HOUSE AND LAND PRICES IN AUSTRALIA WITH SPECIAL REFERENCE TO SYDNEY

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"The hard scientific discipline has yet to be learned, that all theories must be constantly tested and re-tested against observed facts, and those which prove wrong ruthlessly rejected. Theory has a valuable, indeed an essential part to play in the development of economic science. But is must be theory which respects the facts, not tries to supersede them... There is room for two or three economic theorists in each generation, not more... The rest of us should be economic scientists, content steadily to lay stone upon stone in building the structure of ordered knowledge."

Clark, 1940.

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ABSTRACT
HOUSE AND LAND PRICES IN AUSTRALIA WITH SPECIAL REFERENCE TO SYDNEY

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The thesis describes and explains average house prices and the distribution of house prices in Sydney, Melbourne and Adelaide in the 1970s and 1980s, and average house and land prices and their distribution in Sydney from 1925 to 1970.

Part I starts with a brief discussion of the special nature of housing. The rest of Part I describes the house and land prices that the study aims to explain. The Sydney data are described at greater length because these were developed mainly by the writer.

Part II reviews economic theories of the price of housing services in the long and short run, the distribution of house prices, and the relationship between house and land prices. The models of average house prices allow, *inter alia*, for the dual role of housing as a consumption good and asset, the interaction between the demand for and supply of housing, and the disequilibrium nature of the housing market. The models of the distribution of house prices draw on economic theories of urban structure and hedonic house prices.

Part III applies these models to explain short and long-run changes in house prices in Sydney, Melbourne and Adelaide since about 1970; the distribution of house prices within each city; and intercity differences in house prices.

Part IV models average house and land prices, and explains their spatial distribution, in Sydney from 1925 to 1970.

Part V summarises the main results of the research. The thesis provides plausible explanations for most of the observed major house price phenomena.

The Appendices contain a note on the requirements for a Ph.D., a review of relevant literature by other writers, and a summary of related work on property prices by the author.

PREFACE AND ACKNOWLEDGEMENTS

The main aim of the thesis is to provide a coherent and comprehensive explanation of house prices in Australia's three largest cities, Sydney, Melbourne and Adelaide in the 1970s and 1980s. These three cities house about 7.5 million people, or 45 per cent of the total Australian population.

Specifically, I aim to explain short-run movements in average house prices in each city, the distribution of house prices within the cities, and the long-run house price differences between the cities.

Additionally, the thesis seeks to explain house and land prices in Australia's largest city, Sydney, from 1925 to 1970. This is of interest in its own right, as few other countries or cities have house price data over such an extended period. Also, the pre- and post-1970 periods provide interesting contrasts in house prices.

This thesis has grown out of many studies and many years work on house and land prices in Australia. Initially, in the mid-1970s, I conducted a large study of the determinants of individual house prices in Sydney. A major objective was to determine the impacts of environmental and transportation factors on house prices. This study led to several publications (Abelson 1977, 1979a, 1979b).

In the early 1980s I started two major house price studies. One was a study of average house prices in the state capital cities of Australia since the early 1970s. Out of this study I published a number of papers (Abelson 1982a, 1982-83; Abelson and Alcordo, 1986). However, the research was handicapped by poor data, so that it was difficult to produce statistically satisfying models of house prices.

The second major study dealt with house and land prices in Sydney from 1925 to 1970. This required a large data collection program and considerable analysis. A paper describing and explaining average house and land prices was published (Abelson, 1985). In this thesis I have reviewed and revised some of these results. Other results of this second study, relating to the distribution of house and land prices, which are given below, have not been published previously.

Also in the early 1980s I produced another two short articles relating to residential property prices. One dealt with energy prices and house prices (Abelson, 1982c). The other dealt with land prices in Wollongong, a large city to the south of Sydney (Abelson and Cardew, 1983).

However, by the mid-1980s I had exhausted most of the readily available data on house and land prices and turned to other matters (e.g. Abelson 1986, 1987).

In 1989, in response to the then sharply rising house prices in Australian cities, the Commonwealth Department of Industry, Technology and Commerce and the state governments of New South Wales, Victoria and South Australia commissioned a consultant team under my direction to undertake three major related studies of housing costs and house prices in Sydney, Melbourne and Adelaide. These were a study of the costs of new houses; an evaluation of urban consolidation strategies; and a study of the determinants of established house prices. These studies, particularly the third one, provided the data that enabled me to complete this thesis. It is expected that the studies themselves will be published toward the end of 1991.

It can be reasonably claimed, I believe, that each of the major house price studies mentioned above represented original work in Australia. At the time of each study there had been no work on house prices in Australia of comparable depth or scale, and even since then there has been little such work.

The thesis itself draws on much of this earlier work. However, it is designed as a coherent and self-contained study and contains much new and reformulated material. The contributions of the thesis and my other research studies to our knowledge of house and land prices in Australia are discussed further in Appendix A which deals with the "Requirements of the Thesis".

I must acknowledge, however, that in developing my work on residential property prices, I have been helped in many ways, For a start, I have drawn on numerous overseas studies of house prices and especially on the theories of house prices developed in this literature (see references in the thesis). My various studies and the thesis itself are principally exercises in applied research. They may provide some fresh perspectives on economic theories and their application, but this would be incidental to the main objectives of the thesis.

Second, I have received financial assistance for research on house prices from the then Commonwealth Bureau of Transport Economics, the Reserve Bank of Australia, the Australian Research Grants Committee, Macquarie University, as well as the Commonwealth Department of Industry Technology and Commerce. These grants provided assistance for data collection and computing.

Third, I have benefited from many discussions with econometricians and housing experts inside and outside Australia. Dr.Russel Cooper and Mr.Roger Tonkin have given me assistance with econometric work. I am also

indebted to Dr.Christine Whitehead, my thesis supervisor, who has advised me on development of the thesis. My specific debts in relation to this thesis are described in Appendix A.

I am also most grateful to Jane Oldroyd, who cheerfully and ungrudgingly prepared the final presentation of the thesis despite numerous late changes. Special thanks are also due to my wife Jeanne, who has always supported my endeavours despite their exorbitant calls on my time.

Notwithstanding the various assistances received, I am solely responsible for any errors of commission or omission in this thesis.

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PART I

HOUSE PRICES: TRENDS AND PATTERNS

1 THE NATURE OF HOUSING

To explain house prices, it is necessary to understand the special nature of housing. In particular, the heterogeneity and durability of the housing stock, the locational attributes of houses, and the social importance of housing all influence house prices.[1]

Heterogeneity

Each residential property has a unique location and most properties differ from others in at least some characteristics.

Properly regarded, the price of a house (PH) is not the price of a single standard commodity. Rather it is the total capital expenditure for a collection of present and anticipated future housing services, including services from the land and its location (e.g. access and environmental services). Therefore

$$PH = \sum_{i=1}^{n} P_i q_i \qquad (1.1)$$

where P stands for the capital price for each housing service (e.g. m^2 of built floor space), q is quantity of each service, and i = 1...n housing services. This is known as the characteristics, or hedonic, pricing concept (see Lancaster, 1966; Rosen 1974).

Clearly, PH may differ, spatially or temporally, because of variations in P_i or q_i. However, given the law of one price (at any point in time, in the absence of transaction costs, separable services should have a single price), most spatial differences in house prices are due to variations in q_i rather than in P_i.[2] Also, some intertemporal differences in real house prices may be caused by changes in q_i (house quality).

The heterogeneity of housing complicates estimation of house price indices. Although house price indices can be estimated from hedonic price models (Quigley, 1979), this is rarely done. Usually, estimated indices are simple averages of observed house prices (see Chapter 2).

Likewise the problem of heterogeneity is assumed away in many theoretical models of house prices. Typically these models are based on a notional (unobservable) homogeneous commodity, described as a unit of housing services (h), which is demanded and supplied (Muth, 1960). This is a useful analytical device (see Chapters 5 and 6). It is important, however, to distinguish carefully between the notional capital price of housing services (P^h) and actual house prices (PH). Of course, empirical work must be based on observable house prices and housing services.

Durability

Housing is demanded as a capital asset as well as a source of consumption services. Housing stock is usually an important part of the asset portfolios of households and sometimes of businesses.

On the other hand, the supply of housing changes only slowly, typically by between one and three per cent per annum. Consequently, short-run changes in house prices are influenced more by changes in demand than supply.

In some neo-classical models of the demand for durable goods, the flow of services is regarded as directly proportional to the stock of goods and intertemporal problems are ignored (Deaton and Muellbauer, 1980). However, most models of the demand for housing attempt to incorporate explicitly both the consumption and investment elements of demand.

This is complicated because owner-occupiers of houses are both consumers and investors. When houses are rented, rents indicate the consumption value of housing services. However, there is no direct measure of the value of housing services that owner-occupiers implicitly rent out to themselves. Of course, both landlords and owner-occupiers may receive real capital gains.

The price of housing services to an owner is measured by the "user cost" of housing. This is the price an owner must pay to receive a unit of housing service by owning a unit of housing stock. The notion of user cost is developed in Chapter 5. Here, abstracting from numerous complications, such as householder's gearing, inflation, tax, and depreciation, the user cost of housing (UC) may be expressed simply:

$$UC = PH.r + M - dPH \tag{1.2}$$

where r stands for the interest rate, M for maintenance expenditures, and dPH for the change in house prices.

In principle, UC includes both the current costs and investment benefits of housing. This is critical because both affect the demand for housing and hence house prices.

Locational Attributes

Locational attributes include access to employment, urban facilities, neighbourhood or local environmmental attributes, and local public services and taxes.

Local house prices generally rise (fall) with better (worse) access and environmental attributes. Relationships between house prices and local public services are more complex because they depend on whether better services are offset by higher local taxes.

Typically models of urban areas, designed within a neo-classical framework, are used to analyse the relationships between housing prices and accessibility. Utility-maximising households jointly purchase housing services and access (almost invariably to the central business district, [CBD]) and trade-off housing, commuting costs and purchases of other goods subject to a budget constraint. Housing prices are shown to decline, usually at a decreasing rate, with distance to the CBD. (See Chapter 6).

The effects of environmental and fiscal attributes on house prices are generally examined using hedonic price techniques (e.g. Nelson, 1982; Oates, 1969). These techniques provide estimates of the implicit prices of specific attributes. The implicit prices may, in turn, be explained by the demand and supply for the attributes (see Goodman, 1989), but to date there has been little detailed research on these relationships.

Social Importance

Like many other governments, Australian governments have long considered the provision of housing at "affordable prices" to be an important social objective.

To achieve this objective, Australian governments have used many policy instruments. These include the regulation of housing mortgage rates, support for first home buyers, the non-taxation of imputed rents or capital gains on owner-occupied housing, rent controls, and the supply of public housing.

Each of these instruments may affect house prices. However, paradoxically, some of them (e.g. those that reduce the user cost of housing) may increase house prices.

Some Concluding Comments

These introductory observations indicate the complexity of the housing market and the variety of issues to be considered in explaining house prices.

Although economic theory can proceed where necessary by assuming the existence of a standard unit of housing service, recognition of the heterogeneity of houses is fundamental to much empirical analysis of house prices, especially cross-section analysis.

From a practical point of view, it should be noted here that in Australia dwellings are usually divided into (i) "houses" which include semi-detached and terrace houses as well as detached houses and (ii) "flats" which include villas and town houses. This thesis deals mainly with house prices, with houses as defined above.

The durability of houses means that house prices depend on both the consumption values of present housing services and on investment values.

Locational attributes are more important for housing than for any other commodity and are critical to explanations of the distribution of house prices.

Finally, because of the social importance of housing, house prices are likely to be determined by government policies, as well as by market forces.

ENDNOTES

(1) Many commentators have pointed out these housing characteristics. In this chapter, I have drawn on some comments by Smith, Rosen and Fallis (1988).

(2) Straszheim (1973) showed that households do sometimes pay different prices for similar housing services. He argued that this demonstrated the existence of separate housing sub-markets. For further discussion of this point, see Chapter 6.

2 AVERAGE HOUSE PRICES IN SYDNEY, MELBOURNE AND ADELAIDE: FROM ABOUT 1970

2.1 INTRODUCTION

This chapter describes the main trends in average house prices in Sydney, Melbourne and Adelaide in the 1970s and 1980s (with some earlier data for Sydney and Melbourne).

Section 2.2 discusses data sources and house price indices. Section 2.3 describes average house prices, and short and long-run changes in house prices in the three cities. The following section assesses the impact of changes in house quality on house prices. To provide additional perspectives, Section 2.5 provides data on flat prices and the prices of new houses. It also provides some international comparisons of house prices. A final section summarises the main conclusions.

2.2 HOUSE PRICE DATA SOURCES AND INDICES

Data sources and the quality of house price data vary between Australian states.

For Melbourne, I draw mainly on data from the Victorian Office of the Valuer-General (VIC-VG). The VIC-VG has collected data on all property sales in Melbourne since 1970; it has published estimated mean house prices since 1970 and median house prices since 1974. It has also published mean or median house prices for each local government area (LGA) from 1972 to 1980 and both mean and median LGA house prices since 1980.

For Adelaide, I draw mainly on the South Australian Office of the Valuer-General (SA-VG). The SA-VG has collected data on all property sales in Adelaide since 1972; it has published estimated mean house prices since 1972 and median house prices since 1985. It can also provide reasonably accurate mean LGA house prices since about 1976 and median LGA house prices since 1985.

These official price series have the advantage that they are based on comprehensive sale records. Few, if any, house price series in other countries have this feature. However, the series do not provide true price indices in the sense of comparing like with like. They are not based on constant house locations, types, size or quality. The following section and Annex 2 discuss this point further.[1]

By contrast, although the New South Wales Department of the Valuer-General (NSW-VG) has recorded all property transactions in Sydney for many years, it has never estimated average metropolitan or LGA house prices. The Australian Bureau of Statistics (ABS) drew on the NSW-VG's data to estimate mean house prices for Sydney and all Sydney LGAs from September quarter 1976 to June quarter 1979 but then stopped this work (see ABS, Cat.8701.1).

Although other organisations have estimated average house prices in Sydney, these estimates have limitations (see below). I considered it necesary therefore to develop a new house price series.[2] My objectives were to obtain good quarterly estimates of average house prices for the whole of Sydney and annual estimates for each LGA from 1979 to 1989. These results could be spliced on to the ABS's 1976-79 estimates and to Bis-Shrapnel's metropolitan estimates for earlier years (see below).

Because the NSW-VG's property sale records for Sydney were available only on microfiche or hard copy, the data had to be sampled and transferred manually on to my computer. I recorded one in twelve sales subject to a minimum of 30 per LGA per year. This minimum was designed to ensure a representative average figure for each LGA - it meant however that proportionately more sales were sampled in small LGAs. The sample size for Sydney averaged 2957 per annum. Full sample details are given in Applied Economics (AE, 1991, Appendix B).[3]

To develop a house price index for Sydney, I weighted the median house price in each LGA according to the LGA's proportion of total Sydney houses at 30 June 1986 (with the weights adding up to one). This procedure holds the geographical composition of houses constant over the study period. Given the changes in the distribution of sales over time and the sample bias toward sales in smaller LGAs, it would have been inappropriate to calculate an average price from the whole sample.

In addition to these basic data sources, three supplementary sources are quoted at some point below.[4]

The Real Estate Institute of Australia (REIA) has estimated median house prices for each quarter in each capital city in Australia since about 1977. These estimates are based on sales reported by major members of the Institute. Although the sales represent one-fifth of the market, they are not a random selection and under-represent outlying areas. The REIA's estimated median house prices are usually about five per cent higher than estimates based on the VGs' data, but the estimated rates of change in prices are similar (see AE, 1991, Appendix B).

Drawing on its housing loans, the Commonwealth Bank of Australia (CBA) has published quarterly estimates of median house prices since 1979. These loans are said to be evenly spread over the metropolitan areas, but some bias appears unavoidable. The CBA's estimates of median house prices are higher than the SA-VG's in Adelaide but lower then the VIC-VG's in Melbourne. However, the CBA is the main source of data on new house prices.

Thirdly, the consulting company Bis-Shrapnel Pty. Ltd. (BS) has estimated median house prices in Sydney and Melbourne since the early 1960s, based on sales reported in the major metropolitan papers, the Sydney Morning Herald and the Melbourne Age respectively. For Melbourne, the BS estimates are significantly higher than the VIC-VG's; but the differences between the BS and NSW-VG based estimates for Sydney are smaller. However, the rates of change in house prices in the BS and VG-based series are similar. To obtain data series for Sydney and Melbourne back to 1965, I spliced the BS estimates on to the respective VG-based estimates.

Finally, it should be noted that since the June quarter, 1986, the ABS has estimated quarterly house price indices for the eight Australian capital cities. To allow for compositional changes in housing types, the ABS stratifies the sample sales recorded by physical characteristics and geographical areas and derives the index by weighting the price movements in particular strata. Since the ABS attempts to correct for quality changes, the estimated indices should rise more slowly than comparable indices. As shown in AE (1991, Appendix B), this happens.

2.3 AVERAGE HOUSE PRICES

Introduction

Average house prices and real house price indices for each city from 1970 to 1989 are shown in Table 2.1. The consumer price index was used to convert nominal house prices to real ones.

Figure 2.1 graphs nominal house prices and Figure 2.2 shows real house price indices. Note, these figures show Sydney and Melbourne house prices back to 1965.

TABLE 21: AVERAGE HOUSE PRICES IN ADELAIDE, MELBOURNE AND SYDNEY, 1970-1989

	HOUSE PRICES						REAL HOUSE PRICES INDICES					
	Adelaide		Melbourne		Sydney		Adelaide		Melbourne		Sydney	
	Mean (a)	Median (b)	Mean (c)	Median (c)	Mean (d)	Median (e)	Mean	Median	Mean	Median	Mean	Median
1970	na	na	13875	na	na	18100	na	na	69.6	na	na	81.6
1971	na	na	14525	na	na	20500	na	na	70.6	na	na	89.6
1972	14375	na	16275	na	na	23000	75.2	na	74.2	na	na	94.2
1973	17675	na	21471	na	na	26500	84.3	na	89.3	na	na	99.0
1974	24115	22700	27675	25450	na	30800	100.0	100.0	100.0	100.0	na	100.0
1975	28440	26750	31541	28700	na	33200	102.6	102.5	99.1	98.1	na	93.7
1976	32376	31250	37250	32875	38300	35800	102.8	105.4	103.5	98.9	na	89.0
1977	35421	32750	41281	37000	40700	38100	100.2	98.4	101.7	99.2	na	84.4
1978	35979	32850	42337	37625	45000	42100	94.2	91.4	96.6	93.3	na	86.3
1979	36672	33500	43079	36955	na	50700	88.1	85.5	90.2	84.1	na	95.4
1980	39475	36000	47278	38000	na	68900	86.1	83.4	89.9	78.5	na	117.7
1981	42803	39100	53821	44000	na	77800	85.1	82.6	93.2	82.9	na	121.1
1982	46927	42850	55282	46750	na	80000	84.0	81.5	86.2	79.3	na	112.1
1983	52505	47950	61238	52500	na	82200	84.8	82.7	86.7	80.8	na	104.5
1984	67060	61250	75416	65000	na	85900	104.8	101.7	102.7	96.2	na	105.1
1985	79224	72200	87945	75000	na	91900	116.0	112.3	112.2	104.0	na	105.3
1986	83437	73500	100252	82125	na	98400	112.1	104.9	117.3	104.5	na	103.5
1987	85295	74500	113949	89000	na	120200	105.5	97.9	122.8	104.3	na	116.4
1988	94264	80400	139352	109000	na	174300	108.9	98.7	140.3	119.3	na	157.7
1989	108711	90600	169414	132625	na	195300	116.8	103.4	158.6	135.0	na	164.3

(a) Valuer-General's Office, South Australia.
(b) Valuer-General's Office, SA., 1985-89; Consultants' estimates, 1974-84.
(c) Officer of the Valuer-General, Victoria.
(d) Valuer-General's Department, NSW.
(e) AE, 1977-89, using VG data; AE, 1970-77 using Bis-Shrapnel data; see discussion in Chapter 2.
Sources: As above.

FIGURE 2.1 MEDIAN HOUSE PRICES ($'000)
ADELAIDE, MELBOURNE & SYDNEY

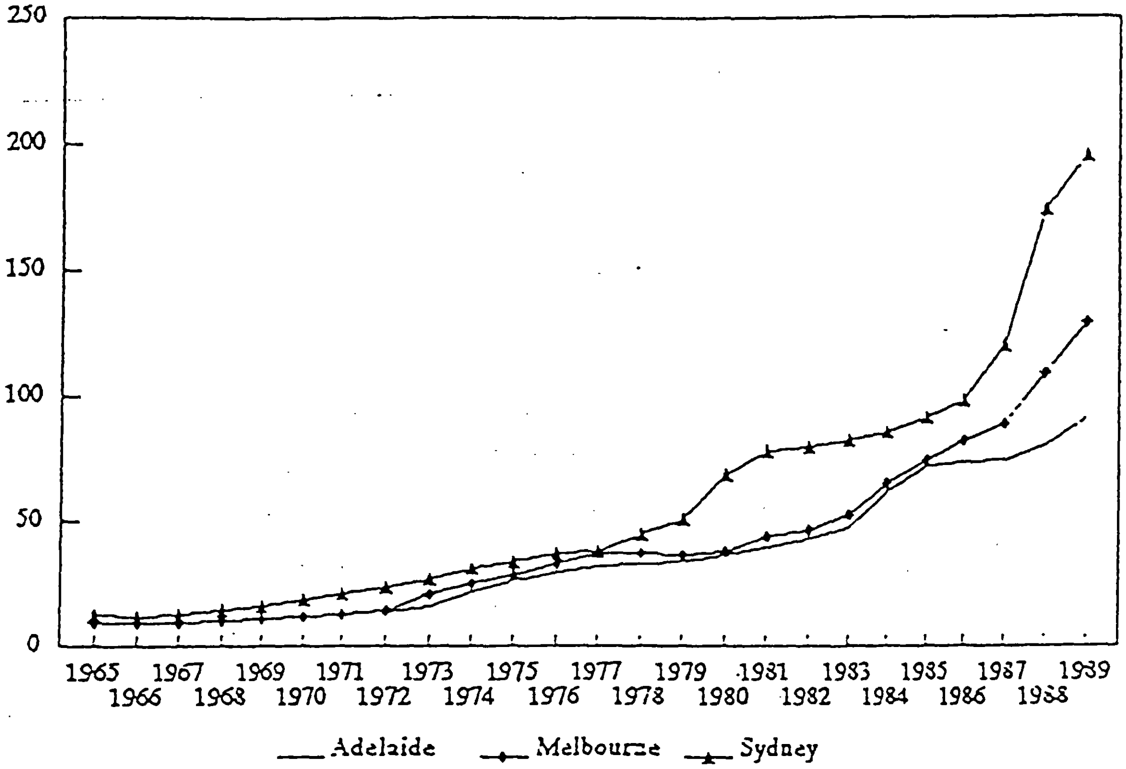
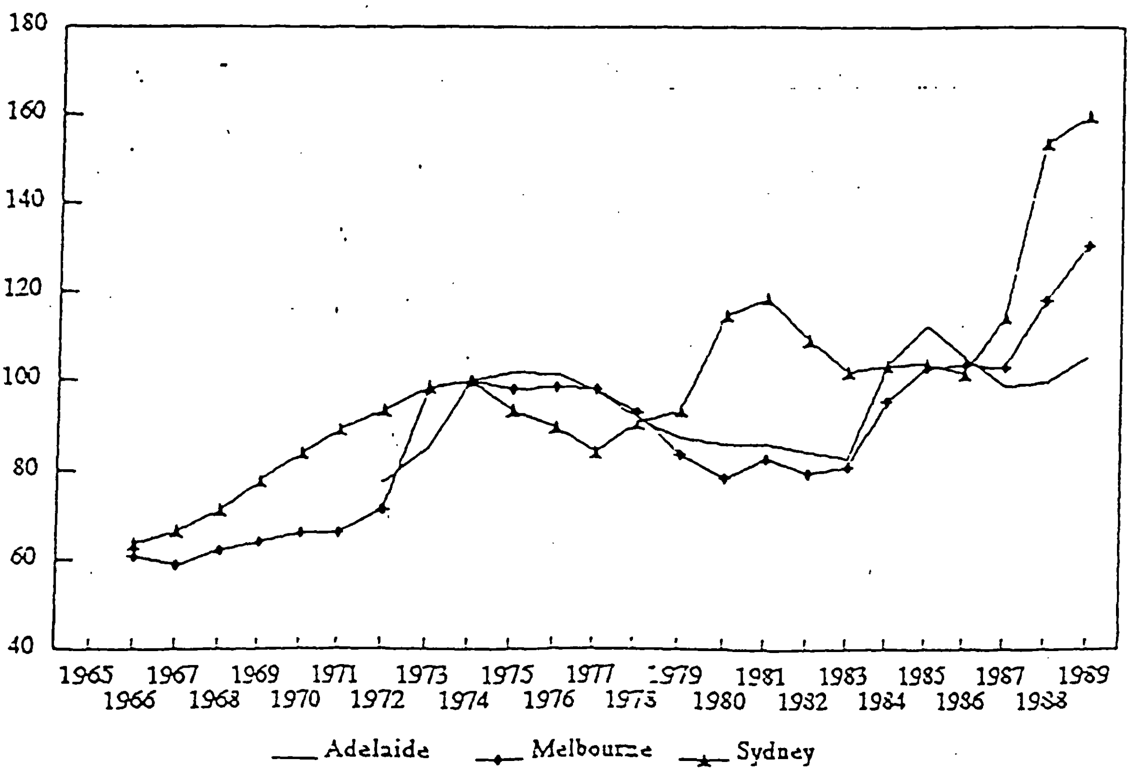


FIGURE 2.2 REAL MEDIAN HOUSE PRICE INDICES (1974 = 100)



As noted above, the estimated average prices are based on actual sales and are not constant quality series. In principle this could affect the Melbourne and Adelaide results where fringe houses are likely to be over-represented (as new houses are mainly produced on the fringe) and where the centres of gravity of sales moved progressively away from the CBD (cf. my Sydney index holds location weights constant). Consequently, both average house prices, and changes in prices, in Melbourne and Adelaide may be understated. However, alternative estimates of average prices based on constant location weights, shown in Annex 2, indicate that the sample biases are slight.

Another statistical issue is the relationship between mean and median house prices. Throughout the period under study, mean house prices exceeded median prices in each city. Also mean house prices rose faster.

In Melbourne, the difference between mean and median house prices rose steadily from about nine per cent in the mid-1970s to over 25 per cent in the late 1980s. In Adelaide, mean house prices exceeded median prices by about 10 per cent in the mid-1980s and by 20 per cent by the late 1980s. Similar data are not available for Sydney. But the relatively skewed distribution of house prices in Sydney, with some very high priced suburbs, implies greater differences between the mean and median house prices.

In this thesis I refer to median house prices (when they are available) as these are not influenced by extreme values.

Table 2.2 summarises the differences (in index form) in median house prices between the cities based on the indices shown in Table 2.1. On average the Sydney median price was 38 per cent higher than the Melbourne price, which was in turn 12 per cent higher than the Adelaide price.

TABLE 2.2 MEDIAN HOUSE PRICE COMPARISONS

Years	Sydney	Melbourne	Adelaide
1974-79	116	100	91
1980-84	164	100	92
1985-89	137	100	82
1974-89	138	100	89

Source: Estimated from Table 2.1.

Short-Run Changes in Real House Prices

Since 1970 real house prices have moved in cycles, accentuated by particularly sharp movements in some years.

Three clear cycles can be identified. In each city, real house prices rose in the early 1970s, fell in the second half of the 1970s, and rose in the second half of the 1980s.

In 1990 and 1991, real house prices have fallen sharply in each city, but these last movements are beyond the scope of the thesis.

In the early 1980s house price patterns were less clear. Between 1979 and 1981, real house prices in Sydney rose by over 35 per cent. They then fell to a low in 1986. On the other hand, real house prices in Melbourne and Adelaide were flat in the early 1980s before rising by about 30 per cent in 1984 and 1985.

As can be seen, until recently house price changes in Adelaide and Melbourne were similar. On the other hand, there is casual evidence that Sydney house prices led those in the other two cities (a point taken up in Chapter 7).

Interestingly, as is common experience in other countries at least before 1990, nominal house prices rarely fell (see Ermisch, 1990).

Nevertheless, real prices were volatile. In several years real prices rose by over 10 per cent (Sydney, 1979, 1980, 1987 and 1988; Melbourne 1973, 1974, 1984, 1988 and 1989; Adelaide, 1973, 1974, 1984 and 1985). Indeed, in all but one case there were two successive years of 10 per cent plus increases. Case and Shiller (1989) also found that rates of change in real (US) house prices in one year tended to be repeated in the next - though at a lower rate.

Between 1971 and 1989,[5] the average annual change in real house prices was 7.6 per cent per annum in Sydney, 6.9 per cent in Melbourne, and 6.7 per cent in Adelaide.

Long-Run Changes in Real House Prices

Given the volatility of house prices, generalisations about long-run changes (especially those based on the evidence of single years) must be made cautiously.

One way to combat bias due to arbitrary date selection is to compare real house prices at similar points in the house price cycle, e.g. at low points like 1966 and 1984 or high points like 1974 and 1989. Another approach is to take averages over full cycles or periods that include full cycles, as do the decades of the 1970s and 1980s.

Table 2.3 shows that, on a peak to peak or trough to trough basis, real house prices (not adjusted for quality changes) increased by slightly over three per cent per annum in Sydney and by about two per cent per annum in Melbourne. There was little change in real Adelaide prices.

Using comparisons over the last two decades, real annual house price increases were just under three per cent in Sydney and just over one per cent in Melbourne.

TABLE 2.3 LONG-RUN CHANGES IN REAL HOUSE PRICES (a)

	Sydney	Melbourne	Adelaide
High points 1974 to 1989			
Total change (%)	64.3	35.0	3.4
Per annum change (%)	3.4	2.0	0.2
Low points 1966 to 1983			
Total change (%)	68.5	34.7	na
Per annum change (%)	3.1	1.8	na
Average index: 1970s	91.3	87.7	92.8
Average index: 1980s	120.8	98.5	94.9
Total change (%)	32.3	12.3	2.3
Per annum change (%) (b)	2.8	1.2	0.2

(a) Based on median prices where available.
(b) Based on compound annual change over 10 year period.

Sources: Estimated from Table 2.1 and Bis-Shrapnel data.

2.4 CHANGES IN HOUSING QUALITY

The relationship between house prices and the quality of housing is a complex one, which has not been examined in detail in Australia. This is not surprising given the difficulty of measuring units of housing services (which include access and environmental attributes as well as land and housing services). However some relevant observations may be made.

In practice, housing quality is normally related to the space per house or the quality of that space.[6] Housing quality, thus perceived, may rise with new residential construction or alterations and additions. However, if not adequately maintained, established housing may depreciate.

The average floor area of private new houses in Australia rose from 130 m² in the early 1970s to 180 m² in the mid-1980s, an increase in size of just over two per cent per annum.

However, although new houses usually have a high structural quality and finish compared with established housing, they often suffer from poor access to employment and amenities. As shown in Section 2.5, typical new house prices in Australian cities are usually only marginally higher than average established house prices. Thus, at any point in time, new house prices have little impact on average house prices.

Unfortunately, official data on alterations and additions underestimate the real value of such work partly because "improvers" have an incentive to understate the value of their work to local councils and partly because low cost work does not require planning approval. Seek (1981) estimated that official statistics underestimated the total value of alterations and additions by over 50 per cent.

Allowing for this understatement, the value of alterations and additions in Australia in the 1980s averaged $4-5 billion per annum (in 1989 dollars), compared with the total value of the housing stock of about $650 billion (in 1989). i.e. Expenditure on alterations and additions added about 0.7 per cent per annum to the value of the housing stock in Australia.

Data on capital housing expenditures, other than mortgage and interest payments, are also available from the Household Expenditure Survey (ABS, 1984). These expenditures include additions and extensions, internal renovations, in-ground swimming pools, outside building and landscaping. In 1984, these expenditures (which make no allowance for unpaid home labour) amounted to $18 per household per week. This was in addition to an average weekly expenditure on home repairs and maintenance of $5.82 per household.

Allowing for inflation and increases in earnings since 1984, average household capital expenditure on housing (other than payments for owner-occupied mortgages and ordinary repairs and maintenance) was about $30 per household per week (about $1500 per annum) in 1989 and average expenditure on repairs and maintenance about $10 per week (about $500 per annum).

This average annual capital expenditure per household amounted to about 1.25 per cent of the average house price in Australia. Of course, allowance would need to be made for variations in expenditures and house prices in different areas, as well as for some depreciation of houses.

The above broad-brush analysis suggests that an increase in housing quality in Australia in the order of one per cent per annum is likely. This is consistent with overseas findings. Hendershott (1980) suggested that the quality of the housing stock in the US rose by around one per cent per annum.[7] Spencer (1987) reached a similar conclusion for the U.K. However, Holmans (1990) argues that the annual increase in quality in the UK was only about 0.5 per cent in the 1980s and lower before that.

2.5 PRICES OF NEW HOUSES AND ESTABLISHED FLATS IN AUSTRALIA AND HOUSE PRICES OVERSEAS

Prices of New Houses

Table 2.4 provides some summary data on new house prices. Fuller details are given in AE (1991, Appendix B).

Two important points should be noted.

(i) From 1984 to 1989, the period for which comparable (CBA) data are available, median new house prices exceeded median established house prices each year in Melbourne and each year to 1987 in Adelaide and Sydney (i.e. for 14 out of the 18 observations).

(ii) In these six years, established house prices rose by 117 per cent in Sydney, 109 per cent in Melbourne, and 46 per cent in Adelaide, compared with a 45 per cent increase in the CPI.

On the other hand, new house prices rose by 94 per cent in Sydney, 109 per cent in Melbourne, and only 25 per cent in Adelaide. Evidently, in Sydney and Melbourne, new house prices were influenced more strongly by established house prices (by the demand for housing) than by increases in supply costs. However in Adelaide, new house prices rose much more slowly. This reflected the large supply of actual and potential new houses and competition from new low-cost public housing in Adelaide.

