same way as those used to compute the materials cost index for sector A1.

(b) For sector B2 a weighted average of the indexes for the following two EPI groups was used: (1) Wool,

(2) Hides and tallow.

The weights were derived in the same way as those used for sector B1.

(c) For sector B3 the index calculated for sector A3 above was used.

(d) No series could be obtained or constructed for sectors B4 and B5 so that a materials price variable could not be tested for these sectors.

(e) As has been the practice in the construction of data for other variables for sector B6 a weighted average of the series calculated for sectors A1 and A3 was used for sector B6.
The weights used were derived by making the same allocations of input-output sectors to the groups combined in the series used for sector A1 and using the same value figures as were used in the derivation of the weights for that sector. The value of intermediate goods used by input-output sector E1 (residential building) was used as the value figure corresponding to the index for sector A3. Weights were then derived as for A1.

Finally, we must consider the case of sectors defined by geographical disaggregation. Here again we find a serious lack of published data for the States and rather than using no materials cost data at all for these sectors it was decided to use the index derived above for sector B6 in each of the equations for sectors C1, ..., C6 i.e., we will use an aggregate explanatory variable in these equations.

4.4.3 Sales Tax and Excise Rates

The sales tax variable will cover excise on beer, motor spirits and tobacco products as well as sales tax on other commodities. Sales tax is payable on goods only. All goods produced in Australia are subject to sales tax unless they are exempt. There is a general rate of 15% (currently) which is applied to a variety of goods not included in other classes. Besides the exempt class covered by the First Schedule there are three further classes covered by the Second, Third and Fifth Schedules of the Sales Tax (Exemptions and Classifications) Act 1953-73. To calculate a sales tax rate index for a particular sector the procedure was to decide which Schedule (or Schedules) applied to the sector and use the information available
on changes in the rates of sales tax applicable to the goods covered by each Schedule\(^1\) to calculate an index of the sales tax rate for that sector. No account was taken of goods being changed from one Schedule to another and the list of goods covered by each Schedule was taken as of March 1973. Where appropriate, account was also taken of changes in excise on beer, motor spirits and tobacco products. The information on excise changes was obtained mainly from the Budget Speech and papers of each year. Since information on changes in excise rates was difficult to obtain, a method similar to the one used by Higgins to calculate an index of the sales tax rate\(^2\) was used to obtain an index of the change in total excise. The proportional change in the rate of excise was calculated as the ratio of the expected change in excise collections due to the new rate to the excise collections of the previous year. An index with base 1959-60=100 was calculated from these proportional changes. Similar indexes were also calculated for the rate of sales tax applicable to the goods covered by each of the Schedules mentioned previously. First consider the indexes used for type A disaggregation.

(a) For sector A1 a weighted average of the following indexes was used.

1. The index of the rate applicable to the goods covered by the Second Schedule,
2. The index of the rate applicable to the goods covered by the Third Schedule,

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(3) The index of the rate applicable to the goods covered by the Fifth Schedule,

(4) The index of the general sales tax rate, and

(5) The index of the excise rate.

An average of these indexes was used for sector A1 because nearly all sales tax applies to consumer goods. The Second Schedule covers mainly "luxuries" such as jewelry, fur articles, cameras, television sets, etc., and also articles such as cosmetics, toilet articles, etc. Hence when we consider consumer sectors below the Second Schedule is allocated to sector B4. The Fifth Schedule covers automobiles and it is therefore allocated to sector B5 when consumer sectors are considered. The general rate also applies mainly to consumer goods.

(b) The output of sectors A2 to A6 is, on the whole covered by the First Schedule and therefore exempt from sales tax. Thus no sales tax or excise indexes were calculated for these sectors.

(c) For sector A7 the weighted average calculated for sector A1 was used.

The weights used to calculate the index for sector A1 and A7 were obtained as follows. It was decided to weight the sales tax indexes by weights derived from gross sale value of goods taxable at the various rates. These data are available from the Commissioner of Taxation.1 Values for 1963-64 were used because this is the period nearest to the centre of the sample period for which the rates

applicable to the various Schedules were all different and the gross sale value data are dissected only by rates of tax and not according to the Schedule by which the taxable goods are covered. However, the gross sale value of the goods subject to excise is not published — only the total excise collections. Hence total excise and total sales tax were weighted by the value of excise and sales tax collections respectively for 1963-64. The weight for total sales tax was then split up by gross sale value of taxable goods as described above.

Turning now to the sectors of type B the procedure adopted was as follows:

(a) For sectors B1 to B3 no index was used as the goods covered by these sectors are generally exempt from sales tax.

(b) For sector B4 a weighted average of the indexes for the rates applying to the goods covered by the Second and Third Schedules was used.

(c) For sector B5 a weighted average of the indexes for the rate of excise and the rate of sales tax applicable to goods covered by the Fifth Schedule was used.

(d) For sector B6 the index calculated for sector A1 was used.

The weights used for consumer sectors were derived in the same manner as those derived above for expenditure sectors.

Finally we have the sectors of type C. Since sales tax and excise are levied by the Commonwealth government, the index calculated above for sector A1 was used for all the sectors C1, ..., C6.

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1. Value of sales tax collected is available for total sales tax but is not disaggregated by rate.
4.4.4 **Product Market Demand Variables**

In this section dealing with product market demand variables, we will discuss the data used to represent expenditure for sectors B1, ..., B6 and sectors C1, ..., C6 and the data used to represent output for all sectors. Both expenditure and output data will be used to represent demand pressure in the product market and will be entered in the regression equations in the form of first differences. All expenditure data are taken from the same source as the data used to compute implicit deflators.¹

For sectors B1, ..., B6 constant price quarterly estimates were not available for all sectors so that current price, seasonally adjusted estimates were used, these being deflated by the appropriate part of the CPI. The following data were used for sectors B1, ..., B6.

(a) For sector B1 data for consumption expenditure on food were used.

(b) For sector B2 data for consumption expenditure on clothing, footwear and drapery were used.

(c) For sector B3 the data used above for sector A3 were used.

(d) For sector B4 the data for consumption expenditure on household durables were used.

(e) For sector B5 the sum of expenditure on the following groups of consumption goods were used:

1. Purchases of motor vehicles,
2. Cigarettes, tobacco and alcoholic drinks, and

(3) Other goods and services.

(f) For sector B6 the sum of total consumption expenditure and gross fixed capital expenditure on dwellings was used. It can be seen that there is quite a close correspondence between the disaggregation of consumption expenditure and the groups for which the CPI is available.

There are no quarterly data on expenditure available for the States so that annual data for the States were used for sectors C1, ..., C6. It had been intended to use data for each State similar in coverage to the aggregate data used for sector B6. However, gross fixed capital expenditure on dwellings is not available for the States so that annual data for private final consumption expenditure were used.

Since output data have already been constructed for each sector for the calculation of short-run productivity\(^1\), these data were used in the first difference form to represent demand pressure in the product market. Since output data were not constructed for sectors C1, ..., C6 the change in output variable will not be tested in the equations for these sectors.

4.4.5 Labour Market Demand Variables

In this subsection we have only to consider the construction of overtime hours data used for type A and type B sectors. As noted in the previous section, only factory overtime hours data are available and these were used. The published data are disaggregated by

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1. See above, sub-section 4.4.1.
industry and as with data discussed previously the approach used
to obtain data for type A and type B sectors was either to use data
for an industrial sector which appeared to correspond reasonably
closely to the particular type A or type B sector in question or,
if this was not possible, to use a weighted average of the data for
more than one industrial sector. If neither of these solutions was
possible and no data could be constructed for a particular sector
the overtime hours variable was not tested for this sector. Where
a weighted average of more than one series is used for a particular
sector the weights are based on the average employment in the sectors
for the year 1969-70. These employment data are obtained from the
same survey from which overtime hours data were obtained.\(^1\) It should
be noted, however, that only about 90% of the factories supplying
employment data also supply overtime data. The data are still pre-
ferable to the employment data obtained for industries from the A.B.S.
since the industries for which these data are available differ somewhat
from the industries for which the Department of Labour publishes over-
time hours. First consider the data used for sectors A1, ..., A7.

(a) For sectors A1 and A2 a weighted average of the overtime
hours worked in the following two industries was used:

(1) Clothing and textiles, and

(2) Food, drink and tobacco.

(b) For sectors A3 and A4 the series for overtime hours worked
in the building and construction industry was used.

(c) For sector A5 a weighted average of the overtime hours worked
in the following four industries was used:

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Situation, op.cit.*
(1) Basic metals,
(2) Transportation equipment,
(3) Other metal manufacturing, and
(4) Chemicals and allied products.

(d) For sector A6 a weighted average of the overtime hours worked in the industries used for sectors A3 and A5 was used.
(e) For sector A7 the series for total factory overtime hours was used.

Now consider the data used for sectors B1, ..., B6.

(a) For sector B1 the data for the food, drink and tobacco industry were used.
(b) For sector B2 the data for the clothing and textiles industry were used.
(c) For sector B3 the data for the building and construction industry were used.
(d) For sectors B4 and B5 no suitable data were available so that an overtime hours variable was not tested in the equations for these sectors.
(e) For sector B6 a weighted average of the overtime hours worked in the following industries was used:
   (1) Food, drink and tobacco,
   (2) Clothing and textiles, and
   (3) Building and construction.

4.4.6 Unit Prime Costs

We will first consider the data to be used to generate the successive C vectors since these are the same for both disaggregation
types A and B. It should be noted at this point that it was not possible to use the Agarwala and Goodson method to compute unit prime costs for geographical sectors. As has been noted previously, industrial prices are not available for Australia, certainly not for the sectors defined by the 1962-63 Input-Output Tables. Hence, the modification Agarwala and Goodson's initial equation suggested in the previous section\(^1\) where the P vector was substituted for the C vector in equation (4.2) was not used. The Input-Output matrix for 1962-63 was used.\(^2\) This matrix is a 105 sector matrix which will be substantially aggregated since, besides being computationally easier to use, the other data needed to compute unit prime costs are not available in nearly as detailed a disaggregation. The precise aggregation of the input-output matrix to be used will be more fully discussed below.

Both the ratio of wage costs/total costs and the ratio of import costs/total costs for each industrial sector can be derived from the industry by industry flow matrix contained in the input-output publication noted above. The ratio of wage costs to total costs for each sector will be represented by wages, salaries and supplements/(intermediate usage + wages, salaries and supplements + complementary imports c.i.f. + competing intermediate imports + duties on the two above items). The ratio of import costs to total costs will be represented by (complementary imports c.i.f. + competing intermediate imports + duty)/ denominator as above.

Regarding the time series required for unit labour costs and

1. See p. 93, *supra*.
unit import costs it was decided to aggregate the 105 input-output sectors so as to correspond as closely as possible to the industrial sectors for which minimum wage-rates which were used to represent unit labour costs are available and then to allocate import prices in a manner similar to the method used by Agarwala and Goodson. 1 Thus, the following aggregated input-output sectors were defined and the corresponding wage-rates were used:

(I) Input-output sectors A1, ..., A9. 2 This sector comprises agriculture, fishing and hunting. Unfortunately, no wage-rate index is available for this sector so that the index for the Food, Drink and Tobacco industry was used.

(II) Input-output sectors B1, ..., B4. The wage-rate index to be used for this sector is the index for mining and quarrying. 3

(III) Input-output sectors C1, ..., C13. The wage-rate for this sector is to be represented by the index for food, drink and tobacco manufacturing.

(IV) Input-output sectors C14, ..., C22. The wage-rate for this sector is to be represented by the index for textiles, clothing and footwear.

(V) Input-output sectors C23, ..., C27. The wage-rate for this sector is to be represented by the index for sawmilling, furniture, etc.

(VI) Input-output sectors C28, ..., C30. The wage-rate for this sector is to be represented by the index for paper, printing, etc.

1. See Agarwala and Goodson, op.cit., p.61.
2. A list of the 105 sectors distinguished in the Input-Output Tables will be found in Appendix 4.1 to this chapter.
3. For the source of the wage-rate data see above, sub-section 4.4.1.
(VII) Input-output sectors C31, ..., C42, C57, ..., C69. The wage-rate for this sector is to be represented by the index for other manufacturing.

(VIII) Input-output sectors C43, ..., C57. The wage-rate for this sector is to be represented by the index for engineering, metals, vehicles, etc.

(IX) Input-output sectors D1, ..., D3, I1, ..., K3. The wage-rate for this sector is to be represented by the index for public authorities, n.e.i. and community and business services.

(X) Input-output sectors E1, E2. The wage-rate for this sector is to be represented by the index for building and construction.

(XI) Input-output sectors F1, ..., F3. The wage-rate for this sector is to be represented by the index for wholesale and retail trade.

(XII) Input-output sector G1. The wage-rate for this sector is to be represented by the index for road and air transport.

(XIII) Input-output sectors H1. The wage-rate for this sector is to be represented by the index for communication.

(XIV) Input-output sectors L1, ..., N1. The wage-rate for this sector is to be represented by the index for amusements, hotels, personal services, etc.

Thus, aggregating the input-output matrix in this way we obtain a 14 x 14 input-output matrix.

Various sections of the RBA Import Price Index were allocated to the 14 sectors of the aggregated input-output matrix as follows:

(I) Machinery prices.
(II) Machinery prices. For both sectors I and II imports are not very significant.

(III) Food, beverages and tobacco.

(IV) Textiles.

(V) The index calculated above for crude materials, inedible and chemicals.

(VI) The index calculated above for crude materials, inedible and chemicals.

(VII) The index calculated above for crude materials, inedible and chemicals.

(VIII) The index calculated above for crude materials, inedible and chemicals.

(IX) Imports are insignificant and no suitable index is available.

(X) Imports are insignificant and no suitable index is available.

(XI) Imports are insignificant and no suitable index is available.

(XII) Transportation equipment.

(XIII) Electrical machinery.

(XIV) Imports for this sector appear significant from the information given in the input-output tables but no suitable data are available so none were used.

To enable us to compute the elements of both the conversion matrices, we need a more complete breakdown of the final demand section of the industry by industry flow matrix of the Input-output tables so that the columns are expanded to the following:

1. Consumption expenditure - food,
2. Consumption expenditure - clothing and textiles,
3. Consumption expenditure - household supplies and equipment,
4. Consumption expenditure - miscellaneous,  
5. Consumption expenditure - public,  
6. Gross fixed capital expenditure - dwellings,  
7. Gross fixed capital expenditure - other building and construction,  
8. Gross fixed capital expenditure - all other, and  

A request was made to the A.B.S. for this additional information and although they could not supply a complete reconciliation of the input-output industries with the CPI groups (1 to 4 above), they suggested a method of allocating the whole of the final demand figures of each of the 105 input-output industries to the classes 1 to 9 listed above. Firstly, sectors A1, A2 and A6 have corresponding columns in the final demand section of the input-output tables. Secondly, the final demand section of the tables had 6, 7 and 8 above aggregated under one heading of "Private gross fixed capital expenditure" and the figures in this column had to be allocated to one of 6, 7 or 8. This was straightforward since the input-output sector E1 corresponds to 6 above, input-output sector E2 corresponds to 7 above, and the remaining figures in the column for Private gross fixed capital expenditure were allocated to 8 above. Thirdly, the figures in the column for Private consumption expenditure were allocated to one of 1, 2, 3 or 4 above by following the guide provided by the A.B.S. The contribution to final demand of the following input-output sectors was allocated to 1 to 4 respectively.

(1) The contribution to final demand of the following input-output sectors was allocated to the food group 1 above: A1, A4, A5, A6, A7, C1, C2, C3, C4, C5, C6, C7, C8, C9, C10.
(2) The contribution to final demand of the following input-output sectors was allocated to 2 above: C20, C21, C22.

(3) The contribution to final demand of the following input-output sectors was allocated to 3 above: A8, B2, C16, C18, C25, C30, C35, C36, C37, C39, C49, C51, C59, C60, C67, C69, D1, D2.

(4) The contribution to final demand of the following input-output sectors was allocated to 4 above: C11, C13, C29, C38, C66, F3, G1, H1, I2, L1, L2.

After these allocations were made the input-output sectors were aggregated as described above.

4.5 Evaluation of the data

This section will contain an assessment of the statistical information described in the previous section. Where appropriate, the data will be examined in two ways: firstly, we will consider how reliable the data series are in themselves and secondly, we will consider how well the series measure the variables they are to be used to measure. The order of the discussion in this section will be the same as that in the previous three sections.

4.5.1 Prices (dependent variable)

The implicit deflators to be used to represent prices for the expenditure sectors were derived by dividing current price estimates of expenditure for each sector by the corresponding constant price estimates. The Commonwealth Statistician states that

"... in concept, constant price estimates may be thought of as being derived by expressing the value of every component
commodity as the product of a price and a quantity, and by substituting for each actual current price the corresponding price in the chosen base year. Aggregates at constant prices for each year are then obtained by summation."

Thus, the index obtained by dividing the current price by the constant price estimates should be a price index with current-period weights. However, the "ideal" method of calculating constant price estimates (and hence implicit deflators) described above is not always used where data required for such calculations are unavailable. Hence in some cases current prices estimates are revalued by independently constructed price indexes which ought to provide the same results as the "ideal" method if the price index used is a current-weight one which, however, is not always the case, e.g., where components of the CPI are used. Another method used to obtain constant price estimates is by the use of implicit price indexes. In this case an implicit deflator as described above is obtained for those components of an aggregate for which direct revaluation is possible and this implicit deflator is then applied to those components for which direct revaluation is impossible. It would appear that this last method is the least satisfactory but it is used in only a small number of cases.

Thus, while the implicit deflators obtained from the National Accounts and used to represent prices for expenditure sectors are largely a mixture of current-weight and base-weight indexes, they would appear to be reasonably reliable measures of price changes.

Since the expenditure sectors were chosen on the basis of available implicit deflators, the implicit deflators and the sectors for which they are used are well matched.

The prices for the consumer goods sectors are measured by components of the CPI and since the consumer sectors used in this thesis were defined to correspond to the components of the CPI available, the price measures used correspond to the sectors chosen. Secondly, the CPI itself reliably measures price changes of the goods and services it covers which represent "a high proportion of the expenditure of wage-earner households". ¹

The prices for geographical sectors are somewhat less satisfactory than the prices for the previous two types of sectors. This is because consumer prices were used to represent all prices in each State. Secondly, the consumer prices measured for each geographical sector represent only prices in the capital city of each State. It is felt that the first defect is worse than the second, i.e., it is more likely than consumer prices in various parts of any one State will move in a manner similar to the prices in the capital city of the State than that prices of non-consumer goods move in a manner similar to the prices of consumer goods. However, the fact that consumer prices were used was taken into consideration when data measuring explanatory variables were chosen.

4.5.2 Labour costs

Under this heading we will consider four different types of

series, viz., minimum weekly wage-rates, average weekly earnings, production or output and employment.

Some mention has already been made of the difficulties involved in using minimum weekly wage-rates as a basis for the computation of ULC or ULCN. Some further disadvantages of using these data are that only wages are covered and therefore salaries are excluded making the measure narrower than the aggregate measure used successfully in the RBA and T-ABS studies for Australia. These studies based their ULC and ULCN series on "non-farm wages salaries and supplements". Secondly, the wage-rate for each industry is based on a weighted average of wages for several representative occupations in each industry, the weights being based on surveys carried out in 1954 and thus possibly being outdated especially for the latter part of the sample period. But, as stated previously, since minimum wage-rates are the only quarterly labour cost data available for industries they were nevertheless experimented with.

The use of average weekly earnings data overcame some of the difficulties associated with the use of wage-rates in that they cover a far greater number of items entering into labour costs. In fact, "... the earnings figures used in the calculation of averages comprise award and over-award wages and salaries, the earnings of employees not covered by awards, overtime earnings, bonuses and allowances, commissions, directors' fees and payments made retrospectively or in advance during the quarter."1

However, as stated above, these data are not available on an industrial basis so that aggregate earnings variables were used in equations

for sectors of type A and type B. Unfortunately, there is a break in the comparability of the series between the June 1966 quarter and the September 1966 quarter but since there was no way in which this could be rectified it was ignored.

The third type of series to be considered here is the series used to represent output or production in the calculation of labour productivity. Consider first the A.N.Z. production indexes used. The Index is based on (1) data published by the A.B.S., (2) Unpublished data from the A.B.S., and (3) data available only to the Bank from a number of companies and other sources. In this sense the indexes used, where factory production is concerned, are more comprehensive than data published by the A.B.S. However, the coverage of various groups varies from 22% (Miscellaneous) to 100% (Fuel and Power), the coverage for most groups being between 65% and 85% which, while not perfect, appears to be satisfactory although it should be noted that the coverage is only in relation to factory production. One problem encountered in the use of these indexes was that in 1967 all indexes were rebased on the base 1963-64. Some changes were incorporated in the series when the base was changed and indexes with the new base were published only from January 1963 onwards. Since data were collected for this study for the period 1959-60 to 1972-73 data for periods prior to 1963 were calculated on the assumption that the series published with base 1958-59 were comparable to the series published with base 1963-64 and the data for 1959-60 to 1962 were converted to base 1963-64 by dividing by the figure for 1963-64 with base 1958-59.
The crudeness with which the indexes approximate production for the sectors used in this study is likely to be more serious than the imperfect quality of the series themselves. As can be seen from a comparison of the indexes used with the series required for each sector, in many cases only a part of the output of a certain sector was covered by the index used and in some cases a broader index than was appropriate was used. This problem was aggravated by the fact that the production indexes were chosen only where a corresponding employment series was available. Much of the lack of correspondence between production series and the sector for which the series was used was due to the fact that the aggregate Index was disaggregated on an industrial basis whereas the sectors used in this study were defined by class of expenditures, class of consumer good and State.

Besides the A.N.Z. production indexes other measures of output were used. For sector A3 (Private Gross Fixed Capital Expenditure: Dwellings) the number of houses and flats completed in the quarter was used to measure output. The use of this series was felt to be preferable to the use of the A.N.Z. index for Building Materials since it more closely corresponds to the sector. The number rather than the value of new houses and flats completed was used to eliminate the effect of price changes. The weakness of the series is that because the production of houses and flats is far from instantaneous, some of the houses and flats completed in any one quarter are likely to have been commenced in the previous quarter so that the number of houses and flats completed in any one quarter is not a true measure of the "output" of the sector for that quarter. However, it is felt
that this difficulty will not be too serious provided the output
of the housing sector does not fluctuate too widely. For sector
A4 (Private Gross Fixed Capital Expenditure: Other Building and
Construction) the value of other new building and construction com-
pleted deflated by the implicit deflator for sector A4 was used to
represent output. Finally, for sector A7 the series for non-farm
product at constant prices was used to represent output. This series
was chosen as the widest constant price series published which corres-
dponded to the total employment series. Apart from consideration of
the nature of the employment statistics used, farm production is
probably best excluded from total output data because it is strongly
influenced by exogenous factors causing production to fluctuate widely
and the resulting fluctuations in productivity are unlikely to be
reflected in prices especially because prices are not usually "fixed"
by farmers.

Finally, in this section on labour costs, consider the employ-
ment data used in the calculation of productivity. The employment
series used were obtained from A.B.S. publications. The A.B.S. pro-
duces estimates of employees by industries on the basis of pay-roll
tax and other returns which in 1966

"... accounted for about 85% of the
total number of employees in the
industries covered." 1

Hence the coverage is satisfactory. The data exclude employers,
self-employed persons and unpaid helpers but this is not likely to
seriously affect the data. As with some other series, there is a
break in the continuity of the employment series at June 1966 but

since this could not be overcome it was ignored.

As in the case of production indexes, the lack of correspondence between the series and the sectors for which they are used is likely to be a greater cause for concern than any defects in the series themselves and as a result of this the regression results to be presented in later chapters cannot hope to provide definite answers to questions posed about the importance of productivity movements in the pricing process.

4.5.3 Materials cost

As mentioned above, the use of the materials price data proposed in the previous section is not very satisfactory but they were used because of the lack of more satisfactory data. It was proposed to use mainly components of the Export Price Index and the Import Price Index (subsequently referred to as the EPI and IPI respectively). As an alternative approach to the use of these indexes and wage-rate or earnings indexes it was suggested that Agarwala and Goodson's input-output method of computing unit prime cost ought to be experimented with.

Consider, first, the use of the components of the IPI. The RBA Import Price Index is reasonably comprehensive although

"... in many instances one indicator is assumed to measure price movements for a number of similar commodities."^1

A more serious weakness in the series used for this study is caused by the change in classification incorporated when the series was

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rebased to 1966-67=100. Series using the new base were calculated only back to 1964-65 so that the old series for periods prior to 1964-65 had to be linked to the new series to provide data for the entire proposed sample period. All except two of the groups in the new classification used in this study had counterparts in the old classification and price indexes for these groups were linked to their counterparts. The Bank states that these groups

"... suffered a change in composition but are otherwise comparable with similar groups in the 1962-63 based index." 1

The break in continuity of these series does not appear very serious especially since they were linked at 1966-67 rather than 1965-66. The exceptions mentioned above are the Crude Materials, inedible and the Chemicals groups in the new classification which have no counterpart in the old classification. As explained in the previous section this problem was overcome by assuming that these two groups combined are comparable to the two groups Basic Materials and Base Metals in the old classification combined so that these two combined series were linked. It was decided to use this somewhat questionable approximation since this provides one of the few raw materials indexes available.

The problems arising out of the imperfections of the IPI as such do not appear to be as serious as those arising from the use of import prices as proxies for materials prices. The use of import prices for a particular sector would appear justified where import prices, in fact, represent the prices of materials used by that sector. They would also probably be suitable as a measure of materials prices

1. Ibid.
where the particular sector for which they are used uses materials inputs which are imported as well as produced within Australia and the prices of imported materials and home-produced materials move in a similar way. However, import prices are too narrow a measure of materials prices although this restriction is eased somewhat by the use of components of the EPI and some other price indexes. Despite the use of additional price indexes, it will be difficult to draw any strong conclusions concerning the importance of materials prices in the pricing process from the results obtained using import prices.

A further difficulty in the interpretation of the results using components of the IPI is caused by the possibility that included in the regimen of a particular component of the IPI are goods also produced by the sector for which the component is being used so that a positive coefficient in a regression equation would be expected on the basis of similar movements of the prices of competing goods rather than on the basis of the importance of materials prices in the pricing process.

Hence regarding the components of the IPI, the components to be used appear to be quite satisfactory measures of import prices with the exception of the series which had to be combined and linked in a rather primitive fashion. The use of the series to measure materials prices does not appear to be very satisfactory and this will have to be taken into account when the regression results are interpreted. Consider now the components of the EPI to be used.

The weights and composition of the EPI was originally based on the pattern of exports in the years 1956-57 to 1960-61. After some
years the coverage of the index declined markedly and a review of the index was undertaken with the result that an interim series was published from 1969 onwards linked to the old index at July 1969 and based on the composition of exports for 1969-70. This has caused some discontinuity at the point of linkage. Since in some cases this break in the series is quite marked, it will have to be kept in mind when the regression results are evaluated. Apart from this problem the series appears quite satisfactory. The variation in the coverage of the EPI as a whole over the sample period should be no cause for concern since in this study we are only using the components of the index as proxies for the prices of materials used by Australian producers rather than the EPI as a whole to measure changes in export prices.

Now consider the appropriateness of the components of the EPI as measures of materials prices in this study. The index is used mainly where it is felt that Australian producers use inputs which are also exported (e.g., wool) and that Australian producers pay the same prices as overseas buyers. If this is the case in the sectors for which export prices are used as a proxy for materials prices then the components of the EPI used appear appropriate especially since they are based on prices measured f.o.b. at the Australian port of export. However, there is the danger in some cases that the component of the index used for a particular sector also measures the price of the output of the sector in which case a significant positive regression coefficient would be expected but this would tell us nothing about the importance of materials costs in the pricing process.

Apart from the IPI and the EPI, three other series were used as measures of materials prices for some sectors. Two of these involved the linking of the Building Materials section of the discontinued WPI to the two Building Materials prices indexes available from the A.B.S. since 1966-67. This procedure was necessary since the two new building materials price indexes are not available for the entire sample period. The obvious weakness of the procedure is that the WPI was discontinued because it was out of date and the validity of linking part of it to more up to date indexes is questionable. This is apparent when the weights of the two new indexes are compared to the weights of the old index. There are some similarities between the weights of the Building Materials section of the WPI and the weights of the Price Index of Materials used in House Building but few between the weights of the WPI Building Materials section and those of the Price Index of Materials used in Building other than House Building. Thus, as with other material price indexes, the regression results will have to be interpreted with these weaknesses in mind.

The remaining series to be considered is another linked series which links the index for the Metals and Coal group of the WPI to the Index of Metallic Materials used in the Manufacture of Fabricated Metal Products (subsequently referred to as the PMP). The weaknesses of this linked series are similar to those described above concerning the building materials indexes, i.e., the WPI is out of date and it seems unsatisfactory to link it to an up to date index and secondly, the items covered and the weights of the two indexes differ substantially especially since the PMP does not cover coal which has a weight of 64% in the Metals and Coal section of the WPI. Hence the same
caution will have to be used in the interpretation of the regression results.

Thus, on the whole, the data used in this study to represent materials prices are not very satisfactory. This is because there is no unified set of materials price indexes available for Australia so that the data used had to be obtained from various different sources. The data used was often of a type not designed for use as materials prices. Added to this difficulty was that during the sample period the A.B.S. ceased to publish the WPI which had become outdated and since 1966-67 has been in the process of replacing it by the "Price Index of Materials used in Manufacturing".

4.5.4 Sales Tax and Excise

Although the sales tax data used are accurate since the rates are published by the Commissioner of Taxation, the goods grouped under the various Schedules do not correspond very closely to the sectors used in this thesis since they are, obviously, not grouped for statistical purposes. Thus for each sector the sales tax series used (where applicable) was a weighted average of the rates applied to the goods included in that sector, the weights being based on the gross sales value of goods taxable at various rates. The weights were based on data published by the Commissioner of Taxation for 1963-64.1 This year was chosen as the year closest to the middle of the sample period in which the rates of sales tax applicable under the various Schedules were all different. This was necessary because the dissection of gross sales value of taxable goods was by rate of tax and not by

The calculation of an index measuring changes in excise duties was more difficult since the information was obtained from the Budget Speech but was insufficient to calculate the percentage increase in excise duties for each year of the sample period. In general, where an increase in excise is proposed in the Budget, the increase in revenue estimated to result from the increase in excise duties is given and this figure was divided by the excise collections for the previous year to obtain an estimate of the percentage increase in the "rate" of excise. This approach, which was used by Higgins to obtain an index for the rate of sales tax, ¹ is based on the assumption that the estimates are calculated by the Treasury under the assumption that a change in excise will not significantly affect the quantity of goods sold. The series so derived will be inaccurate to the extent that this assumption is invalid.

4.5.5 Product Market Demand Variables

In this subsection we will consider the use of output and expenditure data to represent the pressure of demand in the product market.

The output data used is the same as those used to calculate output/man and is thus subject to the same limitations. Output data will be used in the form of the change in output. The use of the change in output to represent the pressure of demand in the product market is based on the reasoning that an increase (decrease) in demand will bring about an increase (decrease) in output. It is

¹. See Higgins, op.cit., p.27.
possible that this variable should enter a price equation with a 
lag since it may take an increase in demand persisting over several 
periods to bring about an increase in output and a fall in demand 
may need to persist for several periods before producers will cut 
production.

The expenditure data for sectors A1, ..., A7 is satisfactory 
since constant price estimates of expenditure are available for each 
sector and these estimates will be seasonally adjusted. For sectors 
B1, ..., B6 the expenditure data are from the same source but do not 
match the sectors as well. This is disadvantageous for two reasons: 
firstly, the expenditure variable will not closely match the sector 
for which the dependent variable is defined; secondly, the components 
of the CPI used to deflate the expenditure data will not closely match 
the data being deflated. However, the mis-matching will not be as 
serious as for some other variables, e.g., output, wages. The expen-
diture data used for the States has the weakness that, because only 
annual data are available, the annual level of expenditure in each 
State had to be assumed to hold for each quarter.

4.5.6. Labour Market Demand Variables

Now consider the four labour market demand variables to be 
used as proxies for the pressure of demand in the product market.

The most widely used measures of demand pressure in the labour 
market in Australia are the number of unemployed and the number of 
vacancies or some combination of these variables. Both original and 
seasonally adjusted series will be used in this study although it is 
likely that the seasonally adjusted series will perform more
satisfactorily in regression equations since it is unlikely that producers will vary prices in response to changes in demand which are known to be of a seasonal nature only. Unfortunately, unemployment and vacancy series are not available for industrial, consumer or expenditure sectors so that for the type A and type B sectors the aggregate number of vacancies or the aggregate number of unemployed had to be used. Hence it will be difficult to draw conclusions regarding the importance of sectoral demand pressure from regression equations using these data.

The data for overtime hours used was more satisfactory in that it was available for industrial sectors. However, the data have several weaknesses. Firstly, only factory overtime hours are available. Secondly, as with most data obtained from an industrial disaggregation difficulties were experienced in matching industrial sectors and sectors of type A and type B. In fact for two sectors of type B no suitable data could be obtained.

4.5.7 **Unit Prime Costs**

As an alternative to the use of materials prices and wage costs as described above, it was proposed to experiment with the input-output method for computing unit prime costs used by Agarwala and Goodson in their study of prices for the U.K. As explained in section 4.4, the modification of Agarwala and Goodson's initial equation suggested in section 4.3 was not possible so that their less satisfactory initial equation had to be used. The common criticism of the input-output assumption of constant coefficients for the sample period may also be made in this case especially since the input-output
data used relate to 1962-63 which is in the beginning of the sample period so that we cannot assume that the coefficients used represent the average for the period. However, since the most recent input-output tables for Australia relate to 1962-63, no alternative was available. Both the measures used for the ratio of labour costs to total costs and the ratio of import costs to total costs appear satisfactory since all the data needed for their calculation were available from the input-output tables. This was not the case for the elements of the conversion matrix. The elements corresponding to three type A sectors were calculated directly from the tables, viz., those for sectors A1, A2, A6. The elements for the remaining sectors could not be calculated until the final demand columns of the input-output table had been dissected to correspond to the sectors to be used in this study.

Firstly, the figures in the column for Gross Fixed Capital Expenditure - Private had to be allocated to one of the groups: (1) Gross Fixed Capital Expenditure - Dwellings, (2) Private Gross Fixed Capital Expenditure - Other Building and Construction, and (3) Private Gross Fixed Capital Expenditure - Other. The allocation used should be satisfactory since input-output sector E1 (Residential Building) corresponds to (1) above and input-output sector E2 (Other Building and Construction) corresponds to (2) above with the remaining figures in the column for Private Gross Fixed Capital Expenditure being allocated to group (3). The allocation of figures for Current Expenditure - Personal Consumption to the five sectors B1, ..., B5 (i.e., corresponding to the CPI groups) was a little less straightforward but, using the guide for allocation provided by the Commonwealth Statistician, the resulting figures are felt to be reasonably close
to those which would have been obtained if a proper reconciliation between the groups of the CPI and the input-output sectors had been carried out. It should be noted that not all industries contributing to the Current Expenditure - Personal Consumption column of the input-output tables produce goods covered by the CPI. In fact, if the output of the input-output sectors is allocated to the CPI groups as suggested by the Commonwealth Statistician then 13.71% of Current Expenditure - Personal Consumption is not covered by any of the CPI groups. However, this will not affect the validity of the results obtained using this method since the elements of the conversion matrix are designed to show the proportions of the commodities covered by each CPI group derived from the various input-output sectors. It does mean that the coverage of the CPI is narrower than the implicit deflator for Current Expenditure - Personal Consumption. (sector Al).

Discussion of the wage-rate and import cost data used will be brief since these have been discussed previously. An additional weakness of the wage-rate data is that they do not match the ratios of labour costs to total costs very closely since minimum wage-rates are used and the numerator (and denominator) of the ratio of labour costs to total costs also includes salaries and supplements. Another unsatisfactory aspect of the wage-rate data used is that no wage-rate index is available for (aggregate) input-output sector I (Agriculture) so that the index for the Food, Drink and Tobacco industry was used to represent wage costs for this sector. Apart from the quality of the import cost data used, the allocation of indexes to the input-output sectors is clearly unsatisfactory but given the data available this is difficult to improve upon.
Below is a list of the 105 industrial sectors of the Australian Input-Output Tables which have been aggregated to obtain the 14 sectors to be used in this thesis.

A1 Sheep
A2 Wheat
A3 Other grains
A4 Meat cattle
A5 Milk cattle and pigs
A6 Poultry
A7 Other crops
A8 Forestry and logging
A9 Fishing and hunting
B1 Metallic minerals
B2 Coal and crude petroleum
B3 Other non-metallic minerals n.e.c.
C1 Meat and fish products
C2 Milk products
C3 Fruit and vegetable products
C4 Margarine, oils and fats
C5 Flour mill and cereal food products
C6 Bread, cakes and biscuits
C7 Sugar
C8 Confectionary and cocoa products
C9 Food products n.e.c.
C10 Soft drinks, cordials and syrups
C11 Beer and malt
C12 Other Alcoholic beverages
C13 Tobacco products
C14 Prepared fibres
C15 Yarns and rope
C16 Woven piece goods, carpets and felt
C17 Textile finishing
C18 Blinds, mattresses and household textiles
C19 Other textile products
C20 Knitting mills
C21 Clothing
C22 Footwear n.e.c.
C23 Saw-mill products
C24 Manufactures board and joinery
C25 Wooden furniture
C26 Pulp, paper and paperboard
C27 Fibreboard and paper containers
C28 Paper products n.e.c.
C29 Newspapers and books
C30 General printing and stationery
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C31</td>
<td>Fertilisers and industrial chemicals</td>
</tr>
<tr>
<td>C32</td>
<td>Industrial gases and other chemical products</td>
</tr>
<tr>
<td>C33</td>
<td>Arms, ammunition and explosives</td>
</tr>
<tr>
<td>C34</td>
<td>Paints</td>
</tr>
<tr>
<td>C35</td>
<td>Pharmaceutical and toilet preparations</td>
</tr>
<tr>
<td>C36</td>
<td>Soap and other detergents</td>
</tr>
<tr>
<td>C37</td>
<td>Inks, polishes, adhesives, etc.</td>
</tr>
<tr>
<td>C38</td>
<td>Petroleum products</td>
</tr>
<tr>
<td>C39</td>
<td>Glass and glass products</td>
</tr>
<tr>
<td>C40</td>
<td>Clay products</td>
</tr>
<tr>
<td>C41</td>
<td>Cement and concrete products</td>
</tr>
<tr>
<td>C42</td>
<td>Other non-metallic mineral products</td>
</tr>
<tr>
<td>C43</td>
<td>Iron and steel</td>
</tr>
<tr>
<td>C44</td>
<td>Ferrous foundry and engineering products</td>
</tr>
<tr>
<td>C45</td>
<td>Non-ferrous metal smelting and refining</td>
</tr>
<tr>
<td>C46</td>
<td>Non-ferrous metal rolling</td>
</tr>
<tr>
<td>C47</td>
<td>Fabricated structural metal products</td>
</tr>
<tr>
<td>C48</td>
<td>Metal containers</td>
</tr>
<tr>
<td>C49</td>
<td>Metal furniture</td>
</tr>
<tr>
<td>C50</td>
<td>Other metal products</td>
</tr>
<tr>
<td>C51</td>
<td>Cutlery and hand tools</td>
</tr>
<tr>
<td>C52</td>
<td>Wire products</td>
</tr>
<tr>
<td>C53</td>
<td>Hardware and plumbing equipment</td>
</tr>
<tr>
<td>C54</td>
<td>Motor vehicles and parts</td>
</tr>
<tr>
<td>C55</td>
<td>Ship and boat building and repair</td>
</tr>
<tr>
<td>C56</td>
<td>Locomotives, rolling stock and repair</td>
</tr>
<tr>
<td>C57</td>
<td>Aircraft building and repair</td>
</tr>
<tr>
<td>C58</td>
<td>Medical, photographic etc. equipment</td>
</tr>
<tr>
<td>C59</td>
<td>T.V., radios, electronic equipment, n.e.c.</td>
</tr>
<tr>
<td>C60</td>
<td>Household appliances n.e.c.</td>
</tr>
<tr>
<td>C61</td>
<td>Electric Cable, machinery, equipment n.e.c.</td>
</tr>
<tr>
<td>C62</td>
<td>Agricultural machinery and equipment</td>
</tr>
<tr>
<td>C63</td>
<td>Other industrial machinery and equipment</td>
</tr>
<tr>
<td>C64</td>
<td>Leather tanning</td>
</tr>
<tr>
<td>C65</td>
<td>Leather and substitute products n.e.c.</td>
</tr>
<tr>
<td>C66</td>
<td>Rubber products (including retreading)</td>
</tr>
<tr>
<td>C67</td>
<td>Plastic materials and products</td>
</tr>
<tr>
<td>C68</td>
<td>Toys and sporting equipment</td>
</tr>
<tr>
<td>C69</td>
<td>Writing and marking equipment</td>
</tr>
<tr>
<td>D1</td>
<td>Electricity</td>
</tr>
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I4 Business services
J1 Public administration
J2 Defence
K1 Health
K2 Education
K3 Welfare and religious institutions
L1 Entertainment and hotels
L2 Other personal services
M1 Ownership of dwellings
N1 Miscellaneous business expenses
This Appendix contains the time-series constructed as described in this chapter. All series cover the period 1960-61 to 1972-73, i.e., they all have 52 elements. The observations are arranged in rows so that for any variable row 1 contains the observations for 1960-61 (I) to 1961-62 (IV), etc. The data are preceded by a list of the symbols used for all the variables tested in this study. They are:

PAi = price level, sector Ai
PB1 = price level, sector Bi
PCi = price level, sector Ci
WAi = minimum wage rate index, sector Ai
WB1 = minimum wage rate index, sector Bi
WCi = minimum wage rate index, sector Ci
EOAi = average weekly earnings (original), sector Ai
EOBi = average weekly earnings (original), sector Bi
EOCi = average weekly earnings (original), sector Ci
ESAi = average weekly earnings (seasonally adjusted), sector Ai
ESBi = average weekly earnings (seasonally adjusted), sector Bi
PYAi = productivity, sector Ai
PYBi = productivity, sector Bi
ULWAi = WAi/PYAi
ULWB1 = WB1/PYBi
ULEOAi = EOAi/PYAi
ULEOB1 = EOBi/PYBi
ULESAi = ESAi/PYAi
ULESBi = ESBi/PYBi
PYAi* = 4-quarter moving average of PYAi
PYBi* = 4-quarter moving average of PYBi
ULNWAi = WAi/PYAi*
ULNWB1 = WB1/PYBi*
ULNEOAi = EOAi/PYAi*
ULNEOB1 = EOBi/PYBi*
ULNESAi = ESAi/PYAi*
ULNESBi = ESBi/PYBi*
UPAi = unit prime costs, sector Ai
UPBi = unit prime costs, sector Bi
MAi = materials costs, sector Ai
MB1 = materials costs, sector Bi
MCi = materials costs, sector Ci
TAi = sales tax rate, sector Ai
TB1 = sales tax rate, sector Bi
TCi = sales tax rate, sector Ci
DEXAi = change in expenditure, sector Ai
DEXBi = change in expenditure, sector Bi
DEXCi = change in expenditure, sector Ci
DOPAi = change in output, sector Ai
DOPBi = change in output, sector Bi
OTAi = overtime hours, sector Ai
OTBi = overtime hours, sector Bi
OTCi = overtime hours, sector Ci
UAi = unemployed, sector Ai
UBi = unemployed, sector Bi
UCi = unemployed, sector Ci
VAi = vacancies, sector Ai
VBi = vacancies, sector Bi
VCi = vacancies, sector Ci
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| 118.60896 | 117.57865 | 110.69493 | 113.35204 |
| 115.30921 | 114.35668 | 112.94522 | 116.67174 |
| 119.30810 | 119.44722 | 114.49401 | 117.65129 |

**PY8**

| 89.48713 | 92.88755 | 96.49276 | 82.88445 |
| 94.23046 | 100.84320 | 103.68641 | 99.19575 |
| 107.37493 | 104.14824 | 97.99579 | 108.80225 |
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| 114.28665 | 115.45711 | 116.30264 | 119.15927 |
| 123.15158 | 121.95901 | 125.31975 | 132.13843 |
| 143.69700 | 137.78333 | 143.83851 | 147.03889 |

**PY2**

| 96.17150 | 94.66969 | 112.87050 | 98.96354 |
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| 100.42579 | 96.97946 | 98.02708 | 101.00167 |
| 112.05383 | 108.49990 | 111.62904 | 107.93326 |
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**PY3**

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| 118.91927 | 120.26895 | 120.03639 | 127.27044 |
| 127.89938 | 123.51626 | 123.67418 | 125.84925 |
| 140.26418 | 138.84514 | 138.44021 | 146.10185 |
| 169.80934 | 173.79920 | 179.70644 | 188.53327 |
| 214.60835 | 219.04346 | 231.67547 | 231.21571 |

**PY4**

| 93.46045 | 95.35540 | 98.78669 | 94.13699 |
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| 110.44910 | 108.46090 | 105.17857 | 113.11180 |
| 114.09036 | 113.48659 | 113.11776 | 116.36304 |
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| 3.00740 | 3.24172 | 3.48274 | 3.87889 |         |         |         |         |         |

**OTA5**

| 3.41277 | 2.98342 | 2.28821 | 1.77166 | 1.54614 | 1.97168 | 2.03573 | 2.35119 |
| 2.66058 | 2.74082 | 2.78429 | 2.61553 | 2.85916 | 3.11181 | 3.41054 | 3.59422 |
| 3.15756 | 3.37753 | 3.64694 | 4.00998 |         |         |         |         |         |

**OTA6**

| 2.08953 | 1.92960 | 1.65155 | 1.31035 | 1.44017 | 1.75003 | 1.93675 | 1.86162 |
| 1.89601 | 2.02076 | 2.03611 | 1.97245 | 2.06511 | 2.20784 | 2.42429 | 2.57269 |
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| 2.76189 | 2.67295 | 2.58128 | 2.69916 | 2.69934 | 2.56090 | 2.34868 | 2.83355 |
| 2.69934 | 2.65771 | 2.83641 | 3.00515 |         |         |         |         |
CHAPTER 5

TYPE A RESULTS

5.1 Introduction

In this chapter we will discuss the results of estimating price equations for sectors of type A using the data described in the previous chapter. Before presenting the regression results some preliminaries will be discussed in this introductory section. These relate to the limits placed on the experimentation by the impossibility of testing all possible combinations of variables and lag structures, the estimation method used, the statistical problems encountered and the test statistics used. The following section (5.2) will describe the results for type A sectors in general, concentrating on results which appear to be common to most sectors. Section 5.3 will be concerned with a description of the results for each sector in turn and the final section will attempt to compare the results obtained for the different sectors one with another and with the aggregate equation (i.e. the equation for A7).