TABLE 2.4 MEDIAN ESTABLISHED AND NEW HOUSE PRICES

	Adelaide			Melbourne			Sydney		
	New	Est.	% diff.	New	Est.	% diff.	New	Est.	% diff.
1984	68430	67000	+2.1	68160	65400	+4.2	87350	81875	+6.7
1989	85225	97562	-12.6	142650	135250	+5.5	169225	177425	-4.6
Inc.%	24.6	45.6		109.3	106.8		93.4	116.7	

Source: Commonwealth Bank of Australia.

Prices of Flats

Table 2.5 provides a summary of average flat prices. Some interesting results may be noted.

(i) Mean flat prices were higher, and rose faster, than median prices.

(ii) Short-run changes in real flat prices followed similar paths to changes in real house prices.

(iii) With a base year of 1974, price increases for flats were highest in Sydney, followed by Melbourne and then Adelaide (where real prices fell).

TABLE 2.5 FLAT PRICES IN ADELAIDE, MELBOURNE AND SYDNEY

	FLAT PRICES						REAL FLAT PRICES INDICES					
	Adelaide		Melbourne		Sydney		Adelaide		Melbourne		Sydney	
	Mean (a)	Median (b)	Mean (c)	Median (c)	Mean	Median (d)	Mean	Median	Mean	Median	Mean	Median
1974	23113	22000	25341	23300	na	25200	100.0	100.0	100.0	100.0	na	100.0
1975	24345	23150	28435	25875	na	26700	91.6	91.5	97.6	96.6	na	92.1
1976	29599	28000	33521	29625	na	28700	98.1	97.5	101.3	97.4	na	87.2
1977	31537	29650	36641	32050	na	30900	93.1	91.9	98.6	93.8	na	83.6
1978	30750	28750	35860	33050	na	33300	84.0	82.5	89.3	89.5	na	83.4
1979	31979	29600	36994	31500	na	40400	80.2	78.0	84.5	78.3	na	92.9
1980	31997	29600	41435	33000	na	56500	72.8	70.8	86.0	74.5	na	117.9
1981	34334	31750	42855	36500	na	67300	71.2	69.2	81.1	75.1	na	128.0
1982	38887	36000	45362	38500	na	70200	72.6	70.6	77.3	71.3	na	120.2
1983	45213	41800	49096	42500	na	66000	76.6	74.4	75.9	71.4	na	102.6
1984	58238	53850	58581	52500	na	67800	94.9	92.2	87.1	84.9	na	101.4
1985	66352	61600	68207	60000	na	70500	101.3	98.8	95.0	90.9	na	98.8
1986	70338	65400	78349	66750	na	72300	98.6	96.3	100.2	92.8	na	92.9
1987	68276	64200	86229	72250	na	86200	88.1	87.1	101.5	92.5	na	102.0
1988	73546	67000	107774	85000	na	118400	88.7	84.9	118.5	101.7	na	130.9
1989	80611	74000	127484	104500	na	141300	90.4	87.1	130.3	116.2	na	145.3

(a) Valuer-General's Office, South Australia.
(b) Valuer-General's Office, SA., 1985-89; Consultants' estimates, 1974-84
(c) Officer of the Valuer-General, Victoria.
(d) AE . estimates 1979-88, based on VG data; spliced on to BS data 1974-78, REIA data 1989.
Sources: As above.

(iv) However, between 1974 and 1989 price increases for flats were significantly lower than for houses. In 1989 the real flat price index was 11.6 per cent lower than the real house price index in Sydney, 14.0 per cent lower in Melbourne, and 15.8 per cent lower in Adelaide. This means that over the 15 year period, flat prices rose by approximately one per cent less per annum than house prices.

A detailed explanation of the relative changes in house and flat prices (for example, in terms of demand and supply equations for houses and flats) is beyond the scope of this study. However, two explanatory observations may be made.

The relative price effect may be explained partly by the higher capital-land ratios for flats compared with houses. Capital costs (plant and equipment, construction labour, and building materials) rose by less than land prices, because the capital factors were in elastic supply. Second, quality changes (alterations and additions) are generally greater for (established) houses than for flats.

A Note on International House Prices

Few countries have compiled reliable data on average house prices since 1970. For example, according to Holmans (1990), neither France nor Germany has these data and the Netherlands series has been discontinued.

Table 2.6 shows indices of real average house prices in the UK, the US and Italy since 1970 (in local currencies). Although these are national house price series, containing considerable regional variations (especially in the US), the results show interesting parallels with Australian house prices.

TABLE 2.6 REAL INTERNATIONAL HOUSE PRICE INDICES (1974 = 100)

	UK (a)	US (b)	ITALY (c)	SYDNEY (d)
1970	60	87	100	82
1971	68	89	99	90
1972	87	90	96	94
1973	109	96	89	99
1974	100	100	100	100
1975	85	99	134	94
1976	79	98	124	89
1977	73	105	121	84
1978	78	111	117	86
1979	91	106	112	95
1980	93	119	131	118
1981	87	112	156	121
1982	81	104	135	112
1983	88	101	116	105
1984	92	101	108	105
1985	94	101	102	105
1986	104	105	99	104
1987	116	109	99	116
1988	139	108	100	158
1989	na	na	107	164

(a) This series represents a constant quality mix of dwellings.
(b) Index for median second-hand house prices deflated by consumer price index.
(c) House prices from Censis research organisation - reliability not known.
(d) Median house price index from Table 2.1.

Sources: Author's estimates based on Holmans (1990) and Table 2.1 above.

In all three countries, house prices rose sharply in the first half of the 1970s; were then flat or declined for a few years; rose sharply around 1979-80; tended to decline in the 1980s; and then rose at the end of the 1980s. The UK pattern was especially similar to that in Sydney (the most international of the Australian cities).

The similarities between countries suggest that international factors, most likely world-wide credit conditions and interest rates, influence house prices. Possibly, migration into developed economies could also be a factor. However, examination of these hypotheses has been beyond the scope of this thesis.

2.6 MAIN CONCLUSIONS

In the 1980s, median house prices averaged about one-third more in Sydney than in Melbourne and were about 15 per cent higher in Melbourne than in Adelaide. However, these differentials are increasing.

In the 1970s and 1980s, the average real increase in median house prices was slightly under three per cent per annum in Sydney and about one and a half per cent per annum in Melbourne. Over the period, real house prices were about constant in Adelaide.

Mean house prices have risen nearly one per cent per annum faster than median prices, which is indicative of higher rates of increase for high priced houses.

However, of the real increases in house prices, about one per cent per annum appears attributable to improvements in housing quality.

Also, because the trade-weighted value of the A$ has fallen by about two per cent per annum since the early 1970s, the real (quality adjusted) price of housing, even in Sydney, has not risen for foreigners.

House prices generally moved in cycles with real prices in each city rising in the first half of the 1970s and falling in the second half. Although house price patterns diverged in the early 1980s, they generally rose in the second half of the 1980s.

Until the late 1980s, Melbourne and Adelaide prices moved closely together. It appears that both price series tended to follow Sydney.

Although nominal house prices rarely fell, real house prices were volatile with annual changes in each city averaging about seven per cent. On several occasions, double digit increases in real house prices occurred in two successive years.

Until recently, average prices of new houses in each city were higher than average prices of established houses. Recent evidence suggests that new house prices are determined in the short run by established house prices rather than by production costs.

Also, prices of flats generally followed house price patterns. However, real flat prices rose by approximately one per cent per annum less than real house prices due in part to higher capital/land ratios and fewer improvements.

Finally it was observed that changes in Australian real house prices followed similar patterns to those overseas, notably in the UK.

ENDNOTES

(1) The UK index of house prices uses weights to standardise for location, type and size, but not for quality. Also, it is not based on comprehensive sales records. See Holmans, (1990).

(2) The research for a new house price series for Sydney was funded by the Commonwealth-State housing cost study (see the Preface).

(3) I was the author of over 90 per cent of Applied Economics (1991), see Appendix A of this thesis.

(4) Another source of estimated house prices in Sydney is the consulting company, Property Building and Advisory Services Pty. Ltd.

(5) The Adelaide data starts in 1973.

(6) Actually, in relation to individual welfare, it would be more appropriate to think in terms of house space per person than space per house. It is possible for house size to fall while house space per person rises.

(7) Professor Hendershott has informed the writer that his recent research finds that house quality improvements could account for real price increases of nearly two per cent per annum in the US.

ANNEX 2: ALTERNATIVE ESTIMATES OF AVERAGE HOUSE PRICES IN MELBOURNE AND ADELAIDE

This annex investigates whether holding location weights constant (based on the number of houses in each LGA in 1986) produces significantly different estimates of average house prices in Melbourne and Adelaide. Table 2A.1 shows estimated average house prices using 1986 housing weights.

It turns out that the estimated mean house prices in both cities are remarkably similar in Tables 2.1 and 2A.1.

Also, the estimated Melbourne median prices from 1977 to 1986 are broadly similar in the two tables, although they are slightly higher in Table 2A.1 and the differences increase over time. This is consistent with our expectations that failure to weight housing would result in an underestimate of average prices and that failure to hold locations constant would result in an underestimate of the true price increase.

It is more difficult to explain the large differences between estimated median house prices in the two tables between 1987 and 1989 in Melbourne and in 1989 in Adelaide, especially given the similar results for estimated mean house prices.

These inconsistencies (between the mean and median comparisons) and the implications for alternative house price indices require further investigation.

TABLE 2A.1 AVERAGE HOUSE PRICES BASED ON 1986 HOUSING WEIGHTS

	MELBOURNE		ADELAIDE	
	Mean	Median	Mean	Median
1975	31243	na	na	na
1976	37167	na	na	na
1977	na	37816	35368	na
1978	na	38252	35679	na
1979	na	38283	36212	na
1980	na	40632	38736	na
1981	52058	46019	42083	na
1982	54512	48555	46215	na
1983	60025	53859	51445	na
1984	74651	67350	67148	na
1985	87409	78599	79251	nra
1986	99498	86931	83207	nra
1987	112273	96463	84706	nra
1988	141981	121606	95952	nra
1989	170906	145997	109178	99268

Notes: "na" indicates some base LGA data not available.
"nra" indicates LGA data not readily available.

Source: Author's estimates based on VG data.

3 THE DISTRIBUTION OF HOUSE PRICES IN SYDNEY, MELBOURNE AND ADELAIDE: 1977 TO 1989

3.1 INTRODUCTION

This chapter overviews the distributions of house prices in Sydney, Melbourne and Adelaide.

Section 3.2 provides indicators of the ranges of house prices in each city. The indicators include simple frequency distributions; measures of dispersion; differences between upper and lower quartile prices; and data on house prices in the lowest and highest priced LGAs in each city.

Section 3.3 describes the geographical patterns of house prices in each city. It includes maps of the geographical distributions in 1989 and changes in the distributions between 1977 and 1989. The base year 1977 was chosen because it was the first year for which LGA house price data were available for each city. Detailed data are given in the Annex.

Section 3.4 summarises the key findings.

3.2 INDICATORS OF HOUSE PRICE RANGES

Simple Frequency Distributions

The range of house prices in each city is shown by the simple frequency distributions of house prices by LGA in 1989 shown in Table 3.1. Note, however, that house prices in Sydney and Melbourne were exceptionally high in 1989.

TABLE 3.1 NUMBERS OF LGAS IN MAJOR HOUSE PRICE RANGES IN 1989

Median house prices ($)	Adelaide	Melbourne	Sydney
400,000 +	0	1	4
300-399,000	0	2	5
200-299,000	1	11	13
150-199,000	3	12	9
125-149,000	5	11	4
100-124,000	7	19	8
75-99,000	9	4	0
Under 75,000	5	0	0

Source: See Tables in Annex 3.

More Comprehensive Measures of Dispersion

The Tables in Annex 3 give two measures of the distribution of house prices: standard deviations and standard deviations as a percentage of average prices for all LGAs.

These measures confirm that the range of house prices is greatest in Sydney. In 1989, the standard deviation for median LGA house prices in Sydney was $102,000, compared with $52,000 in Melbourne, and $38,000 in Adelaide. Even allowing for the higher average prices in Sydney (i.e. using the second measure of dispersion), the range was relatively greater in Sydney than in Melbourne or Adelaide.

Differences in Upper and Lower Quartile Prices

Table 3.2 shows indices of upper and lower quartile house prices from 1985 to 1989. As a generalisation, intercity differentials were greater at the higher end of the market.

In the second half of the 1980s, Sydney's upper quartile price averaged 37 per cent more than Melbourne's. The lower quartile price difference averaged 25 per cent.

TABLE 3.2 INDICES OF QUARTILE HOUSE PRICES

	Lower Quartile Indices			Upper Quartile Indices		
	Sydney	Melbourne	Adelaide	Sydney	Melbourne	Adelaide
1985	111	100	96	126	100	95
1986	113	100	90	123	100	84
1987	115	100	84	137	100	77
1988	150	100	74	150	100	67
1989	135	100	67	149	100	71
Average	125	100	82	137	100	79

Source: Real Estate Institute of Australia.

Over the same period, Melbourne's upper quartile price averaged 27 per cent more than Adelaide's. The lower quartile difference averaged 22 per cent.

The Five Highest and Lowest Priced LGAs

Table 3.3 shows indices for average house prices in the five highest and lowest priced LGAs in 1985 and 1989. The results confirm that differentials tend to increase at the high end of the market and reduce at the lower end.

At the high end of the market, Sydney prices were about 50 per cent higher than Melbourne's. Melbourne's were in turn about 40 per cent higher than Adelaide's in 1989 (the difference was much smaller in 1985).

At the low end of the market, Sydney house prices were 12 per cent higher than Melbourne's in 1989 but only four per cent higher in 1985. However, very low priced houses in Adelaide were 30 per cent lower than the lowest priced house in Melbourne in 1989. Even allowing for the high proportion of public housing in Adelaide, this was an exceptionally high differential for this part of the market. The 16 per cent difference in 1985 was more typical.

TABLE 3.3 AVERAGE INDICES FOR FIVE LOWEST AND HIGHEST PRICED LGAS (a)

	INDICES				
	Lowest priced LGAs			Highest priced LGAs	
	1985	1989		1985	1989
Adelaide	84	70	Adelaide	98	62
Melbourne	100	100	Melbourne	100	100
Sydney	104	112	Sydney	154	155

(a) All are median house prices except for Adelaide 1985 which are mean prices.
(b) To prevent a small area distorting the results, Prahran 1 prices are counted as equal to Brighton's.

Sources: See Tables in Annex 3.

3.2 GEOGRAPHICAL PATTERNS IN HOUSE PRICES

The geographical patterns in house prices are illustrated in Figures 3.1 to 3.6. Three of these (3.1, 3.3 and 3.5) show the 1989 patterns. The other three show the rates of change from 1977 to 1989. Note that the price scales used for the legends vary from one city to another.

The figures illustrate the strong positive relationship in each city between house prices and proximity to the CBD. They also show other geographical patterns: e.g. the relatively high prices to the east and south in Adelaide and Melbourne and the north in Sydney and the low prices in the west in Melbourne and Sydney.

There is also a strong relationship between the rates of increase in house prices and proximity to the CBD in each city. However, in Sydney, price increases in the most distant areas were higher than in the adjacent areas closer to the city, possibly reflecting the environmental attractions of the remoter areas. There also appears to be a positive correlation between house prices in 1977 and rates of house price increases between 1977 and 1989.

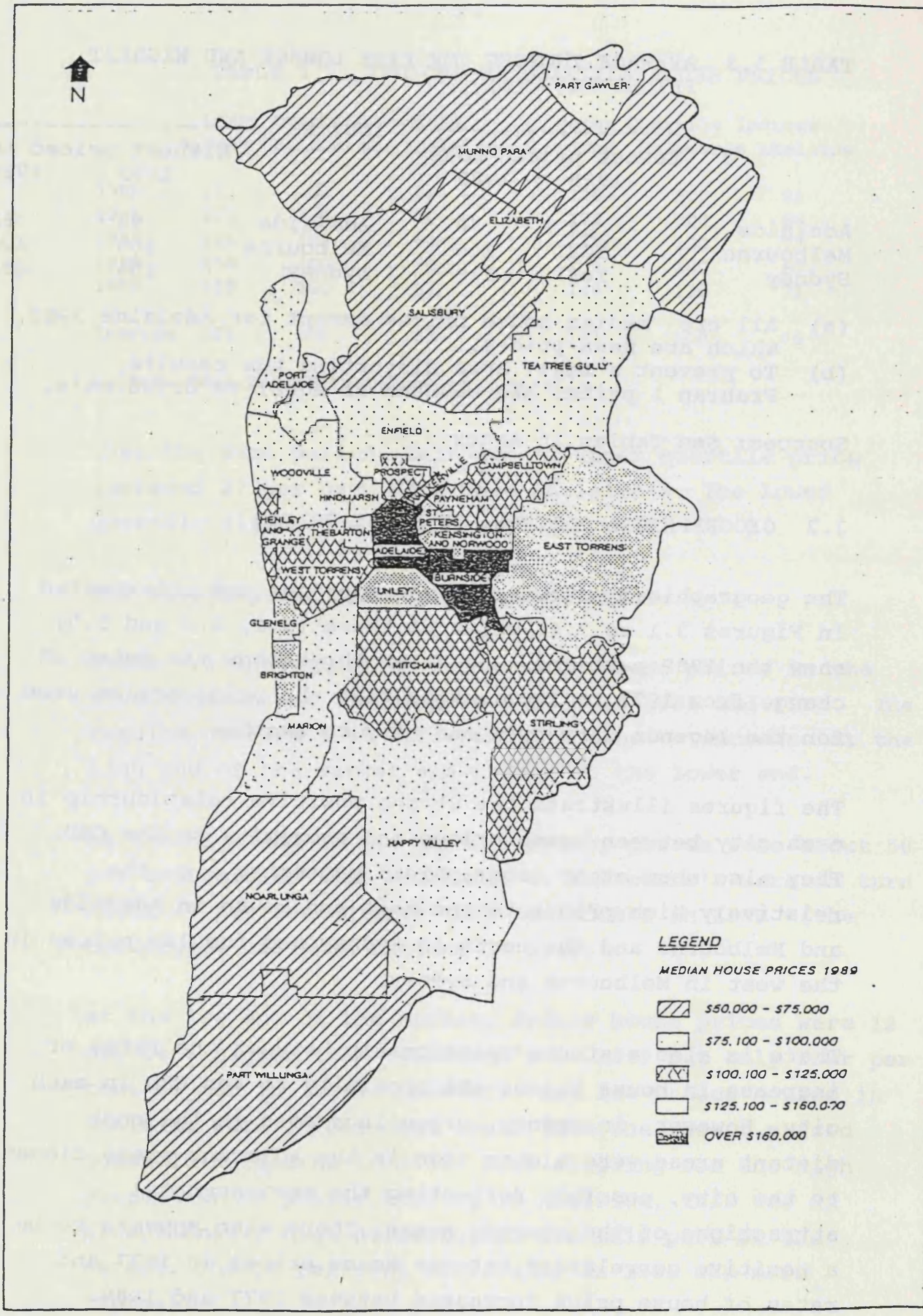


FIGURE 3.1 MEDIAN HOUSE PRICES: ADELAIDE 1989

Source Applied Economics, 1991

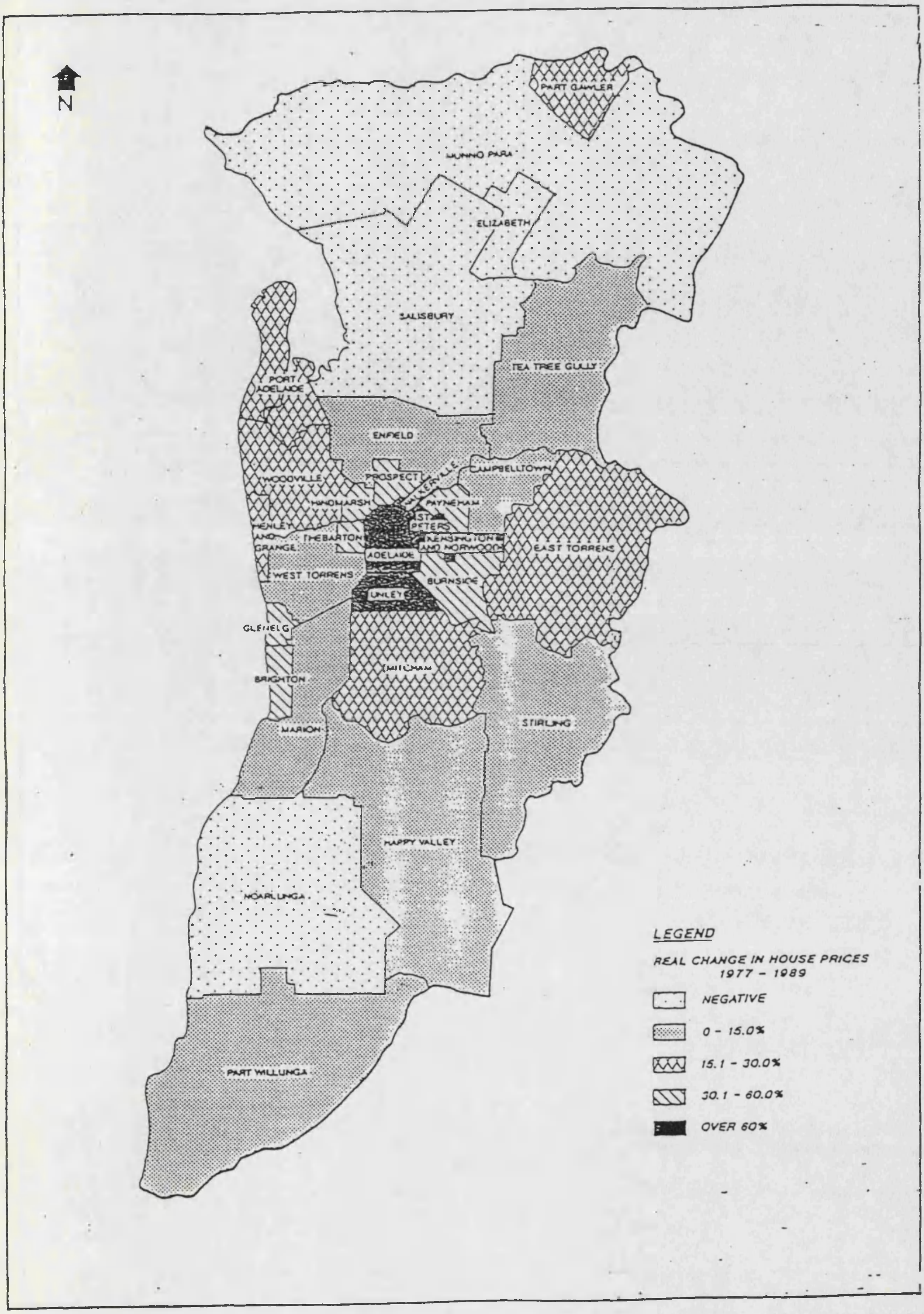


FIGURE 3.2 REAL CHANGES IN HOUSE PRICES: ADELAIDE, 1977-89

Source: Applied Economics, 1991.

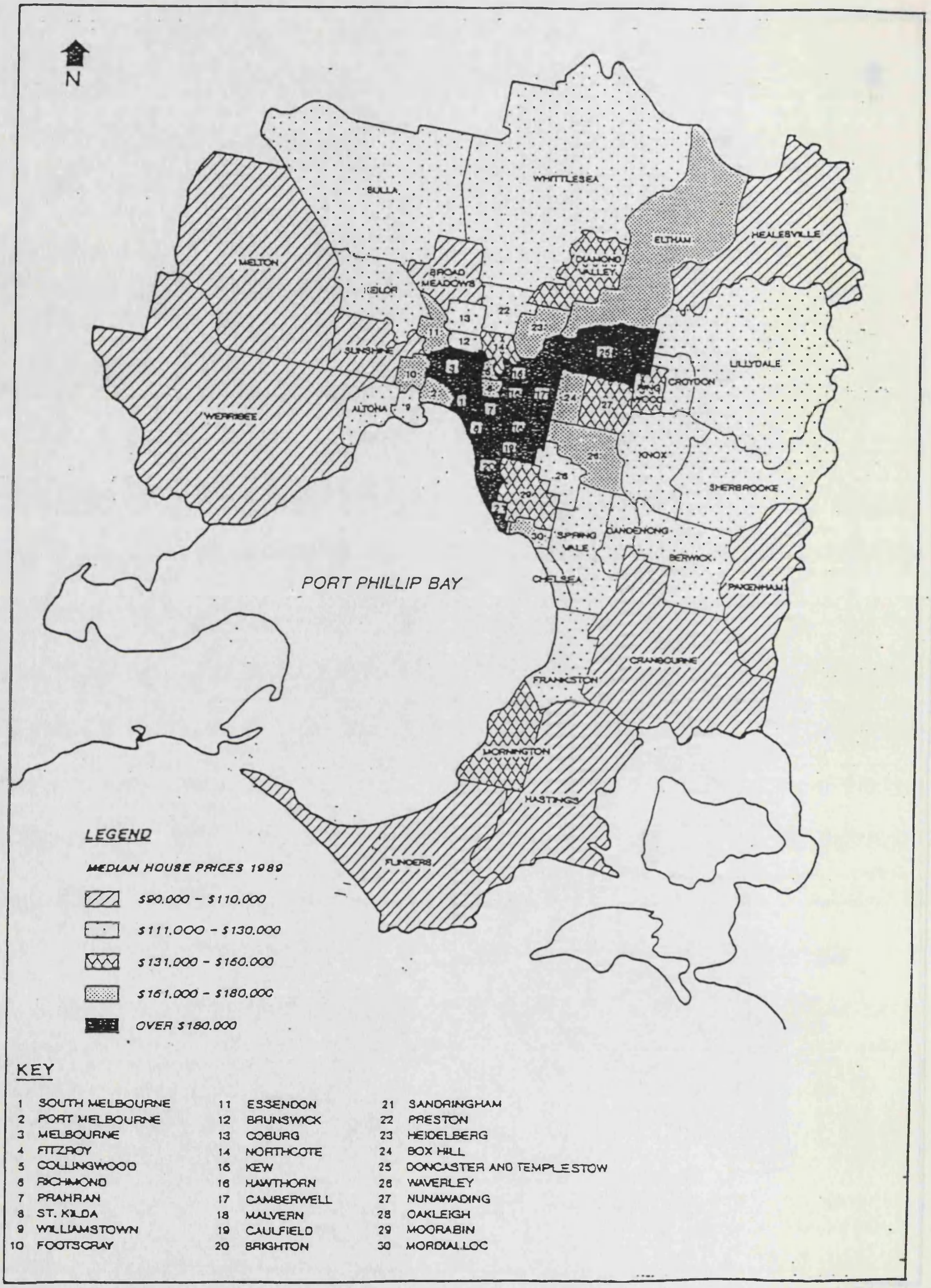


FIGURE 3.3 MEDIAN HOUSE PRICES: MELBOURNE, 1989

Source: Applied Economics, 1991.

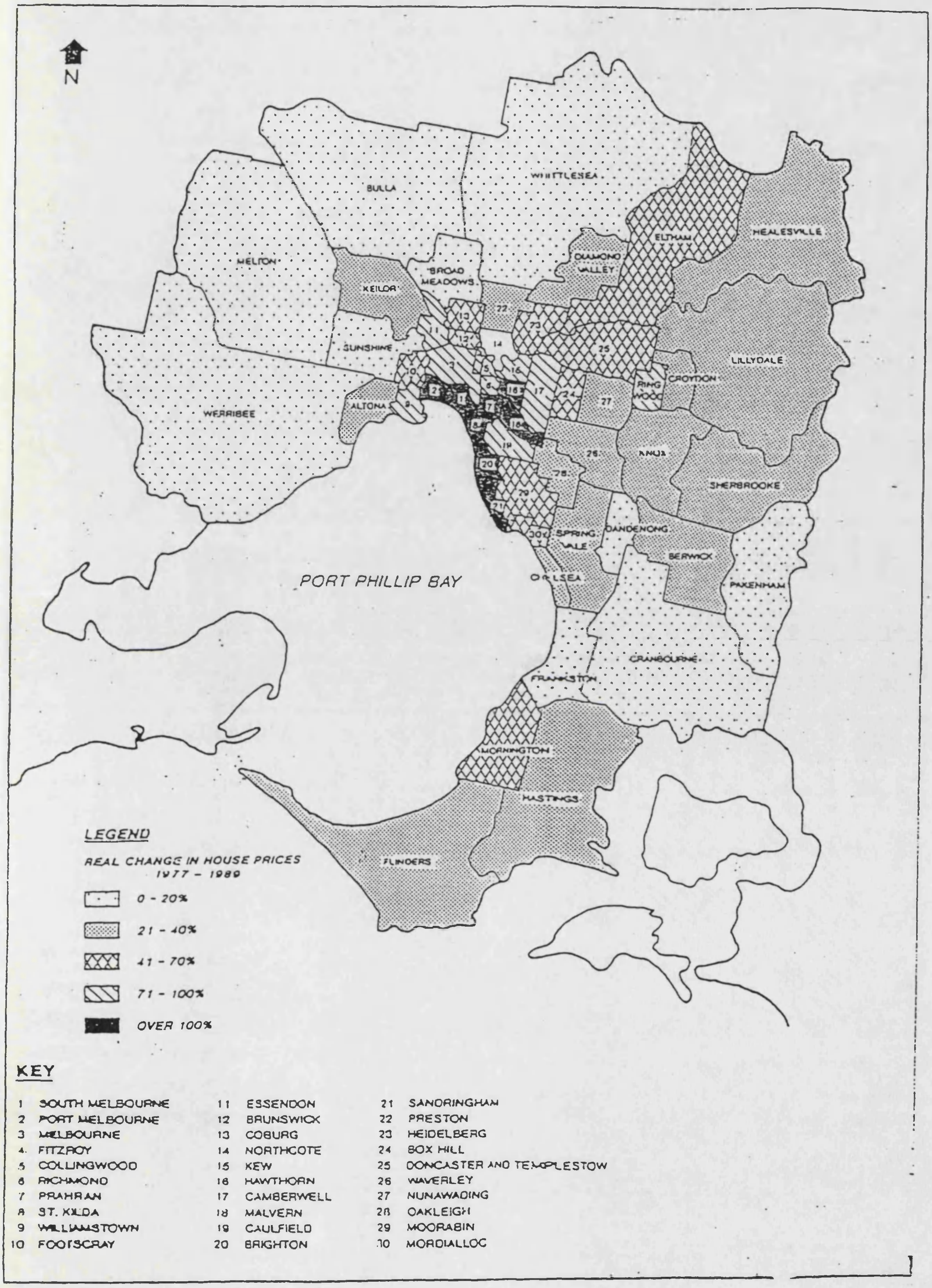


FIGURE 3.4 REAL CHANGES IN HOUSE PRICES: MELBOURNE 1977-89

Source: Applied Economics, 1991.

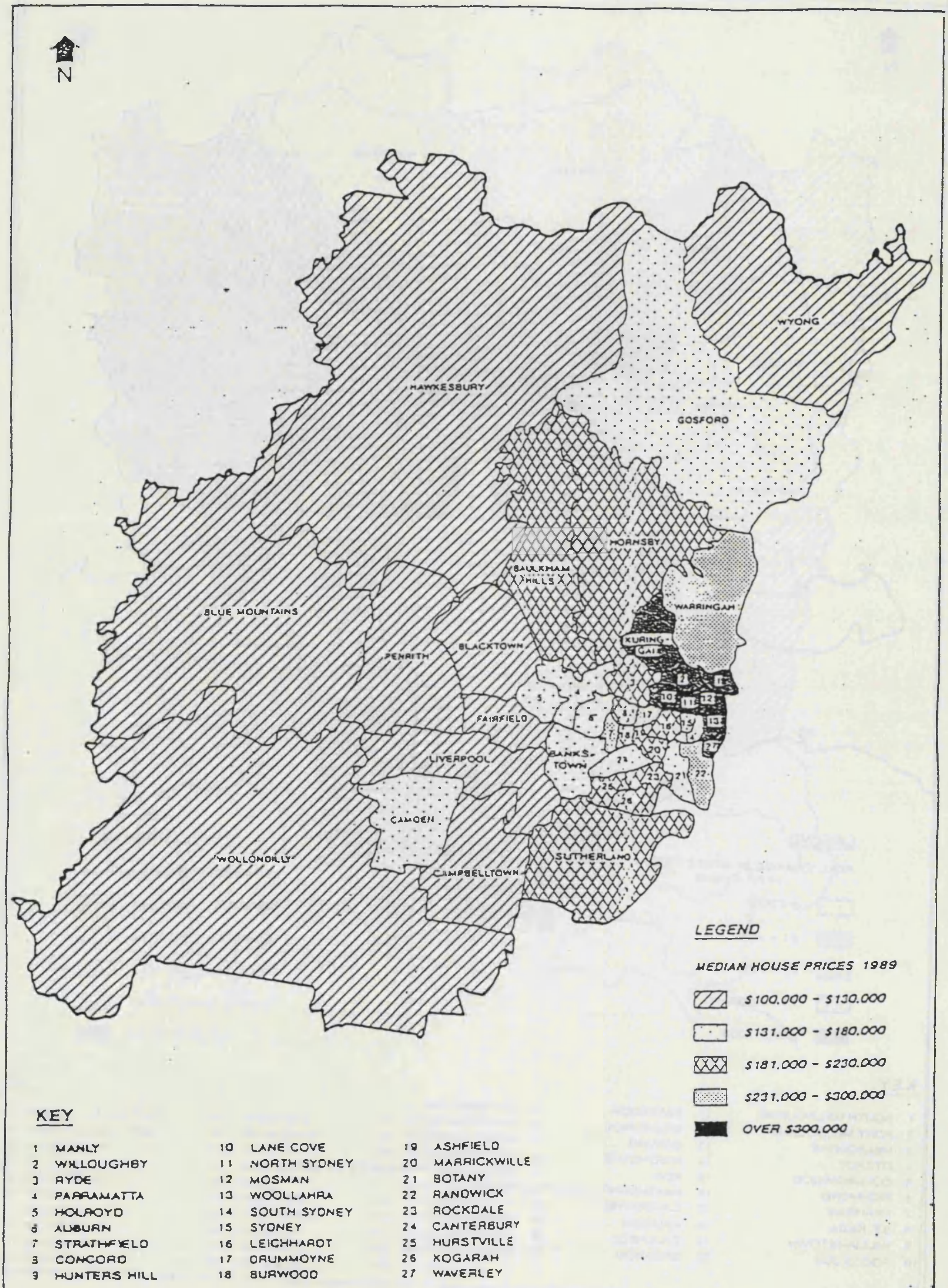


FIGURE 3.5 MEDIAN HOUSE PRICES: SYDNEY 1989

Source: Applied Economics, 1991.

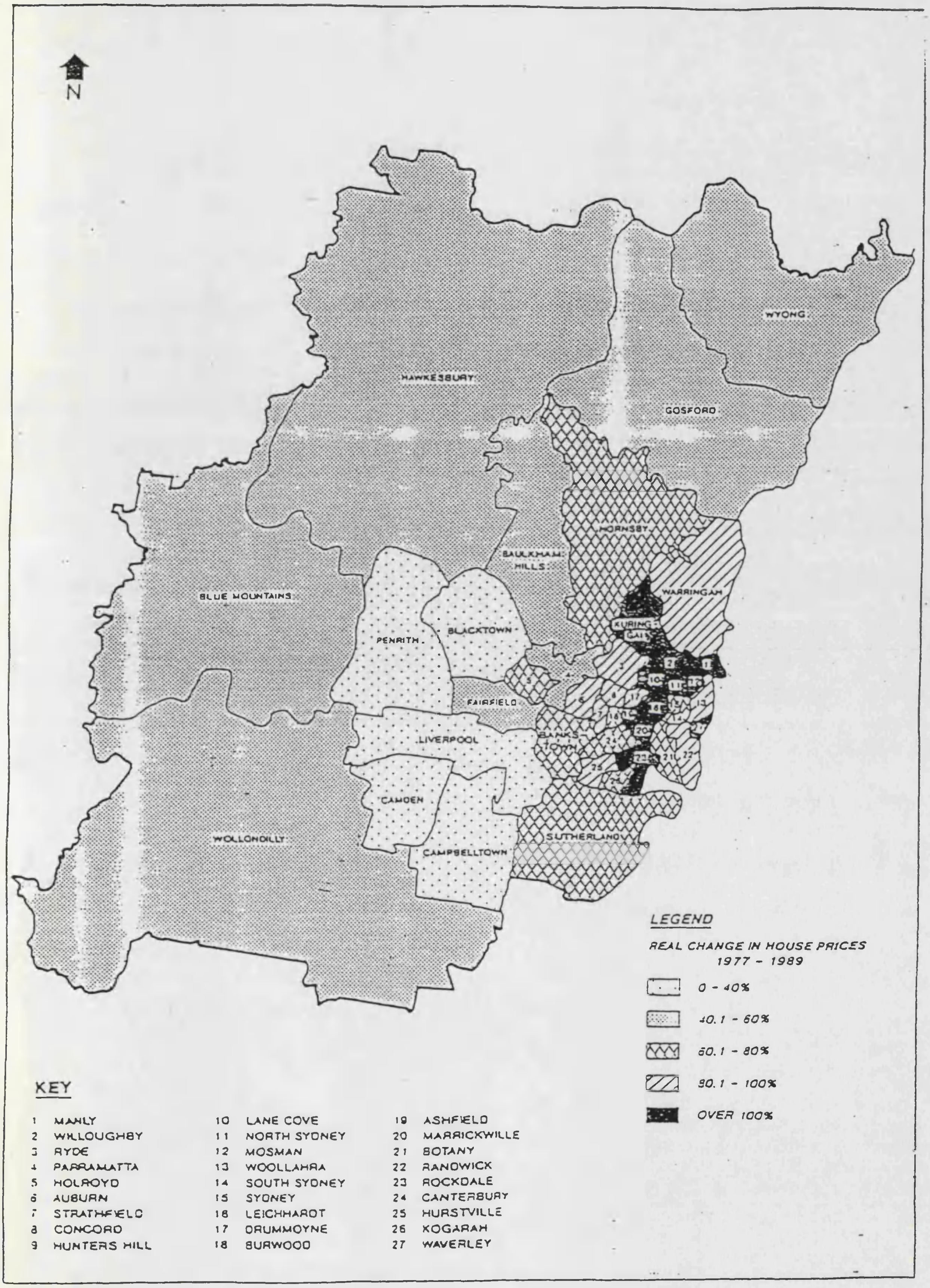


FIGURE 3.6 REAL CHANGES IN HOUSE PRICES: SYDNEY 1977-89

Source: Applied Economics, 1991.

3.4 MAIN CONCLUSIONS

In this review of the distribution of house prices in Sydney, Melbourne and Adelaide, the main points to emerge are:

- The range of house prices is greatest in Sydney and least in Adelaide.

- At the top end of the market, house prices in Sydney are often 50 per cent higher in Sydney than in Melbourne and 40 per cent higher in Melbourne than in Adelaide.

- At the bottom of the market, Sydney house prices are typically only some 10 per cent higher than Melbourne's, and Melbourne prices are about 20 per cent higher than Adelaide's. However these differences fluctuate considerably.

- In each city, house prices tend to decline with distance from the CBD.

- Also, between 1977 and 1989, house price increases were apparently inversely related to distance from the CBD.

ANNEX 3: LOCAL AREA HOUSE AND FLAT PRICES: 1977 and 1989

TABLE A3.1 LOCAL AREA HOUSE AND FLAT PRICES IN ADELAIDE: SUMMARY AND REAL CHANGES

	HOUSE PRICES				FLAT PRICES			
	Mean	Mean	Median	Real Change (a)	Mean	Mean	Median	Real Change (a)
AREA	1977	1989	1989	1977-89	1977	1989	1989	1977-89
Adelaide	45291	272682	186200	128.7	45380	111613	128338	7.4
Brighton	41500	146755	127700	34.3	30340	73940	84614	5.9
Burnside	53273	212660	186800	51.6	40546	83557	97525	-8.6
Campbelltown	36855	108562	101900	11.9	28464	67018	65818	-12.2
Elizabeth	28392	54569	55300	-27.0	na	ns	ns	na
Enfield	28712	79325	75200	4.9	30332	54515	58803	-26.4
E. Torrens	50961	159672	140000	19.0	na	na	103947	na
Gawler	25343	80545	76600	20.7	26858	61124	69060	-2.3
Glenelg	39271	154735	141785	49.6	31544	94974	100387	20.9
Happy Valley	40426	110568	99100	3.9	na	74425	72300	na
Henley Grange	39076	131658	121500	28.0	29094	68929	71828	-6.2
Hindmarsh	24234	91639	89400	43.6	ns	65277	69224	na
Marion	36454	97762	93200	1.9	29362	67745	74303	-3.9
Mitcham	43686	141220	123800	22.8	31131	74603	76640	-6.5
Munno Para	27501	60206	55300	-16.9	na	ns	ns	na
Noarlunga	30933	75450	72500	-7.4	24840	52148	59233	-9.4
Norwood	36267	161099	149100	68.7	33794	83656	104379	17.3
Payneham	34599	122054	116500	34.0	29788	68317	77990	-0.6
Prospect	32138	132225	121300	56.3	33089	70261	76229	-12.5
Pt Adelaide	24468	83256	77000	29.2	28047	65156	74767	1.2
Salisbury	30463	72027	70000	-10.2	28570	50435	56517	-24.9
St Peters	35864	170550	151700	80.6	26807	81563	85247	20.8
Stirling	44664	129369	117900	10.0	na	na	ns	na
Tea Tree Gully	35673	97756	89900	4.1	30700	67685	75147	-7.0
Thebarton	24803	99967	98900	53.1	26964	56484	63807	-10.1
Unley	39559	170719	147800	63.9	32006	77010	88408	4.9
Walkerville	52495	256244	210900	85.4	43478	106237	104576	-3.6
Willunga	25859	74756	68100	9.8	24588	50640	57827	-10.7
Woodville	35989	116364	98500	22.8	35871	80829	89891	-4.8
W. Torrens	38145	110012	100700	9.5	23998	59768	63835	1.0
Average	36097	125814	112153	30	24853	62264	71688	-3
Standard deviation	8109	52238	38739	33	13332	28255	29040	11
SD as % of average	22	42	35	113	54	45	41	367

(a) Real percentage changes in mean house and unit prices. Median prices were not available for 1977.

Source: Office of Valuer-General, Department of Lands, S.A.

TABLE A3.2 LOCAL AREA HOUSE AND FLAT PRICES IN MELBOURNE: SUAMMARY & REAL CHANGES

	HOUSE PRICES				FLAT PRICES			
AREA	Median 1977	Median 1989	Mean 1989	Real Change (a) 1977–89	Median 1977	Median 1989	Mean 1989	Real Change (a) 1977–89
Altona	35100	113000	122644	22.3	30750	90000	93869	11.2
Berwick	36500	120000	132714	24.9	30000	98000	112875	24.1
Box Hill	38000	155000	175951	54.9	37000	126000	131785	29.3
Brighton	54000	300000	377098	111.0	51598	185000	219482	36.2
Broadmeadows	36000	107750	115560	13.7	33000	95000	100502	9.3
Brunswick	29000	125000	137931	63.7	24600	82500	87846	27.4
Bulla	37000	114000	131089	17.0	na	96000	104320	na
Camberwell	46250	242500	294584	99.1	42800	170000	196294	50.9
Caulfield	41500	204750	246425	87.4	31000	114000	125905	39.7
Chelsea	32975	121000	151536	39.4	34975	96500	110275	4.8
Coburg	32000	120000	125966	42.4	28750	91000	97635	20.2
Collingwood	29950	151000	184109	91.5	18050	100000	133802	110.4
Cranbourne	34500	105000	117238	15.6	32000	87000	85380	3.3
Croydon	36200	130000	145267	36.4	32050	102000	109280	20.9
Dandenong	37800	112000	120350	12.5	28250	84000	93953	12.9
Diamond Valley	40000	142500	156815	35.3	34750	124000	137715	35.5
Doncaster/T'ton	52500	200000	249878	44.7	38625	143000	148119	40.6
Eltham	41500	161000	194165	47.3	35000	117000	122795	27.0
Essendon	32500	160000	185024	87.0	27250	98000	111598	36.6
Fitzroy	35000	170000	193768	84.5	28000	122500	157878	66.2
Flinders	28750	98000	121952	29.5	32931	98000	129030	13.0
Footscray	26000	100000	108964	46.1	23000	65000	71034	7.3
Frankston	37000	114000	140409	17.0	32000	91000	101899	8.0
Hastings	31000	105000	129621	28.6	ns	86500	94204	na
Hawthorn	46000	283000	345905	133.7	32000	120000	132624	42.4
Healesville	29000	97000	114442	27.0	33750	83000	76552	-6.6
Heidelburg	40000	156000	190254	48.1	36450	129000	136602	34.4
Keilor	37553	126000	136133	27.4	33000	102500	115212	18.0
Kew	49750	261000	364967	99.2	48000	168000	199013	32.9
Knox	37250	128750	141635	31.3	33000	102000	111684	17.4
Lillydale	36000	124000	140278	30.8	26000	97000	111881	41.7
Malvern	45000	300000	413875	153.2	36000	125000	158672	31.9
Melb CBD	ns	183500	276333	na	30000	150000	257724	89.9
Melb Sect 1	48000	210000	306627	66.2	38000	160000	260777	59.9
Melb Sect 2	27500	138000	161170	90.6	27500	86500	103361	19.5
Melton	32000	92000	99256	9.2	26500	74250	72133	6.4
Moorabbin	40000	150000	164869	42.4	33000	117500	123514	35.2
Mordialloc	38000	163000	197666	62.9	33000	110000	126987	26.6
Mornington	38800	147000	174473	43.9	33500	99750	108070	13.1
Northcote	na	133000	145473	na	na	82000	92248	na
Nunawading	41000	140000	161859	29.7	39000	132500	136974	29.0
Oakleigh	35000	125000	137535	35.6	35000	97000	101886	5.3
Pakenham	32400	102000	123935	19.6	30900	87500	86118	7.5
Port Melbourne	31000	173000	182058	112.0	na	185000	201946	na
Prahran 1	77500	960000	1254317	370.5	40000	226000	234184	114.6
Prahran 2	39750	238000	399779	127.4	29700	125500	169841	60.5
Preston	32725	115000	123757	33.5	34000	95000	101288	6.1
Richmond	29250	151000	174326	96.1	24000	85250	105320	34.9
Ringwood	36750	134000	151979	38.5	53000	105000	98124	-24.8
Sandringham	47625	255000	290461	103.4	34500	157000	175429	72.8
Sherbrooke	33725	115000	130956	29.5	32350	108000	107214	26.8
Sth Melbourne	37000	215000	256653	120.7	31500	122500	172500	47.7
Springvale	37250	119000	131145	21.3	32950	94000	106850	8.3
St.Kilda	38000	225000	272415	124.9	28000	111000	119000	50.6
Sunshine	33350	97000	104461	10.5	24000	75000	79053	18.7
Waverley	45000	151000	173357	27.4	40500	135000	142169	26.6
Werribee	34232	100000	108351	10.9	30900	83500	85490	2.6
Whittlesea	40500	122500	131516	14.9	na	96000	103175	na
Williamstown	28000	128000	147048	73.6	25500	92500	118839	37.3
Average of LGAs	36596	167797	203166	58.7	30136	112185	128119	27.7
Standard deviation	9208	53285	79155	38 (b)	11079	30888	43362	27
SD as % of average	25	32	39	65	37	28	34	96

(a) Percentage changes in real median prices.
(b) Excluding Prahran 1 for houses
Source: Office of the Valuer-General Victoria.

TABLE A 3.3 LOCAL AREA HOUSE 7 FLAT PRICES IN SYDNEY: SUMMARY AND REAL CHANGES

AREA	------ HOUSE PRICES ------ Mean 1976-77 (a)	Median 1979 (b)	Median 1989 (b)	Real Changes 1976-77 to 1989 (c)	Real Changes 1979-89	---FLAT PRICES---- Median 1979 (b)	Median 1989 (d)	Real Changes 1979-89 (e)
Ashfield	35400	49500	212300	107.5	48.4	36400	129500	58.8
Auburn	27000	34300	150900	93.4	52.2	34300	103400	34.6
Bankstown	34000	45100	158100	60.9	21.3	43200	130100	34.4
Baulkham Hills	49900	65600	228300	58.3	20.4	65600	na	na
Blacktown	29100	35400	108400	28.9	6.0	35400	92600	16.8
Blue Mountains	25900	30200	112700	50.6	29.1	30200	na	na
Botany	35000	47200	175400	73.4	28.6	35400	115700	45.9
Burwood	38700	53600	191900	71.6	23.9	43800	148700	51.6
Camden	35000	41600	139200	37.6	15.8	na	na	na
Campbelltown	31800	40400	122200	33.0	4.7	30500	92800	35.8
Canterbury	33900	46300	172300	75.9	28.8	30000	109900	63.5
Concord	35400	54100	204000	99.4	30.5	44400	152100	52.9
Drumoyne	41600	55500	233300	94.1	45.5	50300	200000	77.5
Fairfield	28900	38600	124200	48.7	11.3	38600	89300	3.3
Gosford	30000	39700	134200	54.8	17.0	36500	na	na
Hawkesbury	30300	34100	125500	43.3	27.3	34100	na	na
Holroyd	30700	40100	148700	67.6	28.3	40100	111600	24.2
Hornsby	46400	62100	223900	67.0	24.8	62100	156400	12.4
Hunters Hill	70900	83600	450000	119.6	86.3	83600	na	na
Hurstville	40500	53000	224300	91.6	46.4	38100	137700	61.3
Kogarah	44500	56600	219200	70.4	34.0	42200	131500	39.1
Kuringai	69700	95000	426000	111.5	55.2	95000	231500	8.8
Lane Cove	54400	72100	319000	102.9	53.1	72100	172000	6.5
Leichardt	31400	44800	187500	106.6	44.8	34800	149900	92.3
Liverpool	32100	39800	121400	30.9	5.5	25200	93000	64.8
Manly	51100	73500	359200	143.2	69.1	73500	220700	34.1
Marrickville	28200	34600	184500	126.4	84.5	28800	105800	64.0
Mosman	74200	100900	531400	147.8	82.2	100900	239500	6.0
North Sydney	49500	78000	370800	159.2	64.5	78000	234000	33.9
Parramatta	36000	45400	155100	49.1	18.2	45000	124400	23.4
Penrith	29900	36300	115900	34.1	10.5	36300	90500	11.3
Randwick	46200	63800	258900	93.9	40.4	46500	154500	48.3
Rockdale	36000	54000	217800	109.3	39.6	42400	137000	44.2
Ryde	40800	55700	221300	87.7	37.5	55700	142100	13.9
Strathfield	45000	53600	254700	95.8	64.4	39200	146700	67.1
Sutherland	44000	58100	205300	61.5	22.3	43400	139700	43.7
Sydney (f)	35800	38600	171100	65.4	53.4	31500	121600	72.3
Warringah	49900	66300	259900	80.2	35.6	66300	154200	3.8
Waverley	48400	67600	310100	121.7	58.7	43700	136700	39.6
Willoughby	55600	73100	328600	104.5	55.5	73100	204900	25.1
Wollondilly	24800	30800	103500	44.4	16.3	na	na	na
Woollahra	80200	86100	421600	81.9	69.4	50200	208100	85.1
Wyong	24400	30500	103300	46.5	17.2	34700	na	na
Average of LGAs	40988	53609	220602	80	38	45840	118793	33
Standard deviation	13366	17616	102394	33	22	20693	68711	27
SD as % of average	33	33	46	41	58	45	58	82

(a) NSW Valuer-General data published by ABS.
(b) AE estimates based on NSW Valuer-General data.
(c) Change from mean to median prices, but effect of different average price considered minor.
(d) Based on PBAS data.
(e) Changes in median prices.
(f) Includes South Sydney.
Sources: As shown.

4 HOUSE AND LAND PRICES IN SYDNEY: 1925 to 1970

4.1 INTRODUCTION

This chapter describes average house and land prices, and their geographical distribution, in Sydney from 1925 and 1970

To generate the price data, a substantial research exercise was required.[1] This exercise is described in the following section. Before my study there were no estimates of residential property prices in Sydney for this period and the basic data on property values were not readily accessible.

Sections 4.3 and 4.4 describe average annual house and land prices respectively in Sydney from 1925 to 1970.

The geographical distributions of house and land prices are described and illustrated in Section 4.5. Data details are given in Annex 4.

There is a brief concluding section.

4.2 DATA COLLECTION

To estimate average Sydney and LGA prices, it was necessary to sample a large and representative selection of property records (held on cards by the NSW-VG). The estimates below are based on sales and valuations of some 4,400 properties in 22 LGAs, i.e. about 200 properties per LGA. This sample was designed to obtain a representative geographical spread of LGAs and sufficient observations of sales each year in each LGA.

The sample was selected by a stratified random process. The LGAs were chosen to ensure that the sample distribution of properties represented the actual distribution of properties in Sydney with respect to both distance to the

CBD and to geographical sectors over the study period. The streets within each LGA and the properties within the streets were selected randomly.

In practice, various complications arose. Of the properties selected, only about half were developed with houses at the start of the period. To some extent the developments in our sample mirrored the actual growth of Sydney over the study period, which meant that our sample was representative of the city. But, before about 1950, the smaller sample size combined with low turnover rates meant that there were often too few sales to permit development of accurate estimates of average prices. The problem was particularly acute for land.

Consequently I supplemented the sales data with valuation estimates. But valuations are not precise reflections of sale prices. Moreover, valuations were done irregularly and were, in any one year, not a random representation of the property market. Various steps, described below, were taken to deal with these issues.

Table 4.1 shows the distribution of residential properties in Sydney and in our sample in 1933 and 1966, two Census years. In 1933, over half of all dwellings were within 8 km of the CBD. By 1966, nearly half of all dwellings were over 15 km from the CBD. Over the same period, dwellings in the Inner-East sector (as defined in Table 4.1) declined from 30 to 20 per cent of all dwellings in Sydney. The proportion of dwellings in each of the other three sectors increased, especially in the West-N.W. sector. As far as possible, I selected LGAs (and sample sizes within these LGAs) to reflect these trends. In 1933, the mean distance between houses in the sample and CBD was 11 km; in 1966, it was 16 km. Nevertheless, houses close to the CBD are slightly under-represented at the start of the period and over-represented at the end.

TABLE 4.1: THE DISTRIBUTION OF DWELLINGS IN SYDNEY

Distance from GPO (km)	ACTUAL 1933 No.	%	1966 No.	%	SAMPLE 1933 No.	%	1966 No.	%
0-3	48584	16.2	68693	9.7	344	16.7	505	11.7
3-8	108710	36.3	155246	21.9	611	29.6	902	20.8
8-15	75660	25.3	153018	21.6	456	22.1	977	22.6
15-24	40660	13.6	144233	20.3	322	15.6	811	18.7
24 +	26256	8.6	188771	26.6	332	16.0	1132	26.2
<u>Sector</u>								
Inner-East	91301	30.4	142990	20.1	651	31.6	924	21.4
South-SW	84657	28.2	217591	30.6	546	26.4	1078	24.9
West-NW	66634	22.2	195650	27.6	562	27.2	1237	28.6
North	57278	19.1	153930	21.7	306	14.8	1088	25.1
Total	299870		709961		2065		4327	

Source: Census data.

<u>Definitions</u> (LGA's or parts thereof)

0-3 km. Sydney, South Sydney*, Woollahra*(½), Leichardt*(½)

4-8 km. Waverley, Randwick,* Drummoyne, Burwood, Marrickville*, Hunters Hill, North Sydney,* Mosman, Botany (½), Woollahra*(½), Leichardt*(½)

9-15 km. Rockdale, Canterbury*, Strathfield,* Concord, Ryde,* Lane Cove, Manly*, Willoughby,* Mosman, Botany (½).

16-24 km. Bankstown,* Hurstville, Auburn,* Parramatta,* Kogarah,* Holroyd, Kuringai*(½).

25 + km. Sutherland,* Liverpool,* Fairfield Penrith,* Blacktown, Baulkham Hills,* Hornsby,* Warringah,* Kuringai*(½)

Inner-East Sydney, Woollahra,* South Sydney,* Randwick,* Waverley, Leichardt.*

South-SW Botany, Marrickville,* Rockdale, Hurstville, Kogarah,* Sutherland,* Canterbury,* Bankstown,* Liverpool.*

West-NW Strathfield,* Ryde,* Auburn,* Baulkham Hills,* Parramatta,* Fairfield, Blacktown, Holroyd, Penrith,* Ashfield, Burwood, Concord, Drummoyne.

North North Sydney,* Willoughby,* Kuringai,* Hornsby,* Lane Cove, Hunters Hill, Mosman, Manly,* Warringah.*

* Indicates LGA's included in sample.

To offset the low turnover of house sales before 1950, (usually less than four per cent per annum) I collected the NSW-VG's estimates of house values (known as "improved values" - IVs). To overcome the lack of land sales, it was necessary to rely on the VG's estimates of land values (known as "unimproved values" - UVs). Note that estimated UVs allow for the provision of urban services to the land, so they are not pure land values. Over the study period, the sample contains an annual average of 800 IVs and 1100 UVs.

For all Sydney, I estimated the following median IVs and sale prices from the sample data.

	Median IV	Median sale price
1930-32	$1400	$1350
1947-49	$1665	$1125
1967-69	$11920	$13100

In the early 1930s, IVs were close to sale prices. But, between then and the immediate post-war years, IVs were sticky and did not fully reflect the decline in nominal house prices. In fact, the median 1947-49 IV did represent a real fall in value of some 20 per cent compared with 1930-32. Then, when house prices rose strongly in the post-war period, IVs again lagged behind. Overall, IVs and UVs are reasonable guides to trends in real estate values although they understate slightly the falls between 1930-32 and 1947-49 and the rises thereafter.

It should be remarked, however, that between 1939 and the early 1950s house prices themselves were subject to indirect regulation and did not fully reflect market forces. In 1939, the Commonwealth government introduced widespread price controls, including controls on land sales and rents. In 1948, it devolved these controls to the states and the controls were relaxed (see Commonwealth Bureau of Census and Statistics, 1949).

The main problem with the valuation data is bias rather than sample size. In many years the properties valued were not representative of the distribution of dwellings in Sydney and the results are biased, see Tables 4.2 and 4.3. A major exception was 1931 when over three-quarters of our sample was valued (there were 1577 IVs and 1878 UVs).

To counter the bias caused by the valuation cycle, I estimated "repeat valuation" indices. In each year, between 300 and 800 of the properties valued in 1931 were revalued. The differences between the average (mean) valuations for the revalued properties formed the basis for the repeat indices shown in Tables 4.2 and 4.3, where 1931 = 100. The repeat indices presume that valuation changes for the sub-set of revalued properties mirror the changes for all Sydney properties. Since property value changes were not uniform (see Chapter 12), this presumption is not strictly valid. Unfortunately, however, the biases in the repeat indices cannot be readily identified. Also, the repeat indices exclude new housing of presumably higher quality than the existing stock, but usually constructed on lower value land.

The development of comparable LGA data was also complicated by the valuation cycle. In the first half of the study period, valuations of each property were made triennially. Later, they were made each fifth or sixth year. Thus, all properties in the sample LGAs were valued between 1930 and 1932 and between 1947 and 1949. But, in the 1960s, the city-wide valuation process took from 1965 to 1970. To ensure comparability between LGAS, I standardised the valuations to selected years (1931, 1948 and 1968). Valuations made in adjacent years were inflated (or deflated) in accordance with the estimated changes in nominal land or house prices, as appropriate, for the whole of Sydney over the relevant years. As shown in the Annex, the 1968 estimates for six LGAs were obtained by factoring up or down from 1965 or 1970 data. Given the length of time between 1965 and 1968 and the rapid price rises between 1968 and 1970, the 1968 estimates for these LGAs should be treated with caution.

Sample size was a minor issue in seven LGAs (all 16 km or more from the CBD), where houses were constructed on only a quarter of the lots before the 1950s. In these LGAs, the sample size for houses in the first half of our period was only around 50 (see the Annex). Fortunately, the median statistic obviates the influence that outliers can have in a small sample.

The final point concerns units of measure. It is generally desirable to employ standard units of land and housing (say in m^2), even if the units differ somewhat in quality. Fortunately data on lot sizes were available and land prices per m^2 could be estimated. However, data on house sizes were not readily available.

4.3 AVERAGE HOUSE PRICES AND INDICES

Table 4.2 shows average house prices from 1925 to 1970 and the real house price and IV indices (based on 1931 = 100). In 1931 the estimated mean house price was $1,623 and the median house price was $1,320. The mean IV was $1,676 and the median IV was $1,400.

In nominal terms, house prices changed little between the late 1920s and the mid-1940s. They rose very sharply between 1948 (when the Commonwealth government ceased price controls on land and rents) and 1952 and increased steadily through the 1950s. Fluctuations increased in the 1960s. House prices rose sharply between 1959 and 1961, fell in 1962-63, rose steadily to 1967 and sharply again to 1970. Generally mean house prices were significantly higher than median prices.

TABLE 4.2 HOUSE PRICES AND IMPROVED VALUATIONS 1925-1970

	Current House Prices		Real House Price Indices (1931=100)		Real IV Indices (1931=100)		
	Mean	Median	Mean	Median	Mean	Median	Repeats
1925	na	na	na	na	66	70	101
1926	1148	1130[a]	64	63	109	103	96
1927	1136	1130[a]	63	63	104	109	103
1928	1342	1065	73	70	83	95	101
1929	1540	1250	81	81	113	104	102
1930	1621	1200	90	81	100	103	104
1931	1623[b]	1320[b]	100	100	100	100	100
1932	1623[b]	1320[b]	99	99	84	91	97
1933	1623[b]	1320[b]	110	110	96	106	103
1934	1853	975	124	80	117	102	102
1935	1301	936	86	76	85	93	98
1936	1515	1000	98	80	90	98	97
1937	1611	1200	102	94	128	100	102
1938	1379	1200	85	91	86	90	96
1939	1512	1400	91	104	87	98	93
1940	1439	1120	84	80	121	87	96
1941	1425	1050	77	71	79	83	90
1942	1706	1300	87	82	79	86	82
1943	1093	770	53	46	107	79	86
1944	1408	1030	69	83	76	83	85
1945	1502	1200	74	73	79	86	84
1946	1557	1200	75	71	110	84	88
1947	1721	1220	80	70	82	89	88
1948	1610	1000	67	53	77	82	80
1949	2105	1150	82	56	92	78	85
1950	3426	1950	124	87	94	97	97
1951	4065	2700	130	106	114	104	105
1952	4259	3000	111	96	114	93	101
1953	4557	3200	108	94	113	124	117
1954	4733	3390	111	98	131	142	117
1955	4887	3200	113	91	141	129	137
1956	5101	4400	112	119	152	173	139
1957	5844	5000	123	128	158	170	156
1958	6726	5600	139	143	181	168	148
1959	6354	5665	130	144	156	172	154
1960	8566	8000	170	196	181	190	180
1961	10325	8270	205	203	178	201	179
1962	9143	8000	178	191	236	215	178
1963	9986	8550	193	202	140	161	192
1964	10881	9900	207	231	179	198	194
1965	11588	10400	212	235	204	212	221
1966	11112	9500	197	207	235	257	200
1967	13108	11000	228	235	193	216	223
1968	15718	12500	264	259	282	258	238
1969	17422	15570	284	316	186	223	248
1970	20000[c]	18000[c]	313[c]	350[c]	243	255	270

(a) Average of 1926 and 1927 figures.
(b) Average of 1931, 1932 and 1933 figures.
(c) From Abelson (1982). Because of a change in the system of data storage by the V.G., our sample contained fewer house sales in 1970.

Source: Author's research - see text.

But the real prices indices are of greater interest. Between the late 1920s and the late 1930s, real house prices held up or even rose slightly. However due to the small annual sample in the 1930s, estimates of real house prices in the 1930s are not reliable.[2] Between the late 1930s and 1948/49, real house prices fell by around 40 per cent. By the late 1940s, they were significantly lower than in the late 1920s or early 1930s.

Real house prices doubled in the 1950s and rose by a further 50 per cent in the 1960s. Over the period 1928-29 to 1968-69, the median house price index rose nearly fourfold. Of course in so far as houses were renovated over this period, this increase overstates the true increase in the value of houses. (I collected data on house improvements recorded by the VG but the data were incomplete and excluding homes with recorded improvements from the sample made little difference to the results).

According to the most reliable IV index, the 'repeat' index, real house prices in the late 1920s and early 1930s were constant. They did not rise as suggested by our rather scant data on actual house prices. The 'repeat IV' index then indicates that real house prices fell by 15 to 20 per cent between the late 1930s and 1940s. This is consistent with the house price indices, although valuations fell less than estimated house prices. In particular, valuations in 1948/49 did not reflect the fall in real house prices in those years.

From the late 1940s the 'repeat IV' and house price indices are similar. Both indicate that real house prices rose threefold between then and the late 1960s. However valuations appear to lag behind price increases in periods of rapid change, such as between 1948 and 1951 and between 1967 and 1970. They are usually adjusted in other years to compensate.

4.4 AVERAGE LAND PRICES AND INDICES

Turning to unimproved valuations, in 1931 the mean UV in our sample was $492 per lot; the median was $360 per lot. Unfortunately, in other years, similar problems of sample bias arise with UVs as with IVs. Consequently, I prefer the 'repeat UV' index to the mean and median UV indices (Table 4.3).

Using the 'repeat' index, real land values per lot in the 1920s and 1930s fluctuated but did not show a trend (although they were low in 1925-26 and high in 1937). In the 1940s, real land values per lot fell much as IVs did. Between 1950 and the late 1960s, valuations per lot rose by 250 to 300 per cent (excluding 1970 as an exceptional year). This was a significantly greater increase than for house prices. Moreover, in a period of rapid change, increases in valuations may understate the true increases. By the late 1960s, the mean UV per lot was around $8,500 and the median UV was about $6,000.

A significant factor in the increase in lot value was the 25 per cent increase in average lot size from an estimated 407 m^2 in 1931 to 511 m^2 in 1967. This reflected the decentralisation of the population. As shown in Table 4.3, again using the repeat valuation index, the real value of land per m^2 fell by 25 per cent between 1931 and 1949 (slightly more than the fall in real house prices). After the war, real land values per m^2 did not rise until the late 1950s. However, by the end of the 1960s, the real UV per m^2 had risen substantially.

TABLE 4.3
INDICES OF REAL UNIMPROVED VALUATIONS (1931=100)

	Real UV/lot			Real UV/m²		
	Mean	Median	Repeats	Mean	Median	Repeats
1925	69	70	87	135	138	86
1926	101	97	87	97	100	91
1927	96	95	102	87	76	101
1928	71	78	98	78	83	98
1929	112	95	104	101	102	95
1930	95	93	105	87	77	103
1931	100	100	100	100	100	100
1932	76	86	96	88	86	94
1933	93	104	102	102	118	103
1934	129	105	105	109	120	96
1935	80	82	95	85	71	94
1936	92	101	101	98	113	98
1937	146	100	117	118	126	101
1938	80	79	99	81	72	94
1939	91	101	91	96	110	97
1940	143	102	116	115	129	98
1941	69	79	90	71	66	79
1942	80	91	87	81	92	83
1943	120	89	99	96	106	83
1944	66	72	84	68	67	73
1945	80	92	85	84	97	81
1946	121	87	103	91	100	86
1947	67	75	87	59	59	75
1948	74	86	88	77	90	76
1949	97	74	102	81	82	78
1950	80	98	101	71	70	80
1951	97	104	102	110	96	86
1952	103	78	116	83	70	71
1953	76	94	93	78	75	96
1954	101	106	113	83	86	93
1955	122	94	132	102	93	83
1956	110	133	126	82	86	73
1957	134	155	161	128	119	127
1958	190	166	177	129	115	85
1959	158	172	203	129	139	129
1960	212	252	229	129	187	186
1961	215	270	249	188	207	179
1962	326	326	265	209	176	281
1963	153	170	176	235	230	162
1964	248	309	328	229	270	296
1965	321	348	381	222	238	333
1966	360	451	329	305	381	261
1967	285	360	351	228	233	264
1968	462	433	383	329	275	286
1969	282	369	373	311	378	246
1970	470	507	545	306	314	456

Source: Author's research - see text.