Consider first the limits placed on the experimentation. Obviously, given the number of sectors and the number of explanatory variables (including lagged variables) which were relevant for each sector an almost infinite number of plausible relationships could have been estimated. For this reason several limitations were placed on the equations to be estimated. The most severe limitations were placed on the experimentation with different lag structures. It will
be recalled that in Chapter 3 it was felt that one and two period lags on the cost variables would be most likely to be useful. In addition it was felt that, since Almon lags had been reasonably successful in the T-ABS study, these types of lags ought also to be tried in this study. In the event experimentation with lags on cost variables was restricted mainly to one period lags since these appeared to be the more important. Almon lags were not experimented with. In most cases little experimentation with lags on demand variables was carried out. As regards the variables tested, all variables for which data were available were tested, at least in current form, with the exception that the variable (ULC-ULCN) was not tested as it appears to have been of only marginal significance in the studies reviewed. Added to this was the fact that neither ULC nor ULCN performed very satisfactorily in the estimated equations, this probably being due to the rather questionable quality of the short-run productivity data used. If this is in fact the case then the testing of (ULC-ULCN) would appear to be of limited usefulness. If these limits on the experimentation are compared with the programme set out in Chapter 3 (and modified in Chapter 4) it will be seen that a considerable amount of experimentation was still undertaken. In fact, 9 different labour cost variables, UPA, MA, TA, two different produce market demand variables and four different labour market demand variables were tested, in most cases for each of the 7 sectors. In addition, one-period lags were tried for the most successful labour cost variables, UPA and MA.

Turn now to a consideration of some statistical questions. Firstly, all equations were estimated by the single equation least
squares (SELS) method. Since the price equations proposed in this study ought to be part of a system of simultaneous equations, the estimates of the parameters obtained using SELS will be biased and inconsistent. However, in this study the relative simplicity of the SELS method outweighed any distinct advantage associated with more complex methods.

Secondly, consider the test-statistics used. The statistics accompanying each equation presented in this and the following chapters are $R^2$, the t-ratio for each estimated coefficient and the Durbin-Watson statistic (DWS). Since no equations were estimated with the lagged dependent variable on the right-hand-side, the DWS may appropriately be used to test the null hypothesis that the first order serial correlation in the residuals is zero against the alternative hypothesis that it is non-zero for each equation. In general an attempt has been made to obtain an equation for each sector having a satisfactory $R^2$, all the coefficients significant at the 5% level and a satisfactory DWS at the 1% significance level. Besides this, it was required, of course, that the coefficients be of the correct sign. In section 5.4, where the preferred equations for different sectors are compared, the partial correlations coefficient corresponding to each variable in the preferred equations is used to measure the relative importance of the variable in the regression equation.  

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It should be noted that the partial correlation coefficient is closely related to the t-ratio and in most cases the relative sizes of the t-ratios will give an unambiguous indication of the relative sizes of the partial correlation coefficients. This will not necessarily be the case if the partial correlation coefficients from different equations are compared and hence in the final section the partial correlation coefficients will be included in the table containing the preferred estimated equation for each sector.

In general it was not possible, even given the limitations placed on the extent of experimentation, to estimate all plausible equations for type A sectors at the same time. Hence the approach generally taken was to experiment with various cost variables (labour cost variables, materials cost variables, and sales tax variables) first. These equations with only cost variables usually had unsatisfactory DWS's but this was to be expected since they were incomplete. On the basis of these equations, the "best" types of variables were chosen (i.e. those with the highest $R^2$ and t-ratios) and further experimentation was carried out with these equations by trying various additional explanatory variables and lag structures. It is recognized that this is not an ideal method but given the number of equations and variables to be estimated, it appeared to be the only possible approach.

Finally in this introductory section it should be noted in advance that, as expected, the problem of multicollinearity was


2. See above p. 71.
encountered in many of the equations, especially where both the current and lagged form of the same variable were used in the same equation. The presence of multicollinearity made the parameter estimates in some equations somewhat unreliable. Since the partial correlation coefficients are closely related to the t-ratios, the presence of multicollinearity will also affect these measures making them somewhat unreliable. However, the alternative measure, the $\beta$ coefficient, is also made unreliable by the presence of multicollinearity since it is dependent on the estimated regression coefficient. Hence, it was decided to proceed with the use of the partial correlation coefficient, keeping in mind its limitations when the preferred estimated equations are compared.

5.2 General Observations on the Results

In this section each type of variable will be considered in turn and an attempt made to state some results which were common to most sectors. This will be done to avoid repetition in the next section as far as possible.

Firstly, consider the various labour cost variables tested. The discussion here will relate mainly to estimated equations of the form:

\[
(5.1) \quad PA_i = \hat{a} + \hat{b}X_i
\]

where $PA_i$ = price level in sector $i$,

$X_i$ = labour cost variable for sector $i$.

On the whole, a comparison of the various forms taken by $X_i$ was made on the basis of the $R^2$ associated with the equations and the t-ratio
associated with the coefficient of $X_i$. The forms taken by $X_i$ are as follows: $W_{Ai}^1$, $E_{OAi}$, $ESA_i$, $ULWA_i$, $ULEOA_i$, $ULESA_i$, $ULNWA_i$, $ULNEOA_i$, $ULNESAi$. In addition, short-run productivity ($PYAi$) was tried as a separate variable in equations with $WA_i$, $EOAi$, $ESA_i$.

Estimated equations of the form (5.1) with $X_i$ as $WA_i$, $EOAi$ or $ESA_i$ showed a strong correlation between the dependent and the independent variables. The labour cost variable was always highly significant and the $R^2$ was generally greater than 0.9. On the basis of both $R^2$ and the t-ratio (both of these usually led to the same conclusion) $WA_i$ and $ESA_i$ were better than $EOAi$. This was so for all sectors. This bears out the point made previously that firms are less likely to adjust their prices to increases in earnings which are known to be temporary and of a seasonal nature than they are to increases in earnings which result from, for example, a wage rise which is likely to be permanent. Thus little further experimentation was carried out using $EOAi$. When the $R^2$'s and t-ratios of equations with $WA$ and $ESA$ are compared there is little basis for choosing between them, $ESA$ having higher associated $R^2$'s and t-ratios for some sectors and $WA$ for others.

When short-run productivity ($PYAi$) was added to (5.1) as a separate variable it was seldom significant and of the right sign. The only exception is sector A5 where $PYAi$ was significant and of the right sign in the equations with $WA$, $EOA$ and $ESA$. Hence, except for sector A5, little further experimentation was carried out with short-run productivity. More will be said about this variable when we

1. A list of the symbols used to denote the variables tested is contained in Appendix 4.2.
consider the ULC and ULCN variables below.

Three different types of ULC variables were tried in the regressions, viz., ULWA, ULEOA, ULESA and again on the basis of both $R^2$ and the $t$-ratio they performed worse than WA and ESA for all sectors. There are several possible explanations for the failure of short-run productivity either as a separate variable or when combined with WA, EOA or ESA to form ULC variables. Firstly, it may be simply that short-run productivity does not influence the price level. In the ideal situation where the quality of the data used to represent short-run productivity is not subject to serious question this would be the conclusion which could be drawn from the results. However, this is not the case. As stated in Chapter 4, there are many flaws in the sectoral short-run productivity data which were constructed and it is quite possible that the data used do not measure productivity at all accurately. This would seem to be the conclusion when we consider that in more equations of the form

\[(5.2) \quad PA_i = a + b X_i + cPYAi\]

was PYAi significantly positive than it was significantly negative.

A third possible reason is that the output data used to calculate PYA should not have been seasonally adjusted. However, this explanation is difficult to accept, especially since prices show little seasonal variation whereas output series exhibit marked seasonal variation. If the poor performance of the short-run productivity

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1. See the reference to Pitchford, above p. 98. Where prices show some seasonal variation (e.g. some food prices) this is more likely to result from seasonal variation in materials prices than in productivity.
variable is at all due to seasonal influences in production it is more likely that the method used to seasonally adjust the production series was unsatisfactory and that not all seasonal movements were removed from the series.

Consider now the ULCN variables used. As in the case of the ULC variables, 3 types of ULCN variables were experimented with, viz., ULNWA, ULNEOA, ULNESAA. For equations with ULNWA, $R^2$ and the t-ratios associated with the estimated coefficient of the ULNWAi were smaller than those for equations with WA or ESA for all sectors. The same holds for equations with ULNEOA except that the $R^2$'s and t-ratios were marginally better than for the ULNWA equations. Of the three ULCN variables tested, ULNESAA performed best but performed better than ESA only for sector A5. Hence, on the whole, while the ULCN variables used were more satisfactory than the ULC variables (as would be expected from previous Australian price equation studies), only for sector A5 did they prove superior to ESA.

When UPAl was used as $X_i$ in equations of the form of (5.1) the resulting $R^2$'s and t-ratios were better in all sectors than when WA and EOA were used. This was not the case when ESAi is compared with UPAl; ESA gave better results than UPA for some sectors and not for others. It is interesting to note that the equation with UPA for sector A5 was better (in terms of the t-ratio and $R^2$) than the equation ULNESAA for sector A5. Thus for all sectors of type A the equations with ULC or ULCN variables could be improved by using either WA or ESA or UPA. When PYA was added to the price equations with UPA it was significant and of the right sign only in the equation
for sector A5. This reinforces the results obtained previously with productivity. On the whole, the UPA variables were more successful than expected, especially in the light of the simplifying assumptions which were made in order to construct the series.

Turn now to the results obtained using MA. The results using materials cost variables were less conclusive than those obtained using the various labour cost variables. This is probably due to two factors. Firstly, materials costs are likely to be less important than labour costs are in price equations. Secondly, the data used to represent materials costs were, on the whole, less satisfactory than the data used to represent the various labour cost variables. It is felt that these are the main reason for materials cost variables being significant less often than labour cost variables. The relationship between price levels and materials costs was the weakest in the equations for sectors A1 and A2. When the materials cost variable was added to equations with a labour cost variable it was generally insignificant or of the wrong sign for A1 and often insignificant for A2. The relationship was the strongest in the equations for A5, A6 and A7. It will be recalled that for both sectors A5 and A6, two different materials cost variables were proposed. For sector A5 the second materials cost variable, i.e. the one for which the Metals and Coal section of the WPI, linked to the "Price Index of Metallic Materials used in the Manufacture of Fabricated Metal Products" was used, was significant far more often than the first. In fact, the first materials cost variable for sector A5, where significant, was

1. See above pp. 126, 127.
often of the wrong sign. Hence further experimentation with materials costs was confined to the use of the alternative variable. For sector A6 the same appears to be true although the results were not so conclusive.

It will be recalled that a sales tax variable was proposed only for sectors A1 and A7. For both sectors the tax variable proved to be highly significant in nearly all equations in which it was used.

Now consider the results of experimentation with the various demand variables proposed. A general conclusion which can be drawn is that both product market demand variables proposed (i.e. DEXA, DOPA) performed very poorly in all equations and neither of the variables were significant very often. On the other hand, of the labour market demand variables used OTA was significant more often than UA or VA. Since sectoral data were used to represent OTA and aggregate data were used to represent UA and VA, it was decided to use OTA rather than UA or VA in the preferred equations. The remaining labour market demand variables tried were the ratio of VA to UA and the ratio of (VA-UA) to employment (denoted VA*). The results obtained using the ratio of VA/UA were disappointing, but understandable in the light of the results obtained by Higgins using the same variable. On the other hand, those obtained using VA* were more satisfactory and consequently VA* was used in some of the preferred equations to be reported later in this chapter.

Finally, in this section, we will consider the results of

the limited experimentation carried out with one-period lags. Firstly, consider lagged labour costs. In general, current WA has a larger t-ratio (and was more often significant) than WA\(_{-1}\) when both WA and WA\(_{-1}\) were included in the same equation. This applies for all sectors except A7 where the results were not clear-cut. Similar results were obtained with ESA although the difference in the significance of ESA and ESA\(_{-1}\) was not as clear as for some sectors. Similarly UPA was more often significant than UPA\(_{-1}\) when both were included in the same equation except in the equation for sector A5 where UPA\(_{-1}\) was more often significant than UPA.

When both MA and MA\(_{-1}\) were included in the same equation both were significant in only few cases and on the whole it appears that MA\(_{-1}\) is more satisfactory than MA.

5.3. Detailed Results

5.3.1 Sector A1

For sector A1 the most satisfactory labour cost variable was ESA although it was not usually markedly better than WA. The estimated equation of the form of (5.1) where Xi takes the form of ESA\(_{i}\) is:

\[
(5.3) \quad PA1 = 51.8239 + 0.7743 \text{ESA}_1 \\
(136.76) \quad R^2 = 0.9973 \quad DWS = 0.83
\]

If ESA\(_{-1}\) is added to this equation we get:
Comparing these two estimated equations it is obvious that there is strong multicollinearity between ESA1 and ESA1−1 since the t-ratio of ESA has fallen dramatically and $R^2$ is only slightly higher for the equation with both ESA1 and ESA1−1. Note also the decrease in the size of the coefficient of ESA1. Similar results were obtained with WA1 and WA1−1 and UPA1 and UPA1−1. It will be recalled that the materials cost variable was dropped from the equation for sector Al. If TA1 is added to the above equation ESA−1 becomes insignificant while TA1 is significant. The estimated equation is

\[
(5.5) \quad PA1 = 44.6329 + 0.5285 \text{ESA1} + 0.1974 \text{ESA1}_1 \\
(4.46) \quad (1.58) \\
+ 0.0985 \text{TA1} \\
(4.62) \\
R^2 = 0.9982 \quad \text{DWS} = 1.08
\]

As indicated by the size of the coefficients and the partial correlation coefficients for ESA1 and ESA1−1, ESA1 contributes more to the explanation of PA1 and both of these variables are more important than TA1 (when ESA1 and ESA1−1 are used separately).

When demand variables were added to equations with ESA1 and/or ESA1−1 their coefficient was invariably negative and often significantly negative. This was not the case when they were added to equations with WA or UPA. Therefore, ESA1 was replaced by UPA1 which was only marginally better than WA1 but has the advantage that it also includes
materials costs. OTA1 was chosen in preference to VA1* for two reasons - firstly, OTA1 is a sectoral variable while VA1* is an aggregate one; secondly, equations with OTA1 always had better DWS's than the corresponding equations with VA1* although on the basis of $R^2$ and the t-ratio there was little difference between OTA1 and VA1*. The equations from which the preferred equation was finally chosen are presented in Table 5.1.  

On the basis of the $R^2$'s for the equations presented in Table 5.1, the preferred equation would be (5.1e). It should be noted that at best the DWS falls in the inconclusive region thus indicating that there is still some serial correlation in the residuals. It is felt that this may be due to the fact that a materials cost variable is not included and it may be possible to remove this serial correlation by trying alternative materials cost variables. Secondly, it may be due to the fact that a ULC or ULCN variable is not used. It will be recalled that the poor performance of ULCN was felt to be due largely to the poor data used to measure productivity.

5.3.2. Sector A2

For sector A2 there were far less equations with all the variables significant than there were for sector A1. In addition to this, it will be recalled that a sales tax variable was not defined for sector A2. Despite this, the DWS's were, on the whole, far better than those for sector A2.

As regards the labour cost variables, WA was marginally better on the basis of $R^2$ and the t-statistic than ESA. This also applied

1. See p. 198.
### Table 5.1: Sector A Equations

<table>
<thead>
<tr>
<th>Equation Number</th>
<th>Equation</th>
<th>$R^2$</th>
<th>DWS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 a</td>
<td>$PA_1 = 24.8571 + 0.3307 WA_1 + 0.2003 TA_1 + 1.6577 OTA_1$</td>
<td>0.9973</td>
<td>1.38</td>
</tr>
<tr>
<td></td>
<td>(41.95) (8.30) (3.92)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1 b</td>
<td>$PA_1 = 24.6746 + 0.2466 WA_1 + 0.0911 WA_{1-1} + 0.1949 TA_1 + 1.5892 OTA_1$</td>
<td>0.9974</td>
<td>1.08</td>
</tr>
<tr>
<td></td>
<td>(6.07) (2.11) (8.31) (3.88)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1 c</td>
<td>$PA_1 = 31.8975 + 0.3087 UPA_1 + 0.1558 TA_1 + 1.2107 OTA_1$</td>
<td>0.9974</td>
<td>1.18</td>
</tr>
<tr>
<td></td>
<td>(45.52) (6.44) (2.95)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1 d</td>
<td>$PA_1 = 23.1635 + 0.3653 UPA_{1-1} + 0.1789 TA_1 + 1.4821 OTA_1$</td>
<td>0.9961</td>
<td>1.45</td>
</tr>
<tr>
<td></td>
<td>(34.97) (6.07) (2.93)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1 e</td>
<td>$PA_1 = 29.4501 + 0.2034 UPA_1 + 0.1282 UPA_{1-1} + 0.1545 TA_1 + 1.2529 OTA_1$</td>
<td>0.9979</td>
<td>1.12</td>
</tr>
<tr>
<td></td>
<td>(6.59) (3.48) (7.09) (3.39)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
to lagged values of these variables. In fact, in estimated equations with either WA2-1 and WA2 or EA2-1 and EA2, both WA2 and WA2-1 are significant while both EA, EA2-1 are insignificant. On their own UPA2 and UPA2-1 gave better results than WA2 or ESA2 but when both UPA2 and UPA2-1 were included in the same equation UPA2-1 was not significant.

It will be recalled that MA was not successful in equations for sector A2. Since PA2 is represented by the implicit deflator for final government consumption expenditure, it is not certain whether a demand variable would be relevant. OTA2 was nevertheless included in the regressions and proved to be significant in many cases. It marginally increased the value of $R^2$ and also increased the DWS. Some of the more satisfactory equations for sector A2 are given in Table 5.2. It will be noted that in neither case is OTA2 significant at the 5% level, but it is significant at the 10% level. On the basis of both $R^2$ and the DWS, equation (5.2d) was chosen as the preferred equation for sector A2.

5.3.3 Sector A3

The results obtained for sector A3 were far from satisfactory. This was evidenced by both the number of variables which were significant and of the right sign and by the DWS. This was all the more surprising when it was found that the results for sector A4 (also a building sector) were far better. It had not been expected that the results for these sectors would differ so much especially as the same

1. See p. 200.
<table>
<thead>
<tr>
<th>Equation No.</th>
<th>EQUATION</th>
<th>$\bar{r}^2$</th>
<th>DWS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.2 a</td>
<td>PA2 = $-5.7584 + 0.6993$ WA2 &lt;br&gt; (91.94)</td>
<td>0.9940</td>
<td>1.35</td>
</tr>
<tr>
<td>5.2 b</td>
<td>PA2 = $-0.8137 + 0.6171$ UPA2 &lt;br&gt; (105.12)</td>
<td>0.9954</td>
<td>1.58</td>
</tr>
<tr>
<td>5.2 c</td>
<td>PA2 = $-0.8685 + 0.6908$ WA2 + 1.8664 OTA2 &lt;br&gt; (77.52) &lt;br&gt; (1.73)</td>
<td>0.9942</td>
<td>1.45</td>
</tr>
<tr>
<td>5.2 d</td>
<td>PA2 = $-3.1235 + 0.6106$ UPA2 + 1.6168 OTA2 &lt;br&gt; (88.50) &lt;br&gt; (1.70)</td>
<td>0.9956</td>
<td>1.70</td>
</tr>
</tbody>
</table>
data were often used for both sectors.