4.5 THE GEOGRAPHICAL DISTRIBUTION OF HOUSE AND LAND PRICES

House and land prices in the sampled LGAs in 1931 are shown in Figures 4.1 and 4.2 respectively.

As shown, house prices tended to fall with distance from the CBD. There were, of course, some exceptions, e.g. some low priced houses in inner areas, while Kuringai, a middle/outer suburb, was highly priced then as now.

Land prices declined much more sharply with distance from the CBD.

Figures 4.3 and 4.4 show the changes in real house and land prices between 1931 and 1968. Unlike the experience of the last 15 years, house price appreciation was greater with distance from the CBD. Land prices also appreciated much more further from the CBD.

Details of house and land prices in the sampled LGAs are given in the Annex. Further analysis of the spatial distributions of house and land prices is made in Chapter 12.

4.6 MAIN CONCLUSIONS

This study of residential property prices in Sydney from 1925 to 1970 is based on sales and valuations of over 4000 properties, of which about half were developed at the start of the period. Because of the limited number of house sales before 1948, and the geographical biases in the properties valued each year, I generated several indices of property prices. Fortunately, clear trends can be derived.

There was little change in real house prices between the late 1920s and the late 1930s. Real house prices then fell by around 30 per cent between 1938 and 1948. However, they more than doubled between 1948 and 1960 and rose by nearly

Figure 4.1: House prices in Sydney in 1931 ($)

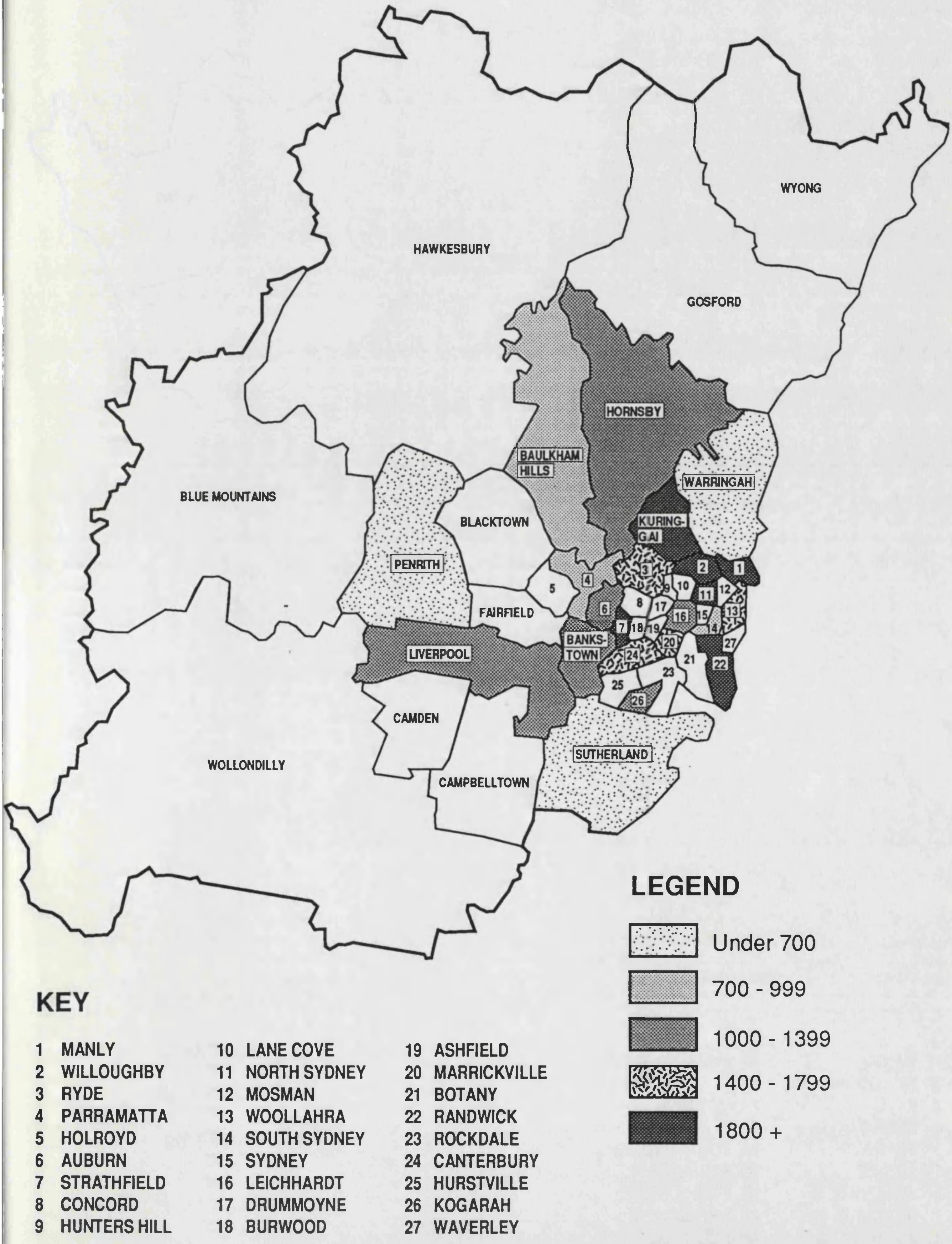
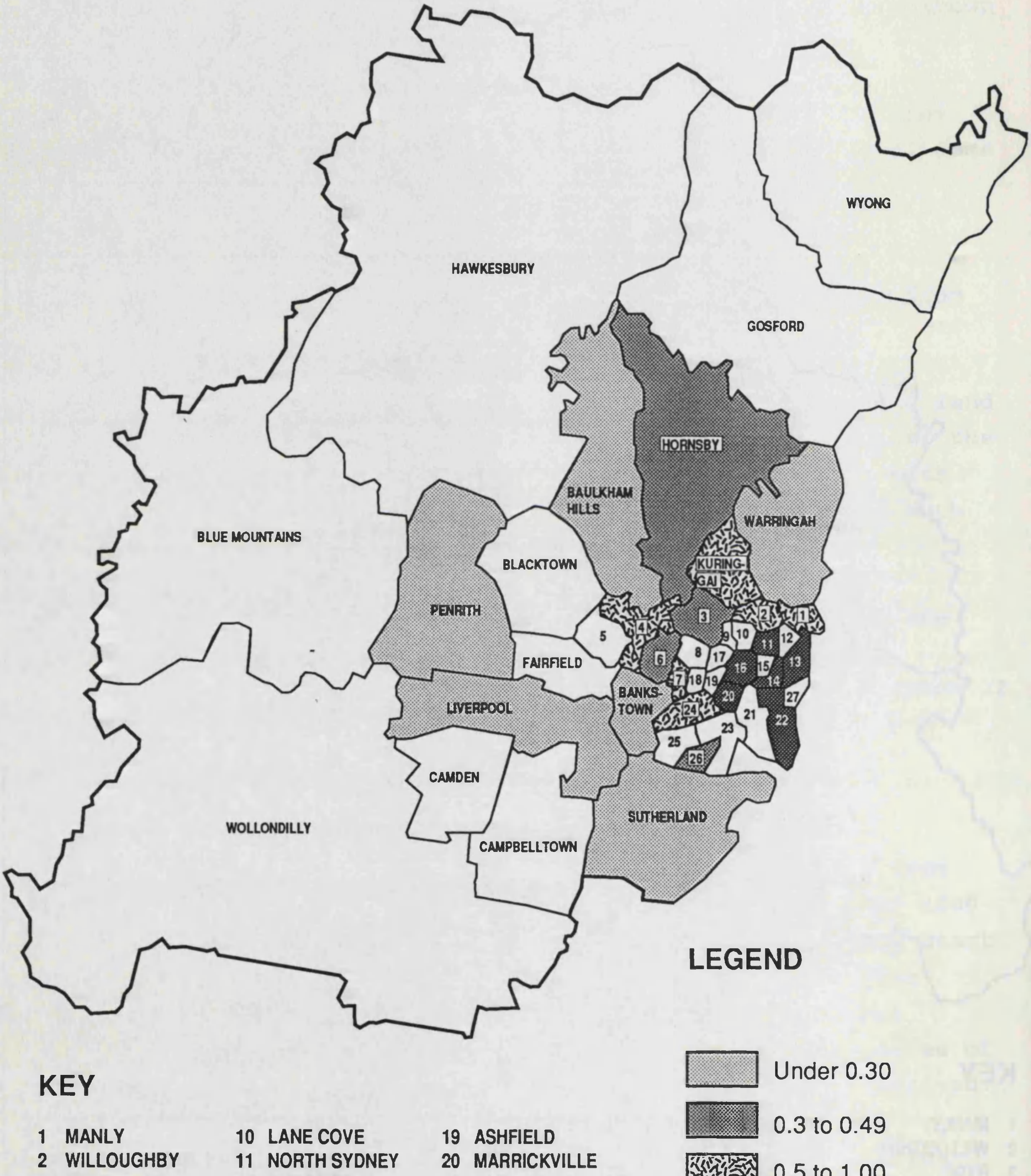


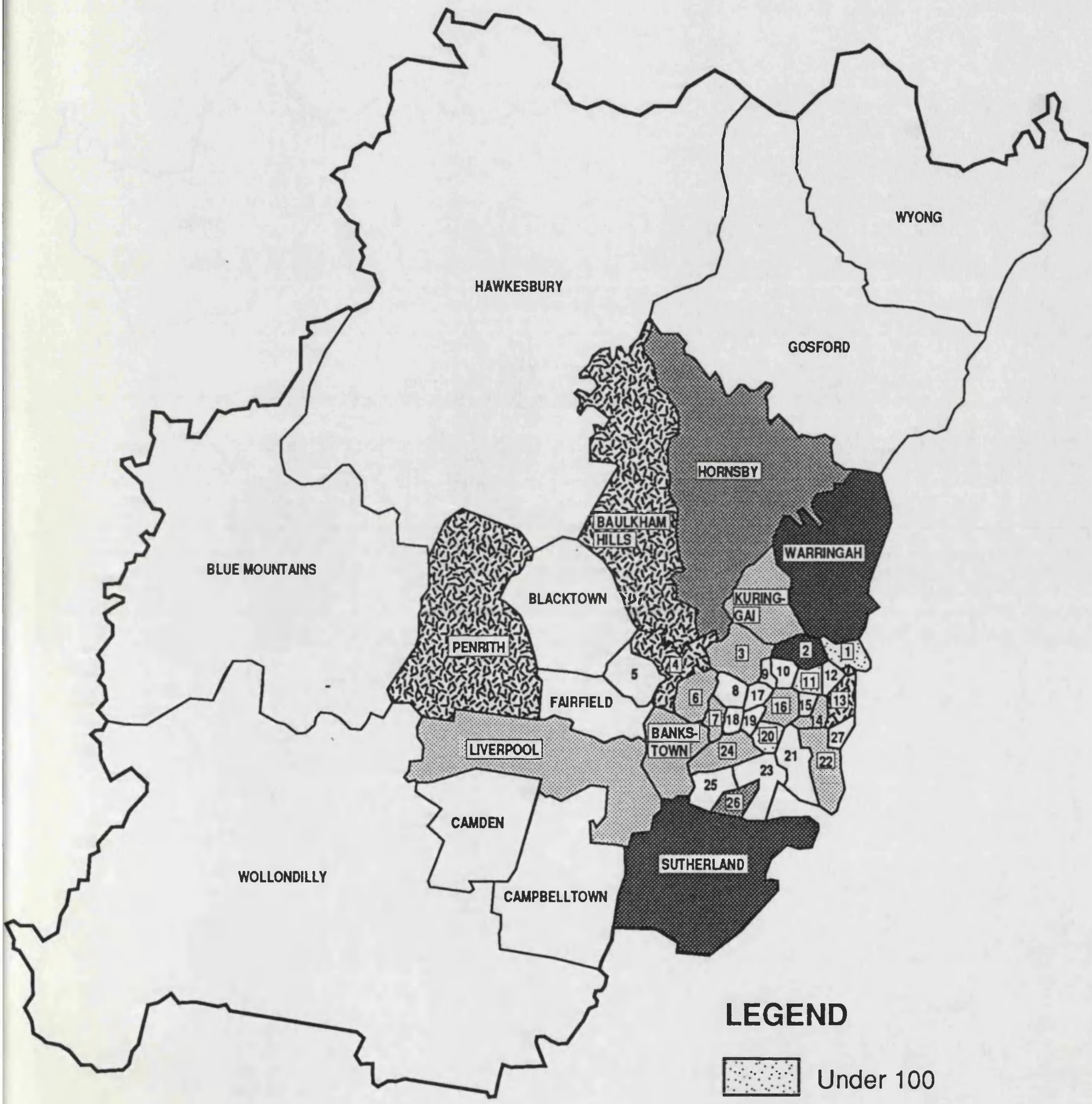
Figure 4.2: Land values in Sydney in 1931 ($ / m^2)



KEY

1 MANLY
2 WILLOUGHBY
3 RYDE
4 PARRAMATTA
5 HOLROYD
6 AUBURN
7 STRATHFIELD
8 CONCORD
9 HUNTERS HILL
10 LANE COVE
11 NORTH SYDNEY
12 MOSMAN
13 WOOLLAHRA
14 SOUTH SYDNEY
15 SYDNEY
16 LEICHHARDT
17 DRUMMOYNE
18 BURWOOD
19 ASHFIELD
20 MARRICKVILLE
21 BOTANY
22 RANDWICK
23 ROCKDALE
24 CANTERBURY
25 HURSTVILLE
26 KOGARAH
27 WAVERLEY

Figure 4.3: Real increases in Sydney house prices: 1931 to 1968 (in percentages)



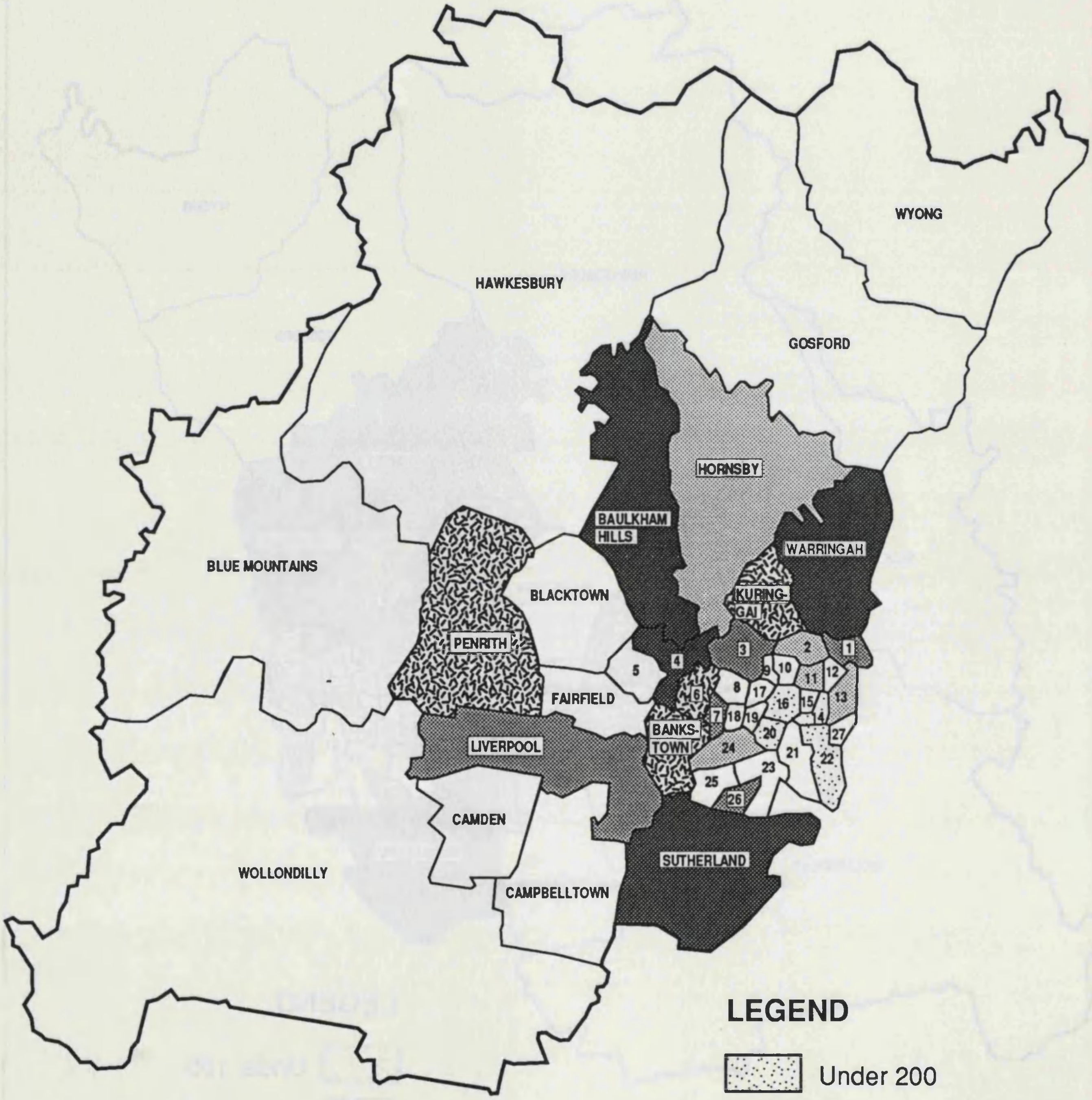
LEGEND

- Under 100
- 100 - 149
- 150 - 199
- 200 - 299
- Over 300

KEY

1	MANLY	10	LANE COVE	19	ASHFIELD
2	WILLOUGHBY	11	NORTH SYDNEY	20	MARRICKVILLE
3	RYDE	12	MOSMAN	21	BOTANY
4	PARRAMATTA	13	WOOLLAHRA	22	RANDWICK
5	HOLROYD	14	SOUTH SYDNEY	23	ROCKDALE
6	AUBURN	15	SYDNEY	24	CANTERBURY
7	STRATHFIELD	16	LEICHHARDT	25	HURSTVILLE
8	CONCORD	17	DRUMMOYNE	26	KOGARAH
9	HUNTERS HILL	18	BURWOOD	27	WAVERLEY

Figure 4.4: Real increases in Sydney land values: 1931 to 1968 (in percentages)



KEY

1 MANLY	10 LANE COVE	19 ASHFIELD
2 WILLOUGHBY	11 NORTH SYDNEY	20 MARRICKVILLE
3 RYDE	12 MOSMAN	21 BOTANY
4 PARRAMATTA	13 WOOLLAHRA	22 RANDWICK
5 HOLROYD	14 SOUTH SYDNEY	23 ROCKDALE
6 AUBURN	15 SYDNEY	24 CANTERBURY
7 STRATHFIELD	16 LEICHHARDT	25 HURSTVILLE
8 CONCORD	17 DRUMMOYNE	26 KOGARAH
9 HUNTERS HILL	18 BURWOOD	27 WAVERLEY

50 per cent in the 1960s. Overall, real house prices rose by 150 to 200 per cent (according to the index chosen) between 1930 and 1969.

Remarkably, the long-run (1930 to 1969) average annual rate of growth in real house prices, before quality adjustment, was about two and a half per cent. This is similar to the average increase in real house prices since 1970. However, prices from 1930 to 1970 were less prone to the sharp short cycles of the last two decades.

Real land values per lot followed a similar pattern to house prices, but they fell by slightly less between 1938 and 1948 and rose faster in the post-war period. Over the 1930 to 1969 period, using the repeat index, they rose by just under 300 per cent. This reflected in part a 25 per cent increase in average lot size. The long-term increase in the real price of urban land per m^2 was only slightly greater than the increase in real house prices.

Throughout the period, 1930 to 1970, house and land prices tended to decline with distance from the CBD. However, they appreciated more with distance from the CBD, so that the price gradients flattened. This trend is quite different from that of the last 15 years when house price gradients (and by inference land price gradients) became much steeper.

ENDNOTES

(1) The data collection was funded by the Australian Research Grants Commission.

(2) Also, consumer prices were volatile. Between 1929 and 1935, they fell by 25 per cent.

ANNEX 4 LOCAL AREA HOUSE AND LAND VALUES: 1931, 1948 AND 1968.

TABLE A4.1: MEDIAN LOT SIZES AND UNIMPROVED VALUATIONS PER M².

Area	Lot Size (m²)			UV/m² ($)		
	1931	1948	1968	1931	1948	1968
<u>0-8 km/CBD</u>						
Leichardt	237	220	232	1.35	1.55	12.68
Marrickville	290	286	295	1.53	1.40	15.66
N. Sydney	343	342	332	1.34	1.40	16.86
Randwick	328	349	380	1.66	1.79	17.64
S. Sydney	201	228	235	1.74	1.62	12.87
Wollahra	248	393	410	1.93	2.10	29.25
<u>8-16 km/CBD</u>						
Canterbury	536	500	527	0.82	0.76	11.48
Manly	461	556	487	0.89	0.93	14.87[b]
Ryde	769	714	653	0.39	0.49	8.60
Strathfield	800	767	760	0.80	0.88	10.36
Willoughby	570	600	625	0.77	0.92	11.56
<u>16-24 km/CBD</u>						
Auburn	578	606	560	0.32	0.33	7.12
Bankstown	660	642	635	0.28[a]	0.28	7.03[b]
Kogarah	610	550	450	0.50	0.67	9.76
Kuringai	1070	1100	1054	0.28	0.43	7.29[b]
Parramatta	750	750	600	0.12[a]	0.16[a]	6.75[b]
<u>24 km+.CBD</u>						
Baulkham Hills	857	889	896	0.12[a]	0.14	5.10
Hornsby	723	800	705	0.38[a]	0.41	5.95[b]
Liverpool	785	785	758	0.21	0.21	4.32
Penrith	750	733	731	0.12	0.15	2.87[b]
Sutherland	769	750	680	0.13[a]	0.16[a]	8.43[b]
Warrigah	629	616	660	0.25[a]	0.25[a]	9.63
TOTAL	409	447	513	0.92	1.02[c]	9.95[d]

(a) sample size around 50.
(b) valued in 1965 and in 1970 or 1971.
(c) average 1947 to 1949.
(d) average 1966 to 1970.

Source: Author's research.

TABLE A4.2: MEDIAN UNIMPROVED AND IMPROVED VALUATIONS

Area	UV/lot ($)			IV ($)		
	1931	1948	1968	1931	1948	1968
<u>0-8 km/CBD</u>						
Leichardt	320	325	2940	1075	1100	9520
Marrickville	445	450	4610	1595	1500	10930
N. Sydney	460	480	5600	1800	1750	12320
Randwick	545	625	6720	1850	2059	14560
S. Sydney	350	370	3020	950	800	8310
Wollahra	480	825	12000	1550	2410	18500
<u>8-16 km/CBD</u>						
Canterbury	440	380	6055	1400	1800	11395
Manly	410	500	7250[b]	2000	2350	14000[b]
Ryde	300	350	5620	1700	1810	12720
Strathfield	480	767	8400	1900	2750	15680
Willoughby	440	550	7225	1800	2155	16520
<u>16-24 km/CBD</u>						
Auburn	185	200	3975	1050	1250	8480
Bankstown	185	180	4465[b]	1150[a]	1300	10410[b]
Kogarah	305	360	5300[b]	1325	2010	12735[b]
Kuringai	300	500	8100	2150	2175	19000
Parramatta	90[a]	120	4000[b]	750[a]	1000[a]	10000[b]
<u>24 km+.CBD</u>						
Baulkham Hills	130[a]	180[a]	4500	910[a]	1380[a]	11500
Hornsby	275	330	5000[b]	1150	1275	12495[b]
Liverpool	165[a]	165[a]	3275[b]	1155[a]	1635[a]	9500[b]
Penrith	90[a]	110[a]	2100	605[a]	855[a]	7500
Sutherland	100[a]	120	5725	480[a]	775	12720
Warrigah	135[a]	145[a]	6000	630[a]	1000[a]	13000
TOTAL	360	410[c]	5100[d]	1400	1650[c]	11920[d]

(a) sample size around 50.
(b) valued in 1965 and in 1970 or 1971.
(c) average 1947 to 1949.
(d) average 1966 to 1970.

Source: Author's research.

TABLE A4.3: REAL INDICES FOR UNIMPROVED AND UNIMPROVED VALUATIONS 1931 = 100

Area	UV/m²		UV/lot		IV	
	1948	1968	1948	1968	1948	1968
<u>0-8 km/CBD</u>						
Leichardt	80	254	71	251	72	242
Marrickville	64	276	63	282	66	187
N. Sydney	73	340	73	332	68	187
Randwick	75	287	80	337	78	214
S. Sydney	65	200	74	235	63	238
Wollahra	76	409	120	683	109	326
<u>8-16 km/CBD</u>						
Canterbury	65	378	60	376	90	222
Manly	73	452	94	482	82	191
Ryde	88	595	82	511	75	204
Strathfield	103	466	98	478	101	225
Willoughby	84	405	88	448	84	250
<u>16-24 km/CBD</u>						
Auburn	72	600	76	586	83	220
Bankstown	70	678	68	658	79	247
Kogarah	94	527	83	474	106	262
Kuringai	107	702	117	736	90	241
Parramatta	93	1518	93	1212	93	364
<u>24 km+.CBD</u>						
Baulkham Hills	82	1147	97	945	106	345
Hornsby	76	423	84	496	78	297
Liverpool	70	555	70	541	99	225
Penrith	88	646	86	636	99	338
Sutherland	86	1750	84	1562	113	723
Warrigah	70	1040	75	1213	111	563
TOTAL	78	292	80	386	82	232

Source: Author's research.

PART II

HOUSE AND LAND PRICES:

GENERAL EXPLANATIONS

5 THE DETERMINATION OF AVERAGE HOUSE PRICES

5.1 INTRODUCTION

This chapter discusses how house prices are determined in the long and short run. Models are developed for the subsequent empirical analysis of average house prices.

The theories are based on the artificial concept of the price for a standard unit of housing services, referred to hereafter as the price of housing. Of course that standard unit may be taken to be a standard house, somehow defined.

The analysis below is intended principally to explain changes in house prices. The level of house prices in any city, which depends *inter alia* on city size and population, is explained better within the theoretical framework developed in the next chapter.

Section 5.2 describes a long-run model of house and land prices. Although, the price of housing will tend in the long run toward the cost of adding another unit of housing to the stock, it is shown that long-run house prices depend on both the demand for, and supply of, housing.

Section 5.3 discusses equilibrium models of house prices in the short run. In this case, the housing stock is virtually fixed and house prices are determined principally by demand. Annex 5 describes in more technical detail how house price equations may be derived from various formal models of the housing market.

The rationale for adoption of a disequilibrium model of house prices, and some specifications of a disequilibrium model, are discussed in Section 5.4.

Section 5.5 discusses the main determinants of short-run house prices, applicable in equilibrium or disequilibrium models, in more detail.

Section 5.6 summarises the major short-run house price hypotheses that emerge from these discussions which need testing.

A final section briefly summarises the main points in the chapter.

5.2 HOUSE AND LAND PRICES IN THE LONG RUN

As we have seen, in Sydney long-run real (quality adjusted) house prices have risen by slightly under two per cent per annum. They have also risen in Melbourne, but by less than one per cent per annum. On the other hand, they have fallen in Adelaide. In the UK, average real house prices have risen in the long run, but by less than real incomes (see Holmans, 1990).

What is needed therefore is a model that can explain these long-run changes in house prices - as distinct from a model in which house prices reach an unrealistic nirvana of long-run static equilibrium. The model that follows draws heavily on Ermisch (1990), though some notations and minor points are changed.

Starting with the aggregate demand for standard units of housing services, h^d, let this be expressed simply as a function of housing user costs (UC) and a vector of all other non-price demand factors (X) such as household income and population.

Then, in logs,

$$\text{Log } h^d = \alpha \log X - \beta \log UC \tag{5.1}$$

where α and β are elasticities.

Housing services are assumed to be produced by land (L) and non-land (N) factors of production, where ψ represents productivity changes in N. Thus,

$$h = F(L, \psi N) \tag{5.2}$$

The costs of housing producers (C) are given by

$$C = P^L L + p^N N \qquad (5.3)$$

where P^L is the capital price of land and p^N is the price of non-land factors.

Assuming that producers minimise costs subject to (5.2), then

$$P^L/F_L = p^N/\psi F_N \qquad (5.4)$$

where F_L and ψF_N are the marginal products of land and non-land inputs.

It follows that the demand for land for housing is given by:

$$\text{Log } L^d = - \sigma\ S_N \log P^L + \sigma\ S_N \log (p^N/\psi) + \log h \qquad (5.5)$$

where σ is the elasticity of substitution between land and other inputs and S_N is the share of non-land inputs in total costs. The demand for non-land inputs takes on similar form.

The supply of land for housing (L^S) is assumed to depend only on its price,

$$\text{Log } L^S = \varnothing \log P^L \qquad (5.6)$$

where $\varnothing$ is the price elasticity of the supply of land.

In long-run equilibrium, in a competitive market, housing producers will expand output so that there are no excess profits. Therefore

$$P^h h = P^L L + p^N N \qquad (5.7)$$

Using the input demand functions (e.g. 5.5), the producers' equilibrium condition (5.7) implies:

$$\text{Log } P^h = S_L \log P^L + S_N \log p^N/\psi \qquad (5.8)$$

where S_L is the share of land costs. Eq. 5.8 states that the (capital) price of housing services is the sum of the product of the share of land and its price and the share of other factors and their (productivity-adjusted) prices.

Of course, if all factors of (housing) production were in completely elastic supply, or if those in elastic supply could be substituted perfectly for those not in elastic supply, the long-run real price of housing would be constant. But while it is often assumed that non-land factors are in elastic supply (i.e. $d\log p^N/\psi = 0$), land for housing is rarely in perfectly elastic supply and capital is not a perfect substitute for land.

Given these assumptions it follows that the elasticity of the supply of housing with respect to its own price (ϵ) can be expressed as:

$$\epsilon = d\log h^s/d\log P^h = (\sigma S_N + \varnothing) S_L \qquad (5.9)$$

i.e. the supply of housing depends upon the price elasticity of the supply of land, the shares of land and non-land factors, and the substitutability of these factors.

Finally the above relationships imply the following equations for changes in house and land prices.

$$\begin{aligned} d\log P^h &= (\alpha d\log X - \beta d\log UC)/(\varepsilon + \beta) \\ &\quad + [S_N\ (\varepsilon + \sigma)/(\varepsilon + \beta)]\ d\log(p^N/\psi) \qquad (5.10) \end{aligned}$$

$$\begin{aligned} d\log P^L &= (\alpha d\log x - \beta d\log UC)/(\varepsilon + \beta) S_L \\ &\quad + [S_N\ (\sigma - \beta)/(\varepsilon + b) S_L]\ d\log(p^N/\psi) \qquad (5.11) \end{aligned}$$

Holmans (1990) claims that, in the UK, increases in the real prices of non-land factors of production have been offset by changes in productivity so that real building costs have risen broadly in line with inflation. In these circumstances, drawing implicitly on (5.7), Holmans argues that changes in real house prices have reflected changes in land prices. But he also points out that when the supply of land is not perfectly elastic, income elasticities of demand for housing will affect house prices.

Eq. 5.10 confirms that changes in house prices depend also on the major demand elasticities, e.g. income and price elasticities, and on the elasticity of substitution of non-land factors of production for land. In general, the real price of housing will rise most when the income elasticity of demand for house is high and when the price elasticity of demand for housing and the two supply elasticities (the supply of land and the substitution elasticity) are low. Of course, house prices will also depend upon the aggregation variable, population.

Note, however, that the distinction between land and non-land factors is not always as sharp in practice as in theory. Land is not homogeneous. Two parcels of land may have a similar non-urban opportunity cost, but one parcel may require substantial non-land inputs before building can proceed. The use of inferior land for housing implicitly raises the price of land (and the price of housing) even when the nominal price of land, based on its opportunity cost, is unchanged.[1]

Finally, note that the demand variables implicit in (5.1) (e.g. population and income) have been assumed to be exogenous, that is not influenced by house prices. However, as discussed more fully in the next chapter, in an open city model an increase in house prices in one city represents a reduction in real incomes and may cause people to emigrate. In the short run, emigration of workers may put pressure on building (and other costs) and increase the costs of new houses. On the other hand, emigration will reduce the demand for housing in the high priced city and increase the demand for housing and house prices in other cities. If migration is highly responsive to house prices, in the long run, rates of change in real city house prices will tend to converge. But so long as there are intercity differences in population and income growth and in the supply price elasticities of land for housing, long-run differential rates of change in house prices are likely to persist.

5.3 HOUSE PRICES IN THE SHORT RUN: IN EQUILIBRIUM

In Annex 5 I develop three approaches to the construction of house price models.[2] The first is based on the conventional one-period theory of price determination. Prices of housing services are related to the demand for and supply of housing services, with the demand and supply functions defined in terms of income and relevant product and input prices. The durable nature of housing is allowed for by the introduction of interest rates, capital gains and price expectations. This approach has been adopted, usually informally, in many studies (for example Kearl, 1978; Ferri and McGee, 1979; Mayes, 1979; Grebler and Mittelbach, 1979).

Second, house price equations can be developed from an intertemporal model, which treats housing explicitly as a consumer durable, (see for example Kau and Keenan, 1980; and Schwab, 1982). In these papers the demand for housing is treated as a function of the user cost of housing, but price equations were not derived since the studies were concerned with housing demand.

The third approach treats housing as an asset (see, for example, Buckley and Ermisch, 1982; Ebrill and Possen, 1982; and Kearl, 1979.) Drawing on portfolio selection theory, the demand for housing and the price of housing depend mainly upon wealth, income and relative asset prices.

As shown in the Annex, it turns out that the form of the housing price equation is not very sensitive to the choice of approach. The conventional one-period model incorporates the major factors that the other approaches might suggest. The key element is the inclusion of the user cost of housing as an explanator of the demand for housing because this ensures that both the consumption costs and the investment benefits of housing are accounted for in the housing price equation. Consequently I shall start here with the simple framework of the one-period model and then consider modifications, for example allowing for permanent household income.

Three other points need to be made here. First, in this section I shall assume that the housing market is in equilibrium - that housing prices, rather than vacancies or selling times, adjust to equate demand and supply.

The second premise is that the housing market operates recursively. The supply of housing in any period is assumed to be fixed, i.e. determined by housing prices and costs in previous periods. This means that housing prices are determined in the short run primarily by changes in demand and that the price equation can be estimated by ordinary least squares regression. This premise is adopted through most of this study, as in almost all other studies, and is considered realistic. However, I consider briefly below, and in the Annex, the implications of relaxing this assumption, and Chapter 11 reports the results of an estimated two-stage least squares model.

Third, the demand and supply functions are treated as real (inflation adjusted) equations, i.e. they are homogeneous of degree zero. As discussed in Section 5.5, the non-neutality of taxation under inflation may invalidate this assumption.

As shown in Annex 5, if an individual maximises a utility function $U = f(g, h)$, where g is non-housing goods, subject to an annual budget constraint $Y = p^g g + p^h h$, where p^h is interpreted as the user cost of housing, then the demand for housing services is given by:

$$h_t^d = h(UC,\ p^g,\ Y)_t \qquad (5.12)$$

where the subscript t represents the present period (see

Eqs. A.15 and A.3).

Now if p^g is ignored, because this is essentially equivalent to the rate of inflation, and DEM (demographic factors) is added to construct an aggregate demand function, we have

$$h^d_t = (UC,\ Y,\ DEM)_t \tag{5.13}$$

Adding the equilibrium and recursive market conditions already noted, we have

$$h^s_t = (h^s,\ P^h,\ p^N,\ P^L)_{t-1} \tag{5.14}$$

$$h^d_t = h^s_t \tag{5.15}$$

$$P^h_t = P(UC^1,\ Y,\ DEM,\ h)_t \tag{5.16}$$

where UC^1 is all factors included in user costs other than P^h.

We now need to specify the user cost term. In many house price modelling exercises, user costs are considered in Jorgensen (1967) terms simply as a function of capital housing prices (P^h), interest rates (r) and expected housing prices:

$$UC_t = P^h_t r + (P^h_{t+1} - P^h_t) \tag{5.17}$$

Then, as shown in Annex 5 (see A.19), we obtain:

$$P^h_t = P(EP^h,\ r,\ Y,\ DEM,\ h)_t \tag{5.18}$$

when EP^h stands for expected housing prices.

In more detail, user costs may be specified as:

$$UC_t = P^h_\cdot\ e.\ br(1 - tr) + P^h_\cdot\ mr(1-e) + P^h(D + M + th) -$$

$$(P^h_{t+1} - P^h_t)(1 - cgt) \tag{5.19}$$

where e = equity in housing services,

br = bond rate,

tr = marginal tax rate for individuals

mr = mortgage rate

D = depreciation rate

M = maintenance costs as a percentage rate

th = tax rate on housing services

cgt = capital gains tax on housing services.

Subject to data availability, we can substitute all the user cost components in (5.19) other than P^h into the right hand side of the reduced form housing price equation (5.16). The final estimating form will not contain the explicit UC term, but only those components of it which are not currently endogenous.

It may be noted that some intertemporal models now include adjustment costs of investment (see Hayashi, 1982). An equivalent feature in housing markets would be transaction costs - the costs of moving houses which could be included in the user cost function. However as Muth (1990, p. 9) remarks "several examinations of this problem have convinced me that it is not very fruitful of interesting implications".

Some further points need to be made about the above model.

(i) The model assumes that a standard unit of housing service is demanded and supplied. It is generally assumed that the flow of housing services is proportional to the stock of houses so that the model can be applied directly to house prices. In models of actual house prices, however, allowance may have to be made for changes in quality. If the house price series itself is not quality-adjusted, this may be done by introducing a quality index variable in the demand and supply equations (e.g. Ferri and McGee, 1979).

(ii) The model assumes that separate city housing markets can be identified. As a first approximation, this is a reasonable assumption in Australia where distances are great and intercity migration is influenced only

5.4 HOUSE PRICES IN THE SHORT RUN: IN DISEQUILIBRIUM

So far we have assumed that housing markets are in equilibrium and that prices are determined by current demand and supply conditions (including house price expectations). However, the cyclical behaviour and volatility of house prices (see Chapter 2) suggest that prices may not always be in equilibrium. The lengthy downward parts of the real price cycles indicate that nominal prices may be sticky downwards. The sharp upward movements suggest over-adjustment to demand changes. Disequilibrium is also evident in the variations in turnover rates and selling times in Australian (and other) housing markets.

As we shall see, several economists consider that house prices are not market-clearing prices. For example, Rosen and Smith (1983) wrote "Although the existence of a clearly defined unambiguous disequilibrium static is not conclusively demonstrated by any individual macro study, the preponderance of macro evidence does support a slowly adjusting market in which non-equilibrium conditions may persist for some time."

Given the premise of non-market-clearing prices, we need to consider the nature and causes of housing market disequilibria; the implications for price dynamics; and the implications for modelling house prices.

Causes of Housing Market Disequilibria

Housing market disequilibria can occur for two main reasons. Either individuals in the market fail to appreciate the true demand and supply conditions or the market itself is sticky. In our view the first of these is the more important factor.

There are many possible sources of individual errors of judgement or lags in behaviour. On the demand side, households may adjust only slowly to changes in income or weakly by relative house prices. However expectations and investor demand may be influenced by relative city house prices. It is of course straightforward to include house prices in other cities as independent variables in (5.18).

(iii) Although (5.18), together with (5.19), includes a large number of potential house price explanators, various studies have emphasised other factors such as the money supply, the rate of inflation or the provision of public housing (see Appendix B). These points are discussed further in Section 5.5.

(iv) The key variables in (5.18), for example interest rates, income and demographic variables, require more precise definition and specification. These points are also taken up in Section 5.5.

Finally some comments on the assumption that the supply of houses is determined independently of current housing prices. Although I regard this as a realistic assumption, in an ideal world the assumption would be tested.

However, there are three practical reasons why testing would not be very productive. First, there is no readily available (annual or quarterly) estimate of housing stock or house completions in Australian cities. Second, to develop a simultaneous model of the housing market it is also necessary to have adequate data on supply explanators. Again the data, for example for labour costs in house building, are poor. Third, using annual data, the sample sizes for Adelaide and Melbourne, and for Sydney from 1965 to 1989, were too small to allow the benefits of simultaneous equation estimation (e.g. consistency of estimators) to be reflected in the values of the parameter estimates. Notwithstanding these problems, I tested a simultaneous model for the Sydney housing market from 1925 to 1970 (see Chapter 11).

interest rates. Also, they may hold mistaken views about future house prices. Alternatively, households may plan their allocation of assets on the basis of expected asset prices and, if actual house prices turn out to be lower (higher) than expected prices, they will increase (reduce) their subsequent demand for housing to achieve their desired mix of assets (Deaton and Muellbouer, 1980; Buckley and Ermisch, 1982). On the supply side, housing producers may make erroneous forecasts of house prices and so over or under-supply housing. Alternatively, if sellers and buyers have different price expectations, transaction times and vacancies increase until sellers reduce prices in line with buyer expectations.

Turning to the characteristics of the housing market, which of these could cause non-market-clearing prices? First, high transaction costs create stickiness in the market, so that at any point in time many households are not housed optimally. However, since transaction costs do not vary much from one year to the next, they cannot be responsible for the volatility of house prices. Second, the regulation of credit costs for housing (common in Australia and other countries before the 1980s) may have distorted housing markets. This point needs to be taken into account in modelling house prices (see the next section). But credit regulation does not prevent house prices adjusting to changes in demand and supply, subject to the credit constraint. Given the competitive nature of the housing market, and the lack of direct price regulation in Australia, I would expect house prices to adjust quite freely, depending upon individual behaviour and expectations.

Implications for House Price Dynamics

Where are the implications of the above discussion for house price dynamics? The most common presumption (see the Smith and Rosen quote) is that the market adjusts only slowly to changes in demand and supply conditions. In their recent survey article, Smith, Rosen and Fallis (1988) claim that "Because prices appear not to clear the market instantaneously, changing demand conditions are reflected first in changed vacancies and prices (rents) are affected only after a lag of approximately 6-24 months."

However there is another view (see for example Hendry, 1980) that prices may rise too fast, due to excessive price expectations and over-shoot in the short run. There then occurs a ratchet effect as nominal prices are sticky downwards, (due not to market stickiness but seller intransigence). This latter scenario seems to describe some Australian (and UK) experience.

A special problem arises when expectations of high price increases cause expected housing user costs to be very low or even negative. If a rise in house prices creates expectations of further rises, expected capital gains can increase the demand for housing - thus part of the demand curve is upward sloping. In Figure 5.1, E_1 and E_3 are locally stable equilibrium points: following small moves away from P_1 and P_3, the market price is likely to revert back to these prices. However small departures from P_2, or slightly larger departures from P_1 or P_3, can cause large discontinuous jumps in prices between equilibrium points. This kind of scenario may explain why large changes in house prices occur. Unfortunately, it is not easy to predict when the initial shocks to the system will occur.

Moreover, the various kinds of disequilibria may be linked. In Figure 5.2, for example, an exogenous event, such as a resource discovery, sets off a speculative boom and excess demand for houses. Initially supply lags behind; but, in response to the high house prices, producers over-supply new houses. Rather than reduce prices and sell "at a loss", producers let stocks build up. However, the high unsold stock levels exert a downward presence on the whole housing market and prices decline below their equilibrium level. This continues until normal unsold stock levels are reached or another exogenous event occurs.

Figure 5.1 Multiple Equilibria in the Housing Market

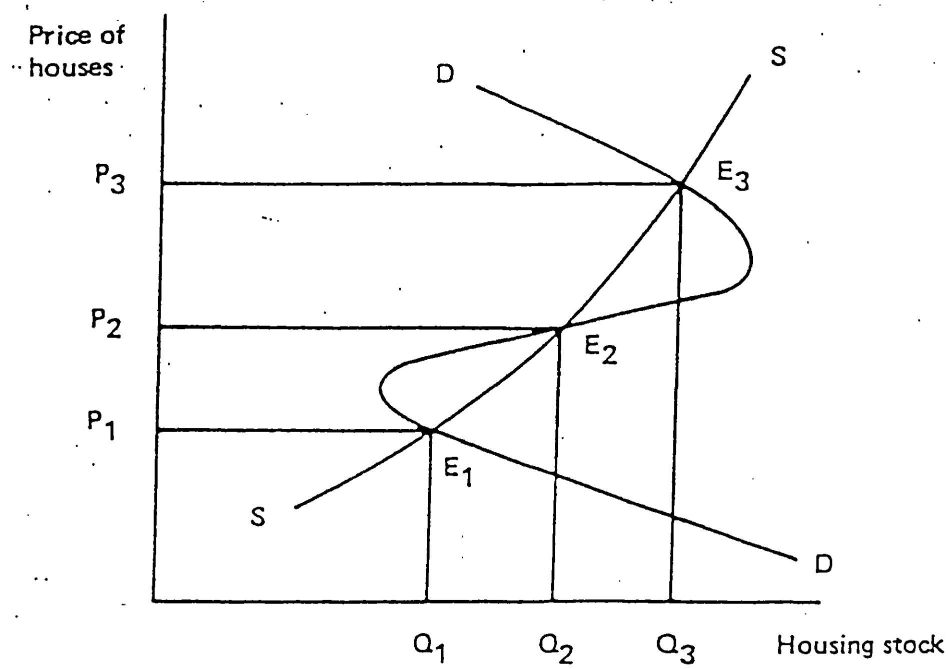
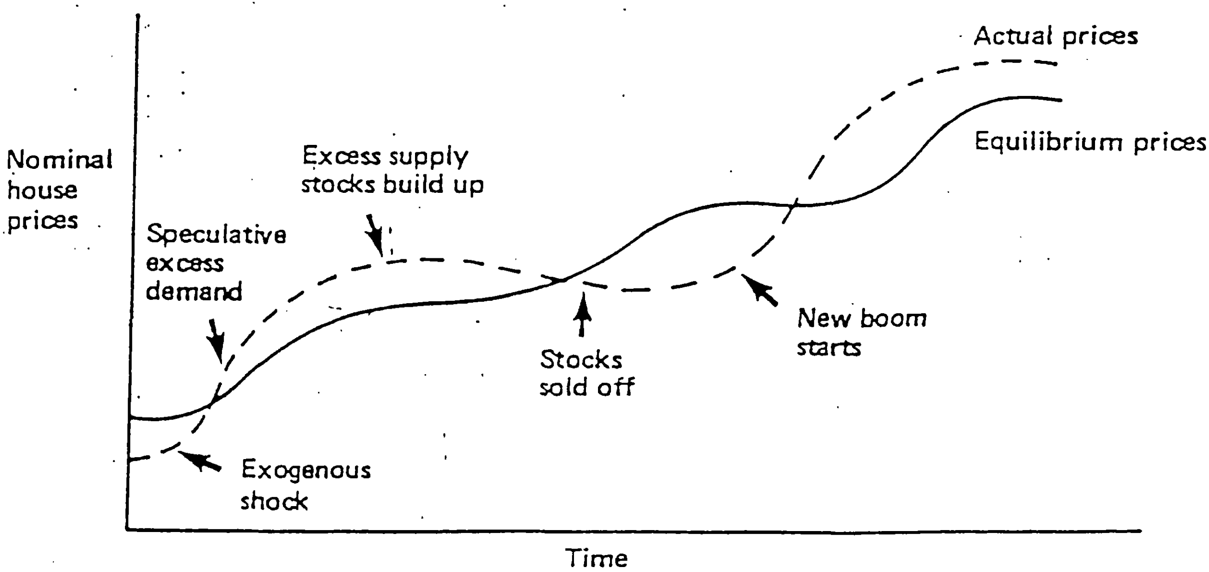


Figure 5.2 House Price Cycles



There is considerable evidence that house prices do move in cycles. Most likely, these cycles are caused by combinations of disequilibrating influences superimposed upon the underlying equilibrium conditions.

Modelling Disequilibria

In their classic article, Fair and Jaffee (FJ, 1972) proposed that when markets are in disequilibrium, prices and quantities are determined by either demand or supply, but not by both at once. When prices are high (in relation to equilibrium), there is excess supply and quantities consumed are demand determined. When prices are low, there is excess demand, vacancies are low, and quantities are supply determined.

Unfortunately, strong assumptions are required to identify whether quantities at any point in time are demand or supply-determined. Also the FJ approach requires more data, for example on housing stocks, and more observations than were available to me; it was not a practical option for this study. In fact, there appear to be few successful applications of the FJ model to housing markets, Markandya and Pemberton (1984) being one. However, Upcher and Walters (1978) found that the Australian housing market could not be modelled with the FJ method.

When a market is not in equilibrium, there are two common practical assumptions about how prices change. Rosen and Quandt (1978) and Muth (1989) assume that price change is proportional to excess demand:

$$P^h_t - P^h_{t-1} = y(h^d_t - h^s_t) \qquad (5.20)$$

where "y" is a partial adjustment parameter.

Huang (1980) and Abelson and Cooper (1991) assume that the change in price is proportional to the difference between the current equilibrium price (P^{h*}) and the actual price in the previous period:

$$P_t^h - P_{t-1}^h = z\ (P_t^{h*} - P_{t-1}^h) \qquad (5.21)$$

where "z" is the adjustment parameter.

As Markandya and Pemberton (1984) point out, without information about the market there are no strong prior grounds for preferring one to the other, and indeed under certain specifications (when P^{h*} is determined by linear demand and supply equations) the two equations are similar.

To model (5.20), we can write

$$P_t^h = y\ f(h_t^d,\ h_t^s) + v\ P_{t-1}^h \qquad (5.22)$$

To model (5.21) it is conventional to substitute in the demand and supply determinants of P^{h*}. Therefore (5.21) becomes:

$$P_t^h - P_{t-1}^h = z\ [h(h_t^d, h_t^s) - P_{t-1}^h] \qquad (5.23)$$

In words, the <u>change</u> in real house prices depends on various determinants of the demand for and supply of houses in the current period and on house prices in the previous period.

Alternatively, the <u>level</u> of house prices at any point in time can be modelled as a function of the current level of demand for houses, and house prices in the previous period, as in:

$$P_t^h = zh(h_t^d, h_t^s) + vP^h{}_{t-1} \qquad (5.24)$$

where "v" is the (negative of the partial) adjustment parameter.

In this formulation, if the equation is formulated in log-linear form, the coefficients of the demand and supply variables may be interpreted as short-run elasticities. To estimate the respective long-run elasticities, the short-run elasticities are multiplied by 1/(1-v).[3]

Hendry (1980) extended the above analysis by arguing that to model rapid changes in house prices, it is "sensible to consider a cubic" expression:

$$P^h_t - P^h_{t-1} = \Phi_1 (\log h^d - \log h^s)_t + \Phi_2 (\log h^d - \log h^s)^3_t \quad (5.25)$$

where Φ_1, $\Phi_2 > 0$.

As Hendry remarks, because small differences in (h^d-h^s) are negligible when cubed, the equation deviates substantially from the linear form only when excess demand (or supply) is large, in which case P^h alters quickly.

Hendry further argued that since h^d and h^s are unobservable, empirical estimation of (5.25) is difficult. He adopted an "expectations disequilibrium" rather than an "excess demand" formulation. Thus

$$\text{Log } h^d - \log h^s = K(\log EP^h - \log P^h) \quad (5.26)$$

Hendry approximated the term on the right hand side of (5.26) by the cubic of changes in lagged house prices.

The Hendry model has aroused considerable interest, especially in the UK, because it attempts to deal with the critical issue of rapid price changes (unlike most models which assume slowly adjusting markets). Hendry (1980) admitted that "the justifications are somewhat *ad hoc*" but argued that "the overall idea is of adequate prior plausibility to merit empirical testing". He also claimed that use of a cubed lagged dependent variable helped to explain the UK house price booms from 1971 to 1973 and 1978 to 1979.

However, Dicks' (1990) detailed review of Hendry's model does not support the use of the cubed lagged dependent variable. Dicks writes

> "the term's contribution is close to zero throughout much of the last two decades, only becoming significant during the periods 1971 Q3 to 1973 Q3 and 1978 Q3 to 1980 Q1 (contributing an average 13% and 8%] of the total predicted changes during these

> periods) ... Nevertheless, the re-estimated Hendry equation performs poorly in terms of explaining the house price "booms". In addition it suffers from first-order autocorrelation and predicts poorly."

Finally, as has been noted, disequilibria may manifest themselves in vacancy rates. In this case, prices may adjust to equate demand with modified supply (h^{s*}) as in:

$$h^{s*} = S(1 - VR) = h^s - V \tag{5.27}$$

$$h^d = D(P^h, X) = h^s - V \tag{5.28}$$

$$P^h = f\ (X,\ h_s - V) \tag{5.29}$$

where VR is the vacancy rate and V is the number of vacancies. Alternatively VR can be viewed simply as a function of excess supply $v(h^s - h^d)$ and prices expressed as:

$$P^h = f(VR) \tag{5.30}$$

Such models have been applied to the housing rental market (e.g. Rosen and Smith, 1983) and the commercial rental market (e.g. Wheaton and Tonto, 1989; Abelson and Cooper, 1991). However they have limited applicability to the housing (asset) price market since all unoccupied houses are owned by someone. Practically, data on vacant housing in Australian cities are available only from five-yearly census data and not at other times.

Conclusions

From a practical viewpoint (5.22 to 5.24) represent the basic (similar) equations for modelling disequilibria in the housing market. These equations are enhanced if suitable explicit measures of house price expectations can be found and incorporated in them. However, the equations are at best crude approximations of the complex disequilibrating forces discussed in this section.

5.5 POTENTIAL DETERMINANTS OF HOUSE PRICES IN THE SHORT RUN

I now consider the potential regressors in the price equation in more detail. The main points here are theoretical although some attention is paid to measurement problems. The latter concern us more in Chapter 7.

Income and Employment

In a perfect financial market, where individuals could borrow against future real income and where loan repayments and interest payments were scheduled in real terms, a household's demand for housing services would depend on its expected permanent disposable income, not on its current income. Reid (1962) found that there was a more stable relation between housing expenditure and permanent income than between housing expenditure and curent income. de Leeuw (1971) found the permanent income elasticity of demand for housing to be significantly higher than the current income elasticity of demand. In this case, since anticipated changes in income do not change expected permanent income, only unexpected large changes would affect h^d and P^h.

However, capital markets in Australia, as in many other places, are imperfect. Loan and interest repayments are generally scheduled in equal nominal instalments rather than in equal real ones. Also households often face a front-end financing problem. Therefore current disposable income is frequently a constraint on housing demand. Moreover, it appears less important to take account of permanent income changes in aggregate time series work than in cross-section work (Muth, 1989).

There are two reasons why employment might be considered a substitute regressor for income in Australian city house price equations. First, there is no regular measure of income in Australian cities. Second, when wages are regulated, as many are in Australia, the quantity of employment may be a better indicator of prosperity than average wages.

Interest Rates, the Supply of Credit and Related Issues

As we saw in (5.19) interest costs are not a simple function of house prices and mortgage rates. They depend as well on the opportunity costs of capital, gearing and marginal tax rates. Theoretically a weighted rate of interest could be computed that allowed for various interest rates, gearing and tax rates. However this would not necessarily be representative of many households.

Instead, conventional practice is to select one interest rate as typical of the (marginal) cost of capital. This makes practical sense, as bond and mortgage rates are usually correlated. Nevertheless, there are still three substantive issues that deserve consideration.

First, given that house price equations are usually expressed in real terms, consistency would require the interest rate also to be measured in real terms. In a perfect financial market, real interest rates would be the key variable. However, there are cogent reasons why nominal interest rates are often adopted as explanators of house prices. (i) As mortgages are usually repaid as flat nominal payments, nominal interest rates are probably as significant as real rates. (ii) Real rates are not observable ex-ante. (iii) Real and nominal rates are usually correlated. As shown in Appendix B, most house price studies have included nominal rather than real interest rates as an explanator in house price equations.

Second, a rational household would base its purchase decision in part on expected future interest rates. These may be more closely related to the long-term bond rate than to the current mortgage rate.

Third, When mortgage rates are regulated and do not clear the market for housing finance, the availability of housing finance, as well as its cost, may influence h^d (Whitehead, 1974; Jaffee and Rosen, 1979). Accordingly, the demand for housing may increase despite a rise in mortgage rates, if housing finance becomes more plentiful. This can be allowed for crudely by including a supply of housing finance variable in the housing demand equation (e.g. Mayes, 1979). Unfortunately, such a variable may be an endogenous function of housing demand. Consequently, even if the credit coefficient is significant, it is difficult to interpret.

Given that equities as well as financial assets represent an alternative investment to housing, consideration needs to be given to inclusion of returns to equities as an independent regressor in a house price equation. Generally the demand for housing would be highest when equities were highly priced and yields low (which would reflect high wealth and low interest rates). On the other hand, many in the Australian real estate industry argue that the stock market crash in October 1987 increased the demand for housing as a (secure) asset. However, possibly because of the presumed positive correlation between equity yields and interest rates, returns to equities are rarely included in house price equations as well as interest rates.

Related to the supply of credit is foreign investor demand for housing (financed from overseas) in major cities such as Sydney or Melbourne. Daly (1982) argued that Australian property markets are strongly influenced by international capital movements. To some extent such movements are independent of domestic determinants of housing demand.

Expected House Prices and Inflation

As we have seen, expected capital gains can have a major impact on h^d and P^h. The absence of a capital gains tax on owner occupied property in Australia increases the attractiveness of housing as an asset. Of course, to include expected capital gains as a regressor, some measure of these expectations is required. Various measures are discussed in Chapter 7.

The structure of taxes in Australia, as in many other countries, makes housing a specially desirable asset during high inflation, when the nominal gains of financial assets and nominal dividends are taxed but capital gains on owner-occupied houses are not taxed. Generally, investment in housing is perceived to be a hedge against inflation. Inflationary expectations are likely to increase h^d and consequently P^h.

Effects of Substitutes

Some UK analysts (e.g. Mayes, 1978; Buckley and Ermisch, 1982) include completions of public houses as a (negative) explanator of established (private) house prices. Public housing is not very important in Sydney or Melbourne, but could be a factor in Adelaide prices.

Probably more important would be completions (or prices) of flats. However flat and house prices have similar explanators. The inclusion of flat prices in a house price equation would cause problems of interpretation.

As previously noted, relative city house (asset) prices may affect h^d by influencing both population movements and investment demand for housing.

Demographic Factors

It appears that UK house price studies are more likely than US studies to include population as an explanator of house prices (see literature review, Appendix B). The reason for this is not clear. However population does not change speed or direction very quickly and is not likely to affect house prices significantly in the short run. Natural increases trend up at a fairly steady rate and net migration is usually small in proportion to city population.

Since households demand houses, the number of households is sometimes considered to be a more important determinant of housing demand than is population. However there are various objections to substituting households for population. First, since our models are based on units of housing services, it is wrong to think of houses as the object of demand. Second, household formation is itself related to both income levels and house prices. Third, as a practical matter, it is much more difficult to obtain regular estimates of households than of population.

Mankiw and Weil (MW, 1989) and Holmans (1990), among many, argue that the age distribution of the population has an important effect on housing demand and house prices. Within Australia, the Housing Industry Association and many planners argue strongly that population in the 25 to 35 age group, the major first time home buyers, has a major influence on housing demand.

However, this notion also fails to distinguish between the demand for housing services and the demand for houses. Moreover, Hendershott (1991) has shown that the MW model is oversimplified (it does not include income or interest rates, for example) and it does not explain house prices well in the 1970s and 1980s. Dicks (1990) finds that, if the proportion of the UK population between 25 and 34 is included as an additional variable in the house price equation, the coefficient is negative and the explanation not improved.

Many Australian commentators (e.g. Birrel, 1990) argue that foreign immigrants are an important component of housing demand, because they additional housing, and that they have a major impact on house prices especially in Sydney. Currently, about 45,000 immigrants enter Sydney each year. They require some 15,000 dwellings compared with an annual production in Sydney of about 20,000 dwellings (or a total stock of 1.23 million private dwellings). The effects on house prices would be mitigated by the fact that most migrants have below average wealth and income. Also, an increase in house prices could cause other households to economise on housing or to move out of the city. There is a significant positive relationship between foreign migration into Sydney and domestic migration out of Sydney (NSW Department of Planning, 1990).

Other Demand Factors

Housing user cost expressions usually include elements for maintenance and depreciation (M & D). The higher such costs, the lower h^d and P^h. However, M & D do not vary much over time and rarely show up in empirical work on house prices.

Recurrent taxes on real estate, such as taxes on imputed rents or rates levied on capital or land values, also increase user costs and depress house prices. However, in Australia, recurrent property taxes owners are usually a small and constant proportion of house prices and can be ignored in this study.

Of course, any tax on housing (or subsidy for other goods) reduces h^d. Conversely, housing subsidies (or taxes on other goods) increase. In the empirical work (Chapter 7), the effects of some major fiscal changes on house prices are tested.

Supply Factors

As shown above, house price equations usually include housing stock as a determinant of house prices. Actually, it is not clear whether all houses should be included as a regressor as many houses are not on the market. In any case, in the absence of regular figures for housing stock in each city, these figures have to be estimated.

House completions are used sometimes as a proxy for housing stock (see Appendix B). But, in the short run, house completions are unlikely to have much (negative) impact on house prices as they are only a small part of the total stock. Indeed, in the short run, completions are likely to be positively related to house prices (due to the supply-side effect) and new house prices will be determined by existing house prices.

It follows that in the short term an increase in building costs is usually borne by the landowner. In the longer run, if land prices reflect the real opportunity costs, higher building costs would be reflected in increased house prices.

If the price of land reflects its opportunity cost (plus the costs of resources applied to it), an increase in the price of land will increase house prices as more land is used. But if the stock of land for residential use is more or less fixed in the short run, the price of land generally rises because the price of housing has risen, rather than the reverse.

5.6 MAJOR HYPOTHESES FOR SHORT-TERM CHANGES IN HOUSE PRICES

Given the range of variables that may determine house prices in the short run, it is useful to identify some key hypotheses for investigation. Support for some of these hypotheses can be found in the literature survey (see Appendix B).

(i) The Standard Explanation. Overseas studies of house prices have produced a range of results. Their basic theme is that house prices are determined in the short run by demand rather than by supply variables. Of the demand variables, most emphasis has been placed on income, interest rates and expected capital gains (which is often linked to the rate of inflation).

(ii) The Demographic Explanation. This is usually regarded as a long-run explanation, though some analysts have incorporated population, households or some other demographic variable in short-run models.

(iii) The International Angle. As noted above, some commentators have ascribed the volatility of house prices in Australia, especially in Sydney, to volatile movements in foreign capital or migration, or both. However, there has been very little discussion of international transmission effects from overseas housing markets to Australian ones.

(iv) The Supply Side. Although the supply of housing is usually regarded as a long-term rather than short-term influence on house prices, the major forecaster of property prices in Australia, Bis-Shrapnel Pty. Ltd., considers house completions to be an important determinant of house prices in the short run.

(v) The Credit Effect. MacFarlane (1990), then Head of Research of the Reserve Bank, argued that asset price inflation in the 1980s was due to the explosion of credit. Mayes (1979) and others have used a similar argument for UK house prices.

(vi) The Stock Market Crash. The REIA believes that the the stock market crash in 1987 was a major cause of house price inflation in 1988-89. As noted above, this is the reverse of the usually assumed relationship between equity prices and house prices.

(vii) Housing Policies. Policy makers usually have a special interest in the possible effects of housing policies on house prices. A recent concern has been the potential impact of financial deregulation. This and other policy issues are analysed in Chapter 7.

5.7 CONCLUSIONS

It is generally held that, in the long run, established house prices will tend toward the cost of providing new houses. However, this is an over-simplification. We saw that long-run (real) prices depend on household income, population, the price elasticity of demand for houses, the price of land and the elasticity of substitution of non-land factors for land in the supply of housing. This assumes that material and labour costs, after allowing for productivity gains, rise broadly in line with inflation.

In a conventional equilibrium model in a competitive economy, house prices are determined in the short run mainly by the demand for housing, notably by household income, interest rates and expected changes in house prices. In principle, short-run house prices are also determined by demographic factors and the size of the housing stock. But these factors usually change slowly and may have little short-run impact.

Allowing for a more complex economic environment, including market imperfections, we find that house prices may be influenced by a variety of other variables, including the availability of credit, employment, relative city house prices, inflation, household formation, the age composition of the local population, migrants, the return on equities, and by policy variables, such as housing subsidies and capital gains taxes.

It also appears that the housing market may sometimes, possibly often, be in disequilibrium, with people either under or over-adjusting to changes in economic phenomena. Whether this is so is an empirical question. However, econometric models cannot easily replicate the richness of the human envirnment and simulate both forms of adjustment in one model. Most econometric models of disequilibrium employ lagged adjustment models. The Hendry model of the UK housing market attempted (to-date unsuccessfully) to model excesssive adjustments.

Difficulties also arise in the definition and measurement of some key variables. Theoretically, for example, the demand for housing should depend on permanent disposable household income and expected real interest rates, but both of these are difficult to measure and it is not clear that real interest rates are as important as nominal rates. It is also difficult to obtain realistic measures of expected house prices. As Joan Robinson (1960) wrote,

> "... the causal elements in the situation are expectations; the evidence can never catch them. We are looking in a dark room for a black cat which left before we got there."

Finally, to set a practical agenda for the econometric analysis, seven sets of hypotheses for short-run house price determination were established. These were the "standard" explanation (emphasising income, interest rates and expected capital gains or inflation); the demographic effect; the international angle (migrants or foreign investment); supply-side effects; credit effects; the stock market crash; and the impacts of housing policies.

ENDNOTES

1. In the model presented in this section, similar factors determine house and land prices (see 5.10 and 5.11). In a model designed to explain land prices, Capozza and Helsley (1989) show that the price of urban land has four additive components: the value of agricultural land rent, the cost of conversion, the value of accessibility, and the value of expected future rent increases - a growth premium.

2. Annex 5 was written jointly with Dr Russel Cooper (see Appendix A).

3. Justification for the statement is given in Abelson and Cooper (1991). It may be noted that, under this formulation, the relationship between the short and long-run impacts is assumed to be the same for all independent variables. In practice, some variables are likely to have faster impacts than others.

ANNEX 5 - MODELS OF HOUSE PRICE DETERMINATION IN THE SHORT RUN

In this Annex, three ways to derive a house price equation are outlined. These are based on three models of housing demand: a one-period allocation of expenditure model, an intertemporal model, and a portfolio (asset-holding) model. We start by assuming that the individual maximises a general utility function and that the supply of housing is fixed. These two assumptions are dropped in the last two sections.

The main purpose of the Annex is to examine the extent to which the house price equation is sensitive to the choice of model of housing demand. It turns out that the price equation is not very sensitive to the choice of model.

A One-Period Expenditure Allocation Model

We assume that an individual maximises

$$U = f\ (h,\ g) \tag{A.1}$$

subject to

$$Y = p^h h + p^g g \tag{A.2}$$

where h is housing services, g is other goods, Y is household income, p^h is the annual price of housing services, and p^g is the price of other goods. But now following Jorgensen (1967), the annual price of housing can be expressed as

$$p^h_t = UC = P^h_t r - (P^h_{t+1} - P^h_t) \tag{A.3}$$

where P^h is the capital price of housing services, r is the (real) rate of interest and the subscript 't' refers to the period. This effectively changes the budget constraint to

$$Y + (P^h_{t+1} - P^h_t)h = P^h_t rh + p^g g \tag{A.4}$$

assuming that the individual can borrow against the expected (real) capital gain.