For sector A3 WA proved to be a better labour cost variable than ESA. This was the case for both current and lagged forms of the labour cost variables. Where both current and lagged labour cost variables were included in the same equation WA3 and WA3\_1 proved to be both significant while this was not the case for ESA3. When UPA3 was used in the place of WA3 or ESA3 the equations improved slightly in terms of \( R^2 \), the t-ratio and the DWS. In estimated equations of the form:

\[
(5.6) \quad \hat{P}A3 = \hat{a} + \hat{b} MA3
\]

\( \hat{b} \) was significantly different from zero. However, when MA3 is added to an equation with WA3 it becomes insignificant. Similarly, in all other equations where MA3 is included amongst the regressors it is insignificant. In only one case is MA3\_1 significant and then only at the 10% level. This was in an equation with WA3. This may be because of the data used to represent MA3. It will be recalled that for sector A3 the Building Materials section of the WPI was linked to the "Price Index of Materials used in House Building" and when the data were evaluated in Chapter 4 some doubt was expressed as to the validity of this procedure. However, a similar procedure was used in the case of sector A4 where the Building Materials section of the WPI was linked to the "Price Index for Materials used in Building Other than House Building" and in this case both MA4 and MA4\_1 were significant in a number of cases. Hence it is difficult to provide a good explanation of the failure of the materials price variable for sector A3 and it is difficult to believe that the price of dwellings is insensitive
to changing building materials costs.

Another disappointing feature of the results obtained for sector A3 was that in nearly all cases where a demand variable was included in the estimated equations its coefficient was of the wrong sign. Where the coefficient was positive it was insignificant and where negative it was often significantly negative. Thus the estimated equations presented below explain the price level for sector A3 only in the terms of labour costs (and materials where UPA3 is used). Equations using WA3 and UPA3 are presented in table 5.3.¹

Several points will be noted from this table. Firstly, there is again marked multicollinearity between MA3 and MA3_1 and between UPA3 and UPA3_1. Secondly, the DWS for all equations leaves much to be desired; this is due most probably to the few variables in the equations and to the fact that neither materials cost variables nor demand variables were successful. The poor DWS almost certainly points to the fact that either one or both of these variables ought to be present in the equations and that the reason why they were not significant or of the wrong sign was that the data did not accurately measure the variables they represent. It is difficult to accept that both the demand and the labour cost variables were rejected because they were not relevant. It is of course, also possible that other influences have been omitted which were not tested in this study.

On the basis of the equations presented in Table 5.3 equation (5.3f) was chosen as preferred equation for sector A3.

¹ See p. 203.
<table>
<thead>
<tr>
<th>Equation No.</th>
<th>EQUATION</th>
<th>$R^2$</th>
<th>DWS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.3 a</td>
<td>PA3 = 42.8532 + 0.3616 WA3 (90.43)</td>
<td>0.9938</td>
<td>0.73</td>
</tr>
<tr>
<td>5.3 b</td>
<td>PA3 = 40.6059 + 0.3811 WA3-1 (84.32)</td>
<td>0.9929</td>
<td>0.65</td>
</tr>
<tr>
<td>5.3 c</td>
<td>PA3 = 42.0034 + 0.2323 WA3 + 0.1365 WA3-1 (3.37) (1.88)</td>
<td>0.9941</td>
<td>0.49</td>
</tr>
<tr>
<td>5.3 d</td>
<td>PA3 = 36.8910 + 0.4214 UPA3 (96.90)</td>
<td>0.9946</td>
<td>0.79</td>
</tr>
<tr>
<td>5.3 e</td>
<td>PA3 = 34.2469 + 0.4445 UPA3-1 (87.46)</td>
<td>0.9934</td>
<td>0.74</td>
</tr>
<tr>
<td>5.3 f</td>
<td>PA3 = 35.9612 + 0.2819 UPA3 + 0.1475 UPA3-1 (4.0) (1.97)</td>
<td>0.9949</td>
<td>0.52</td>
</tr>
</tbody>
</table>
5.3.4 **Sector A4**

As remarked in the previous subsection, the results obtained for sector A4 were more satisfactory than those obtained for sector A3. As regards labour costs, ESA4 was found to be marginally superior to WA4. However, since the demand variables were again invariably of the wrong sign when included in the equations with ESA4 and/or ESA4\_1 we will centre our attention on the equations using WA4 and WA4\_1, where this was not the case. In most cases both WA4 and WA4\_1 were significant when entered in the same equation and the coefficient and t-ratio of WA4 were larger than those for WA4\_1, suggesting that the larger part of the adjustment of prices to wage changes is accomplished within the same quarter. This was also the case where ESA4 was used to represent labour costs. The results obtained using UPA4 and UPA4\_1 were in general similar to those obtained using WA4 and WA4\_1.

Materials costs were usually significant for sector A4. While MA4 and MA4\_1 were never both significant in the same equation, in general MA4 had a smaller coefficient and t-ratio than MA4\_1 suggesting a rather longer lag in the adjustment of prices to materials costs than in the adjustment of prices to labour costs.

Regarding the two demand variables experimented with, both OTA4 and VA4\* were generally significant and of the correct sign except when used in equations with ESA4 or ESA4\_1 as stated above. On the basis of the t-ratio, VA4\* was usually better than OTA4. However, when either of the demand variables was introduced into an equation with MA4 or MA4\_1 the coefficient of the materials cost variable became insignificant. Hence the preferred equation was chosen to
include UPA4 since this variable includes the effects of materials costs. Some equations obtained for sector A4 are given in Table 5.4. The last equation in the table was chosen as the preferred equation for sector A4 since all the variables are significant and of the correct sign, and $R^2$ and the DWS are slightly higher than for the equation using OTA4 instead of VA4*. It will be noted from this table that the DWS is the highest and $R^2$ the lowest when the labour cost variable is used in lagged form. This has also been the case for most other sectors. It would seem to indicate that for this sector the poor DWS for the equations with both current and lagged labour cost variables included does not result from the omission of some systematic influence and that a different estimation method may remove the serial correlation in the residuals. A second point emerging from the table is the apparent contradiction between the indications of the relative importance of current and lagged labour cost variables. However, on the whole, the lagged labour cost variable appears to be more important.

5.3.5 **Sector A5**

The results for sector A5 were, on the whole, not as satisfactory as those for sector A4. This was evident both from the somewhat lower $R^2$'s and, more noticeably, in the DWS's. Besides this, fewer variables were significant.

There was little difference between the results obtained using WA5 and ESA5, in most cases the $R^2$'s for equations using WA5 to represent labour costs were similar to those for equations using ESA5 but

1. See pp. 206. 207.
<table>
<thead>
<tr>
<th>Equation Number</th>
<th>Equation</th>
<th>$R^2$</th>
<th>DWS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.4 a</td>
<td>$PA_4 = 24.2913 + 0.3448\ WA_4 + 0.2153\ MA_{4-1}$</td>
<td>0.9983</td>
<td>0.91</td>
</tr>
<tr>
<td></td>
<td>(14.85) (6.21)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.4 b</td>
<td>$PA_4 = 22.1398 + 0.3630\ WA_{4-1} + 0.2160\ MA_{4-1}$</td>
<td>0.9972</td>
<td>1.81</td>
</tr>
<tr>
<td></td>
<td>(22.11) (4.73)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.4 c</td>
<td>$PA_4 = 24.2871 + 0.2589\ WA_4 + 0.0961\ WA_{4-1} + 0.2001\ MA_{4-1}$</td>
<td>0.9984</td>
<td>0.95</td>
</tr>
<tr>
<td></td>
<td>(6.35) (2.19) (5.87)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.4 d</td>
<td>$PA_4 = 33.6381 + 0.4038\ WA_4 + 0.7673\ OTA_4$</td>
<td>0.9976</td>
<td>0.86</td>
</tr>
<tr>
<td></td>
<td>(84.65) (3.39)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.4 e</td>
<td>$PA_4 = 31.1208 + 0.4251\ WA_{4-1} + 0.7926\ OTA_4$</td>
<td>0.9965</td>
<td>1.68</td>
</tr>
<tr>
<td></td>
<td>(70.62) (2.92)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.4 f</td>
<td>$PA_4 = 32.7693 + 0.2699\ WA_4 + 0.1418\ WA_{4-1} + 0.7457\ OTA_4$</td>
<td>0.9979</td>
<td>0.84</td>
</tr>
<tr>
<td></td>
<td>(5.67) (2.83) (3.52)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.4 g</td>
<td>$PA_4 = 26.9568 + 0.4688\ UPA_4 + 0.8573\ OTA_4$</td>
<td>0.9981</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>(95.14) (4.27)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.4 h</td>
<td>$PA_4 = 24.0222 + 0.4937\ UPA_{4-1} + 0.8928\ OTA_4$</td>
<td>0.9965</td>
<td>1.77</td>
</tr>
<tr>
<td></td>
<td>(70.62) (3.31)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 5.4 : SECTOR A4 EQUATIONS (continued)

<table>
<thead>
<tr>
<th>Equation Number</th>
<th>EQUATIONS</th>
<th>$R^2$</th>
<th>DWS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.4 i</td>
<td>$PA_4 = 26.1036 + 0.3401 , UA_4 + 0.1365 , UA_4^{-1} + 0.8375 , OT_4$</td>
<td>(7.24) (2.75) (4.44)</td>
<td>0.9983</td>
</tr>
<tr>
<td>5.4 j</td>
<td>$PA_4 = 34.8277 + 0.4151 , WA_4 + 0.0486 , VA_4^*$</td>
<td>(149.44) (4.14)</td>
<td>0.9978</td>
</tr>
<tr>
<td>5.4 k</td>
<td>$PA_4 = 32.3027 + 0.4373 , WA_4^{-1} + 0.0523 , VA_4^*$</td>
<td>(124.71) (3.72)</td>
<td>0.9968</td>
</tr>
<tr>
<td>5.4 l</td>
<td>$PA_4 = 33.8785 + 0.2682 , WA_4 + 0.1551 , WA_4^{-1} + 0.0497 , VA_4^*$</td>
<td>(6.06) (3.32) (4.65)</td>
<td>0.9982</td>
</tr>
<tr>
<td>5.4 m</td>
<td>$PA_4 = 28.0485 + 0.4835 , UA_4 + 0.0521 , VA_4^*$</td>
<td>(168.53) (5.01)</td>
<td>0.9983</td>
</tr>
<tr>
<td>5.4 n</td>
<td>$PA_4 = 25.0982 + 0.5098 , UA_4^{-1} + 0.0572 , VA_4^*$</td>
<td>(124.88) (4.08)</td>
<td>0.9968</td>
</tr>
<tr>
<td>5.4 o</td>
<td>$PA_4 = 27.0865 + 0.3361 , UA_4 + 0.1558 , UA_4^{-1} + 0.0535 , VA_4^*$</td>
<td>(7.78) (3.42) (5.67)</td>
<td>0.9986</td>
</tr>
</tbody>
</table>
the DWS was usually somewhat higher for equations using WAS. Further, the use of UPA5 in place of WAS or ESA5 resulted in a higher $R^2$ and DWS and if the estimated equation explaining PAS in terms of UPA5 is compared with the estimated equation explaining PA5 in terms of WAS and MA5, $R^2$ is slightly higher and the DWS is slightly lower for the former. If ESA5 is substituted for WA5 both $R^2$ and the DWS are higher than in the equation using UPA5. Both WA5 and WA5-1 are significant when included in the same equation as are UPA5 and UPA5-1. However when both ESA5 and ESA5-1 are used together neither are significant even at 10%. In the equation where PA5 is explained in terms of WA5 and WA5-1, WA5 is significant at the 5% level and WA5-1 only at the 10% level. In a similar equation using UPA5 and UPA5-1 the opposite is true, i.e., UPA5-1 is significant at 5% and UPA5 at 10%. Thus, it would appear that WA5 is more important than WA5-1 (this is also indicated by the relative size of the partial correlation coefficients) and that when materials costs are taken into account (as in UPA5) the lagged variable is more important in the explanation of PA5 than the current variable.

When MA5 is added to the equations with labour cost variables both MA5 and MA5-1 are significant (when used separately) but are never both significant in the same equation. Also, when MA5 or MA5-1 are added to the equation with both WA5 and WA5-1, WA5-1 becomes insignificant. The appropriate lag for MA5 is difficult to discern especially since MA5 and MA5-1 are both insignificant when included in the same equation. In the absence of any clear indication it was decided to use the current form of the materials cost variable in
the preferred equation.

When demand variables were added to the equations for sector A5 they proved to be invariably of the wrong sign and have, therefore, been omitted from the preferred equation. Recalling from the discussion in the previous section that short-run productivity was also significant in the equations estimated for sector A5, the choice of a preferred equation for this sector must be made from the following two equations:

\[ (5.7) \quad \text{PAS} = 48.1619 + 0.4435 \ UPA5 - 0.1052 \ PYA5 \]
\[ R^2 = 0.9886 \quad \text{DWS} = 1.01 \]

\[ (5.8) \quad \text{PAS} = 47.8211 + 0.6536 \ ESA5 - 0.1203 \ PYA5 + 0.2635 \ MA5 \]
\[ R^2 = 0.9922 \quad \text{DWS} = 1.08 \]

On the basis of both \( R^2 \) and the DWS, equation (5.8) was chosen as the preferred equation for sector A5.

5.4.6 Sector A6

For sector A6 better equations were obtained using ESA6 than WA6 on the basis of \( R^2 \), the t-ratio for the variable and the DWS. However, in the equation using both WA6 and WA\_1 both were significant (although WA\_1 only marginally) while this was not the case for ESA6 where ESA6 was significant and ESA\_1 was insignificant. \( R^2 \) and the DWS for equations using UPA6 and UPA\_1 fall in between those for the WA equations and the ESA equations. When both UPA6 and UPA\_1 are used as regressors, both are significant but UPA\_1 only at the
10% level of significance. Using the partial correlation coefficients, the current value of the labour cost variable is more important than the lagged value.

Turning now to the results obtained using materials costs, this variable proved to be insignificant in nearly all equations in which it was used. In the few equations where materials costs were significant, only the lagged value of the variable was significant and then only at the 10% level of significance. This is similar to the results obtained for the other government sector (sector A2). The DWS was, however, substantially lower in the equations estimated for sector A6 than for the equations estimated for sector A2.

Demand variables proved to be significant in many of the estimated equations for sector A6 and on the basis of $R^2$, the t-ratio and the DWS there was little basis for choice between OTA6 and VA6*, the partial correlation coefficient indicating that in equations with UPA6 and UPA6$_{-1}$, OTA6 is slightly more important and that in equations with WA6 and WA6$_{-1}$, VA6* is more important. As has previously been the case for sectors where a demand variable has proved significant, when OTA6 or VA6* was introduced into an equation with ESA6 its coefficient was invariably negative but usually insignificantly negative.

As in the case of sector A4, the DWS was the highest for the equations using only the lagged labour cost variable and it fell when both current and lagged variables were included in the same equation. However, for all equations the DWS indicated serially correlated residuals. Some of the better equations obtained for sector A6 are presented in Table 5.5.¹

¹ See p. 211.
<table>
<thead>
<tr>
<th>Equation Number</th>
<th>EQUATIONS</th>
<th>$R^2$</th>
<th>DWS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.5 a</td>
<td>$PA6 = 23.4581 + 0.4821 UPA6_1 + 1.1498 OTA6$</td>
<td>0.9966</td>
<td>0.68</td>
</tr>
<tr>
<td></td>
<td>$(102.45)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(4.61)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.5 b</td>
<td>$PA6 = 20.3573 + 0.5073 UPA6_{-1} + 1.2334 OTA6$</td>
<td>0.9953</td>
<td>1.06</td>
</tr>
<tr>
<td></td>
<td>$(86.62)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(4.19)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.5 c</td>
<td>$PA6 = 22.4524 + 0.3316 UPA6 + 0.1589 UPA6_{-1} + 1.1619 OTA6$</td>
<td>0.9969</td>
<td>0.44</td>
</tr>
<tr>
<td></td>
<td>$(5.17)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(2.35)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(4.87)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.5 d</td>
<td>$PA6 = 25.6637 + 0.3261 WA6 + 0.1294 WA6_{-1} + 1.1454 OTA6$</td>
<td>0.9957</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td>$(5.11)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(1.93)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(4.08)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.5 e</td>
<td>$PA6 = 28.7338 + 0.3354 WA6 + 0.1282 WA6_{-1} + 0.0693 VA6*$</td>
<td>0.9958</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>$(5.31)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(1.93)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(4.24)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.5 f</td>
<td>$PA6 = 25.3386 + 0.3348 UPA6 + 0.1651 UPA6_{-1} + 0.0604 VA6*$</td>
<td>0.9966</td>
<td>0.39</td>
</tr>
<tr>
<td></td>
<td>$(4.96)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(2.32)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(4.08)$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The first three equations were included in the table to demonstrate the changes in $R^2$ and the DWS which results from adding the current labour cost variable to an equation with the lagged labour cost variable or from adding the lagged variable to an equation with the current variable. The first three equations also demonstrate the ever-present problem of multicollinearity between the current and lagged labour cost variables. Equation (5.5c) was chosen as the preferred equation for sector A6.

5.3.7 Sector A7

Consider now the results obtained for the aggregate sector. In most ways, the aggregate equations were superior to the sectoral equations. Comparing the current labour cost variables used for this sector, the use of ESA7 resulted in marginally better equations than WA7 as regards the t-ratio of the estimated coefficient and $R^2$. However, while both WA7 and WA7-1 were significant when used together, this was not the case for ESA. When both WA7 and WA7-1 were used together the lagged variable proved to have a larger coefficient, t-ratio and partial correlation coefficient indicating that for this sector WA7-1 is more important than WA7. This is a somewhat surprising result especially in view of the fact that for most of the sectoral equations the opposite was the case.

When MA7 was introduced into the equation with WA7 and WA7-1 all variables are significant. This was also the case of MA7-1. However, MA7 and MA7-1 were never significant together. An examination of the partial correlation coefficients shows current materials costs to be more important than lagged materials costs so that the current
form of the variable was used in the preferred equation for this sector. It should be noted that a UPA series was not constructed for sector A7.

The sales tax variable was significant in all equations in which it was used except when it was included in equations with ESA7 and/or ESA7-1. It will be noted that this was not the case for sector A1, the only other sector for which a sales tax rate variable was used.

Both demand variables were significant in most equations in which they were tried with the notable exception of the equations including ESA7. On the basis of the partial correlation coefficients, OTA7 was more important than VA7*.

The preferred equation chosen for sector A7 is

\[ PA7 = 10.1193 + 0.1519 \text{ WA7} + 0.2106 \text{ WA7} - 1 + 0.2500 \text{ MA7} \]
\[ + 0.0660 \text{ TA7} + 0.8209 \text{ OTA7} \]
\[ R^2 = 0.9973 \quad \text{DWS} = 1.69 \]

5.4 Conclusions

To facilitate a comparison of the preferred equations chosen in the previous section, the preferred equation for each sector is reproduced in Table 5.6.1 The partial correlation coefficients for each variable are also included in the table (beneath the t-ratio) so that the importance of the explanatory variables may be compared.

### Table 5.6: Preferred Equations

<table>
<thead>
<tr>
<th>Sector</th>
<th>Equation</th>
<th>$R^2$</th>
<th>DWS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>$PA1 = 29.4501 + 0.2034 UPA1 + 0.1282 UPA1_{-1} + 0.1545 TA1 + 1.2529 OTA1$</td>
<td>0.9981</td>
<td>1.12</td>
</tr>
<tr>
<td></td>
<td>(6.59) (3.48) (7.09) (3.39)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>p.c.c. [0.6892] [0.4489] [0.7152] [0.4398]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>$PA2 = -3.1235 + 0.6106 UPA2 + 1.6168 OTA2$</td>
<td>0.9956</td>
<td>1.70</td>
</tr>
<tr>
<td></td>
<td>(88.50) (1.70)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>p.c.c. [0.9968] [0.2338]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A3</td>
<td>$PA3 = 35.9612 + 0.2819 UPA3 + 0.1475 UPA3_{-1}$</td>
<td>0.9949</td>
<td>0.52</td>
</tr>
<tr>
<td></td>
<td>(3.98) (1.97)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>p.c.c. [0.4905] [0.2684]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A4</td>
<td>$PA4 = 27.0865 + 0.3361 UPA4 + 0.1558 UPA4_{-1} + 0.0535 VA4^*$</td>
<td>0.9986</td>
<td>1.01</td>
</tr>
<tr>
<td></td>
<td>(7.78) (3.42) (5.60)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>p.c.c. [0.7434] [0.4390] [0.6287]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A5</td>
<td>$PA5 = 47.8211 + 0.6536 ESA5 - 0.1203 PYA5 + 0.2635 MA5$</td>
<td>0.9922</td>
<td>1.08</td>
</tr>
<tr>
<td></td>
<td>(16.57) (-3.39) (4.17)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>p.c.c. [0.9212] [0.4359] [0.5118]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 5.6: PREFERRED EQUATIONS (continued)

<table>
<thead>
<tr>
<th>Sector</th>
<th>EQUATION</th>
<th>$R^2$</th>
<th>DWS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A6</td>
<td>PA6 = 22.4524 + 0.3316 UP\textsubscript{A6} + 0.1589 UP\textsubscript{A6-1} + 1.1619 OTA\textsubscript{A6}</td>
<td>0.9969</td>
<td>0.44</td>
</tr>
<tr>
<td></td>
<td>(5.17) (2.35) (4.87)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.5941] [0.3183] [0.5711]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A7</td>
<td>PA7 = 10.1193 + 0.1519 W\textsubscript{A7} + 0.2106 W\textsubscript{A7-1} + 0.2500 MA\textsubscript{A7} + 0.0660 TA\textsubscript{A7} + 0.8209 OTA\textsubscript{A7}</td>
<td>0.9973</td>
<td>1.69</td>
</tr>
<tr>
<td></td>
<td>(3.04) (3.92) (4.13) (2.24) (2.88)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.4054] [0.4964] [0.5160] [0.3106] [0.3873]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Before considering the results contained in Table 5.6, we will briefly compare the quality of the equations. As mentioned in the previous section, the statistical quality of the equations estimated for sector A7 was on the whole substantially better than that of the equations estimated for sectors A1, ..., A6. This was evidenced by two main facts. In the first place, far more variables were significant and significant together in the equations for sector A7 than was generally the case for the other sectors. Secondly, the DWS for the sector A7 equations was generally much better. It is felt that the more satisfactory nature of the aggregate equations was in large part due to the better data used to measure the aggregate explanatory variables. Unfortunately, it was not possible in this study to re-estimate all the different sectoral equations using aggregate data for the explanatory variables. If this had been possible it is likely that the resulting sectoral equations would have been more satisfactory at least for some sectors. This is also suggested by a comparison of the sectoral equations obtained in this study with the estimated equations reported in the RBA studies. When comparing these it would appear that, on the whole, the attempt to improve the RBA equations by using sectoral equivalents of their aggregate variables and/or experimenting with other variables which have been successfully used in overseas studies has not been successful. Before coming to this conclusion, however, it must be pointed out that since all the price equations reported in Paper 3F have the lagged dependent variable included among the regressors the comparison is not strictly valid. However, given the nature of the sectoral data available, it is quite possible that for some sectors better equations could be obtained
using aggregate data for the explanatory variables even if the lagged dependent variable is not included among the regressors.

A second consequence of the difference in the quality of the aggregate and sectoral equations is that a comparison of the preferred sectoral equations with the preferred aggregate equation will be difficult. It is probable that the differences between them are due partly to the differences in the quality of the data used to represent the explanatory variables and partly to the differences in the sectors themselves. With this in mind we will, nevertheless, attempt some comparisons.

If we compare the preferred equations we find that the $R^2$'s are satisfactory but that in most cases the DWS's are not. Only for sectors A2 and A7 do the DWS's indicate an absence of serial correlation in the residuals.

Comparing the labour cost variables we find that in most of the equations both the current and lagged labour cost variables are significant. Further, if the partial correlation coefficients of the current and lagged labour cost variables are compared for each equation in which both occur we find that in all the sectoral equations the current labour cost variable is more important than the lagged variable but that in the aggregate equation the opposite is true. In the sectoral equations this appears to be based on fairly strong evidence as shown in the differences in the partial correlation coefficients. However, in the aggregate equation the difference between the partial correlation coefficients is not so large and it would thus appear that the lagged wage rate variable is not substantially more important than
the current one. Despite this it would appear that the appropriate lag structure for labour costs in the aggregate equation is not the same as that for the majority of the sectoral equations. It should be noted that all but one of the sectoral equations use UPA to represent labour costs and this variable was not calculated (and thus not used) for sector A7. Hence the change in the relative importance of the current and lagged labour cost variables may be due partly to the influence of materials costs (which are included in UPA) although it is unlikely that the use of UPA rather than WA is the sole reason.

If we examine the partial correlation coefficients to see which of the explanatory variables are the most important in the explanation of prices we find the indications in most of the equations to be somewhat obscured by the presence of multicollinearity between the current and lagged labour cost variables. It will be noted that in the equations for sectors A2 and A5 where only the current form of the labour cost variable is included, labour costs are by far the most important determinant of prices. In the equation for A1, the partial correlation coefficient of TAI is larger than the partial correlation coefficient of either of the UPA variables. However, if either UPA or UPA -1 is used alone the partial correlation coefficient indicates that it is more important than any of the other variables in the equation. The same holds for sector A7 with respect to WA7. Hence it may be concluded that the labour cost variables are in fact the most important determinants of prices.

The performance of the materials cost variable has in general been disappointing but for the two sectors for which the variable was
successful, materials costs do appear to be important in the pricing process and more important than demand, productivity and sales tax. They are less important than labour costs (if the type of reasoning advanced in the previous paragraph is accepted). It is somewhat unfortunate that more suitable materials cost series could not be obtained so that a valid comparison could be made of the importance of materials costs for the various sector and of the importance of materials costs in the sectoral equations with their importance in the aggregate equation. It should be noted that the preferred equations which do not have a separate materials cost variable all have UPA variables in which materials costs are included. However, the UPA variable was usually used where the separate materials cost variable was not successful and it is difficult, using the UPA variables, to test for the separate impact of materials costs on prices. Besides this, it will be recalled that because of the unavailability of suitable industrial price indexes, a simplifying assumption was made to make it possible to calculate the unit prime cost series\(^1\) and it is felt that because of this simplifying assumption the resulting unit prime cost series are more a measure of labour costs than they would have been if the assumption had not been made.

Demand variables proved to be important for most sectors although less important than labour costs and, in those sectors for which a materials cost variable was significant, less important than material costs. For sector A7 the influence of demand on the price level proved to be slightly stronger than that of the sales tax rate.

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1. See above, pp. 92, 93 and 136.
Finally, the tax rate proved to be more important for sector A1 than for A7, although this may be influenced by the number of significant variables in the equations. However, the results are in accordance with expectations since, as stated in Chapter 4, sales tax and excise are levied mainly on consumer goods and we would, therefore, expect them to be more important in the sectoral equation explaining the price of final consumption expenditure than in the aggregate equation.
CHAPTER 6

TYPE B RESULTS

6.1 Introduction

Much of what was said in the introduction to the previous chapter is also relevant to this chapter. Firstly, the structure of this chapter will be the same as that of the previous one. Section 6.2 will deal with general results, section 6.3 with more detailed results sector by sector and the final section will contain a brief comparison of the results for each sector on the basis of the preferred equation for each sector.

Secondly, the same restrictions were placed on the experimentation for equations for type B sectors.1

Thirdly, the estimation method and test statistics used are the same as those used in the previous chapter.

6.2 General Observations on the Results

Consider firstly, the performance of the labour cost variables tried. On the whole, the relative performance of the labour cost variables was similar to their relative performance in the estimated equations for type A sectors. As in the case of the equations for sectors A1, ..., A7, initial experimentation was carried out using the labour cost variables in equations of the form:

1. See above p. 186.
For most labour cost variables lagged values of $X_i$ were also tried. The merits of the labour cost variables were then judged on the basis mainly of $R^2$ and the t-ratio associated with $\hat{\beta}$ and further experimentation was carried out with the equations in which the labour cost variables gave the best results. It is realized that elimination of certain variables in this way is not ideal and that eliminated variables may have performed better if other variables were added to the equations, but some method had to be used to reduce the number of possible explanatory variables, since both time and computer space made the testing of all plausible combinations of variables for all sectors prohibitive. This type of preliminary experimentation was carried out using the following different labour cost variables: $WB$, $EOB$, $ESB$, $ULWB$, $ULEOB$, $ULESB$, $ULNWB$, $ULNEOB$, $ULNESB$, $UPB$.\(^1\) The preliminary testing resulted in the rejection of the $ULC$ and $ULCN$ variables for reasons similar to those which applied in the case of type A equations. It should be noted that short-run productivity was not calculated for sector B5 and hence $ULC$ and $ULCN$ variables were not tested for this sector. For the remaining sectors, all 3 $ULC$ variables performed poorly on the basis of $R^2$ and the t-ratio. In fact, for no sector were $R^2$ and the t-ratio associated with the labour cost variables higher for equations with any one of the $ULC$ variables than they were for equations with $WB$, $EOB$, $ESB$ or $UPB$. When short-run productivity ($PYB$) was

\(^1\) For a list of the symbols see Appendix 4.2.
used as a separate variable in equations with \( W_B \), \( W_{B-1} \), \( \text{EOB} \), \( \text{EOB}_{-1} \), or \( \text{ESB} \), \( \text{ESB}_{-1} \) (current and lagged variables being used separately or together), it was significant and of the required sign only 3 times out of 45, and was not consistently so for any one sector. Hence no further experimentation with \( \text{PYB} \) was carried out. When the ULCN variables were tried in the regressions the results were worse than those obtained in the case of type A sectors. For all type B sectors except sector B4 the ULCN variables were significant in the form of (6.1). For sector B4 \( \text{ULNW}_B \), \( \text{ULNES}_B \) were significant but had a negative coefficient and \( \text{ULNE}_B \) was insignificant and had a negative coefficient. In all cases the ULCN variables were inferior on the basis of \( R^2 \) and the t-ratio than \( W_B \). Thus we find again that the labour cost variables, when adjusted for short-run or long-run productivity, performed disappointingly especially ULCN which had been most successful in other Australian studies reviewed in Chapter 2 and overseas studies reviewed in Chapter 3. Two factors ought to be noted. Firstly, that where ULCN was used successfully in other studies it was not of the form used here. Hence experimentation with alternative forms of sectoral ULCN variables may reverse the conclusions reached above, at least for some sectors. Secondly, as stated in the previous chapter, the sectoral short-run productivity series calculated in this thesis leave much to be desired and if more accurate series could be devised, the performance of the type of ULCN variables used in this study may be improved.

Let us turn now to the labour cost variables with which further experimentation was carried out, i.e., \( W_B \), \( \text{EOB} \), \( \text{ESB} \) and \( \text{UPB} \), noting that \( \text{UPB} \) also covers materials costs so that care will have to be
taken when comparing the performance of UPB with that of the other variables mentioned. For type B sectors we again find that equations with WB and ESB were more satisfactory than those with EOB. However, in this case the difference between the performance of EOB and the other two variables was often not as marked as was the case in the equations for type A sectors. Hence it was decided not to reject EOB after the preliminary testing as was done in Chapter 5. A further factor was that while equations with EOB usually had better DWS's than the equations with WB or ESB this was not always the case and again the difference was not as marked. There proved to be little basis for the choice between WB and ESB when $R^2$ and the t-ratios were examined but the equations with WB usually had somewhat better DWS's especially for sector B2. When equations with UPB are compared to equations with WB or ESB, the current form of all variables gives very much the same results.

If both the current and lagged values of these labour cost variables are entered as regressors in the same equation, we find that with the exception of EOB, they are not often significant together although they are always significant separately. Hence the problem of multicollinearity made it difficult to draw any firm conclusions as to the relative importance of the current and lagged variables. If both EOB and EOB$_{-1}$ are used in the same equation they are both significant for all sectors but this may result from the fact that neither EOB nor EOB$_{-1}$ provides as good an explanation of prices on its own as WB, WB$_{-1}$, ESB or ESB$_{-1}$. If a comparison is made between equations with only a current labour cost variable and equations with only the lagged labour cost variable there is no consistent pattern
in the size of the estimated coefficient, $R^2$, the t-ratio and the partial correlation coefficient.

Consider now the performance of materials costs. Recall firstly, that suitable materials costs data could not be obtained or constructed for sectors B4 and B5, so that the discussion here will be only relevant to the remaining type B sectors. The materials cost variable was nearly always negative and often significantly negative when added to equations with labour cost variables for sector B1. Since this is unacceptable, MB was not used in further experimentation for this sector. Note that this result for B1 is similar to the result obtained for sector A1 where the materials costs variable was often of the wrong sign. This may well be caused by the materials cost data used to represent the variable. It will be recalled from the discussion in Chapter 4\(^1\) that for both sectors A1 and B1 a weighted average of the prices of various exports was used, the number of goods covered by the index used for sector A1 being somewhat larger than the number of goods covered by the index for B1. If the series constructed for these two sectors\(^2\) are examined, it will be seen that they both fluctuate quite widely and it appears that these fluctuations have not been reflected in the price levels for the two sectors. Two conclusions are possible. Firstly, that the series used to measure materials costs were too narrow and that if more satisfactory series had been used, materials may have been significant and of the correct sign. Secondly, it may be that the prices in these 2 sectors do not

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1. See pp. 123-128 above.
2. See above, Appendix 4.2.
follow very closely the fluctuations in materials prices, or at least, do not follow materials prices when they fall. In sector B6 the coefficient is also sometimes negative, especially when used in equations with WB or WB\_1. In sector B2 materials are usually significantly positive, and for sector B3 they are significant only sometimes. For sectors B2, B3 and B6 the best results appear to be obtained when MB is used in conjunction with EOB and/or EOB\_1. If a lagged materials cost variable is used instead of a current one, the results generally improve especially when used in equations with EOB. If both MB and MB\_1 are used in the same equation they are both significant only very rarely.

When considering the sales tax variable it will be recalled that indexes were calculated only for sectors B4, B5 and B6. The variable is significant in all equations with the labour cost variables, both current and lagged and the weakest relationship appears to hold for sector B4.

Turn now to the results obtained using the demand variables. Firstly, consider the preliminary testing carried out. The demand variables used were the two product market demand variables DEXB, DOPB and the five labour market demand variables UB, VB, VB/UB, VB*, OTB. Some experimentation was also carried out using lagged UB and VB. Firstly, DOPB proved unsatisfactory, being insignificant in all equations except the equation for B4. In contrast to the results obtained for the type A sectors, DEXB proved to be significant for all sectors and the results obtained for sector B4 were better than those obtained for B4 using DOPB so that no further experimentation was carried out with the change in output as a measure of the strength
of demand. As in the case of the type A sectors, most of the labour market demand variables except OTB proved to be insignificant. UB was significant for some sectors but where this was the case the use of OTB and DEXB provided superior equations. The results using VB were similar. Where lagged UB or VB were used it was found that they gave worse results than the corresponding current variable, suggesting that firms respond fairly quickly to change in demand. Neither of VB/UB or VB* proved useful. Both were insignificant in current and lagged form for all sectors. Hence DEXB and OTB proved to be the most successful indicators of demand pressure in the equations for type B sectors and further experimentation with demand variables was confined to these two variables. When these two variables were included in equations with labour cost variables, they proved to be significant in only a few cases - mainly in equations for sector B3. Thus for type B sectors demand variables do not appear to be very successful. This is rather surprising in the light of the results obtained for type A sectors where a demand variable was included in the preferred equations for 5 of the 7 sectors including sector A1 (Private Final Consumption Expenditure). If any reliance is to be placed on the results obtained in the previous chapter, it would appear that while demand is the least important of the explanatory variables it ought to be significant in at least some of the type B equations and that if better measures of demand could be obtained this might be the case.

6.3 Detailed Results

6.3.1 Sector B1

As hinted in the previous section, the results for sector B1
were not very satisfactory. In fact, only labour cost variables were significant and only in the case of EOB were both EOB and $EOB_{-1}$ significant together. On the whole, equations with ESB or $ESB_{-1}$ had the highest $R^2$'s and also the highest t-ratio and, as has often been the case in the results described in Chapter 5, the lowest DWS. However, the DWS for all the equations for sector B1 showed strong evidence of positive first order serial correlation in the residuals. Equations with UPB or $UPB_{-1}$ had slightly higher $R^2$'s than equations with WB and EOB.

Some discussion has already been presented in the previous section on the performance of the materials cost variable in equations for sector B1 and this will not be repeated in this section. As also stated in the previous section, the results obtained using various demand variables were disappointing. Thus the preferred equation for sector B1 was chosen from amongst those presented in Table 6.1.¹

From this table equation (6.1 f) was chosen as the preferred equation for sector B1. This equation was chosen because to some extent, UPB1 also includes materials costs. Secondly, the $R^2$ associated with this equation was only slightly lower than the best $R^2$ (i.e. for (6.1 d)). Thirdly, although its DWS is the lowest in the table (except for equation (6.1 a)), the DWS for all equations shown give strong indication of serial correlation in the residuals so that the value of the DWS did not affect the choice of the preferred equation.

Before proceeding to a discussion of the results obtained for sector B2, let us consider briefly some of the possible causes of the

¹. See p. 229.
<table>
<thead>
<tr>
<th>Equation Number</th>
<th>EQUATION</th>
<th>$R^2$</th>
<th>DWS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1 a</td>
<td>$PB_1 = 48.4441 + 0.3281 \cdot WB_1$ (30.87)</td>
<td>0.9492</td>
<td>0.26</td>
</tr>
<tr>
<td>6.1 b</td>
<td>$PB_1 = 58.9090 + 0.6466 \cdot EOB_1$ (29.67)</td>
<td>0.9452</td>
<td>1.06</td>
</tr>
<tr>
<td>6.1 c</td>
<td>$PB_1 = 57.9389 + 0.3784 \cdot EOB_1 + 0.2881 \cdot EOB_1^{-1}$ (4.31) (3.14)</td>
<td>0.9534</td>
<td>0.46</td>
</tr>
<tr>
<td>6.1 d</td>
<td>$PB_1 = 58.2284 + 0.6569 \cdot ESB_1$ (35.08)</td>
<td>0.9602</td>
<td>0.32</td>
</tr>
<tr>
<td>6.1 e</td>
<td>$PB_1 = 57.2613 + 0.6838 \cdot ESB_1^{-1}$ (35.04)</td>
<td>0.9601</td>
<td>0.33</td>
</tr>
<tr>
<td>6.1 f</td>
<td>$PB_1 = 44.6942 + 0.3638 \cdot UPB_1$ (33.29)</td>
<td>0.9600</td>
<td>0.30</td>
</tr>
<tr>
<td>6.1 g</td>
<td>$PB_1 = 42.3688 + 0.3840 \cdot UPB_1^{-1}$ (32.40)</td>
<td>0.9536</td>
<td>0.33</td>
</tr>
</tbody>
</table>
unsatisfactory results obtained for sector Bl. Firstly, the failure of the materials cost variable has already been discussed. In addition to the previous reasons for failure put forward previously, it may be that the components of the EPI used do not measure the prices to Australian manufacturers even of the goods covered by these components, and it appears very likely that if it were possible to construct alternative materials cost series which covered a wider range of materials inputs for sector Bl and measured the prices to Australian manufacturers more accurately, better equations could be obtained for this sector. Secondly, it would appear that certain of the elements covered by the price index for sector Bl are subject to seasonal fluctuations. It may be possible to account for these by a suitably constructed materials cost index or alternatively, better results may be obtained if the influence of these seasonally affected items could be removed from the dependent variable. Thirdly, it may well be that demand is an important influence on the prices of the goods covered by the sector Bl but that the measures of demand tested in this study have been unsatisfactory. Hence, further experimentation with alternative indicators of demand pressure if they can be obtained or constructed may also improve the statistical quality of the equations. Since the problem of poor DWS's is common to the equations for various sectors, this will be dealt with in the final chapter.

6.3.2 Sector B2

For sector B2 it was found that WB and UPB provided the best results for the labour cost variables in terms of $R^2$ and the t-ratio. Except for ESB, both current and lagged labour variables were significant
when used in the same equation although in the case of UPB, $UPB_{-1}$ was significant only at the 10% level of significance. From the results obtained with the labour cost variables it appears that the current value of the variable is more important than the lagged value. If equations with only one labour cost variable are compared then those with the current value have a higher $R^2$ and $t$-ratio than those with the lagged value of the same variable and similarly, for those cases in which both the current and lagged values appear significantly in the same equation, the estimated coefficient of the current value is larger than the estimated coefficient of the lagged. Hence, the evidence points fairly clearly to the fact that prices adjust fairly quickly to changes in labour costs as measured by the variables used.

The materials cost variable used for sector B2 is usually significant both in current and lagged form although current and lagged MB are never significant when both are used as regressors together. Comparing estimated equations of the type:

$$(6.2)\quad PB2 = \hat{a} + \hat{b}X2 + \hat{c}MB2$$

with estimated equations of the form:

$$(6.3)\quad PB2 = \hat{a} + \hat{b}X2 + \hat{c}MB2_{-1}$$

where $X2$ takes the form of WB, EOB or ESB or lagged values of these variables, we find that in equations with the WB variables the lagged materials cost variable has a higher partial correlation coefficient than the current variable and that in equations with ESB and EOB variables the opposite is true.

It will be recalled that in the preliminary testing, the use
of OTB to represent demand pressure for sector B2 provided better results than the use of other demand variables. Hence it was decided to restrict further testing of the influence of demand for B2 to the use of OTB. When OTB was included in the equations with the labour cost and materials cost variables it was usually found to be negative and often significantly negative. Hence a demand variable does not appear in the preferred equation for sector B2. Since a sales tax variable was not tested in the equations for this sector, the preferred equation was selected from amongst those presented in Table 6.2.1 From these equations number (6.2 c) was chosen as the preferred equation since all the variables are significant at the 5% level and it has the highest $R^2$ and DWS.

6.3.3 Sector B3

In sector B3 we again strike the problem which arose in the previous chapter that if EOB or EOB\textsubscript{-1} are used separately the estimated equation shows strong evidence of negative serial correlation in the residuals. This problem does not disappear if OTB is added to the equation but the DWS drops to satisfactory levels if MB is added to the equations with EOB. In fact, in the equations with EOB, EOB\textsubscript{-1} and MB or MB\textsubscript{-1} the DWS suggests positive serial correlation. If equations of the type (6.1) with $X_3$ variously taking the form WB\textsubscript{3}, WB\textsubscript{3-1}, EOB\textsubscript{3}, EOB\textsubscript{3-1}, ESB\textsubscript{3}, ESB\textsubscript{3-1}, UPB\textsubscript{3}, UPB\textsubscript{3-1} are compared, we find the equations with ESB or ESB\textsubscript{-1} usually giving the best results although they are not markedly better than the equations with WB or WB\textsubscript{-1}. On the other hand, the equations with EOB or UPB (current or lagged) are generally of poorer quality (as regards $R^2$ and the t-ratio) than those.

1. See p. 233.
### TABLE 6.2: Sector B2 Results

<table>
<thead>
<tr>
<th>Equation Number</th>
<th>EQUATION</th>
<th>$\frac{-2}{R^2}$</th>
<th>DWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2 a</td>
<td>$PB_2 = 54.7826 + 0.3163 , UPB_2$</td>
<td>0.9946</td>
<td>1.18</td>
</tr>
<tr>
<td></td>
<td>(96.95)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2 b</td>
<td>$PB_2 = 54.1637 + 0.2330 , UPB_2 + 0.0886 , UPB_{2-1}$</td>
<td>0.9949</td>
<td>0.87</td>
</tr>
<tr>
<td></td>
<td>(5.39)</td>
<td>(1.93)</td>
<td></td>
</tr>
<tr>
<td>6.2 c</td>
<td>$PB_2 = 55.5427 + 0.1422 , WB_2 + 0.1463 , WB_{2-1} + 0.0155 , MB_{2-1}$</td>
<td>0.9976</td>
<td>1.39</td>
</tr>
<tr>
<td></td>
<td>(5.02)</td>
<td>(4.86)</td>
<td>(5.27)</td>
</tr>
<tr>
<td>6.2 d</td>
<td>$PB_2 = 63.3456 + 0.3500 , EOB_2 + 0.2046 , EOB_{2-1} + 0.0350 , MB_{2-1}$</td>
<td>0.9828</td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td>(7.78)</td>
<td>(4.34)</td>
<td>(5.19)</td>
</tr>
<tr>
<td>6.2 e</td>
<td>$PB_2 = 63.0179 + 0.5712 , ESB_2 + 0.3160 , MB_2$</td>
<td>0.9862</td>
<td>0.58</td>
</tr>
<tr>
<td></td>
<td>(57.52)</td>
<td>(5.23)</td>
<td></td>
</tr>
</tbody>
</table>
with WB or ESB (current or lagged). UPB was found to provide slightly better results than EOB.