We now maximise (A.1) subject to (A.4). The Lagrangean is:

$$z = f(h,g) + \lambda[Y + (P^h_{t+1} - P^h_t)h - P^h_t rh - p^g g] \tag{A.5}$$

and the first order conditions imply:

$$\frac{dz}{dh} = f_h + \lambda(P^h_{t+1} - P^h_t) - \lambda P^h_t\, r = 0 \tag{A.6}$$

$$\frac{dz}{dg} = f_g + \lambda p^g = 0 \tag{A.7}$$

$$\frac{dz}{d\lambda} = Y + (P^h_{t+1} - P^h_t)h - P^h_t\, rh - P^g g = 0 \tag{A.8}$$

Multiplying (A.6) by h and (A.7) by g, we get

$$f_h h + \lambda\, [h(P^h_{t+1} - P^h_t) - hP^h_t\, r] = 0 \tag{A.9}$$

$$f_g g - \lambda\, p^g g = 0 \tag{A.10}$$

Adding (A.9) and (A.10) together and solving for λ we obtain

$$\lambda = \frac{f_h h + f_g g}{-h(P^h_{t+1} - P^h_t) + hP^h_t\, r + p^g g} \tag{A.11}$$

$$= \frac{f_h h + f_g g}{Y}, \text{ using (A.8).} \tag{A.12}$$

Substituting (A.12) into (A.6) and (A.7),

$$f_h = \left[\frac{f_h h + f_g g}{Y}\right][P^h_t r - (P^h_{t+1} - P^h_t)] \tag{A.13}$$

$$f_g = \left[\frac{f_h h + f_g g}{Y}\right] p^g \tag{A.14}$$

(A.13) and (A.14) are two equations in two variables (h, g) as functions of $P^h_t\, r - (P^h_{t+1} - P^h_t)$, p^g, and Y. The general solutions are therefore

$$h^d_t = h\left[P^h_t r_t - (P^h_{t+1} - P^h_t),\ p^g_t,\ Y_t\right] \tag{A.15}$$

$$g^d_t = g\left[P^h_t r_t - (P^h_{t+1} - P^h_t),\ p^g_t,\ Y_t\right] \tag{A.16}$$

Since (A.15) and (A.16) represent individual demand functions, aggregate demand functions require an aggregation variable such as population or households (although both, especially the latter, may be a function of P^h and Y).

Given (A.15) and adding population (POP), and given the equilibrium condition,

$$h^d_t = h^s_t = \bar{h}^s_t \tag{A.17}$$

where $\bar{h}^s_{t,}$ the supply of housing, is fixed exogenously, then

$$P^h_t\ r - (P^h_{t+1} - P^h_t) = h^{-1}\ (P^g_{t,}\ Y_{t,}\ POP_{t,}\ h^s_t) \tag{A.18}$$

$$P^h_t = \frac{P^h_{t+1} - P^h_t}{r_t} + \frac{1}{r_t}\ h^{-1}(p^g_t,\ Y_t,\ POP_t,\ h^s_t) \tag{A.19}$$

where h^{-1} denotes inversion of the h [ ] function in its first argument.

Since (A.15) is homogeneous of degree zero in prices, (A.18) and (A.19) are expressed in real terms. However, because of market imperfections (notably taxation and regulated interest rates) the rate of inflation, nominal incomes and nominal interest rates can also affect real house prices. For example unless mortgage repayments are indexed, an increase in nominal interest rates increases the real debt burden in the present and reduces it in the future. In a one-period model with inflation over the period, non-indexed loans and no borrowing against future increases on nominal income, the 'r' in the budget constraint would be the nominal rate of interest.

An Intertemporal Model

In our intertemporal model we assume that an individual maximises his lifetime utility and that utilities are additive intertemporally,

$$U = U(g_o \ldots g_n, H_o \ldots H_n) = \sum_{t=0}^{n} U(g_t, H_t)(1+\phi)^{-t} \qquad (A.20)$$

where H is the stock of housing and the supply of housing services is proportional to the stock of housing, ϕ is the individual's time preference rate, and there are $t = 0 \ldots n$ periods.

In any period purchases of the durable good, H, are given by changes in the stock,

$$D_t = H_t - (1-\delta) H_{t-1} \qquad (A.21)$$

where δ is the physical depreciation of the existing stock and is assumed to be proportional to it.

Assuming that the individual can borrow and lend and that he finishes without any assets, the intertemporal wealth constraint requires that the present value of his initial wealth and his income equals the present value of his consumption. The lifetime budget constraint is therefore given by

$$W_o + \sum_{t=0}^{n} [Y_t - p_t^g g - P_t^h (H_t - (1-\delta)H_{t-1})] (1+r)^{-t} = 0 \qquad (A.22)$$

Maximising (A.20) subject to (A.22) yields as first order conditions the constraint plus

$$U_g(g_t, H_t)(1+\phi)^{-t} - \lambda p^g{}_t (1+r)^{-t} = 0 \qquad (A.23)$$

$$U_H (g_t, H_t)(1+\phi)^{-t} - \lambda [P_t^h - (1-\delta)[P_{t+1}^h (1+r)^{-1}] (1+r)^{-t} = 0 \qquad (A.24)$$

where U_g and U_H are the partial derivatives of utility with respect to g and H.

This leads to a set of 2(n+1) demand equations, one for each good for each period plus a solution for the Lagrange multiplier. Using (A.22) to eliminate the Lagrange multiplier in (A.23) and (A.24), we obtain a demand equation of the general form,

$$H_t^d = H(p^g, P^h, \delta, r, W_0, Y) \tag{A.25}$$

where the demand for housing depends upon the entire time path for p^g, P^h and Y. Allowing for the addition of δ and W, (A.25) is a generalisation of (A.15). As with (A.15) the model disregards market imperfections such as borrowing constraints. Schwab (1982) describes an intertemporal model which incorporates a borrowing constraint (as well as an income constraint) with inflation.

A Portfolio (Asset-Demand) Model

In general, ignoring inflation, the demand for any asset (D^A) may be expressed simply as

$$D^A = D\ (r^A, br, W, Y) \tag{A.26}$$

where r^A represents the expected return on asset A and br is the return on bonds which is assumed here to be risk-free. The relationship between D^A and r^A will depend partly on the variance in r^A and it may be appropriate to include a measure of variance in (A.26) but this is not central to the exposition. Likewise the returns on other risky assets may be important but they are not included here.

The rate of return on housing services (r^h) is given by

$$r^h = \frac{R}{P^h} - \delta + E\dot{P}^h \tag{A.27}$$

where R is the rent from housing services, δ is the proportional rate of depreciation, and $E\dot{P}^h$ is the expected rate of real capital appreciation of housing services.

But assuming perfect markets, R and P^h must satisfy

$$R^h = P^h\ (\delta + mr - E\dot{P}^h) \qquad (A.28)$$

where mr is the mortgage rate.

Accordingly the asset demand for housing is

$$D^h = D(P^h,\ \delta,\ mr,\ E\dot{P}^h,\ r,\ W,\ Y) \qquad (A.29)$$

assuming that $mr \neq r$. (A.29) is of course similar to (A.25), where P^h is the path of house prices. However, since we are here concerned exclusively with housing as an asset, there is no reference to p^g - the price of other consumption goods.

The asset demand for housing will be reduced, *ceteris paribus*, if mortgage funds are rationed. In this case a credit availability variable has to be added to (A.29), (see Kearl, 1979). Asset demand will also depend upon the rate of inflation and taxation when taxes are not inflation-neutral. We may then either calculate the expected returns on assets in nominal post-tax terms, or include expected rates of inflation and taxation in the asset demand equation (see for example Ebrill and Possen, 1982).

A Specific Functional Form in a one-period Expenditure Allocation Model

We can derive slightly more specific demand functions by imposing some restrictions on the utility function. For example drawing on the AIDS indirect utility function (see Deaton and Muellbauer, 1980, pp. 67-78, for reasons for choosing this function) we assume that

$$U(p^g,\ p^h, Y) = \frac{\log Y - \log \pi}{\bar{P}} \qquad (A.30)$$

where $$\log \pi = \sum_{i=g,h} \Theta_i (\log p^i - \log \beta_i) \qquad (A.31)$$

and $$\Theta_i = \beta_i + \tfrac{1}{2} \sum_{j=g,h} \alpha_{ij} \log p^j \qquad (A.32)$$

with $\sum_{i=g,h} \beta_i = 1\ ,\ \sum_{i=g,h} \alpha_{ij} = 0,\ \alpha_{ij} = \alpha_{ji},\ j = g,h$ (A.33)

and $\bar{P}$ is the price index defined by

$$\log \bar{P} = \sum_{i=g,h}^{z} \eta_i \log p^i \tag{A.34}$$

$$\text{with} \quad \sum_{=g,h} \eta_i = 0 \tag{A.35}$$

Now,

$$\frac{dU}{dp^h} = -\frac{(\Theta_h + \frac{1}{2}\Sigma\alpha_{ih} \log p^i)\ /p^h}{\bar{P}} - \frac{\log Y - \log \pi}{\bar{P}}\ \frac{.d \log\bar{P}/dp^h}{} \tag{A.36}$$

$$\text{and} \quad \frac{d \log \bar{P}}{dp^h} = \frac{d \log \bar{P}}{d \ln p^h}\ \frac{d \log p^h}{dp^h} = \frac{\eta_h}{p^h} \tag{A.37}$$

$$\text{also} \quad \frac{dU}{dY} = \frac{1}{Y\bar{P}} \tag{A.38}$$

Given Roy's identity

$$h^d = \frac{-dU\ /\ dp^h}{dU\ /\ dY} \tag{A.39}$$

Therefore

$$h^d = \frac{[\beta_h + \alpha_{hh} \log p^h + \alpha_{hg} \log p^g - \eta_h \log(Y/\pi)]}{p^h} Y \tag{A.40}$$

whereas in (A.3),

$$p^h_t = P^h_t r - (P^h_{t+1} - P^h_t) \tag{A.41}$$

The Supply of Housing

So far we have assumed (A.17) that the supply of housing services is fixed. But if the supply of services is responsive to current period prices we have

$$h^s_t = h^s_{t-1}\ (1 - \delta) + I_t \tag{A.42}$$

where I_t is investment in new housing services in period_t. Assume that producers maximise profits (F), where

$$F = p^h I - C(I) \qquad (A.43)$$

and C(I) represents construction costs. Then the first order condition is $p^h = C'(I)$. Differentiating this with respect to p^h and employing the second order condition $c''(I)>0$, we obtain $dI/dp > 0$. It follows that

$$h_t^s = h\ (h_{t-1}^s,\ \ \delta,\ p^h) \qquad (A.44)$$

In this case, whichever form of demand equation is considered appropriate, an instrumental variables approach, such as two stage least squares, is required to determine the price of housing.

6 THE DETERMINATION OF HOUSE AND LAND PRICE DISTRIBUTIONS

6.1 INTRODUCTION

This chapter explains why house prices vary within and between cities and discusses the implications for empirical analysis.

The chapter draws on two main theories. The economic theory of urban structure provides an overview of the structure of house prices in cities. Hedonic price theory helps to explain more detailed variations in house prices. It also provides the main basis for the subsequent empirical work.

Both theories have been discussed extensively and are well developed. For the theory of urban structure, see for example Alonso (1964), Muth (1969), Mills (1972), Mohan (1979), Wheaton (1979), Henderson (1985), Mills and Hamilton (1989), and numerous journal articles especially in the *Journal of Urban Economics*. For the theory of hedonic pricing, see Lancaster (1966), Griliches (1971), Rosen (1974), Freeman (1979), Goodman (1989), to name just some important contributions.

In this chapter I start with an overview of the basic structure of house and land prices in cities. Sections 6.2 and 6.3 describe closed and open city models respectively and their implications for house prices. Sections 6.4 and 6.5 discuss how major variations in supply and demand conditions in cities influence house prices. Sections 6.6 and 6.7 discuss the implications for empirical analyses of intracity and intercity house prices respectively. The final section summarises the main points.

6.2 A BASIC CLOSED CITY MODEL OF HOUSE AND LAND PRICES

As before, households are assumed to purchase standard units of housing services, h, at an annual price p^h. In the standard urban model, most workers are assumed to be employed in the central business district (CBD). In choosing their residential location, households balance housing costs against transport (commuting) costs. In equilibrium, households must be indifferent between locations. Therefore p^h must fall with distance from the CBD, so that lower housing expenditures for a given quantity of housing precisely offset higher transport costs. Land prices (p^L) fall even more sharply with distance from the CBD.

However, as p^h falls, households may purchase more h, which have become cheaper relative to other goods. Therefore house prices ($p^h h$) may not fall with distance from the CBD. Whether they do, or not, will depend in this simple model on the price elasticity of demand for housing services. Muth (1975) argues that because the price elasticity of demand for housing is about unity, a fall in housing prices leaves total housing expenditures unchanged.

The relationship between house prices and access to the CBD is complicated further when variations in household income are taken into account. Because high income households consume more h than do low income households, to predict $p^h h$, we need to know whether there is a systematic relationship between household income and distance to the CBD. Usually there is not in Australia.

In this basic model, city population is exogenous (not determined by house prices). Households are indifferent between the combinations of land and capital required to produce a given amount of housing services. The city is assumed to be flat and featureless. Also a competitive market is assumed, so that the city expands until the price of land for housing exceeds the opportunity cost of land.

Let us now derive some results for house and land prices more formally.

As in Chapter 5, let households have a utility function:

$$U = f(g, h) \tag{6.1}$$

where g represents goods other than housing.

The household budget constraint is given by:

$$Y = p^g g + p^h(u)h + T(u, y) \tag{6.2}$$

where Y is household income, which here includes the value of leisure time foregone in commuting; p^g is the price of other goods, which is often assumed to be unity; and T is the cost of commuting to the CBD. Both p^h and T vary with distance to the CBD, represented by u. T also rises with household income - as higher income workers are usually willing to pay more to save commuting time than are lower income workers.

Maximising household utility subject to the budget constraint, we obtain the following first order Lagrangean condition with respect to changes in distance from the CBD;

$$\frac{dL}{du} = -\lambda(hp^h_u + T_u) = 0 \tag{6.3}$$

where the subscripts denote the partial derivatives,

e.g. $p^h_u = dp^h/du$

The Price of Housing Services and House Prices

Eq. 6.3 indicates that:

$$-p^h_u h = T_u \tag{6.4}$$

In equilibrium a household must be compensated for an increase in transport costs with u by a decrease in housing expenditure. Since $h > 0$ and $T_u > 0$, p^h_u must be negative.

Now allow for small changes in each variable by totally differentiating (6.3) with respect to u. Then

$$-hp^h_{uu} - p^h_u \frac{dh}{du} - T_{uu} \leq 0 \tag{6.5}$$

Assuming, as is reasonable, that $h > 0$, $p^h_u < 0$, $dh/du > 0$, and $T_{uu} < 0$, then $p^h_{uu} > 0$, i.e. as the marginal cost of commuting falls with distance from the CBD, the price of housing also decreases with distance but at a falling rate.

Note that the amount of housing services purchased is assumed to increase with distance ($dh/du > 0$). As p^h falls, households will substitute housing for other goods. As previously noted this means that house prices may not fall, they may even rise, with distance.

Now consider the relationship between house prices and distance to the CBD when household incomes vary. High income households purchase more h than do low income households, but face the same reductions in p^h with distance from the CBD. Therefore, for a given additional travel cost, high income households obtain a greater absolute increase in housing services than do low income households and have more incentive to move away from the CBD. However, this benefit may be offset if high income households place a high value on their travel time savings.

If the income elasticity of demand for housing is higher (lower) than the elasticity of transport costs, a rise in income makes the bid rent curve shallower (steeper) and high income households move further from (closer to) the CBD. Mills and Hamilton (1989) estimate that with an income elasticity of demand for housing of about 0.7, compared with a unit elasticity of travel time costs and time costs half of total trip costs, there would be marginal tendency for high income households to locate further from the CBD. Although Muth (1969) found that higher income households in the US located further from the CBD,[1] Wheaton (1977) found that there was no evidence for rent bid curves to flatten as income rises. As discussed in Chapter 8 below, there is no evidence of any relationship between household income and access to the CBD in Sydney, Melbourne or Adelaide.

Land Prices

The land price gradient depends upon both the housing price gradient and the share of land in the production of housing. Following Muth's (1969) neo-classical model of housing production, standard units of housing services are produced in a competitive industry by firms using land and non-land inputs, in response to factor prices and housing prices determined in the market.

We assume that housing is produced with the production function h = h(L, N) and that producers aim to maximise profits (F) from building and selling houses:

$$F = P^h h\ (L, N) - P^L L - p^N N \qquad (6.6)$$

where L and N are land and non-land inputs, and P^L and p^N the prices of land and non-land inputs respectively. Land is non-urban land. Profits must be equal at each location, but the prices and combinations of inputs may vary with location.

Profit maximisation yields the following first order conditions:

$$\frac{dF}{dL} = P^h . \frac{dh}{dL} - P^L = 0 \qquad (6.7)$$

$$\frac{dF}{dN} = P^h . \frac{dh}{dN} - p^N = 0 \qquad (6.8)$$

Setting the total differential of the profit function equal to zero and substituting in the first order conditions we obtain:

$$\frac{dP^L}{P^L} = \frac{P^h h}{P^L L} \cdot \frac{dP^h}{P^h} - \frac{p^N N}{P^L L} \cdot \frac{dp^N}{p^N} \qquad (6.9)$$

where dP^L/P^L is the land price gradient.

Letting S_L and S_N be the shares of land and non-land factors in the value of housing, the land price gradient becomes:

$$\frac{dP^L}{P^L} = \frac{1}{S_L}\frac{dP^h}{P^h} - \frac{S_N}{S_L} \cdot \frac{dp^N}{P^N} \qquad (6.10)$$

Given that the gradient of the non-land factors (dp^N/p^N) is usually negligible, in effect the land price gradient is given by first expression or the right hand side, i.e. the land price gradient is (approximately) the product of the inverse of the share of land and the housing price gradient. Since the share of land is nearly always less than 50 per cent and sometimes below 10 per cent, the land price gradient is generally much steeper than the housing price gradient.

Moreover, as the value of land rises closer to the CBD, housing producers substitute capital for land and the share of land in housing, h, falls. Given (6.10), this means that the land price gradient is steeper close to the CBD than further away.

Mills and Hamilton (1989, Appendix A), working with rents instead of capital values, demonstrate that under certain assumptions (most notably that housing services are produced in competitive markets with a Cobb- Douglas production function and that the price elasticity of demand for housing is -1) the land rent gradient will take the form of a negative exponential function:

$$r(u) = r_o e^{-bu} \qquad (6.11)$$

where r_o is the (residential) rent in the CBD, e = 2.718, and b is a parameter to be estimated. As shown in Chapter 12, the negative exponential form of (6.11) is frequently used in empirical work on land prices.

Of course, as land prices fall with distance from the CBD, households consume more land. Therefore, lot prices ($P^L L$) decrease with distance less than land prices.

In a competitive market, the size of the city expands so long as the price of urban land exceeds the price of non-urban land. However, if housing services can be produced by substituting capital for land, denser land uses, a steeper land price gradient, and a smaller city result.

Comparative Statics

In the above model, intraurban housing prices are determined by the cost of producing housing services, transport costs, and the size of the city. Transport costs depend upon the value of travel time as well as out-of pocket costs. City size depends upon population and household income. What happens to housing prices when transport costs, population and household income change?

A decline in transport costs reduces the premium that households are willing to pay for access to the CBD. This flattens the housing price gradient. For a given population and city size, the price gradient would fall from curve P_1 to P_2 as shown in Figure 6.1.However, the reduction in transport costs will increase the demand for housing beyond u, and the city will expand to say u'. In the long run, a new housing price gradient, P_3, will result. Housing and land prices would fall between 0 and u" and rise between u" and u'..

A rise in population or household income increases the demand for housing in a city. In the short run, with the supply of housing services fixed, this leads to a rise in housing prices from curve P_1 to P_2 in Figure 6.2. In the long run, the increase in housing prices causes land to be converted to residential use and the city to expand. Then, the housing price gradient will fall from P_2 to P_3.

Will intraurban house prices ($P^h h$) change in some constant proportion to changes in housing prices (p^h)? The answer is complicated because it depends, as usual in demand theory, on both the substitution and income effects of changes in relative prices. Concentrating on the substitution effects, the answer is clearly 'no' if

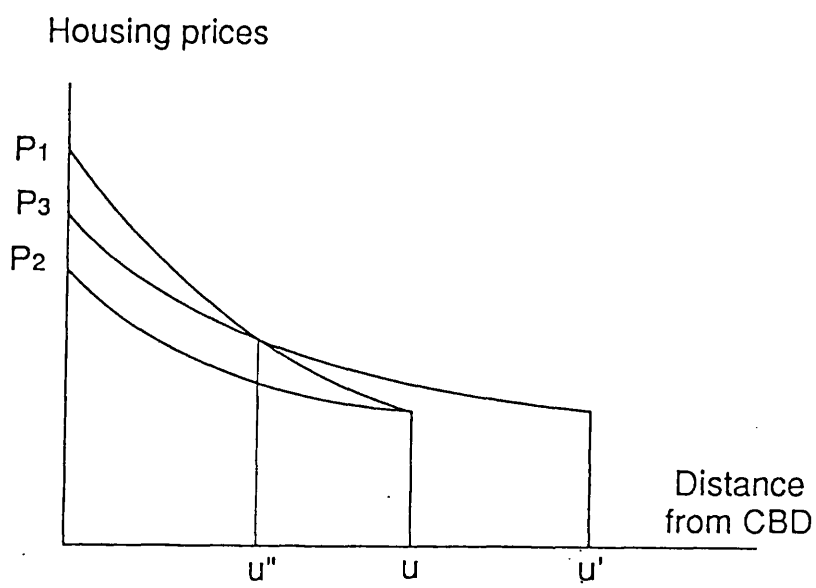


Figure 6.1 Housing Prices and Transport Costs

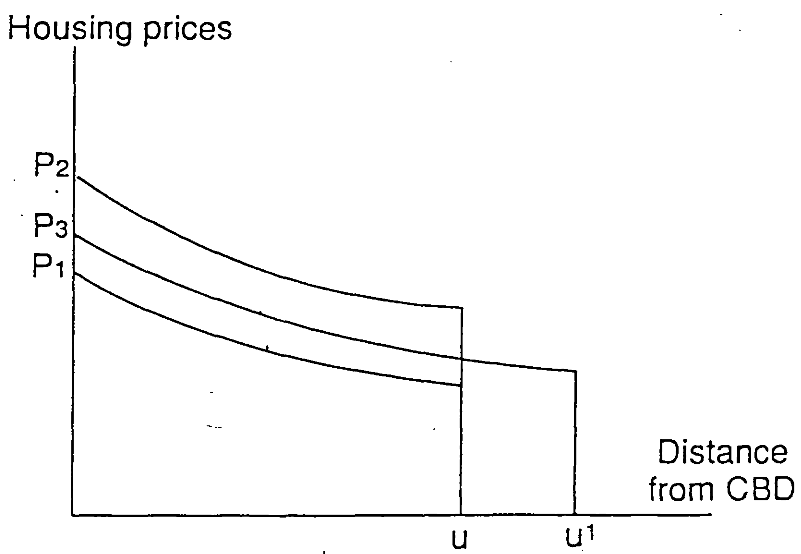


Figure 6.2 Housing Prices and Increased Population or Household Income

relative intraurban housing prices have changed, i.e. if the shape of the housing price gradient has changed. In this case, the consumption of housing services will increase (or fall) where the relative price of housing services has fallen (or risen). Therefore a flattening of the housing price gradient will not bring about equivalent flattening of the house price gradient. Even if the housing price gradient shifts but retains its shape, i.e. there are no changes in relative housing prices, the house price gradient may alter if (i) households in different parts of the city have different price elasticities of demand for housing or (ii) households respond to the changes in absolute housing prices by altering locations (households with a high demand for housing may now prefer to live further from the CBD, for example). In general, intraurban house prices will change in some constant proportion with housing prices only if there is no change in relative housing prices, price elasticities of demand for housing are everywhere the same, and households do not relocate. Of course, if the price elasticities of demand for housing are everywhere (minus) unity, there would be no changes in intraurban house prices.

6.3 HOUSE PRICES IN AN OPEN CITY MODEL

So far we have assumed that city population is determined independently of housing prices and transport costs and that households maximise their utility by moving within the city.

In the pure open city model, with many cities and costless movements between them, the level of household utility in each city is fixed and the same as in all other cities. In equilibrium, no household can increase utility by moving to another city. Changes in urban conditions, (for example, in economic prospects, transport costs or environmental conditions) result in migration between cities until a new equilibrium occurs.

In this section I consider the implications of intercity differences in populations and housing prices; changes in transport costs within a city; and intercity differences in environmental conditions.

Just as an increase in population increases housing prices, so a city with a large population (A) will have higher housing prices than a city with a smaller population, B, (holding other factors like land supply constant). In an open city model, households must either migrate to B to obtain cheaper housing or be compensated for the higher housing prices in A. Typically, compensation would take the form of higher wages. This implies that A has a stronger economy and that firms in A are willing to pay higher wages. American evidence (Rosen, 1979) shows that there is a positive relationship between city populations and wages.

What happens when transport costs fall substantially in a city? The reduction in the sum of house prices and transport costs makes the city more attractive than previously. There will be an increased demand for housing by outsiders, land prices will increase, and the city will expand. With high immigration (given zero movement costs), the housing price gradient would revert back to its original position. However, if marginal wages fall as the city workforce expands, there may be some decline in central city rents with improved transportation, even in the open city model.

Thirdly, what implications, if any, do intercity environmental differences have for house prices? Suppose that cities C and D have similar economies, with similar demands for labour and similar prices for goods, but that C has a preferred environment (e.g. a better climate). For a given nominal wage, workers would prefer to live in C. To satisfy the equilibrium condition that household utility is the same in C and D, housing prices must be higher in C. Also C would be larger than D as developers would convert rural land into housing (see Figure 6.3). Another way of expressing the same conclusion is that workers in D would require a higher real wage to compensate them for the inferior environment.

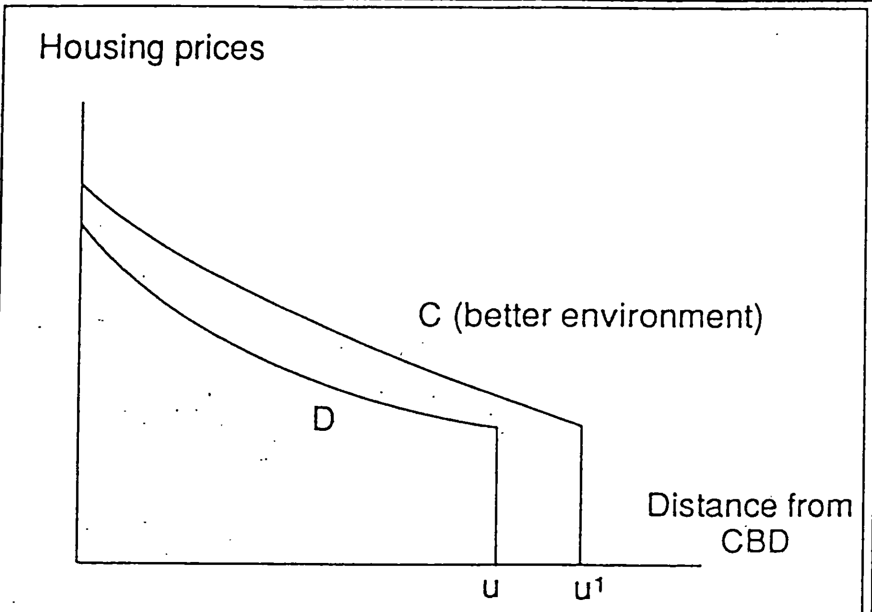


Figure 6.3 Housing Prices and Transport Costs

6.4 VARIATIONS IN THE URBAN ENVIRONMENT

So far we have assumed a simple stylised urban environment and a simple household utility function. Consequently, smooth housing price gradients were derived as a function of population, income and access to the CBD, and housing costs. This section considers how house prices would be determined in a more complex urban environment. The next section considers how more complex household preferences may affect house prices.

Durability of Urban Form

The model developed above presumes that an artificial standard housing unit can be readily produced or modified to meet current housing demand. In practice the existing housing stock is not easily modified. Conversion costs are usually substantial. On the other hand, new houses are produced most easily on the urban fringe. Accordingly there is generally an inverse relationship between house age and distance from the CBD.

Although some old houses are valued for their architectural style and the workmanship embodied in them, usually the housing stock depreciates and maintenance increases. Also, as incomes grow and lifestyles change, old houses become less suitable. Thus, other things being equal, they sell for lower prices than new ones.

The Supply of Land

The supply of land is usually far from homogeneous. Sometimes, as when a city is bordered by sea or mountains, there are major constraints on the supply of land (see Rose, 1989). When the supply of land is severely restricted in some directions, the city has to extend much further in other directions. This increases access costs and house prices. Also, competition for scarce land within the city pushes up the access premium per km, and house prices, because houses are purchased by households with a relatively high valuation of travel time savings.

Further, topographical variations within the city and on the fringe create variations in land development and building costs. Within the city, local high development costs cannot readily be passed on in increased house prices - since house prices in each area are determined by competition with other areas. Rather, high development costs reduce land prices.

On the fringe, if land prices reflect non-urban opportunity costs, high development costs increase new house prices. Because the long-run level of established house prices is influenced by the costs of producing new houses, high development costs on the fringe raise long-run established house prices within a city.

Planning Regulations

Planning regulations take many forms. Within Australian cities, the main regulations relate to density restrictions that limit the amount of capital per unit of land. These restrictions include minimum lot size requirements, restrictions on conversion of houses into flats, and constraints on heights, set-backs etc. for flats. On the fringes, planners often restrict the supply of serviced land so that land prices exceed opportunity costs.

Generally, planning regulations increase house prices. Restrictions on housing and land development reduce the supply, and increase the price, of housing. Also, minimum lot size requirements and other standards tend to raise house prices. On the other hand, in so far as regulations favour the supply of houses and discriminate against flats, they reduce house prices (though not of course the prices of flats).

Intraurban Variations in Transport Costs

Transport costs vary not only with distance to the CBD, but also with distance to major transport corridors. Usually major road, or rail, corridors follow radials out of the city. Households close to these radials save travel time compared with households further from the radials. These travel savings will be reflected in higher house and land prices unless properties are so close to the transport routes that the access savings are offset by environmental disamenity, e.g. traffic noise, air pollution etc.

Intraurban Variations in Local Amenities

Other things being equal, the demand for houses in an attractive neighbourhood 'A' will be higher than the demand in less attractive neighbourhood 'B'. Since, in equilibrium, similar households must enjoy a similar level of utility in each neighbourhood, house prices must rise in A until households no longer wish to move from B to A.

If the amount of housing in A and B is small, variations in local amenities will not affect the overall attractiveness or level of utility in the city. Thus intraurban variations in local amenities and house prices are compatible with the open city model which indicates that high amenity cities attract larger populations and that all households in such cities pay more for the sum of housing and transport costs.

However, the size of the housing price premium for environmentally attractive areas, with say good views or low air pollution, will depend upon the supply and demand for such areas within the city. If there are many (few) attractive areas, the premium will be low (high).

Sub-centers, Housing Price and Wage Gradients

Unlike intraurban variations in amenities, small employment sub-centres are not likely to influence house prices. If house prices were to rise close to such sub-centres, workers in the CBD would be doubly penalised, by high commuting costs and high housing prices, for distance from the CBD. These workers would have a clear incentive to move toward the CBD. In equilibrium, housing prices close to small sub-centres must reflect the city-wide housing price gradient.

However, the slope of the housing price gradient is influenced by the amount of decentralisation. The more employment is decentralised, the lower the demand for housing close to the CBD and the flatter the housing price gradient.

Of course workers employed in sub-centres do obtain reduced commuting costs as well as lower house prices. Labour market equilibrium requires that these workers be paid a lower wage. In competitive markets, there is a declining wage gradient, as well as a declining housing price gradient, in cities with decentralised employment (see Eberts, 1981).

Finally, it should be noted that if the sub-centres are large enough, an urban area may effectively contain a series of mini-cities each with its own housing price gradient. Muth (1975) argues that this occurs in San Francisco, but this appears exceptional.

6.5 SOME DEMAND FACTORS

Household Preferences for Land

In the housing price model developed in Section 6.2, housing units were produced by any combination of capital and land and household utility was a function only of housing units (and other goods) but not of land. In practice, however, households do have preferences for land and lower density living. These preferences increase the demand for housing further from the city and reduce the housing and land price gradients. (See Beckman, 1969; Blackburn, 1971).

Local Public Goods and Local Taxes

When local public goods are paid for by local households, the quantity supplied depends partly upon the income level of the local community. Affluent communities generally demand more local public goods than do poor ones.

However, when local public goods are financed by a property tax (rates on land values are the main local tax in

Australia), property tax rates may be no higher in the rich communities. For example, a community with land valued at $100,000 per property can supply twice the local public goods that a community with land worth $50,000 per over property can supply, with the <u>same</u> tax rate per dollar of land value. Put another way, for a given supply of local public goods, a household's tax share is smaller in a rich community.

Therefore to minimise the cost of access to local public goods, all households have an incentive to locate in affluent areas. But, such a disequilibrium situation cannot persist. Excess demand for housing in more affluent communities causes house prices to rise until the cost of housing offsets the advantages of access to more local public goods or a lower tax rate, or both.

Externalities: Urban Blight and Gentrification

Another reason why local house prices may depend on household incomes is that house prices depend upon the quality of neighbouring houses. In a classic article, Davis and Winston (1961) argued that households are likely to under-maintain their houses because maintenance expenditure not only increases the value of the maintained house but also the value of neighbouring houses. However, since the owner of the maintained property cannot charge his neighbours, there will be under-investment in dwellings. This is especially likely in poor communities, because poor neighbours are more likely to under-maintain their own properties.

On the other hand, if house prices in a neighbourhood are significantly below those in similar, near-by neighbourhoods, households with higher incomes and preferences for inner city living may move in and improve (gentrify) the neighbourhood. This is usually feasible only if sufficient higher income households are expected to move into the area and invest in housing improvements so that there are mutual gains from externalities.

Urban Segregation: Ethnic Factors

In the US, there have been many studies of the effect of racially segregated housing markets on house prices (e.g. Bailey, 1957; Kain and Quigley, 1975; Kanemoto, 1987). These studies show that the impacts of segregation on house prices depend upon the preferences for houses in each market, the supply responses, and externalities.