Both MB3 and MB3-1 were found to be significant when included separately with WB or EOB (and the lagged equivalents of these variables) but current and lagged materials costs were never significant together. Further, neither current nor lagged materials cost variables proved to be significant in equations with ESB. This also proved to be the case for OTB which was the demand variable used for sector B3, i.e., it was never significant in equations with ESB or ESB-1 and neither was it significant in the equation with the current EOB variable.

Finally, when OTB and MB or MB-1 were used in the same equation it was never the case that both were significant and of the right sign. Thus the preferred equation for sector B3 was chosen from those presented in Table 6.3.1

As can be seen from the table, equation (6.2 a) has the highest $R^2$ but only two variables are significant. The equations with OTB do not have as high an $R^2$ as those with MB or MB-1 with an equivalent number of significant variables. Equation (6.3 c) was chosen because its $R^2$ is nearly as high as those for the other equations but since UPB also incorporates materials costs, the equation takes account of wage and materials costs as well as the influence of demand through the demand variable OTB. Since all the equations show evidence of serial correlation in the residuals, the DWS was not taken into consideration in the choice of a preferred equation for this sector.

1. See p. 235.
<table>
<thead>
<tr>
<th>Equation Number</th>
<th>EQUATION</th>
<th>$R^2$</th>
<th>DWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.3 a</td>
<td>$PB_3 = 31.8757 + 0.4118 \text{ ESB}_3 + 0.6968 \text{ ESB}_3^{-1}$</td>
<td>0.9977</td>
<td>0.54</td>
</tr>
<tr>
<td></td>
<td>(2.22) (3.61)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.3 b</td>
<td>$PB_3 = 18.6709 + 0.1860 \text{ WB}_3 + 0.2931 \text{ WB}_3^{-1} + 1.7786 \text{ OTB}_3$</td>
<td>0.9941</td>
<td>0.43</td>
</tr>
<tr>
<td></td>
<td>(1.98) (2.96) (4.24)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.3 c</td>
<td>$PB_3 = 14.6861 + 0.2269 \text{ UPB}_3 + 0.2812 \text{ UPB}_3^{-1} + 2.1925 \text{ OTB}_3$</td>
<td>0.9939</td>
<td>0.48</td>
</tr>
<tr>
<td></td>
<td>(2.58) (3.02) (5.22)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.3 d</td>
<td>$PB_3 = 4.6518 + 0.3914 \text{ WB}_3^{-1} + 0.3414 \text{ MB}_3$</td>
<td>0.9937</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>(12.07) (4.04)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.3 e</td>
<td>$PB_3 = 23.1199 + 0.5107 \text{ EOB}_3 + 0.4454 \text{ EOB}_3^{-1} + 0.1802 \text{ MB}_3$</td>
<td>0.9953</td>
<td>1.06</td>
</tr>
<tr>
<td></td>
<td>(9.04) (7.88) (2.23)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.3 f</td>
<td>$PB_3 = 4.4968 + 0.1757 \text{ WB}_3 + 0.2084 \text{ WB}_3^{-1} + 0.3534 \text{ MB}_3^{-1}$</td>
<td>0.9942</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td>(1.88) (2.07) (4.38)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.3 g</td>
<td>$PB_3 = 22.2756 + 0.5199 \text{ EOB}_3 + 0.4493 \text{ EOB}_3^{-1} + 0.1721 \text{ MB}_3^{-1}$</td>
<td>0.9952</td>
<td>1.07</td>
</tr>
<tr>
<td></td>
<td>(9.30) (7.04) (2.05)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6.3.4 Sector B4.

On the whole, the results obtained for sector B4 proved to be less satisfactory than those obtained for sector B3. This was due, at least in part, to the absence of a materials cost variable for this sector. It will be recalled from the discussion in Chapter 4 that a suitable series for MB4 could not be constructed or obtained so that this variable was not tested for this sector. A second factor contributing to the unsatisfactory nature of the equations estimated for this sector is the failure of the demand variables. It will be recalled from the discussion of the preliminary testing in the previous section, that only DEXB and OTB were retained after the initial experimentation with the demand variables and DEXB was used for sector B4. When this variable was further experimented with it proved to have the wrong sign or to be insignificant in all cases and hence does not appear in the preferred equation for this sector. Unfortunately, the quality of the data used to represent the demand variables in this study will prevent the conclusion that the influence of demand is not important in price equations for this sector.

Regarding the results of the experimentation with the labour cost variables, it was found that in equations of the form (6.1) WB and WB$_{-1}$ resulted in the best equations as far as $R^2$ is concerned. Further it was found that the use of UPB and UPB$_{-1}$ resulted in better equations than when either EOB or ESB were used and that the improvement in the equation when ESB was substituted for EOB was not very large, certainly not as large as has been the case for certain other sectors. When both current and lagged labour cost variables were
included in the same equation, they were both significant only in the case of WB and EOB. In the equation explaining PB in terms of WB and \( WB_{-1} \), WB was significant only at the 10% level. For WB, ESB and UPB the use of the lagged variable resulted in a slightly higher \( R^2 \) than for equations with the current variable and for EOB the opposite was true. In all cases the difference in the \( R^2 \) was only small.

The only other variable tested for sector B4 was the sales tax rate. This variable proved to be significant in all equations in which it was introduced.

The preferred equation for sector B4 was chosen from amongst those presented in Table 6.4. On the basis of both \( R^2 \) and the DWS equation (6.4 a) was chosen as the preferred equation for sector B4. It is noted that the coefficient of the current WB variable is significantly different from zero only at the 10% level of significance and that the coefficient of TB is only just significant at the 5% level.

6.3.5 Sector B5

The results obtained for sector B5 were in many ways similar to those obtained for sector B4, although, on the whole, the statistical quality of the equations obtained was better for sector B5. In the first place, it will be recalled from the discussion of the data in Chapter 4, that suitable data could not be obtained or constructed to represent the materials cost variable for sector B5. Thus, in as far as the price level for sector B5 is sensitive to changes in materials costs, the equations will be deficient in this aspect. Secondly, the demand variable DEXB used for sector B5 proved to be insignificant or

1. See p. 238.
### Table 6.4: Sector B4 Results

<table>
<thead>
<tr>
<th>Equation Number</th>
<th>Equation</th>
<th>$R^2$</th>
<th>DWS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.4 a</td>
<td>$PB4 = 73.2109 + 0.0748 \text{WB}<em>4 + 0.0995 \text{WB}</em>{4-1} + 0.0166 \text{TB}_4$</td>
<td>0.9843</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>(1.79)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.24)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.99)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.4 b</td>
<td>$PB4 = 77.8219 + 0.1877 \text{EOB}<em>4 + 0.1556 \text{EOB}</em>{4-1} + 0.0317 \text{TB}_4$</td>
<td>0.9574</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>(4.42)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.50)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.29)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.5 c</td>
<td>$PB4 = 77.5103 + 0.3518 \text{ESB}_4 + 0.0313 \text{TB}_4$</td>
<td>0.9649</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td>(36.81)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.49)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.5 d</td>
<td>$PB4 = 69.9662 + 0.2035 \text{UPB}_4 + 0.0196 \text{TB}_4$</td>
<td>0.9788</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>(47.66)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.02)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
of the wrong sign in all the equations in which it was used. Again, the quality of the data and the extent of experimentation with alternative demand variables or proxies for the pressure of demand are such that the failure of EXE to be significant and of the required sign cannot be taken as conclusive evidence that demand plays no part in the determination of the price level in this sector.

The performance of the labour cost variables was in some ways similar to the performance of labour cost variables in the estimated equations for sector B4 discussed above. In the results obtained for sector B5, however, both UPB and ESB proved more satisfactory than WB which, in turn, performed better than EOB (on the basis of $R^2$ and the t-ratio). For WB, ESB and UPB the lagged form of the variable resulted in somewhat higher $R^2$'s than did the current form of the variables. In the case of EOB the opposite was found to hold. Thus, on balance, the appropriate lag on the labour cost variable appears to be similar for both sectors B4 and B5. When both current and lagged labour cost variables are included in the same equation they are both significant except when ESB is used in which case the current variable is insignificant and the lagged significant.

The only other variable tested for sector B5 was the rate of sales tax which proved to be consistently significant. It always had a higher t-ratio, coefficient and partial correlation coefficient than the tax variable in the equations for sector B4 suggesting that for sector B5 taxes are a stronger influence on the price level than they are for sector B4.

The preferred equation for sector B5 was chosen from amongst
those presented in Table 6.5. As can be seen from the results presented in this table, the choice of a preferred equation is a marginal one between equations (6.5 a) and (6.5 d). Equation (6.5 d) was chosen because it has a slightly higher $R^2$ and because the two explanatory variables UPB5 and UPB5−1 include some measure of materials costs, while equation (6.5 a) does not include any materials cost effect.

6.3.6 Sector B6

As in the case of type A sectors, the equations estimated for the aggregate sector (in this case B6) proved to be somewhat better than those estimated for the majority of the other sectors. In the case of type B sectors, however, the difference in the quality of the equations for the aggregate sector, and those for the other sectors was not as great as in the case of the type A sectors.

Let us consider the labour cost variables first. It should be remembered that UPB was not calculated for the aggregate sector, this also being the case for the aggregate type A sector. The value of $R^2$ associated with the equations with WB and similar equations with ESB were very similar. Both WB and ESB provided more satisfactory results than did EOB. For the cases of EOB and WB the lagged form of the variable appeared to be more important than the current form although in the case of WB the difference between the two was only very small. For equations with ESB or ESB−1 the opposite was true. As has been the case in the equations for several other sectors, WB and WB−1 were significant together as were EOB and EOB−1 but ESB and ESB−1 were both significant in only one equation and in that case they were both

TABLE 6.5  :  Sector B5 Results

<table>
<thead>
<tr>
<th>Equation Numbers</th>
<th>EQUATION</th>
<th>$R^2$</th>
<th>DWS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.5 a</td>
<td>$PB5 = 5.8803 + 0.1679 WB5 + 0.2400 WB5_\text{1} + 0.2840 TB5$</td>
<td>0.9966</td>
<td>1.39</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.96)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.99)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(9.04)</td>
<td></td>
</tr>
<tr>
<td>6.5 b</td>
<td>$PB5 = 28.3887 + 0.4151 EOB5 + 0.4603 EOB5_\text{1} + 0.1533 TB5$</td>
<td>0.9912</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(7.29)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(7.41)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.65)</td>
<td></td>
</tr>
<tr>
<td>6.5 c</td>
<td>$PB5 = 26.8834 + 0.8837 ESB5_\text{1} + 0.1661 TB5$</td>
<td>0.9929</td>
<td>0.72</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(24.07)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.27)</td>
<td></td>
</tr>
<tr>
<td>6.5 d</td>
<td>$PB5 = 7.4482 + 0.1511 UPB5 + 0.2743 UPB5_\text{1} + 0.2472 TB5$</td>
<td>0.9967</td>
<td>1.39</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.43)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4.15)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(7.77)</td>
<td></td>
</tr>
</tbody>
</table>
significant only at the 10% level of significance (this case being when both MB and TB were included in the equation).

The materials cost variable in current form was significant at the 5% level only in equations with EOB or EOB$_{-1}$ and was significant at the 10% level in some equations with ESB or ESB$_{-1}$. When MB or MB$_{-1}$ was included in equations with WB and/or WB$_{-1}$ its estimated coefficient was invariably negative or insignificant. The current and lagged forms of MB were never significant together and it was found that the lagged form of MB gave marginally better results than the current form.

As has been the case previously, the tax variable was significant in all cases. In general, the estimated coefficient and the partial correlation coefficient of the tax variable in the equations for sector B6 indicate that it is a less important influence on prices for this sector than for sector B5 but more important than for sector B4.

The demand variable used for sector B6, OTB6, proved to be significant in only very few of the equations in which it was included and where it was significant it was so only at the 10% level.

The preferred equation for sector B6 was chosen from amongst those presented in Table 6.6.\footnote{See p. 243.} Several aspects of the results set out in this table should be noted. Firstly, in the only equation where both ESB and ESB$_{-1}$ appear together, they are both significant only at the 10% level. Hence, this equation was rejected in the search for a preferred equation. Secondly, of the variables MB, TB and OTB, OTB is the least well determined, being significant only at the 10%
TABLE 6.6  :  Sector B6 Results

<table>
<thead>
<tr>
<th>Equation Number</th>
<th>EQUATION</th>
<th>$\overline{R}^2$</th>
<th>DWS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.6 a</td>
<td>$PB6 = 50.4122 + 0.3779 EOB6 + 0.3406 EOB6 -1 + 0.0513 MB6$</td>
<td>(8.58)</td>
<td>(7.43)</td>
</tr>
<tr>
<td>6.6 b</td>
<td>$PB6 = 49.2139 + 0.3705 EOB6 + 0.3469 EOB6 -1 + 0.0644 MB6 -1$</td>
<td>(8.43)</td>
<td>(7.71)</td>
</tr>
<tr>
<td>6.6 c</td>
<td>$PB6 = 32.0985 + 0.1715 WB6 + 0.1429 WB6 -1 + 0.1844 TB6$</td>
<td>(4.03)</td>
<td>(3.17)</td>
</tr>
<tr>
<td>6.6 d</td>
<td>$PB6 = 45.3537 + 0.3654 EOB6 + 0.3083 EOB6 -1 + 0.1249 TB6$</td>
<td>(8.37)</td>
<td>(6.51)</td>
</tr>
<tr>
<td>6.6 e</td>
<td>$PB6 = 31.5177 + 0.1718 WB6 + 0.1385 WB6 -1 + 0.6336 OTE6 + 0.1816 TB6$</td>
<td>(4.17)</td>
<td>(3.15)</td>
</tr>
<tr>
<td>6.6 f</td>
<td>$PB6 = 35.7113 + 0.3265 EOB6 + 0.2658 EOB6 -1 + 0.0838 MB6 + 0.1851 TB6$</td>
<td>(8.27)</td>
<td>(6.20)</td>
</tr>
<tr>
<td>6.6 g</td>
<td>$PB6 = 37.7742 + 0.2823 ESB6 + 0.3323 ESB6 -1 + 0.0650 MB6 + 0.1707 TB6$</td>
<td>(1.74)</td>
<td>(1.93)</td>
</tr>
<tr>
<td>6.6 h</td>
<td>$PB6 = 34.7614 + 0.3188 EOB6 + 0.2790 EOB6 -1 + 0.0965 MB6 -1 + 0.1795 TB6$</td>
<td>(8.06)</td>
<td>(6.69)</td>
</tr>
</tbody>
</table>
level in the equation where it was included. This was the case in all the equations in which OTB was included amongst the regressors, i.e., where it was significant it was so only at the 10% level. Hence this variable was also excluded from the preferred equation especially since it was never significant when included with MB6 which appears to be better determined. This reduces the choice of a preferred equation to one between (6.6 f) and (6.6 h) of which (6.6 h) was chosen.

6.4 Conclusions

To facilitate a brief comparison of the preferred equations chosen for the various sectors, they are reproduced together with the partial correlation coefficients in Table 6.7.¹

As in the case of the type A equations, the results for the aggregate sectors were better in the sense that for this sector more variables were significant and significant together. But, on the whole, the $R^2$'s for the estimated equations for the aggregate sector were not noticeably better than for the equations for sectors B1, ..., B5 and the DWS was not always better than for the sectoral equations as evidenced by the preferred equations presented in Table 6.7. This reinforces some conclusions drawn in the previous chapter where it was stated that one of the factors responsible for the better statistical quality of the estimated equations for the aggregate sector was that the data used to represent the aggregate variables was often better than that used to measure the sectoral variables. In the case of type B sectors, this was not in general true since it will be recalled

¹ See p. 245.
<table>
<thead>
<tr>
<th>Sector</th>
<th>EQUATION</th>
<th>$R^2$</th>
<th>DWS</th>
</tr>
</thead>
</table>
| B1     | $PB_1 = 42.3688 + 0.3840 \, UPB_{1-1}$
        | $(32.40)$
        | [0.9766] | 0.9536 | 0.33 |
| B2     | $PB_2 = 55.5427 + 0.1422 \, WB_2 + 0.1463 \, WB_{2-1} + 0.0155 \, MB_{2-1}$
        | $(5.02)$
        | [0.5828] | 0.9976 | 1.39 |
| B3     | $PB_3 = 14.6861 + 0.2269 \, UPB_3 + 0.2802 \, UPB_{3-1} + 2.1925 \, OTB_3$
        | $(2.58)$
        | [0.3458] | 0.9939 | 0.48 |
| B4     | $PB_4 = 73.2109 + 0.0748 \, WB_4 + 0.0995 \, WB_{4-1} + 0.0166 \, TB_4$
        | $(1.79)$
        | [0.2477] | 0.9843 | 0.45 |
| B5     | $PB_5 = 7.4482 + 0.1511 \, UPB_5 + 0.2743 \, UPB_{5-1} + 0.2472 \, TB_5$
        | $(2.43)$
        | [0.3279] | 0.9967 | 1.39 |
| B6     | $PB_6 = 34.7614 + 0.3188 \, EO_6 + 0.2790 \, EO_6_{-1} + 0.0965 \, MB_{6-1} + 0.1795 \, TB_6$
        | $(8.06)$
        | [0.7584] | 0.9932 | 1.13 |
that the data used to measure explanatory variables for sector B6 was a weighted average of the sectoral data used for sectors A1 and A3. Hence, if this type of reasoning is correct, we would expect to find the estimated equations for the aggregate type B sector to be not noticeably better as far as the statistical properties are concerned than the estimated equations for the other type B sectors. This was, in general, the case. Except for sector B1 the $R^2$'s of the preferred equations indicate that price levels have been satisfactorily explained for type B sectors. As was the case with several of the type A sectors, the size of the DWS leaves much to be desired but since this is a problem common to both type A and type B sectors it will be more fully discussed in the final chapter. Again the problem of multicollinearity has appeared especially where both the current and the lagged value of the same variable appear in the one equation. This will make the parameter estimates and $t$-ratios somewhat unreliable and will have to be taken into account when the equations are compared.

Comparing the sectoral equations (i.e., those for B1, ..., B5) with the aggregate equation, we find that, as stated previously, the quality of the estimated equations for sector B6 is not noticeably better than that of the equations for the other sectors. Secondly, we find that in all but the equation for B1, both current and lagged labour cost variables appear, although different variables provide a better explanation of price levels for different sectors. We also find that in all the sectoral equations except the equation for B2 lagged labour costs are more important than current labour costs. In the estimated equation for B2 presented in Table 6.7 the opposite is the case. Further, for the aggregate equation the current labour cost variable
is also somewhat more important than the lagged one. Thus, even
given the limited experimentation carried out with lags in this study,
the preferred estimated equations do provide some evidence that the
lag structure which is appropriate to the aggregate equation is not
necessarily appropriate for any one of the sectoral equations. Simil-
arily, the labour cost variable which produces the best results in the
aggregate case may not do so in the sectoral cases.

On the whole, the performance of the materials cost variable
(separate from UPC) has been disappointing. It should be recalled,
however, that materials costs series could not be obtained or construct-
ed for sectors B4 and B5 and that the equations for these sectors may
well have been improved by the addition of appropriate materials cost
variables. For those sectors for which materials costs were tried they
were not retained in the preferred equations for sectors B1 and B3. For
sector B2 the partial correlation coefficient of the materials cost
variable is larger than that of either the current or lagged labour
cost variables. If only one labour cost variable is included in this
equation, however, it becomes far more important than materials costs
and while it is clearly unacceptable to add the partial correlation
coefficients of the two labour cost variables it does strongly suggest
that labour costs are more important than materials costs. In the
preferred estimated equation for sector B6 the partial correlation
coefficient of the materials cost variable is smaller than the partial
correlation coefficients of both current and lagged labour costs so
that in this case materials costs are clearly less important on the
basis of the partials than labour costs. In the equation for sector B6
materials costs are also slightly less important than the sales tax
variable.

The sales tax rate variable was used only for sectors B4, B5 and B6, being retained in the preferred equations for all these sectors. From a comparison of the partial correlation coefficients, it appears that changes in the rate of sales tax are an important influence on prices in sectors B5 and B6 but not in sector B4. For sectors B5 and B6 the tax rate variable was less important than labour costs and for B6 more important than materials costs.

Given the limited experimentation carried out with the demand variables, it is difficult to draw firm conclusions about the importance of the influence of demand on prices for type B sectors. However, the influence of demand, except for sector B3, does not appear to be very important although further experimentation with demand variables could modify this conclusion. For sector B3 the demand variable, OTB, enters the equation with a significant coefficient and the partial correlation coefficient indicates it to be quite important for this sector.
CHAPTER 7

TYPE C RESULTS

7.1 Introduction

The structure of this chapter is very much the same as that of the previous two chapters. Section 7.2 contains a discussion of the regression results in general. The next section (section (7.3)) is devoted to a discussion of the results sector by sector and the concluding section (section (7.4)) compares the preferred sectoral equations one with another and with the preferred aggregate equation.

Restrictions similar to those placed on the experimentation with type A and type B equations were also placed on the experimentation with the type C equations. It should be noted that for type C sectors the number of variables was further reduced because of unavailability of data for some variables, most noticeably for short-run productivity. Hence short-run productivity has not been tried as a separate variable and the ULC and ULCN variables could not be tested for the type C sectors. Further, it will be recalled that for some variables for which only aggregate data were available in the case of type A and type B sectors, sectoral data were available in the case of type C sectors (unemployment, vacancies, average earnings). On the other hand, the materials cost variables was used in the aggregate form in the type C equations whereas it was used in sectoral form for most of the type A and type B sectors. The restriction placed on the experimentation with lags in the type C equations are similar to those
placed on the experimentation with lags in the type A and type B equations. Hence for type C sectors we experimented with two labour cost variables, a materials cost variable (these three variables also being tried with one period lags), a tax rate variable and five demand variables.

Finally, the estimation method and test statistics used for the type C equations are the same as those used in the previous two chapters.

7.2 General Observations on the Results

We will consider the labour cost variables first. Recall that only two labour cost variables were experimented with, viz., WC and EOC. The unavailability of suitable productivity data for the States precluded the calculation of ULC and ULCN variables and unit prime cost series were not calculated for geographical sectors. If the performance of current WC and EOC variables are compared on the basis of the t-ratio and $\bar{R}^2$ for the estimated equations of the type:

\[ PC_i = a + bX_i \]  

where \( X_i \) takes the form of either WC\( i \) or EOC\( i \) we find that for all sectors the use of WC provides better results than does the use of EOC. The difference between equations using WC and EOC are quite clear but usually not large. As has been the case for most other sectors, the equations using EOC have better DWS's than those using WC. If equations of the form (7.1) with \( X_i \) taking the form WC\( i \) or WC\( i-1 \) are compared we find that for all sectors the equations with WC\( i \) are better than those with WC\( i-1 \) although in most cases the differences are only
marginal. This would suggest that slightly more of the adjustment of prices to changes in wages is achieved in the period of the wage change than in the following period. This is borne out when equations having both current and lagged wage rates are examined where we find that current wage rates are slightly more important on the basis of the partial correlation coefficient than lagged wage rates. Both current and lagged wage rate variables are significant for all sectors except sector C5 where $WC_{5-1}$ is insignificant even at the 10% level of significance. When comparing the performance of current and lagged EOC the same results are obtained except that both EOC and EOC$_{-1}$ are significant together for all sectors including sector C5.

If the equations with a materials cost variable are examined we find that in equations with WC, MC is seldom significant although if TC is also added to the equations MC becomes significant in a number of equations. Further, it was found that MC is more often significant in equations with EOC than it is in equations with WC. Some experimentation was carried out with one and two period lags on MC but it was always found that current MC performed better (on the basis of the t-ratio and $R^2$) than MC$_{-1}$ and MC$_{-2}$ and since two materials cost variables were never significant together the equations to be presented later in this chapter contain only the current materials cost variable.

The final cost variable experimented with is the sales tax rate variable and as has been the case previously, it was very seldom insignificant. Where it was insignificant this usually occurred in equations with EOC or EOC$_{-1}$ or both.

Consider now the four demand variables experimented with -
DEXC, OTC, UC, VC. Besides these, some experimentation was also carried out with the ratio of VC to UC but as has been the case previously, this variable was found to be unsatisfactory. If we consider the results of the use of demand variables in general we find that for sector C5 all four demand variables mentioned above were almost always significant and often highly significant. For the other sectors the results were mixed but on the whole DEXC and OTC gave better results than the labour market demand variable UC and VC.

7.3 Detailed Results

7.3.1 Sector C1

For sector C1, equations with WC had higher $R^2$'s and t-ratios (for WC) than those with EOC. WC and $WC_{-1}$ both proved to be significant in most equations in which they were both used together, despite the presence of multicollinearity. This was also true of EOC. In the case of EOC, however, the multicollinearity between the lagged and the current variables did not appear to be as strong as in the case of WC since in equations with only one labour cost variable (either current or lagged) the t-ratio for WC or $WC_{-1}$ was always higher than the t-ratio for EOC or $EOC_{-1}$ whereas in equations with both the current and lagged labour cost variable the t-ratios of the EOC variables were usually higher than those for the WC variables.

The materials cost variable proved to be significant in many of the equations for sector C1, whether it was used in equations with WC or in equations with EOC. As mentioned in the previous section, current materials costs were always more important than lagged materials.
costs and current and lagged materials costs were never significant together. Hence, no equations with lagged materials costs are reported for sector Cl. As has been the case for most other sectors discussed previously, the sales tax variable was found to be significant in nearly all equations in which it was used, although in equations with EOC and/or EOC\(_{-1}\) it usually has a lower t-ratio than in equations where labour costs are measured by WC and/or WC\(_{-1}\).

Of the demand variables, DEXC was the most successful. In fact, all the other demand variables tried in equations for this sector proved to be either insignificant or of the wrong sign. DEXC proved to be significant only in equations with EOC and/or EOC\(_{-1}\). The best equations obtained for sector Cl are presented in Table 7.1. On the basis of the R\(^2\)'s the two equations which have both current and lagged labour costs are the best (i.e., equations (7.1 a) and (7.1 b)). Because of this and because the partial correlation coefficients indicate that DEXCl is the least important of the variables reported in Table 7.1, it was decided to exclude the demand variable from the preferred equation. Finally, on the basis of R\(^2\) equation (7.1 a) was chosen in preference to equation (7.1 b) since the DWS of both these equations indicate serially correlated residuals and hence did not affect the choice.

### 7.3.2 Sector C2

The equations for sector C2 were generally less satisfactory than those for sector Cl in that there were less equations in which all the variables were significant and the R\(^2\)'s were somewhat lower. As before, WC provided a better explanation of prices than did EOC and

1. See p. 254.
<table>
<thead>
<tr>
<th>Equation Number</th>
<th>Equation</th>
<th>$R^2$</th>
<th>DMS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1 a</td>
<td>$PC_1 = 19.0719 + 0.1749WC_1 + 0.1809WC_{1-1} + 0.0594MC_1 + 0.2007TC_1$</td>
<td>0.9972</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>(4.54)</td>
<td>(4.47)</td>
<td>(3.71)</td>
</tr>
<tr>
<td>7.1 b</td>
<td>$PC_1 = 34.4808 + 0.3380EOC_1 + 0.3077EOC_{1-1} + 0.1263MC_1 + 0.1185TC_1$</td>
<td>0.9954</td>
<td>1.17</td>
</tr>
<tr>
<td></td>
<td>(10.58)</td>
<td>(8.88)</td>
<td>(6.79)</td>
</tr>
<tr>
<td>7.1 c</td>
<td>$PC_1 = 27.9070 + 0.4204EOC_1 + 0.1384MC_1 + 0.2713TC_1 + 0.0080DEXC_1$</td>
<td>0.9893</td>
<td>1.65</td>
</tr>
<tr>
<td></td>
<td>(7.97)</td>
<td>(4.72)</td>
<td>(5.15)</td>
</tr>
<tr>
<td>7.1 d</td>
<td>$PC_1 = 26.7520 + 0.4220EOC_{1-1} + 0.1459MC_1 + 0.2758TC_1 + 0.0087DEXC_1$</td>
<td>0.9862</td>
<td>2.22</td>
</tr>
<tr>
<td></td>
<td>(6.20)</td>
<td>(4.38)</td>
<td>(4.38)</td>
</tr>
</tbody>
</table>
the current and lagged forms of each labour cost variable were significant when both were used in the same equation.

Materials cost performed worse than in the case of sector C1. The materials cost variable was never significant and of the correct sign in equations in which labour costs were represented by WC and/or WC\(_{-1}\). The sales tax variable was significant in all equations in which it was used.

The demand variables were also less successful than in the case of sector C1. DEX2 was significant and of the correct sign in only two equations - with EOC and TC and with EOC\(_{-1}\) and TC. Of the other demand variables only VC was ever significant and of the right sign and in both equations where this was so (with WC\(_{-1}\) and with WC and WC\(_{-1}\)) VC was significant only at the 10% level. The better equations obtained for sector C2 are presented in Table 7.2.\(^1\) It will be noted from the table that in the equation where MC is included with WC and WC\(_{-1}\) it is significant only at the 10% level. Further, it will be noted that no equations which include a demand variable are presented in the table. Since all demand variables performed very poorly they were excluded from the preferred equation. The last equation in the table, equation (7.2 d), was chosen as the preferred equation.

7.3.3 Sector C3

The results obtained for sector C3 were not on the whole better than those obtained for sector C2. WC again proved more satisfactory than EOC on the basis of \(R^2\) and the t-ratio and the current and lagged variables were significant together in both cases.

1. See p. 256.
<table>
<thead>
<tr>
<th>Equation Number</th>
<th>EQUATION</th>
<th>$R^2$</th>
<th>DWS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2 a</td>
<td>$PC_2 = 52.5196 + 0.3579 EOC_2 + 0.3070 EOC_2^{-1} + 0.0505 MC_2$</td>
<td>0.9844</td>
<td>0.70</td>
</tr>
<tr>
<td></td>
<td>(7.32)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(6.03)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.87)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.2 b</td>
<td>$PC_2 = 31.1379 + 0.1688 WC_2 + 0.1089 WC_2^{-1} + 0.2451 TC_2$</td>
<td>0.9938</td>
<td>0.76</td>
</tr>
<tr>
<td></td>
<td>(3.31)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.98)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(7.62)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.2 c</td>
<td>$PC_2 = 44.7835 + 0.3337 EOC_2 + 0.2633 EOC_2^{-1} + 0.1618 TC_2$</td>
<td>0.9858</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>(6.96)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.08)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.93)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.2 d</td>
<td>$PC_2 = 35.5258 + 0.2971 EOC_2 + 0.2225 EOC_2^{-1} + 0.0825 MC_2 + 0.2172 TC_2$</td>
<td>0.9883</td>
<td>0.93</td>
</tr>
<tr>
<td></td>
<td>(6.62)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.58)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.34)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.12)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In contrast to the results obtained for sector C2, the materials cost variable was significant in only two equations estimated for sector C3. As before, the sales tax rate variable proved significant in nearly all equations. The demand variables performed somewhat better in the estimated equations for sector C3 than they did in the equations for sector C2, all demand variables being significant in at least one equation. On the whole, OTC proved to be the most satisfactory of the demand variables tested. The equations from which the preferred equation for sector C3 was chosen are presented in Table 7.3.1 On the basis of $R^2$ and the number of significant variables, equation (7.3 d) was chosen as the preferred equation for sector C3. It was found that if MC3 was added to this equation it was insignificant and of the wrong sign.

7.3.4 **Sector C4**

If we compare the estimation results for sector C4 with those obtained for sector C3 we find that the demand variables were less successful in the equations for sector C4. As has previously been the case, the use of WC to represent labour costs resulted in equations with higher $R^2$'s and t-ratios for the labour cost variable (if WC or WC$_{-1}$ are used separately) than in the case of equations where labour costs are represented by EOC or lagged EOC. Current and lagged labour cost variables were usually both significant when used together irrespective of whether WC or EOC was used.

The materials cost variable, MC, was significant less often than in equations for sector C3 and in only one case was MC significant in an equation where WC was used to represent labour costs. The sales

1. See p. 258.
<table>
<thead>
<tr>
<th>Equation Number</th>
<th>EQUATION</th>
<th>$R^2$</th>
<th>DWS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.3 a</td>
<td>PC3 = 41.0672 + 0.3357 EOC3 + 0.3223 EOC3 + 0.1971 TC3</td>
<td>0.9914</td>
<td>1.09</td>
</tr>
<tr>
<td></td>
<td>(7.12) (6.76) (4.46)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.3 b</td>
<td>PC3 = 33.8696 + 0.3468 EOC3 + 0.3468 TC3 + 0.0160 DEXC3</td>
<td>0.9845</td>
<td>1.64</td>
</tr>
<tr>
<td></td>
<td>(7.39) (5.84) (2.06)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.3 c</td>
<td>PC3 = 42.0139 + 0.1762 WC3 + 0.1705 WC3 + 0.4392 OTC3</td>
<td>0.9944</td>
<td>0.44</td>
</tr>
<tr>
<td></td>
<td>(2.89) (2.96) (2.26)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.3 d</td>
<td>PC3 = 32.2114 + 0.1793 WC3 + 0.1396 WC3 + 0.1602 TC3 + 0.4767 OTC3</td>
<td>0.9966</td>
<td>0.54</td>
</tr>
<tr>
<td></td>
<td>(2.77) (2.74) (2.74)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
tax rate variable was, on the whole, clearly significant. When TC was included in an equation with WC and WC\(_{-1}\), WC\(_{-1}\) became insignificant but this was not the case where EOC and EOC\(_{-1}\) were used. Hence EOC was used to represent labour costs in the preferred equation. Further, MC was significant more often in equations with EOC than in equations with WC.

Finally, as mentioned above, experimentation with demand variables did not prove very successful. Of the demand variables tried in the equations for sector C4 only DEXC was ever significant and of the right sign and then only in equations with EOC and/or EOC\(_{-1}\) and TC. The equations for sector C4 from which the preferred equation was chosen are presented in Table 7.4.\(^1\) In the choice of a preferred equation for sector C4 the equation with the highest value of R\(^2\) (equation (7.4 b)) was rejected because only the lagged labour cost variable is included\(^2\) and it was found that, on the whole, current labour costs were more important than lagged labour costs. The choice was thus reduced to one between equations (7.4 c) and (7.4 d) of which the former was chosen since in (7.4 d) the demand variable, DEXC, is significant only at the 10% level. Further, if both MC\(_4\) and DEXC\(_4\) are included in an equation with EOC\(_4\), EOC\(_{4-1}\) and TC\(_4\), DEXC\(_4\) becomes insignificant and of the wrong sign.

7.3.5 **Sector C5**

The results obtained for sector C5 are striking in that all the

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1. See p. 260.
2. Note that if WC\(_4\) is substituted for WC\(_{4-1}\), MC\(_4\) becomes insignificant and if both WC\(_4\) and WC\(_{4-1}\) are used in this equation MC\(_4\) is insignificant and WC\(_{4-1}\) is significant only at the 10% level.
<table>
<thead>
<tr>
<th>Equation Number</th>
<th>EQUATION</th>
<th>$\bar{R}^2$</th>
<th>DWS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.4 a</td>
<td>$PC_4 = 43.5513 + 0.3670 EOC_4 + 0.2534 EOC_{4-1} + 0.1885 TC_4$</td>
<td>0.9868</td>
<td>1.06</td>
</tr>
<tr>
<td></td>
<td>(5.82)</td>
<td>(3.74)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.73)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.4 b</td>
<td>$PC_4 = 26.6184 + 0.2848 WC_4 - 0.0402 MC_4 + 0.2499 TC_4$</td>
<td>0.9939</td>
<td>1.16</td>
</tr>
<tr>
<td></td>
<td>(19.14)</td>
<td>(2.11)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(7.25)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.4 c</td>
<td>$PC_4 = 34.7087 + 0.3246 EOC_4 + 0.2148 EOC_{4-1} + 0.0774 MC_4 + 0.2428 TC_4$</td>
<td>0.9889</td>
<td>1.21</td>
</tr>
<tr>
<td></td>
<td>(5.46)</td>
<td>(3.39)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.91)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.4 d</td>
<td>$PC_4 = 40.9123 + 0.3272 EOC_4 + 0.2003 EOC_{4-1} + 0.2519 TC_4 + 0.0145 DEXC_4$</td>
<td>0.9873</td>
<td>1.17</td>
</tr>
<tr>
<td></td>
<td>(4.92)</td>
<td>(2.71)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.02)</td>
<td>(1.65)</td>
<td></td>
</tr>
</tbody>
</table>
four demand variables experimented with for type C sectors were significant far more often than for any of the other sectors. Of the two labour cost variables used, WC again gave better results than EOC if only the lagged or current variable was used but when both WC and lagged WC were included in the same equation WC\_1 was often insignificant. This was not the case when current and lagged EOC were used in the same equation.

The materials cost variable was reasonably successful although it was only seldom significant when used in equations with WC and/or WC\_1.

As has previously been the case, the sales tax rate variable was consistently significant although when used in equations with a demand variable it was on occasions only significant at the 10\% level of significance.

Of the demand variables experimented with DEXC was most often significant, while UC and VC were significant least often. In the equations estimated which included one of the demand variables DEXC was more often significant in equations with EOC and the three labour market demand variables were more often significant in equations with WC and/or WC\_1. On the basis of the partial correlation coefficients in equations with only labour cost and demand variables, it appears that where the labour cost variable takes the form of WC, VC is the most important demand variable and where labour costs are represented by the earnings variable, DEXC appears to be the most important of the demand variables.

The preferred equation for sector C5 was chosen from amongst
those presented in Table 7.5.  

Several points should be noted from the table. Firstly, if labour costs are represented by EOC then current labour costs are more important than lagged labour costs whereas if WC is used to represent labour costs then lagged labour costs are more important than current labour costs. Secondly, MC was not included in equations (7.5 e) and (7.5 f) since in both of these equations MC is insignificant (and becomes negative) and if MC is included TC also becomes insignificant (although it is still positive). In the choice of a preferred equation (7.5 e) and (7.5 f) were eliminated because in both equations TC is significant only at the 10% level and MC was insignificant when added to these equations. Secondly, equation (7.5 g) was eliminated because if it is compared to equation (7.5 b) DEXC appears to be a better measure of demand pressure. Hence the choice is between equations (7.5 b) and (7.5 c) of which the latter was chosen.

7.3.6 Sector C6

On the whole, the results obtained for sector C6 were better than those obtained for sectors C3 and C4 but not as good as those obtained for sector C5. In the case of sector C6 equations, the use of WC to represent labour costs generally resulted in equations with higher $R^2$-values than when EOC was used to represent labour costs. If estimated equations of the form (6.1) when X6 takes the form of WC6, WC6-1, LOC6 or EOC6-1 are examined we find that on the basis of $R^2$ and the t-ratio (and hence the partial correlation coefficient) the current variable gives marginally better results than the lagged

1. See p. 263.
<table>
<thead>
<tr>
<th>Equation Number</th>
<th>EQUATION</th>
<th>$R^2$</th>
<th>DWS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5 a</td>
<td>$PC_5 = 40.8670 + 0.3084 EOC_5 + 0.2532 EOC_{5-1} + 0.0716 MC_5 + 0.1849 TC_5$</td>
<td>0.9891</td>
<td>0.79</td>
</tr>
<tr>
<td></td>
<td>$(7.75)$ $+$ $(5.86)$ $+$ $(3.04)$ $+$ $(3.82)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.5 b</td>
<td>$PC_5 = 44.9476 + 0.2569 EOC_5 + 0.2027 EOC_{5-1} + 0.0975 MC_5 + 0.1338 TC_5 + 0.0354 DEXC_5$</td>
<td>0.9928</td>
<td>1.42</td>
</tr>
<tr>
<td></td>
<td>$(5.06)$ $+$ $(3.88)$ $+$ $(5.04)$ $+$ $(3.02)$ $+$ $(3.05)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.5 c</td>
<td>$PC_5 = 33.6788 + 0.1415 WC_5 + 0.1703 WC_{5-1} + 0.0383 MC_5 + 0.0936 TC_5 + 1.1923 OTCS_5$</td>
<td>0.9967</td>
<td>1.18</td>
</tr>
<tr>
<td></td>
<td>$(3.00)$ $+$ $(3.52)$ $+$ $(2.11)$ $+$ $(3.07)$ $+$ $(9.30)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.5 d</td>
<td>$PC_5 = 40.1072 + 0.2765 EOC_5 + 0.2378 EOC_{5-1} + 0.1211 MC_5 + 0.1419 TC_5 + 0.4565 OTCS_5$</td>
<td>0.9921</td>
<td>1.19</td>
</tr>
<tr>
<td></td>
<td>$(5.27)$ $+$ $(4.47)$ $+$ $(4.78)$ $+$ $(3.06)$ $+$ $(2.07)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.5 e</td>
<td>$PC_5 = 35.6342 + 0.1518 WC_5 + 0.2359 WC_{5-1} + 0.0680 TC_5 - 0.0005 UC_5$</td>
<td>0.9950</td>
<td>0.98</td>
</tr>
<tr>
<td></td>
<td>$(2.62)$ $+$ $(3.88)$ $+$ $(1.73)$ $+$ $(6.64)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.5 f</td>
<td>$PC_5 = 37.0187 + 0.1698 WC_5 + 0.1800 WC_{5-1} + 0.0595 TC_5 + 0.0010 VC_5$</td>
<td>0.9965</td>
<td>1.23</td>
</tr>
<tr>
<td></td>
<td>$(3.51)$ $+$ $(3.62)$ $+$ $(1.87)$ $+$ $(9.19)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.5 g</td>
<td>$PC_5 = 42.2360 + 0.2938 EOC_5 + 0.2488 EOC_{5-1} + 0.1057 MC_5 + 0.1279 TC_5 + 0.0003 VC_5$</td>
<td>0.9921</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>$(5.75)$ $+$ $(4.65)$ $+$ $(4.83)$ $+$ $(2.66)$ $+$ $(1.95)$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
variable. This fact is also borne out where both the current and lagged variables are used in the same equation in which case the estimated coefficient and the t-ratio of the estimated coefficient of the current labour cost variable are larger (although not much larger) than those of the lagged variable.

The materials cost variable was found to be significant in equations with WC and/or WC\(_{-1}\) unless TC was also included in the equation. In some cases it was also marginally significant in equations with WC and UC. MC was more often significant in equations where the labour cost variable took the form of EOC.

As has been the case in the estimated equations for all other type C sectors, the sales tax rate variable was always significant and as stated above, the inclusion of the sales tax variable often improved the t-ratio of the materials cost variable.