In Australian cities, some ethnic groups such as Italians, Lebanese and Vietnamese concentrate in particular areas. However, one ethnic group rarely constitutes more than 10 per cent of the local population and there is virtually no segregation on grounds of colour.

In these circumstances a relationship between ethnic groups and house prices is unlikely. In some neighbourhoods a strong ethnic presence may increase housing demands by members of that group and reduce demands by others. The net effect on house prices (if any) has to be determined empirically, (see Chapter 8).

6.6 EMPIRICAL ANALYSIS OF INTRAURBAN VARIATIONS IN HOUSE PRICES

The empirical analysis of intraurban variations in house prices can be approached in two main ways. The most common and most practical approach is by hedonic price analysis. This is the basic approach adopted in this study and is discussed at greater length below. The second approach is based on the application of housing demand and supply equations to housing in each neighbourhood or LGA. This approach is briefly outlined at the end of this section and used to provide some supplementary insights in the later empirical chapters.

Hedonic Price Models

Hedonic price models provide the basic tool for explaining variations in the prices of commodities, such as housing, that consist of a bundle of attributes. In a hedonic house price model, house prices (PH) are a function of the quantities of each housing attribute and their implicit prices. Simplifying, we may write

$$PH = P(S, E, A) \tag{6.12}$$

where S and E are vectors of structural and environmental attributes respectively and A represents access to the CBD. Because house prices in (6.12) are capital prices, they depend upon present and future quantities and prices of attributes.

In this model, dPH/dS, dPH/dE and dPH/dA are the implicit prices for structural and environmental attributes and access. If these prices are similar across the city, then intraurban variations in house prices are explained entirely by different quantities of attributes.

In a housing market in which households could move without cost to areas where prices are low and in which producers could increase the supply of individual attributes at constant costs, attribute price equalisation would occur across urban areas. However, if households have strong locational preferences (say for racial reasons), household movement costs are high, or attribute supply is not responsive to implicit price differentials, attribute price differentials may persist (see Strazheim, 1973).

It is useful here to recognise that the implicit prices are themselves a function of the demand for, and supply of, attributes. Figure 6.4 shows three sets of household demand curves for an environmental attribute, say clean air (with demand depending upon parameters such as income or preferences), and three suppliers' curves (which are fairly inelastic but which indicate some response to prices). The curves of the intersecting demand and supply curves is dPH/dE, the hedonic price schedule.

In Figure 6.4, this schedule is drawn as a linear function. Rosen (1974) showed that linearity requires either constant returns to scale or the costless repackaging of two or more bundles. Such conditions rarely exist.

In principle, house prices could be analyzed in terms of the demand for, and supply of, all housing attributes. However, as Epple (1987) has shown, the econometrics difficulties inherent in identifying and estimating all the underlying demand and supply equations are considerable and this approach is not pursued further here.

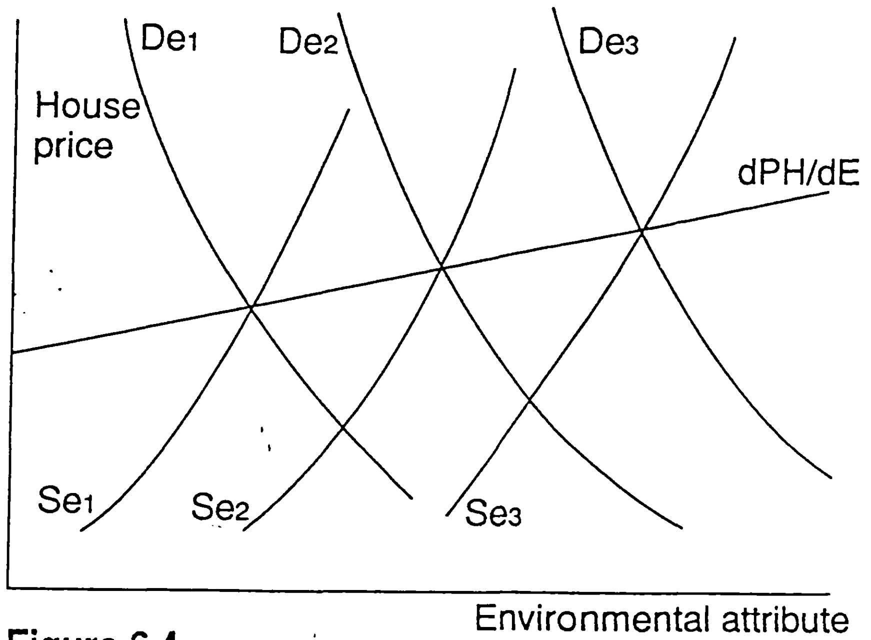


Figure 6.4
The Implicit Price of an Environmental Attribute

Empirically, hedonic price equations may take various functional forms each with different implications for implicit prices.

(i) In an ordinary linear specification, each housing attribute has an absolute dollar value regardless of the quantity of other attributes. For example, a good view would be worth say $10,000 in both a $100,000 and a $200,00 house.

(ii) House prices may be estimated as a non-linear function of log and exponential variables. Abelson (1977) found that house prices fell by an increasing amount for each move of an NEF contour toward Sydney (Kingsford-Smith) airport.

(iii) The log of house price may be estimated as a function of linear variables. In this case, housing attributes are valued as a given percentage of house price; for example, a good view may be valued at say three per cent of house price (for all levels of house prices).

(iv) A double-log specification implies the standard elasticity relationship between dependent and independent variables.

The preferred specification has to be determined empirically (e.g. by goodness-of-fit measures and an absence of spatial auto-correlation) rather than by *a priori* theory. In a detailed hedonic price study of over 1450 properties in Sydney (Abelson, 1977), I tested all four specifications and found that (i) and (iii) above generally provided the best fit and preferred specification. Goodman and Kawai (1984) found that nonlinear functions generally performed better than linear ones.[2]

The next question is: what attributes should be included in the hedonic price equation? The broad answer is any housing attribute that households value that may affect house price.[3] There is no theoretically predetermined list of such attributes. Rather, the list has to be determined by formal or informal survey methods, and by reference to previous hedonic house price studies. It is, of course, important that all major explanators be included in the hedonic equation. Omission of an important factor can cause spatial autocorrelation and biased estimators. In practice, the list will be determined by the objectives of each hedonic price study and by resource and data constraints.

A disputed issue is whether the socio-economic attributes of a neighbourhood, such as household income or race, should be included as explanators of house prices. Some reasons for including such attributes have been given above. For example, households may prefer to invest in a high income area where local public goods are cheaper and capital appreciation more likely – there could also be a "snob" effect. In Abelson (1977), I estimated that houses on roads with a high social status in the Sydney suburb of Rockdale sold for eight per cent more than similar houses (with similar environmental qualities, views etc.) on low status roads. However, in his survey of hedonic price studies, Ball (1973) found that, when socio-economic status was separable from neighbourhood quality, it had only a small effect on house prices.

Moreover, the generally strong correlation between housing attributes (structure, environment, neighbourhood) and socio-economic attributes (especially income) creates econometric problems of specification and interpretation. Since high income household purchase houses with expensive attributes, income and attribute price effects are likely to be confounded. In my view, socio-economic variables should be included only where they produce a clear improvement in model specification.

Of course housing attributes themselves are also subject to multicollinearity. House size is generally correlated with lot size, traffic noise with air pollution, distance from the coast with inferior micro-climates and (in Australian cities) with distance from the CBD. If correlated variables are included, the coefficient for one or both of them may become insignificant. If a correlated variable is omitted, the coefficient on the included variable may pick up some effect of the excluded one. Usually the effects of multicollinearity (when it exists) are examined by sensitivity tests, i.e. by running price equations with and without the correlated variables and attempting to interpret the results. This approach is adopted in this thesis. Alternatively, correlated variables may be grouped into a single component variable, such as 'neighbourhood' or 'environment', using say factor analysis. Little (1976) and Dubin and Goodman (1982) used factor analysis to measure the effects of neighbourhood components on house prices. In the studies reported below, there are too few correlated variables to warrant this approach.

Another important issue is the extent to which hedonic price models can be used to explain variations in average neighbourhood house prices across a city, as distinct from variations in individual house prices within a sub-market such as an LGA. There are two main conditions for satisfactory aggregation within LGAs and analysis across LGAs.

(i) Within each LGA, houses should be reasonably homogeneous. For example, if half the houses in a suburb were 100 years old and the others were new, it would not make much sense to say that the average age is 50 years; moreover, if the true relationship between house prices and age were non-linear, the use of averages would be a mis-specification.

(ii) There is a single underlying price structure across the city (i.e. attribute coefficients are invariant across locations). The necessary conditions for this were described above.

To the extent that these conditions do not hold, the implicit prices in aggregated hedonic price models will be crude approximations of true prices. It is of course possible to test the hypothesis that some LGAs have different implicit housing prices by including dummy variables for these LGAs (see Chapter 8).

Comparative Statics

So far the discussion has concentrated on explaining intraurban house prices at a point in time. How should changes in relative house prices be explained?

Nearly all empirical work on house price changes has focussed on changes in housing attributes, especially access and environmental attributes. Take the simple house price equation (1.1):

$$PH = \sum_{i=1}^{n} P_i \, q_i \qquad (6.13)$$

where a house has i = 1 ... n attributes, and P_i and q_i are the capital prices and quantities of each attribute respectively. Then, $dPH/dq_i = P_i$ shows the impacts on house prices of changes in the independent variables.

The justification is straightforward. A local improvement makes local residents relatively better off than other residents. Providing the locations are small relative to the city, average household utility in the city does not change. Nor does the increased local amenity affect the overall supply of the amenity within the city. Goodman (1989, p.78) notes that such local improvements:

> "should increase local land and housing prices and many empirical studies suggest that they do. There are numerous examples of transportation improvements, shoreline, commercial disamenities, or racial boundaries, all showing localised price effects".

This analysis is simplistic, however, in so far as it ignores the timing of changes and expectations. Although local improvements change house rents, they may have only a small impact on house prices because, as we noted above, house prices are the capitalised value of present and expected future housing services, including environmental services. Since future services need to be discounted to allow for time preference, we may write

$$PH = \sum_{i=1}^{n} \sum_{t=1}^{t} \left(\frac{\alpha_{it} \; q_{it}}{(1+\phi)^{t}} \right) \tag{6.14}$$

where α = annual attribute rents, ϕ the time preference rate, and t = 1 .... t years.

It follows that if changes in q_i are fully anticipated, house prices will rise with local improvements only in so far as there is less discounting of these improvements. Figure 6.5 illustrates the point.

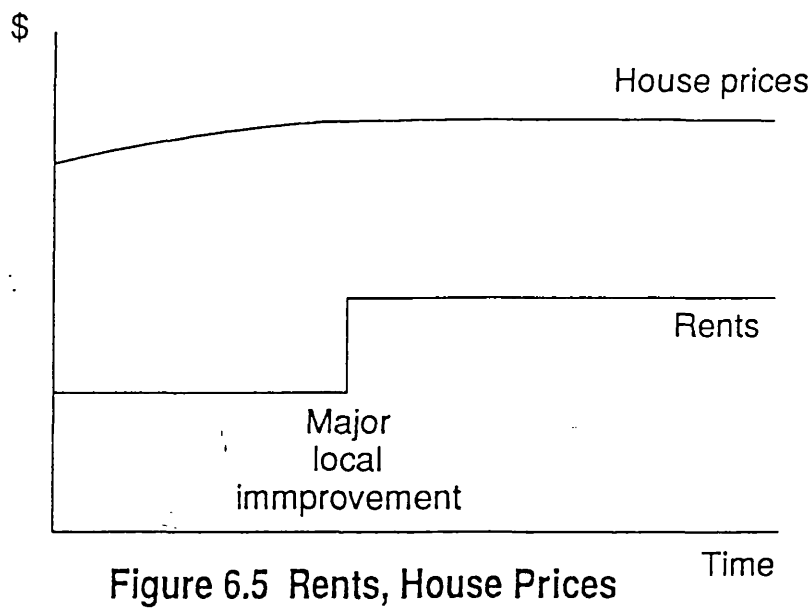


Figure 6.5 Rents, House Prices and Local Improvements

Moreover, (6.14) shows that changes in relative house prices may be due to changes in q_i or a_i. As shown in Figure 6.4, the α_i depend upon the demand and supply of attributes. For example, increased preferences for travel time savings or the environment will change access or environmental premiums (and house rents). Therefore local house prices may change relative to others even with no change in the relative supply of housing services. Indeed this appears to have happened in Australia (see Chapters 8 and 9). Empirically, we can test for this by regressing house prices at different times on constant q_i and examining whether the α_i have changed.

There has been little analysis of hedonic prices in a dynamic environment. To the best of my knowledge, Abelson (1982b) was the first to analyse this problem. Abelson and Markandya (1985) provide a more detailed analysis.

Market Models of House Prices in Small Areas

As shown in Chapter 5, house prices can be modelled as a function of the demand for housing and the stock of houses. This approach can be adapted (with considerable difficulty) to modelling house prices in small areas.

Housing demand may be regarded as a function of household characteristics, such as household income and size, age composition and race, and employment characteristics. Alternatively, housing demand may be a function of the attractiveness of the area and access to employment and other facilities. However, because household and local area attributes are correlated, including both in a demand equation runs the risk of confounding their effects.

Housing supply may be represented by data on the quantity and quality (e.g. age and size) of the housing stock in each area. Also, changes in housing may be modeled with a supply curve for new housing and an allowance for housing depreciation.

Models of this kind have been developed in the US (de Leeuw and Struyk, 1975; Kain and Apgar, 1985). However the main purpose of these models has been to analyse the effects of housing policies on the supply of housing rather than to predict house prices. They suffer from the constraint that employment is usually exogenous to the model, rather than dependant on household location. Most importantly, from our point of view, the simulation models require a daunting amount of resources. According to Mills and Hamilton (1989, p.122), they require "a small team of experts and at least two years to formulate the model, collect the data, estimate the parameters of the model, program a computer to solve the data, and simulate alternative government programs".

6.7 EMPIRICAL ANALYSIS OF INTERURBAN VARIATIONS IN HOUSE PRICES

As described in Appendix B, housing market (demand and supply) models are generally used to model city house prices and to explain differential rates of house price appreciation. Essentially these models are similar to those described in Chapter 5. Here I apply the theoretical analysis in this chapter to explain interurban house price differences.

In an open city model, city housing prices are determined by four basic factors: population (which depends, *inter alia*, on the demand for labour and the attractiveness of the city), the supply of land for housing, access costs and the costs of development at the fringe.

Figure 6.6 illustrates the basic analysis. Housing prices decline with distance from the CBD, with the rate of decline a function of access costs. At the city fringes, housing prices are similar unless there are differential development or land opportunity costs. Large cities have higher housing prices than small cities.

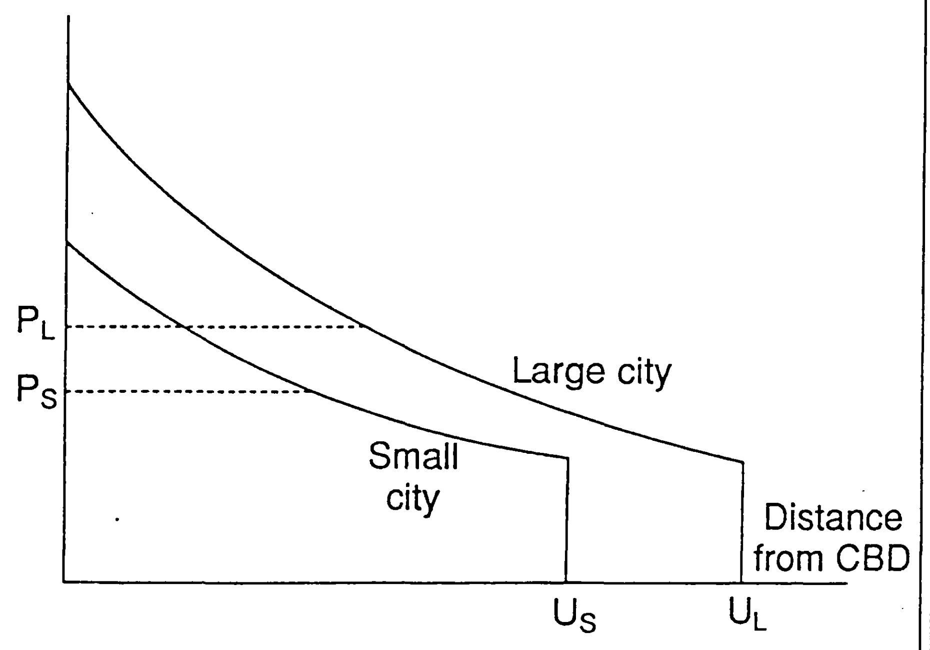


Figure 6.6 Housing Prices and City Size

The house price gradient is flatter than the housing price gradient because the quantity of housing services consumed increases as the price falls. Also irregularities in the gradient occur, due for example to local environmental or neighbourhood conditions.

Note also that, because the median house in a large city is further from the CBD than its counterpart in a small city, the differences in median house prices ($P_L - P_S$) do not reflect the full difference in house prices between comparable houses in large and small cities.

Empirically, house prices at any point in a city may be expressed[4] as:

$$PH = a + b(DISTFRINGE) + cZ \tag{6.15}$$

$$= a + b(CSIZE - CBDDIST) + cZ \tag{6.16}$$

where: a is house cost on the city fringe,

b is the access premium per unit of distance, DISTFRINGE is the distance from house to city fringe,

CSIZE is city size,

CBDDIST is distance from the house to the CBD,

Z is a vector of other housing attributes, and

c are the parameters for the Z attributes.

Ignoring the local variables (Z), the independent elements in (6.16) are explained basically as follows. 'a' is determined by land opportunity and development costs, and by building costs. 'b' is determined by access costs. CSIZE is determined by population and income, the supply of land for housing, and transport technology and costs.

Of course, to understand fully how city house prices are determined, it is necessary to know how the independant elements are themselves determined and how they are inter-related. This is a large topic, but brief comments on population (and its relationship to income) and access costs are especially relevant to our empirical discussions in later chapters. (See also Section 10.2 below).

Population is determined mainly by labour demand and supply. These depend on the strength of the city's economy and the environmental attractiveness of the city respectively. However, within a unified economy, a tendency toward factor price equalisation reduces wage differentials.[5] Also, environmental differences between cities are reflected in lower nominal wages as well as in higher house prices. Statistically, the only observable relationship is between house prices and population, not between house prices and the environment. Cities of equal size (and access gradients) will have similar house prices even if they have dissimilar environments. Conversely, cities of different size will have different house prices even if they have similar environments.[6]

Finally it should be observed that access costs are themselves influenced by the supply of land. First, if supply is restricted by topographical constraints, competition with other land uses increases the price of land for transport. This reduces the supply of land for transport, increase congestion (see Mirrlees, 1972; Solow, 1972) and increase fares when these are set to cover costs. Second, topographical constraints, such as waterways or hilly terrain, increase transport infrastructure costs and trip distances and costs (as routes are more circuitous and gradients more severe). Third, recall that access costs include the subjective value of travel time. When accessible land is scarce and congestion severe, households with high values of travel time compete for the scarce accessible housing. This pushes up house prices and the access gradient.

6.8 CONCLUSIONS

In a city with a strong employment centre, housing prices (p^h) must fall with distance from the CBD to offset higher transport costs. However as housing prices fall, households substitute housing for other goods, so that house prices ($p^h h$) do not necessarily fall with distance to the CBD.

Some American commentators have also argued that household income and distance from the CBD are likely to be correlated, which would further flatten, or even reverse, the house price gradient. However, there is little relationship of any kind between household income and distance from the CBD in Australian cities.

Given the plausible assumption that non-land factor costs are invariant across a city, the land price gradient is the product of the housing price gradient and the inverse of the share of land in housing prices. Since the land share is typically about 20 per cent of house price, the land price gradient is much steeper than the housing price gradient.

The land price gradient is steeper closer to the CBD, where capital is substituted for land, and, under certain plausible assumptions, it can be represented as a negative exponential function of distance from the CBD. Moreover, because the decline in land price encourages land consumption, the lot price gradient is flatter than the land price gradient.

Ignoring differences between houses, housing prices in any city are determined basically by the size of the city, land opportunity and development costs at the fringe, and access costs.

City size in turn is determined by population, income, the supply of land for housing, and transport technology and costs. However, population and income are related because cities offering high incomes attract labour and, in an open city model, factor incomes tend to converge (though not to complete equality) across cities.

Within urban areas, many local factors account for house price differences. These include specific house attributes, such as age and size, and local access, environmental and neighbourhood attributes. The level of local household incomes may also affect local house prices.

Empirically, the distribution of house prices within a city can be explained either by market models of the demand for, and supply of, houses in each area or by hedonic price models. The former method requires considerable data and has rarely been adopted. On the other hand, there have been many hedonic house price studies.

Hedonic price models have been applied most often to individual house prices in particular markets within the city. Applications of the model to average LGA house prices across a city require that houses and households within an LGA be reasonably homogeneous and that the implicit hedonic prices be stable across the city.

The hedonic price model can also be employed to determine the causes of changes in relative house prices. However, in this case it is important to test for changes in implicit prices as well as for the effects of changes in housing attributes on house prices.

ENDNOTES

1. Muth (1969) also noted a high (negative) correlation between household incomes and house age and suggested that the location of high income households could be explained by their demand for new houses rather than by a trade-off between housing and transport expenditures.

2. Land prices, and to a lesser extent house prices, are often explained by a negative exponential function of distance from the CBD. (See for example Chapter 12 below). This may be regarded as a very simple form of hedonic price equation with only one attribute.

3. Let a household utility function be represented by U(S,E,A, g), where S, E, A are housing attributes and g is non-housing goods. The budget constraint is given by Y = R(S, E, A) + g, where R is housing rent and g is a composite consumption good which has a normalised price of unity. Then the first order conditions for maximising utility are (dU/ds)/(dU/dg) = dR/dS etc. In words, any house attribute that contributes to household utility will affect house rents, albeit sometimes by very small amounts.

4. Suppose, more conventionally, we start by expressing house prices as

$$PH = \alpha_o - b\ (CB\ DDIST)$$

where α_o is the house price in the CBD. Then

$$\alpha = \alpha_o - \bar{b}\ (CBDSIZE),$$

$$\alpha_o = \alpha + b\ (CBDSIZE) \text{ and}$$

$$PH = \alpha + b\ (CBDSIZE - CBDDIST).$$

where α is the house price on the city fringe.

5. Of course, international differences in house prices are heavily influenced by income differences.

6. Mills and Hamilton (1989, p. 361) make a similar point although they write about land rents.

PART III

HOUSE PRICES IN SYDNEY, MELBOURNE AND ADELAIDE FROM ABOUT 1970: SPECIFIC EXPLANATIONS

7 MODELS OF SHORT - TERM MOVEMENTS IN AVERAGE CITY HOUSE PRICES FROM ABOUT 1970

7.1 INTRODUCTION

In Chapter 5 we saw that short-run house prices could be explained as a function of income, the components of user costs other than house price itself, demographic variables, the housing stock, and possibly lagged house prices.

Also, various hypotheses to explain house prices were identified. These were the "standard" explanation (income, interest rates, and expected capital gains, often linked with inflation); domestic demographic factors; the international angle (immigrants and foreign investment); supply side effects (housing stock or new housing completions); credit effects; the 1987 stock market crash; and the impacts of housing or fiscal policies.

It was also observed that house prices might be modeled within either an equilibrium or disequilibrium framework. Although I indicated a prior belief in a disequilibrium approach, this can be tested.

This chapter reports on the econometric testing of these hypotheses and the results for Sydney, Melbourne and Adelaide from about 1970. The emphasis is on the short run. Long-run explanations of house prices are discussed in Chapter 10.

The following section describes data availability. Section 7.3 introduces the econometric results. Sections 7.4 and 7.5 describe the detailed results for Sydney house prices and for Melbourne and Adelaide respectively. Section 7.6 discusses briefly the relationship between house prices and commencements. The main conclusions are summarised in the final section.

7.2 DATA FOR THE INDEPENDENT VARIABLES

In this section I describe the data available to represent the potentially significant variables identified in Section 5.5. As will be seen, some data are available only at state or national, rather than at city, level. Also, some data are available only annually, or even five yearly, rather than quarterly. Moreover, data availability varies between states as each state adopts different priorities for data collection.

Also discussed below are some data-related issues such as how to represent price expectations and policy changes.

The emphasis below is on development of practical, straightforward measures of the independent variables. In my experience, when simple measures fail to explain some dependent variable, more complex versions of the same variable rarely add much explanatory power. In the mid-1980s I attempted to develop some more complex variables, for example for permanent real disposable earnings and expected bond rates, to explain house prices in Australian capital cities (in Brisbane, Canberra and Hobart as well as Sydney. Melbourne and Adelaide). However these variables did not help to explain house prices. For more discussion of these points see Abelson and Alcordo (1986).

Full details of the time series data used in this thesis are given in Applied Economics (AE, 1991, Appendix E).

Income and Employment

There are two main measures of income: average weekly earnings (AWE) in each state each quarter (ABS, Cat.6302.0) and national accounts statistics which provide quarterly data for GDP and household disposable income (ABS Cat.No. 5206.0). The AWE figures have the disadvantages that they relate to the states rather than to the cities and, because they are determined substantially by national wage awards, they are not very sensitive to local economic conditions. Given the sizes of Sydney and Melbourne (each account for over 20 per cent of Australian GDP) there is a case for adopting the national income figures in Sydney and Melbourne house price equations.

Data on employed workers in the three cities are available back to 1976 for Sydney, 1978 for Adelaide and 1979 for Melbourne. To obtain a longer series I spliced state employment data on to these series. (ABS, Cat.Nos. 6101.0, 6204.0, 6201.1, 6202.2, 6201.4)

Interest Rates, Credit and Related Variables

Data are available for various quarterly interest rate series including 90-day bill rates, two year bond rates, savings bank and building society housing loans (sources: the Reserve Bank of Australia - RBA, commercial banks and building societies). Of these, the 90-day rate was the most market-determined rate over our period of study and therefore the truest indication of the cost of capital. The other three series were influenced by RBA regulations until the mid-1980s and were, for institutional reasons, often slow to change.

In this study I used Australian data for broad money and total lending by financial institutions (source: RBA, Bulletin) to represent the money supply and credit respectively. Abelson and Alcordo (1986) used the real value of approved housing loans as a potential explanatory factor but this did not perform well and can be regarded as endogenous to housing demand.

For (annual) foreign investment in Australia, I adopted the RBA's non-official (private) foreign investment series (RBA, Bulletin). Data on foreign investment in Australian real estate are available for only a short recent period.

To represent returns to equity (and wealth), I adopted the Australian all-ordinaries index, which is available quarterly (RBA, Bulletin), corrected for inflation.

Expected House Prices and Inflation

In this study, for various reasons, I adopted the inflation rate, as represented by the consumer price index, as a proxy measure for expected house prices. First, because nominal interest payments in Australia are taxed but most capital gains from housing are not,[1] inflation increases the relative attractiveness of investment in housing. Second, North American studies have found inflation to be an important explanator of explaining real house prices (see Appendix B).

Sometimes the lagged dependent variable is interpreted as a form of expectation variable (on the presumption that people expect future changes to be like past ones). However, this interpretation is not convincing. I prefer to interpret the lagged dependent variable in the context of a disequilibrium model (see Section 5.4).

Another alternative would be inclusion of actual future house prices (PH_{t+1}) as a measure of expected future house prices - the perfect foresight assumption favoured in some rational expectations literature. However, Markandya and Pemberton's (1984) objections are convincing. They point out that inclusion of future house prices in the house price equation, without the inclusion of variables to prevent explosive movements in asset prices, renders the house price equation unstable; the assumption of perfect foresight is of doubtful empirical validity; and it is difficult to model the perfect foresight assumption in a disequilibrium model (which, as we saw in Section 5.4, arises mainly because of imperfect foresight).

Hamilton and Schwab (1985) examined expectations of housing appreciation in the 1970s and concluded that "expectations were systematically wrong, and our results do not support the rational expectations hypothesis."

Abelson and Alcordo (1986) attempted to avoid the problem of proxies for expected capital gains by using survey data on expectations provided by the Melbourne Institute of Economic and Social Research. Specifically, we used the proportion of people who considered it a "good time to buy a house" and average expectations of the inflation rate as potential explanators of house prices. To my surprise the first of these did not help to explain house prices and so I did not re-use it in the most recent work. Expected inflation was closely correlated with current inflation rates and performed similarly in the house price equations. Because of their similar performance (to 1982) I did not update this series and re-estimate the results.

Prices of Substitutes

Quarterly house price data are available for Sydney, Melbourne and Adelaide (and for Brisbane and Canberra) from the mid-1970s and annual data for Sydney and Melbourne from 1965.

Abelson and Alcordo (1986) tested the ABS rent series (which apply mainly to flats) as explanators for house prices in Australian capital cities, but the coefficients lacked significance. I did not re-test this variable.

Demographic Factors

The ABS makes annual estimates of population in each capital city (Cat.Nos. 3101.0, 3207.0, 3208.0, 3209.1, 3207.2).

However, the number of households and the composition of the population in each city are provided only by the five-yearly population censuses.

Annual data on immigrants to Australia are available for many years, but data on city of proposed destination are available only recently. As Sydney regularly receives over 40 per cent of immigrants, and Melbourne receives about 30 per cent, the national series provides a reasonable proxy for immigration into these cities.

Other Demand Factors - Including Policy Changes

Dummy variables were used to test for the possible significance of other demand variables. One of these was housing quality. As no measure of housing quality was available, I used a simple trend dummy variable to examine whether there was any underlying tendency for house quality and price to rise. However, the coefficient turned to be insignificant.

Dummy variables were also used to represent significant policy changes. Specifically, I tested the possible impact on house prices of large government subsidies for housing in 1975 and 1976, and 1984 and 1985 (see Flood and Yates, 1987); the disallowance of negative gearing in 1986 and 1987; and the introduction of a tax on capital gains from assets other than owner-occupied housing in 1984. (For a discussion of possible relationships between Australian housing policies and house prices, see AE, 1991, Chapter 14 and Appendix H)

Supply Factors

Data on house commencements are available quarterly for Sydney and Adelaide from the mid-1970s and for Melbourne from 1970. Also, annual data are available for Sydney and Melbourne for earlier years. However, there are no continuous series for house completions in the cities.

For city housing stocks, only five yearly census data are available. Abelson and Alcordo (1986) made annual estimates of the housing stocks (to 1982). However, these estimates did not enhance the explanatory power of the house price equations and I did not attempt to refine or update the estimates for the present study.

The ABS has estimated quarterly cost indices of building materials in each city since 1970 or earlier (ABS Cat.No.6408.0) and award wages in the building industry since the mid-1979s (Cat.No.6248.0)

Data Transformation

I adopted log-linear models. These have the advantage that the rates of change are independent of the units chosen and are therefore generally to be preferred in time series analysis, whereas a given magnitude of change can have a different significance as the levels of the variables change. However, interest rates were included in raw form rather than in logs - this is conventional for a ratio type variable. The coefficient on the interest variable may be interpreted as the percentage change in house prices for a one point change in the rate of interest. Also logs are not used for dummy variables.

7.3 ECONOMETRIC RESULTS: INTRODUCTORY OBSERVATIONS

Abelson and Alcordo (1986) estimated quarterly models for six Australian capital cities but the results were generally poor. Despite this experience, in my recent work on house prices I again collected a large amount of quarterly data and conducted many experiments with quarterly models. However, I found no models which could be regarded as theoretically plausible, statistically satisfactory and robust. There are various reasons for this - the most important are probably poor data for some variables and unstable leading and lagging relationships between some variables and house prices which are difficult to model. Overseas studies have had similar difficulties (see Appendix B). Therefore, I turned to modelling annual data as reported below.

A second general finding is that, using standard diagnostic criteria, such as goodness-of-fit and absence of serial correlation in the errors, a disequilibrium model (with the inclusion of a lagged dependent variable in the explanatory set of variables) is preferred to an equilibrium model. Serial correlation is a critical problem in equilibrium specifications. This again confirmed the findings of Abelson and Alcordo (1986) where a large number of equilibrium model results are given. In this study, I have reported only the relevant disequilibrium results.

A third general finding is that, as expected, demand-side variables are more significant explanators of house prices in the short run than are supply-side variables. When employed, commencements (or lagged commencements) almost always entered the house price equation with a positive coefficient. It is clear from this that, in the short run, commencements are a positive function of house prices (see also Section 7.6). Although, conceivably, a simultaneous model of the demand and supply of housing could show that commencements have a negative effect on house prices in the short run, this is not apparent from the ordinary least squares equations run in this study.

Moreover, in earlier work (see again Abelson and Alcordo, 1986) I attempted to model house prices using a two-stage least squares (quarterly) model of the housing market. The results were generally poor with perverse or insignificant coefficients, including some "wrong" signs on the coefficients for real house prices, and both demand and supply equations exhibited substantial serial correlation. Although the housing stock is the appropriate dependent variable in such a housing market model, it rises slowly and fairly steadily and does not change much as completions are only a small fraction of the stock. Given the relatively fixed nature of supply, it is doubtful whether a simultaneous model would be an improvement on the basic recursive model generally assumed in house price studies.

In the following sections most of the results are reported for levels of real house prices, with a few comparisons given for changes in levels. Because Eqs. (5.23) and (5.24) are precise alternative specifications, it does not matter whether the regressions are run in the level form (5.24) or the change form (5.23). The coefficients and t-statistics are the same in level and change equations for all variables except for the lagged dependent variable. Also the R squared measure is lower for changes than for levels. Of course, these differences are mere statistical artifacts.

In interpreting the results, two general points must be borne in mind. First, with so many potential explanatory variables, the number of possible house price equations (with various permutations of the explanators) to be tested is very large. Unfortunately, there is a thin line between extensive testing and "data mining". As McCloskey (1983) and Leamer (1983) have pointed out, normal tests of significance are premised on the basis that one or two hypotheses are to be tested. In these cases, the tests indicate whether or not the estimated coefficients are significant. If numerous hypotheses are tested, some may turn out accidentally to appear significant and classical tests have little or no meaning.