While all four demand variables were successful to some extent, it was found that VC was the most successful. OCT was significant in only two equations - once with only EOC6\(_{-1}\) and once with EOC6\(_{-1}\) and MC6. UC was significant in more cases but often only at the 10% level of significance. DEXC was also found to be significant in more equations than OCT. In some equations where the influence of demand was measured by VC, TC became insignificant at the 5% level but was still significant at the 10% level. The best equations obtained for sector C6 are presented in Table 7.6.\(^1\) If EOC\(_{-1}\) is included in equation (7.6 c) DEXC becomes insignificant. Since this was not the case where demand was represented by VC, VC was chosen rather than DEXC in the preferred

\(^1\) See p. 265.
## TABLE 7.6: Sector C6 Equations

<table>
<thead>
<tr>
<th>Equation Number</th>
<th>Equation</th>
<th>$R^2$</th>
<th>DWS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.6 a</td>
<td>PC6 = 31.8334 + 0.1578 WC6 + 0.1340 WC6 $^{-1}$ + 0.0460 MC6 + 0.1810 TC6</td>
<td>0.9939</td>
<td>0.98</td>
</tr>
<tr>
<td></td>
<td>(3.39) $(2.74) (2.49)$ $(5.17)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.6 b</td>
<td>PC6 = 40.8670 + 0.3084 EOC6 + 0.2532 EOC6 $^{-1}$ + 0.0716 MC6 + 0.1849 TC6</td>
<td>0.9891</td>
<td>0.79</td>
</tr>
<tr>
<td></td>
<td>(7.75) $(5.86) (3.04) (3.82)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.6 c</td>
<td>PC6 = 34.0641 + 0.4063 EOC6 + 0.0862 MC6 + 0.3025 TC6 + 0.0697 DEXC6</td>
<td>0.9823</td>
<td>1.53</td>
</tr>
<tr>
<td></td>
<td>(8.81) $(2.63) (5.46) (1.67)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.6 d</td>
<td>PC6 = 43.4767 + 0.1625 WC6 + 0.1910 WC6 $^{-1}$ + 0.0427 MC6 - 0.0006 UC6</td>
<td>0.9915</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>(2.97) $(3.39) (1.82) (-2.52)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.6 e</td>
<td>PC6 = 55.1712 + 0.3614 EOC6 + 0.3240 EOC6 $^{-1}$ + 0.0673 MC6 - 0.0005 UC6</td>
<td>0.9868</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>(8.94) $(7.67) (2.41) (-1.95)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.6 f</td>
<td>PC6 = 34.2485 + 0.1539 WC6 + 0.1568 WC6 $^{-1}$ + 0.0449 MC6 + 0.1184 TC6 + 0.0013 VC6</td>
<td>0.9949</td>
<td>1.24</td>
</tr>
<tr>
<td></td>
<td>(3.61) $(3.46) (2.66) (3.15) (3.19)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.6 g</td>
<td>PC6 = 45.6884 + 0.3294 EOC6 + 0.2864 EOC6 $^{-1}$ + 0.0675 MC6 + 0.0958 TC6 + 0.0017 VC6</td>
<td>0.9907</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>(8.78) $(6.88) (3.09) (1.77) (2.96)$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
equation for sector C6. Similarly, if TC is added to equation (7.6 d), UC becomes insignificant. The same happens if TC is added to equation (7.6 e). Hence, the choice of a preferred equation was reduced to one between equations (7.6 f) and (7.6 g) of which (7.6 f) was chosen since it has both a higher $R^2$ and a higher DWS.

7.4 Conclusions

As has been the practice in the previous two chapters the preferred equation for each sector is reproduced in Table 7.71 to facilitate a comparison of the preferred equations sector by sector. It will be recalled from the discussion in Chapter 4 that the dependent variable for the aggregate type C sector and the dependent variable for the aggregate type B sector are identical. Hence, the preferred equation for sector B6 (the aggregate type B sector) is included in Table 7.7 as the preferred equation for sector C7. The partial correlation coefficient for each variable in the table is also included.

If the sectoral equations are compared with the aggregate equation we find that, as was the case for type B sectors, the statistical quality of the aggregate equation was not, on the whole, noticeably better than that of the sectoral equations. Since there is no reason to believe that the quality of the data used for sector C7 is better or worse than the quality of the data used for sectors C1, ..., C6 this observation provides further evidence in favour of the argument advanced previously, that the higher statistical quality of the aggregate type A equations compared with that of the sectoral type A equations was, at least in part, due to the difference in the quality of the data.

1. See pp. 267, 268.
<table>
<thead>
<tr>
<th>Sector</th>
<th>EQUATIONS</th>
<th>$R^2$</th>
<th>DWS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>(PC1 = 19.0719 + 0.1749 WC1 + 0.1809 WC_{1-1} + 0.0594 MC1 + 0.2007 TC1)</td>
<td>0.9972</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>(4.54) (4.47) (3.71) (7.47)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.5481] [0.5421] [0.4721] [0.7332]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>(PC2 = 35.5258 + 0.2971 EOC2 + 0.2225 EOC_{2-1} + 0.0825 MC2 + 0.2172 TC2)</td>
<td>0.9883</td>
<td>0.93</td>
</tr>
<tr>
<td></td>
<td>(6.62) (4.58) (3.34) (4.12)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.6908] [0.5515] [0.4343] [0.5111]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>(PC3 = 32.2114 + 0.1793 WC3 + 0.1396 WC_{3-1} + 0.1602 TC3 + 0.4767 OTC3)</td>
<td>0.9966</td>
<td>0.54</td>
</tr>
<tr>
<td></td>
<td>(3.77) (2.74) (5.66) (3.15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.4780] [0.3678] [0.6327] [0.4139]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td>(PC4 = 34.7087 + 0.3246 EOC4 + 0.2148 EOC_{4-1} + 0.0774 MC4 + 0.2428 TC4)</td>
<td>0.9889</td>
<td>1.21</td>
</tr>
<tr>
<td></td>
<td>(5.46) (3.39) (3.15) (4.19)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.6190] [0.4395] [0.4139] [0.5782]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C5</td>
<td>(PC5 = 33.6788 + 0.1415 WC5 + 0.1703 WC_{5-1} + 0.0383 MC5 + 0.0936 TC5 + 1.1923 OTC5)</td>
<td>0.9967</td>
<td>1.18</td>
</tr>
<tr>
<td></td>
<td>(3.00) (3.52) (2.11) (3.07) (9.30)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.4009] [0.4568] [0.2942] [0.4087] [0.8049]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 7.7 (continued) : Preferred Equations

<table>
<thead>
<tr>
<th>Sector</th>
<th>EQUATION</th>
<th>$\frac{-R^2}{DWS.}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6</td>
<td>$PC_6 = 34.2485 + 0.1539 WC_6 + 0.1568 WC_{6-1} + 0.0449 MC_6 + 0.1184 TC_6 + 0.0013 VC_6$</td>
<td>0.9949 1.24</td>
</tr>
<tr>
<td></td>
<td>(3.61) (3.46) (2.66) (3.15) (3.19)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.4659] [0.4506] [0.3617] [0.4175] [0.4219]</td>
<td></td>
</tr>
<tr>
<td>C7</td>
<td>$PC_7 = 34.7614 + 0.3188 EOC_7 + 0.2790 EOC_{7-1} + 0.0965 MC_{7-1} + 0.1795 TC_7$</td>
<td>0.9932 1.13</td>
</tr>
<tr>
<td></td>
<td>(8.06) (6.69) (4.10) (4.29)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.7583] [0.6946] [0.5093] [0.5265]</td>
<td></td>
</tr>
</tbody>
</table>
used for the type A sectors. A comparison of the equations in Table 7.7 shows further that equations where labour costs are represented by WC rather than EOC have a higher $R^2$. This was generally true for all sectors. Despite this, EOC was used to represent labour costs in some of the preferred equations because in some cases WC and WC$_{-1}$ were not significant together while EOC and EOC$_{-1}$ were and it was often found that more variables were significant in equations with EOC than was the case in equations with WC. As has been the case for most of the other sectors, the $R^2$'s of the preferred type C equations are satisfactory but the DWS's are not.

Consider now the labour cost variables. All the preferred equations have both current and lagged labour cost variables. The partial correlation coefficients for the labour cost variables show that in all but one case (sector C5) current labour costs are more important than one period lagged labour costs. In the equation for sector C5 lagged labour costs are more important than current labour costs although the difference between the two partial correlation coefficients is not large. In fact, in the estimated equation for this sector in which only WC and WC$_{-1}$ are used as regressors, the current labour cost variable proves to be more important than the lagged one, the lagged labour cost variable in this case being insignificant. It will be noted that the difference between the partial correlation coefficient of the current labour cost variable and the partial correlation coefficient of the lagged labour cost variable is greater in the equations where labour costs are measured by EOC than in the equations where they are measured by WC. On the whole, it appears that with the possible exception of sector C5 current labour costs are more important
than lagged labour costs and concerning this aspect of the equations the estimated aggregate equation provides a clear indication of the appropriate lags for the sectoral equations. This is not true with respect to the appropriate type of labour cost variable when we see that EOC is used in the aggregate equation and in some of the sectoral equations and WC is used in the other preferred sectoral equations.

Considering the performance of the materials cost variable, it will be recalled from the discussion in section 7.2 that the preliminary testing with one and two period lags on MC showed that current materials costs were more satisfactory for all the sectoral type C equations and that current and lagged materials cost variables were not significant together. Hence, where MC appears in the preferred sectoral equations it appears in its current form. It will be seen that a materials cost variable appears in all the equations except the equation for sector C3. In all cases it is significant at the 5% level and the partial correlation coefficient of MC is always less than the partial correlation coefficient of either of the labour cost variables, indicating that materials costs are definitely less important in the determination of prices than are labour costs. Further, in all equations where MC is significant it is less important on the basis of the partial correlation coefficients than the sales tax rate variable.

Turning now to the tax rate variable, we find that it enters each of the preferred equations significantly. In fact, in all equations in which a tax rate variable has been used it has been found that the labour cost variable and the tax rate variable are the most consistently significant. Considering the somewhat crude method by which an excise rate series has been obtained and the rather large weight of this
series in the constructed sales tax and excise data, it would appear that changes in sales tax and excise are clearly reflected in price changes. In the three equations in which both TC and a demand variable were used there is no consistent pattern as to which is the most important - for sector C3 TC has the largest partial correlation coefficient whereas for sectors C5 and C6 the opposite is true. Further, if the importance of TC is compared with the importance of the labour cost variable the results are somewhat obscured by the existence of multicollinearity between the current and lagged labour cost variables. However, if only one labour cost variable is used in each equation (i.e., either the current or the lagged) labour costs prove to be more important than taxes in the determination of prices.

Finally, consider the demand variables. Only for sector C5 were all demand variables significant in nearly all the types of equations estimated. Hence, for this sector there is unambiguous evidence that the influence of demand on prices is important. If the partial correlation coefficients for the variables in the preferred equation for sector C5 are examined we find that demand is more important than the sales tax and excise variable and the materials cost variable. If only one labour cost variable is used in this equation (i.e., either WC5 or WC5₋₁) demand is substantially less important than labour costs. For sector C3 the demand variable (OTC3) is less important than the tax rate variable and the labour cost variable and for sector C6 it is marginally more important than the tax rate variable and less important than labour costs.
In Chapter 1 we stated that the primary aim of this study was to estimate sectoral price equations for Australia using quarterly data for the period 1960-61 to 1972-73. The secondary aim was stated to be to use these estimated sectoral equations to answer some questions posed in section 1.1 of that chapter. After a brief review of the most important Australian and overseas sectoral price determination studies (Chapters 2 and 3) and a rather lengthy discussion of the data used for the regression analysis (Chapter 4) it was decided that three possible types of disaggregation could be used for an Australian study given the data which were available or which could be constructed. Since there was little indication from the studies reviewed as to which of the possible types of disaggregation would be most useful, it was decided to use all three types of disaggregation. The estimated sectoral price equations based on these three types of disaggregation were presented in Chapters 5-7 and hence the primary aim has been accomplished. It is the purpose of this concluding chapter to attempt to accomplish the secondary aim, viz., to use the estimated equations presented in the previous three chapters to answer some questions concerning the process of price determination in Australia.

Before these questions are considered some comments will be made on two statistical problems which often occurred in the study,
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viz., multicollinearity and serially correlated residuals. A discussion of these two problems is contained in section 8.2. Section 8.3 deals with the questions posed in Chapter 1 and the final section (section 8.4) offers some suggestions for further work in this area of sectoral price determination.

8.2 Statistical Problems

8.2.1 Multicollinearity

The problem of multicollinearity was found to be worst between current and lagged labour costs. Since the presence of multicollinearity makes for unreliable parameter estimates it was expected that the lag patterns would be difficult to discern in equations of the type used here (i.e., price level equations). However, since only one period lags on the labour cost variables were experimented with, in most cases the relative importance of current and lagged labour costs could be gauged from the estimated equations despite the presence of multicollinearity. However, the relative importance of labour cost variables and other influences on prices were difficult to discern in many cases, especially since the partial correlation coefficients of the labour cost variables which were used as a measure of the importance of these variables were also affected by multicollinearity. The presence of multicollinearity also made it difficult to distinguish the lag pattern on the materials cost variables.

There are two methods by which the problem of multicollinearity may be reduced to some extent. Firstly, extraneous information may

1. See the note above, p. 188, on partial correlation coefficients and the reference to Theil.
be used. For example, if there is strong multicollinearity between materials prices and labour costs in price equations, unit prime costs may be calculated by the use of the input–output method. This approach has been used with some success in this study where the calculated UPC series were often to be found in preferred sectoral equations. Again with respect to the multicollinearity between current and lagged variables used in the same equation, a lag pattern may be imposed on the variable (e.g., on the wage rate variable) a priori and the resulting equation estimated by econometric techniques. The simplest way of doing this is to impose a geometric lag on one or more of the explanatory variables and, using a Koyck transformation, to obtain an equation with the lagged dependent variable on the right-hand-side. This method has not been used in this study for reasons discussed previously.¹

A second possible approach to the multicollinearity problem is to estimate the price equations in the first-difference form. However, Kmenta warns that if the disturbances in the original model are independent, the transformation to first differences

"... introduces autoregression in the disturbances that are otherwise independent. As noted, autoregression has undesirable consequences for the properties of the least squares estimators. This makes working with first differences instead of the original data a dubious practice." ²

The use of first differences also has the danger of magnifying observation errors in the data. It was because the relative importance of these statistical problems was not known in advance that the equations in this study were estimated in level form.³ It is felt, however,

¹. See pp. 82, 83 above.
³. See the discussion above, pp. 71, 72.
that some additional information concerning the parameters may be gained by estimating price equations of the type estimated in this study in the first difference form especially if the results of the estimated first difference equations are closely compared with the estimated price level equations.

8.2.2 Serially Correlated Residuals

The second statistical problem to be commented on is the problem of serially correlated residuals as evidenced by the usually poor DWS's obtained for the equations estimated in this study. The poor DWS's could be caused in many cases by the omission of a variable which ought to have been included.1 It is felt that in many of the equations this may well be the case and that the use of unsatisfactory sectoral data has on several occasions led to the rejection of variables which ought not to have been rejected. Comparison between the estimated type A equations obtained in this study and similar equations obtained in the RBA studies which use mostly aggregate data, suggest that the difficulty in question may have been especially important in relation to the sector A equations.

If the results obtained by Eckstein and Fromm (1968) are examined it can be seen that in all cases reported in their study the addition of the lagged dependent variable to the explanatory variables in price level equations significantly improves the DWS. Since this is the only study reviewed in this thesis to present both types of equations we may presume on the basis of this rather meagre evidence that the inclusion of the lagged dependent variable on the right-

1. See Kmenta, *op.cit.*, Ch. 8, section 8.2.
hand-side of the equations would significantly improve the DWS at least for some sectors. However, to include the lagged dependent variable amongst the regressors with the sole purpose of improving the DWS appears very unsatisfactory and is therefore not advocated in the section of this chapter dealing with suggestions for further work. The study by Eckstein and Fromm further indicates that the use of first differences rather than price levels may improve the DWS's (contrary to Kmenta's expectations) so that if first difference equations were to be estimated in an attempt to obtain better estimates of the parameters as cautiously suggested above, the DWS's may well improve also.

Despite this, it is likely that the most satisfactory method of improving the DWS's is firstly to attempt to improve the data used for the regressions so that certain variables may be accepted or rejected with more confidence and secondly to give special attention to those sectors for which the estimated equations are the least satisfactory in an attempt to determine whether there are special features of these sectors which ought to have been taken into account but which were not. In this sense, the results obtained in this study are only of a preliminary nature. Thirdly, it is quite possible that further experimentation with lags will improve the estimated equations provided that this approach does not stumble on the problem of multicollinearity.

8.3 Conclusions

Having discussed the two recurring statistical problems in the previous section let us now turn to the questions which were posed in Chapter 1. In this section we will first compare the determinants
of prices for different sectors (including the aggregate sector) and then compare the lags for different sectors. Before this is proceeded with, however, a note of caution must be sounded. As explained in previous chapters, such a comparison will be difficult to make because of the unsatisfactory nature of the data used for many of the sectoral explanatory variables. Since it does not appear possible to distinguish between the case where a variable has been rejected because of the poor data used to measure it and the case where the variable has been rejected because it does not influence the price level in that sector and further, since these cases are not necessarily always distinct, the conclusions reached will necessarily be somewhat tentative - we shall have to be satisfied with rather broad conclusions.

If the results for the three types of disaggregation are compared it appears that the greatest difference between the sectoral equations and between the sectoral equations and the aggregate equations occur for type A and type B disaggregations. However, for all types of disaggregation the size of the estimated parameters and the types of variables appearing in the preferred estimated equations differ quite widely. Thus it would appear that the answers to the first two questions posed in Chapter 1\(^1\) should both be in the affirmative. However, for all sectors it seems fairly clear that labour costs are the most important influence on price levels. In this sense the determinants are not greatly different. They do differ in the types of variables found to represent labour costs most satisfactorily. The

1. i.e., (1) Do the determinants of sectoral prices differ from sector to sector?
(2) Do the determinants of sectoral prices differ from those of aggregate prices?
order of the importance of the other variables is not so clear and, even allowing for the deficiencies of the data used it seems that, apart from labour costs, there is substantial variation in the relative importance of the remaining variables used. Even for the type C equations where the importance of the variables does not differ as much as for the other two types of sectors, there are differences in the relative importance of certain variables amongst the equations. There are probably two reasons why there is less variation in the type C results than in the type A and type B results. Firstly, this would be expected a priori since there is likely to be less variation in economic structure between States than between final demand or consumer sectors. Secondly, the quality of the data is likely to be more uniform. However, it is unlikely that either of the causes should carry sole responsibility.

Thus as regards the first two questions posed in Chapter 1 it appears that the determinants of prices do differ from sector to sector especially in the case of type A and type B sectors so that price determination can be more adequately understood by examining sectoral price determination equations than by examining price determination at the aggregate level. Against this advantage of sectoral analysis must be balanced the disadvantage that the sectoral data are on the whole poorer than the aggregate data. As to the type of disaggregation which might best be used in further work in this area two points ought to be given consideration. Firstly, type A disaggregation defines broader sectors and covers a far greater part of the economy. Thus the use of this type of disaggregation has the advantage that data are easier to obtain and that a more complete coverage of the economy is possible.
However, the implicit deflators used are not devised to be used in this type of work. Furthermore, the sectors are not defined with the object of providing sectoral price indexes, whereas this is the case for the type B sectors where the dependent variables may be measured by the components of the CPI and the sectors are defined according to classes of goods which are often more narrow and more homogeneous than the classes of goods covered by the different type A sectors.

Let us now turn to a consideration of questions (3) and (4) posed in Chapter 1.1 As was mentioned in the previous section when the problem of multicollinearity was discussed, there was some difficulty in obtaining accurate estimates of the lags. Added to the problem of multicollinearity was the limits placed on the experimentation with lags. Given that only one period lags on labour costs were tried, the results are usually fairly clear as to whether current or lagged labour costs are the more important. For the type A sectors there did not appear to be much difference between the results obtained for the various sectors and current labour costs were nearly always more important than lagged labour costs. But the results for the aggregate sector showed the opposite and while the difference between the partial correlation coefficient of the current labour cost variable and the partial correlation coefficient of the lagged labour cost variable (in the preferred equation) is not very large it is nevertheless clear. Hence for the

1. i.e., (3) Do the lag structures found to be most appropriate differ from sector to sector? (4) Do the lag structures found to be most appropriate for the sectoral equations differ from the lag structure found to be most appropriate for the aggregate equation?
type A sector equations the appropriate lag structure for the labour cost variable is not unambiguously given by the appropriate lag structure for the aggregate case. The same appears to be true for the materials cost variable although in this case the evidence is not as strong since this variable was less often significant.

In the case of the type B sectors there are differences in the appropriate lag structures both between sectors and between the sectoral equations and the aggregate equation. For the type C sectors the appropriate lag structures for the labour cost variables in the sectoral equations show few differences as between the sectors and between the sectoral and the aggregate equations and it appears that the aggregate equations gives a fairly unambiguous indication of the lag structure appropriate for the sectoral equations with the possible exception of the equation for sector C5. In the case of materials costs for type C sectors, it was found that the current materials cost variable was always more important than the variable lagged one or two periods. For the aggregate type C equation, however, the opposite was true and hence again the aggregate equation does not give an unambiguous indication of the appropriate lag structures for the sectoral equations.

Thus, two broad conclusions emerge. Firstly, it would appear that there are sufficient differences (both in the determinants and in the lag structures) in the preferred estimated sectoral equations to warrant further work in the area of sectoral price determination. Secondly, there are sufficient differences between the preferred aggregate equation and the preferred sectoral equations to support the view that it is preferable to explain sectoral prices separately in order
to obtain a better understanding of the process of price determination in the Australian economy. Thus the analysis of one price determination equation for the whole economy does not take account of differences between the sectors of the economy and in as far as those differences affect the process of price determination (as was shown in this study by the differences in estimated sectoral price equations) a sectoral approach to the study of price determination produces a more realistic and comprehensive picture of price determination in the economy.

8.4 Suggestions for Further Work

In this section we will briefly collect the various suggestions for further work offered at several points in this chapter. Firstly, it appears from the results obtained in this study that geographical disaggregation is probably the least useful of the three types of disaggregation considered in that there are fewer differences between sectoral equations than in the case of the other types of disaggregation. Further work in this area may not, therefore, be warranted. Consumer-goods disaggregation has the advantage that the least work has been done in this area and that the sectors are more suitably defined for work of this type. It suffers from the disadvantages that only part of the economy is covered and that sectoral data are more difficult to obtain than for final demand sectors.

An important area in which further research is necessary is in relation to productivity data. If more satisfactory short-run productivity data could be constructed it is quite possible that the ULCN variables which were so unsuccessful in this study but successful in
most other studies reviewed will be more successful at least for some sectors. Another way in which the ULCN variable could be improved is by trying alternative methods of deriving the series.

A second suggestion for further work offered is to spend more research time on the sectors for which the equations were the least satisfactory (e.g., sectors A2 and A3) in an effort to incorporate any special features of these sectors into the equations.

A third area mentioned previously is to experiment with the first difference form of the equations and to experiment more extensively with lags in order to obtain more conclusive results concerning the lag structures for the various price equations.
I. BOOKS


II. ARTICLES, PAPERS, etc.


, "A Wage-Price Sector for A Quarterly Australian Model", Paper read at the Australasian Conference of Econometricians, Monash, August 1971