In response to such potential criticisms, it may be argued that the robustness of the results can be tested by examining the sensitivity of the parameters to changes in the variables included and to changes in the data sets (see McAleer et al., 1985). Also, consistency with theory and with results of comparable studies in other countries may support the results. On this basis it appears that certain explanators below do have a consistent effect on house prices. Nevertheless, the McCloskey/Leamer points mean that the results must be treated cautiously as suggestive rather than definitive.

Second, in interpreting the results, possible relationships between the independent variables need to be considered. For example, in unreported results I found (as would be expected) a positive relationship between foreign investment in Australia and the 90-day rate of interest and a negative relationship between the all-ordinaries index and the 90-day rate of interest. Where such relationships exist, inclusion of both variables in a house price equation runs the risk of multicollinearity.

7.4 SYDNEY HOUSE PRICES: ECONOMETRIC RESULTS

The econometric results for Sydney (Table 7.1) indicate that Sydney real house prices were determined by GDP, the rate of interest for housing loans, foreign migration into Australia, and lagged house prices.

Figures 7.1 and 7.2 show that Eqs. (S1) and (S2) provide good explanations of the levels and changes of real house prices in Sydney respectively. However, it may be observed that the predictive equation did not pick up the full extent of the extraordinary price rises in 1980 and 1988 (Figure 7.2).

The best equation in Table 7.1 is (S3). In this equation, real house prices are determined by the above variables and by government support for housing in 1975 and 1976. The goodness-of-fit is high, serial correlation is low, and the

TABLE 7.1 SYDNEY HOUSE PRICES: ECONOMETRIC MODELS 1965-1989

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
Level/Change	L	C	L	L	L	L	L	L	L	L	L	L
CONSTANT	-10.7	-10.7	-14.1	-9.7	-4.6	-7.9	-6.9	-18.6	-10.7	-10.2	-10.2	-6.3
SHPLAG	0.67	-0.33	0.60	0.58	0.70	0.78	0.54	0.72	0.63	0.71	0.57	
	(2.5)	(-2.5)	(3.3)	(3.4)	(1.5)	(1.5)	(2.7)	(1.4)	(2.5)	(2.1)	(2.5)	
GDP	0.87	0.87	1.11		0.51	0.7	0.67			0.84	0.86	0.91
	(4.4)	(4.4)	(5.5)		(1.9)	(3.4)	(3.7)			(4.2)	(4.4)	(2.8)
GDP/PC								-0.81	1.12			
								(1.1)	(3.8)			
EMP				1.53								
				(2.7)								
RH	-0.04	-0.04	-0.05	-0.01	-0.02	-0.03	-0.01	-0.03	-0.02	-0.04	-0.03	-0.01
	(-3.0)	(-3.0)	(-4.1)	(-0.7)	(-1.1)	(-2.4)	(-0.6)	(-1.7)	(-2.0)	(-3.0)	(-1.8)	(-0.4)
MIG	0.19	0.19	0.26	-0.05					0.19	0.14	0.19	
	(4.9)	(4.9)	(5.7)	(1.0)					(4.6)	(2.1)	(5.0)	
POP								3.45				
								(2.1)				
ALLORDSR						0.17	0.2			0.06		
						(4.2)	(5.2)			(0.9)		
ASSIST.1			0.13									
			(2.4)									
NONNEG							-0.16				-0.07	
							(-2.3)				(-1.0)	
INFLATION												-0.00
												(-0.1)
R2	0.94	0.65	0.95	0.91	0.85	0.93	0.94	0.87	0.93	0.94	0.94	0.75
DW	1.89	1.89	1.84	1.65	0.96	1.64	1.66	0.98	1.91	1.8	1.87	0.64
DH	0.21	0.21	0.14	2.02	7.46	1	1.24	7	0.12	0.47	0.46	

Figures in brackets are t-statistics testing for coefficient = 0, except for SHPLAG where test is for coefficient = 1.

Notes on Variables

SHPLAG	Sydney house price lagged one year
GDP	Gross domestic product
GDP/PC	Gross domestic product per capita
EMP	Employment in city
RH	Interest rate on housing loans
MIG	Foreign immigration into Australia
POP	Population of city
ALLORDSR	All ordinaries index corrected for inflation
ASSIST.1	Dummy variable for housing assistance in 1975 & 1976
NONNEG	No negative gearing dummy variable 1987 & 1988
INFLATION	Rate of inflation
R2	R squared
DW	Durbin Watson statistic
DH	Durbin-H statistic

Source: Author's research

FIGURE 7.1: SYDNEY REAL MEDIAN HOUSE PRICES
Predicted and Actual Levels

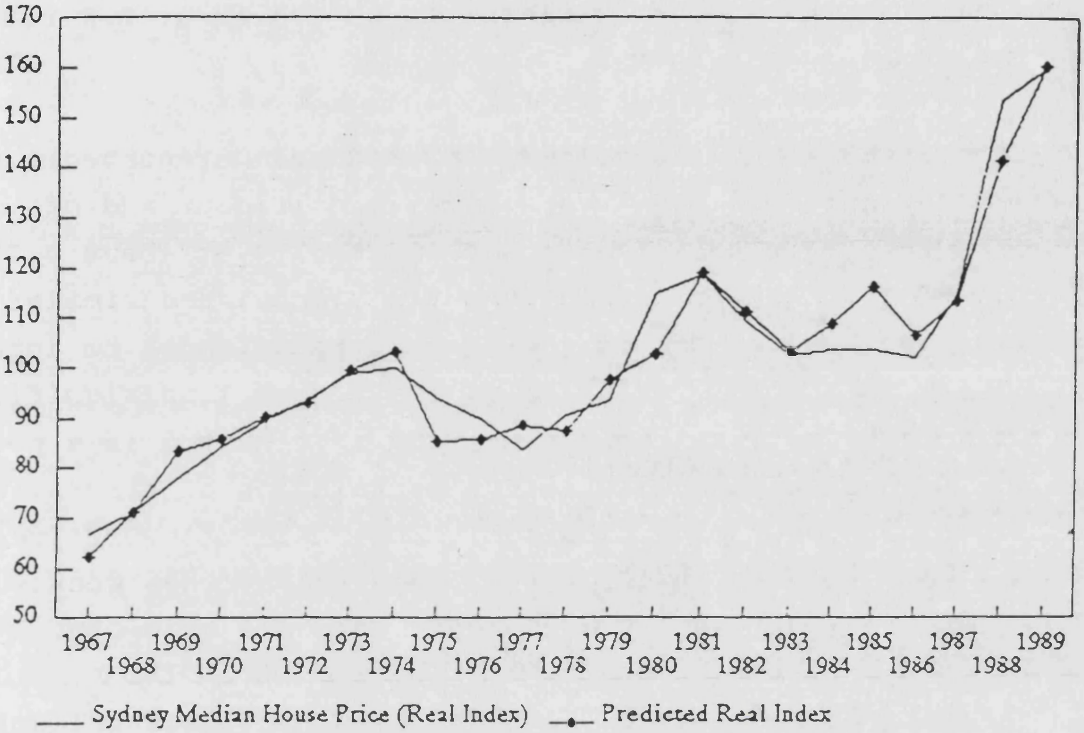
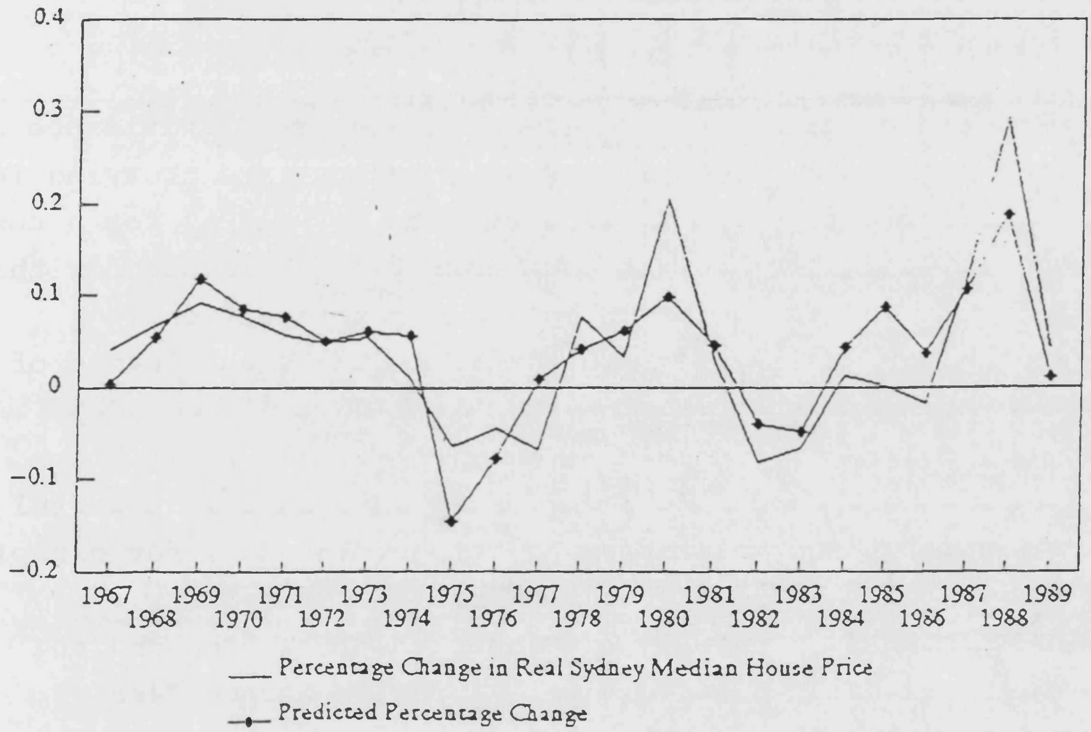


FIGURE 7.2: SYDNEY REAL MEDIAN HOUSE PRICES
Predicted and Actual Percentage Changes



coefficients are significant (with a t-statistic over 2) and have the expected sign. The adjustment parameter (0.6) indicates that long-run elasticities are about 2.5 times impact elasticities.[2]

In virtually all equations (reported and unreported), the coefficient for GDP is positive, significant and of plausible magnitude (an impact elasticity of about 0.7). The coefficient for employment (in Sydney) had similar virtues. However, as in (S4), employment tended to interact poorly with other variables (which became less significant when included with employment) and it resulted in a poorer specification with more serial correlation of errors. GDP per capita performed marginally less well than GDP (see S7 and S8). Also, (in unreported results) average weekly (NSW) earnings usually performed less well than GDP.

The rate of interest on housing loans had a significant negative coefficient in nearly all equations, although the coefficients are surprisingly low. A one point change in the rate of interest has an estimated 0.04 per cent effect on real house prices in the short run and a 0.10 per cent effect in the long run.

A possible reason for the low quantitative significance of (nominal) interest rates may be that they are proxying for an inflationary expectations effect, as well as for a cost effect, and these may be countervailing. Evidence for this appears when inflation is entered as an additional explanator (as in S12). This reduces the significance of the interest rates.

No

On the other hand, immigration has surprisingly powerful effects in the explanatory equations. In (S5), for example, where it is excluded, the goodness-of-fit falls substantially, there is rampant autocorrelation and the coefficients of the remaining variables become less significant. In several equations, immigration has a plausible impact elasticity of about 0.20.[3]

Given the apparent importance of immigration, a number of alternative variables were examined to determine whether immigration was the key explanator or a proxy for another variable.

One possibility is that Sydney house prices are strongly determined by foreign influences but that capital movements (foreign investment) rather than people movements are the key factor. However the foreign investment variable was generally not significant and not as powerful as the migration variable.

Another possibility is that immigration is a proxy for population. Although population is itself generally significant in the Sydney house price equations, as in (S8), it generally did little to improve the overall goodness-of-fit of the regressions, greatly increased serial correlation, and reduced the significance of other variables in the equation. I conclude that population is not a good explanator of short-term changes in house prices.

A further possible explanation could be that immigration levels are determined by confidence in the Australian economy and the future of Australia and that they are consequently correlated with the real all-ordinaries index (ALLORDSR), which is a good barometer of this confidence. As discussed in Chapter 5, house prices would usually to be related positively with ALLORDSR. Eqs.(S6) and (S7) confirm this and show that including ALLORDSR in the house price equation produces significant results. Also, the estimated impact elasticity of about 0.2 is plausible.

Incidentally, (S7) also suggests that a dummy variable for the temporary disallowance of negative gearing for property investors in 1986 and 1987 (NONEG) reduces predicted house prices significantly.

However, when immigration is included with ALLORDSR in (S10) and with NONEG in (S11), the coefficient for immigrants remains significant while the coefficients for ALLORDRS and NONEG turn insignificant. This suggests that immigrants are, statistically at least, a more powerful explanatory factor for house prices than are ALLORDSR or NONEG.

It should also be noted that a possible reason for the under-prediction of the actual house price increase in 1988 was the flight of money out of the stock market. This is not picked up in our equations because this is the reverse of the normal positive equity-house price relationship.

I also tested the potential contributions to Sydney house prices of all the other variables discussed in Section 7.2 (such as broad money, credit for housing and inflation). None of these proved to be significant.

7.5 MELBOURNE AND ADELAIDE HOUSE PRICES: ECONOMETRIC RESULTS

The main results for Melbourne and Adelaide are shown in Table 7.2.

Eqs. (M1) and (A1) show preferred Sydney equations (S1 and S2) applied to Melbourne and Adelaide (using lagged Melbourne and Adelaide house prices respectively). In neither case does the equation perform very well.

The Melbourne equation (M1) has modest goodness-of-fit and exhibits some serial correlation. However the coefficients for GDP and RH are significant and similar to those for Sydney.

TABLE 7.2 MELBOURNE AND ADELAIDE HOUSE PRICES: ECONOMETRIC MODELS

	----- Melbourne 1965-89 -----				----- Adelaide 1972-89 -----			
	M1	M2	M3	M4	A1	A2	A3	A4
Level/Change	L	L	C	L	L	L	C	L
CONSTANT	-9.4	-1.38	-1.38	-9.5	-2.64	-5.0	-5.0	1.3
MELBLAG	0.72	0.64	-0.36	0.74				
	(1.5)	(5.5)	(-3.1)	(1.5)				
ADELLAG					0.61	0.44	-0.56	0.59
					(1.6)	(4.5)	(-5.7)	(1.8)
SHPLAG		0.34	0.34					
		(2.0)	(2.0)					
MELB						0.51	0.51	
						(7.0)	(7.0)	
GDP	0.81				0.4			
	(2.5)				(1.1)			
AWESA						1.19	1.19	
						(5.5)	(5.5)	
EMP								
RH	-0.04				-0.02	-0.03	-0.03	
	(-1.9)				(-0.9)	(5.0)	(5.0)	
R90DAY		-0.03	-0.03	-0.01				0.00
		(-3.6)	(-3.6)	(-1.7)				(0.03)
MONEYR		0.37	0.37					
		(2.7)	(2.7)					
MIG	0.11				-0.02			
	(1.4)				(-0.2)			
POP				1.37				0.08
				(2.3)				(0.10)
ALLORDSR								0.02
								(0.20)
ASSIST.1	0.11							
	(1.2)							
NONNEG								
INFLATION				-0.00				
				(-0.5)				
R2	0.88	0.93	0.57	0.87	0.50	0.91	0.88	0.46
DW	1.38	1.78	1.78	1.33	1.06	2.07	2.07	1.23
DH	2.89	0.61	0.61	3.22	14.07	-0.32	-0.32	4.45

Figures in brackets are t-statistics testing for coefficient = 0, except for SHPLAG where test is for coefficient=1.

Notes on Variables : as shown in Table 7.1 unless stated otherwise.

MELBLAG	Melbourne house price lagged one year
ADELLAG	Adelaide house price laggd one year
AWESA	Average weekly earnings in South Austraia
R90DAY	90 day interest rate
MONEYR	Real broad money
NONNEG	No negative gearing dummy variable 1987 & 1988

Source: Author's research

Many other possible explanatory equations for Melbourne were tested. Generally these equations performed poorly and exhibited substantial serial correlation. For example, although (M4) has apparently a reasonable goodness-of-fit, high serial correlation indicates that it fails to explain many short-term changes.

The best Melbourne equations required lagged Sydney house prices as an explanatory variable. This is plausible because changes in asset prices in Australia's largest (and most international) city are likely to lead changes in asset prices in the second largest.

With the inclusion of lagged Sydney house prices, the determinants of Sydney house prices (such as GDP) are included implicitly, and are not significant as extra variables, in the Melbourne house price equations.

However, 90-day interest rates and broad money (in real terms) are statistically significant and have the expected signs in (M2) and (M3). Interestingly, the adjustment parameter for Melbourne is a similar order of magnitude to that found in Sydney.

Not surprisingly, because the Adelaide economy is relatively small and Adelaide does not attract many immigrants, neither GDP nor immigrants are significant determinants of real house prices in Adelaide (see A1).

Again, several explanatory equations for Adelaide house prices were tested. The best equations included concurrent house prices in Melbourne. To some extent this shows simply that Adelaide house prices are influenced by a similar set of variables to Melbourne house prices rather than that the latter determine the former, although some causal relationship cannot be ruled out.

In addition, (A2) and (A3) indicate that Adelaide house prices are determined by real average weekly earnings and by interest rates for housing. In both cases the coefficients have plausible magnitudes and expected signs. As might be expected in a less complex environment, the adjustment parameter implies a faster rate of adjustment than in Sydney or Melbourne (the long term elasticities are about 1.75 times impact elasticities in Adelaide compared with 2.5 times in the other cities).

Figures 7.3 to 7.6 show that the preferred equations provide good explanations for house prices in Melbourne and Adelaide. However, there is again a slight tendency for rapid price changes to be under-predicted (see Melbourne in 1973 and 1984 - Figure 7.4).

7.6 HOUSE COMMENCEMENTS AND HOUSE PRICES

As we have seen, house commencements do not appear to reduce house prices in the short run. Indeed the relationship between house prices and commencements was generally positive. This relationship is examined further here where commencements are treated as the dependent variable.

Table 7.3 shows econometric results with annual house commencements a (log-linear) function of house prices, the 90-day interest rate, and commencements in the previous year (LAGCOM).

The coefficients in the three equations are plausible (although those for interest rates are low) and have the expected sign. However, the overall levels of explanation are not high and the coefficients for house prices are barely significant. Also the equations reveal serious auto-correlation.

FIGURE 7.3 MELBOURNE REAL MEDIAN HOUSE PRICES PREDICTED AND ACTUAL LEVELS

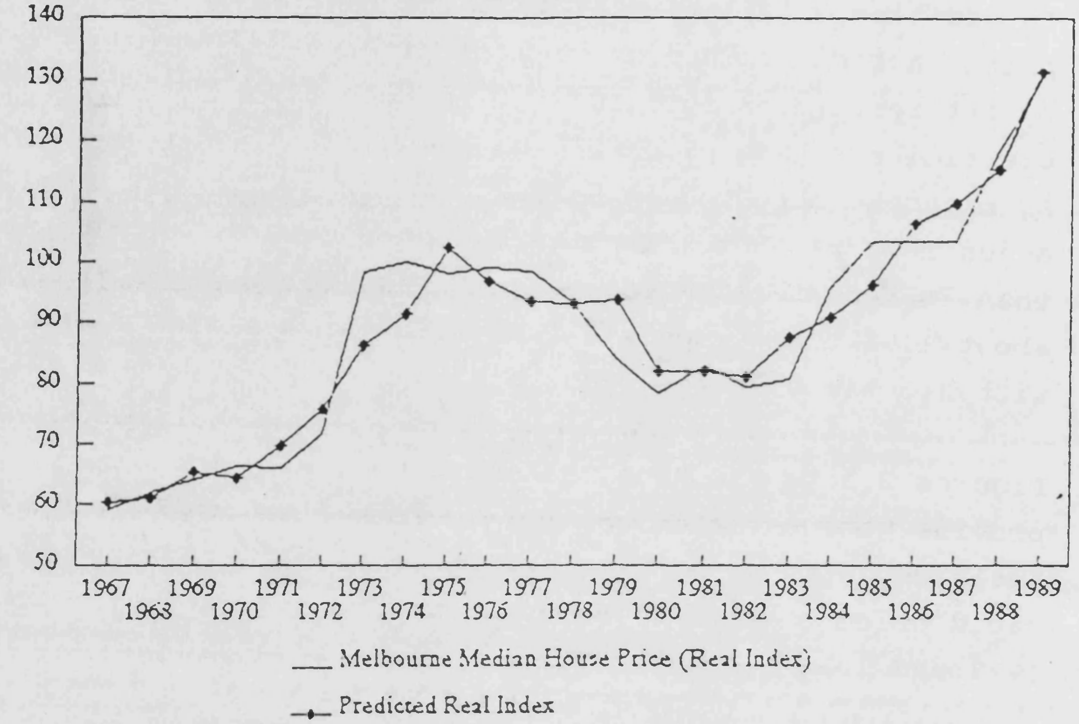


FIGURE 7.4 MELBOURNE REAL MEDIAN HOUSE PRICES PREDICTED AND PERCENTAGE CHANGES

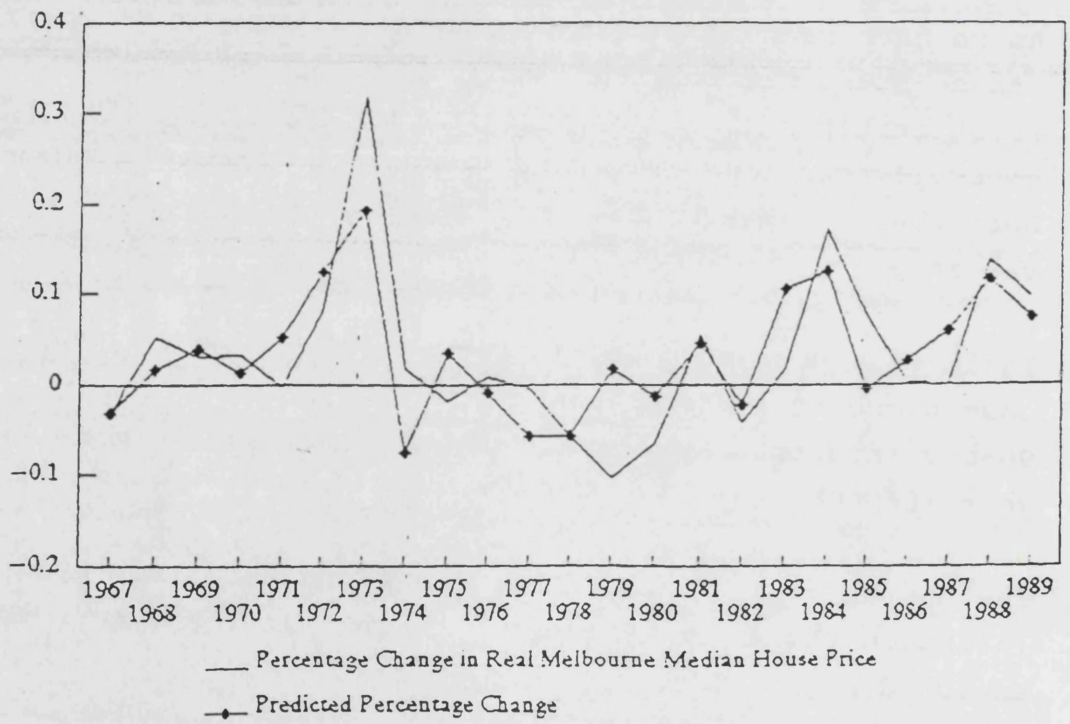


FIGURE 7.5 ADELAIDE REAL MEDIAN HOUSE PRICES PREDICTED AND ACTUAL LEVELS

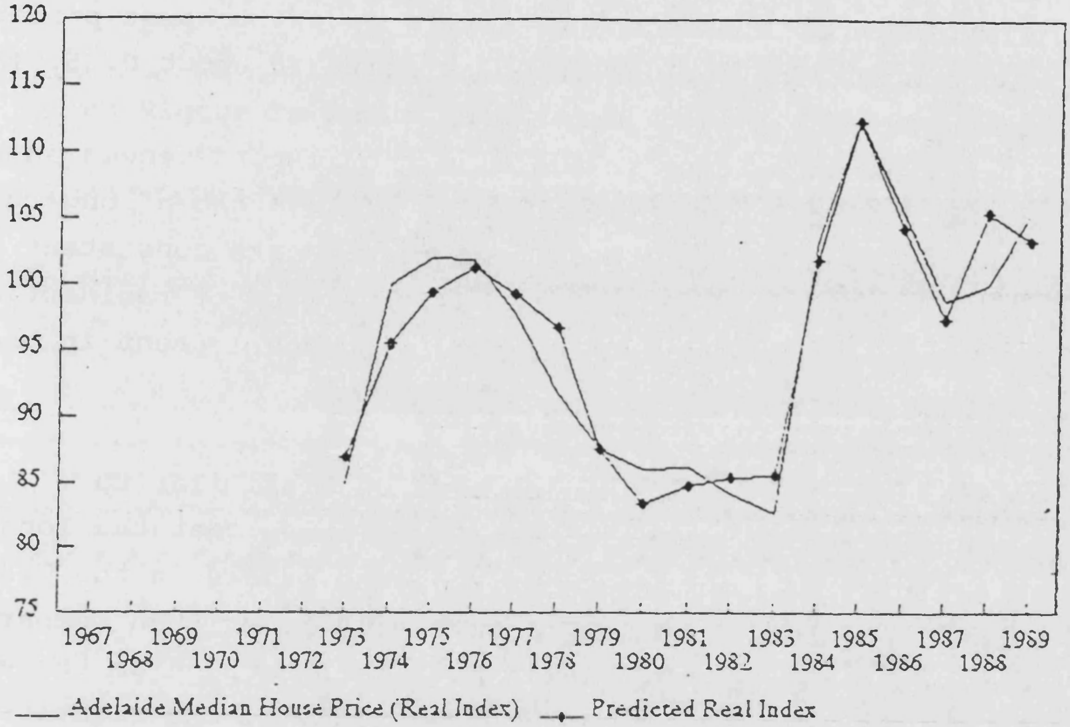
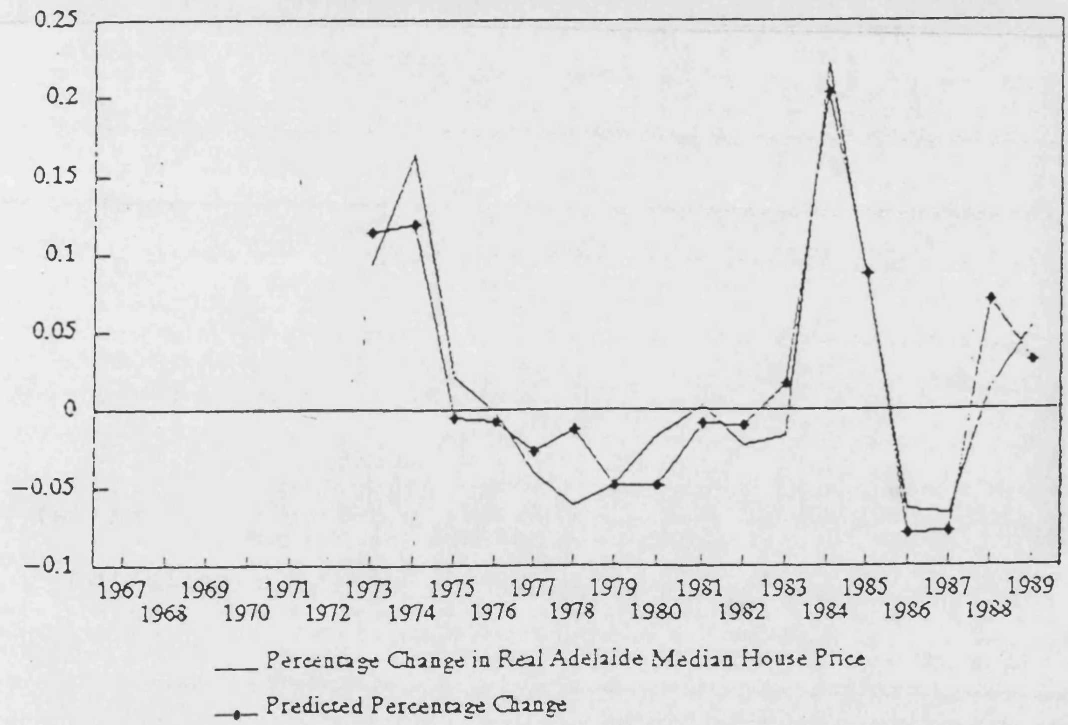


FIGURE 7.6 ADELAIDE REAL MEDIAN HOUSE PRICES PREDICTED AND ACTUAL PERCENTAGE CHANGES



Taken at face value, in Sydney and Melbourne the impact elasticity of commencements with respect to house prices is about 0.35 and the long-run elasticity is about 0.65. This indicates only moderate responsiveness of supply to increases in prices. In Adelaide the responsiveness is much higher, with an impact elasticity of 1.54 and a long-run elasticity of about 1.85. These results are consistent with casual observation about the relative ease of residential development in Adelaide compared with development in the larger cities.

Interestingly, these results are not dissimilar to international results. Dicks (1989) shows that the long-run elasticity of housing starts to house prices in the U.K. is about one-half, which is considerably lower than comparable estimates in the U.S., which have been as high as three. Dicks attributes this difference mainly to the relative scarcity of residential land in the UK.

TABLE 7.3 MODELS OF HOUSE COMMENCEMENTS

	Sydney	Melbourne	Adelaide
Constant	4.25	3.90	0.47
PH	0.39	0.30	1.54
	(1.6)	(1.4)	(1.8)
R90DAY	-0.03	-0.02	-0.04
	(-2.7)	(-2.3)	(-1.7)
LAGCOM	0.41	0.49	0.17
	(2.2)	(2.7)	(0.6)
R^2	0.40	0.60	0.59
DW	1.33	0.97	1.19
DH	2.91	4.93	na (a)

(a) Not given - indicates serious serial correlation.

Source: Author's estimates.

7.7 CONCLUSIONS

In this chapter I have tested various explanations of short-term changes in real house prices in Sydney, Melbourne and Adelaide.

To clarify the analysis, seven main sets of explanations for house prices were distinguished. These were the "standard" explanation (income, interest rates and expected capital gains or inflation); the demographic effect; the international angle (immigrants and foreign investment); supply side effects; credit effects; the 1987 stockmarket crash; and the impacts of housing policies.

In an ideal world, econometric results (based on systematic testing of hypotheses) would provide full solutions. In practice, for various reasons, they do not.

- Many data are crude measures. For example, statistics are poor for such basic data as city incomes, quarterly city population and immigration, and house completions. Another major problem is the regulation of most interest rates, including housing loan rates and bond rates, until the mid-1980s.

- Many changes do not fit into neat periods such as quarters or years. Our results are based on annual data.

- Often there are lags in the market as individuals take time to respond to changes in exogenous factors. But, at other times, individuals act speculatively, for example in fear that if they delay to act they will have to pay more for houses in only a few weeks time. It is difficult, though not impossible, to encompass both reactions within one model. In any case, expectations of capital gains are especially difficult to measure.

- There is considerable correlation, and in some cases causal interaction, between some potential explanatory factors.

- When a large number of econometric models are tested, good econometric results can occur by chance.

All of this means that the econometric results, both positive and negative, must be treated with caution and blended with both economic theory and common sense judgement.

Given these caveats, what are my main findings?

One general finding is that a disequilibrium model, employing the lagged dependent variable as an explanator, was essential for model specification (e.g. to get rid of serial correlation). As a matter of interpretation, long-run elasticities are of the order of 2.5 times impact elasticities in Sydney and Melbourne and 1.75 times impact elasticities in Adelaide.

On the other hand, our models did not fully replicate some of the sharp upward movements in house prices that occurred, almost certainly driven upwards temporarily by expectations of higher prices.

A second general finding is that the "standard" explanatory variables, income and interest rates, influence house prices in the short run in each city. The estimated short-run elasticity of real house prices to real income changes was about 0.7. However, although statistically significant, changes in interest rates appear to have a smaller impact on house prices than is commonly believed.

Moreover, because income and interest rates usually explain only a small part of the short-run variations in real house prices in any city, it is necessary to consider what other variables determine house prices.

Contrary to much US literature, no evidence was found that inflation affected real house prices. Nor was population a significant short-term determinant of house prices. Although the coefficient for population was significant in some regressions, the inclusion of population in the model does not enhance overall goodness-of-fit and it reduces the significance of other explanatory variables.

Another general finding is that short-run house prices were not influenced by the number of commencements. Conceivably a simultaneous model of the housing market could produce a contrary finding, but there is no evidence that it would.

Given the apparent lack of a general theory that explains all the variations in house prices in each city, I considered some specific explanations of house prices for each city.

In Sydney several variables help to explain variations in house prices. Of these, the one which most improved the goodness-of-fit was foreign migration into Australia, which had an estimated impact elasticity of about 0.2. However, in this case, the long-term elasticity may not be higher than the impact elasticity as increased emigration from SLydney usually follows high immigration levels. By contrast, foreign investment in Australia did little to improve goodness-of-fit.

Another variable that improved goodness-of-fit (when not included with immigration) was the (real) all-ordinaries index, which also had a plausible impact elasticity of about 0.2. This is consistent with our expectations that the all-ordinaries would generally be positively related to house prices. Notwithstanding this general finding, it is possible that the sudden collapse in confidence in the stock market after October 1987 caused a temporary flight of savings into real estate and was part cause of the 1988 house price inflation.

Most likely, immigrants and the all-ordinaries index are both correlated with general confidence in the Australian economy, which would lift expectations of capital gains in housing and house prices. Probably, some combination of all these related factors (immigration, equity levels, confidence, and expectations of capital gains) drives house prices.

Moreover, as noted in Chapter 2, there appears to have been a correlation between house prices in Sydney and those overseas, especially in the UK. Although this relationship has not been examined statistically here, I suspect that there may be a causal relationship between overseas and Sydney house prices.

Finally, with regard to Sydney, there is some evidence that government policies affected house prices, specifically that the high level of housing assistance in 1975 and 1976 lifted prices and that the disallowance of negative gearing in 1986 and 1987 depressed them. However the dummy variables used in the regressions to test for policy effects are crude, non-robust, tests of these hypotheses.

Melbourne house prices can also be explained by income, interest rates and immigration, and lagged Melbourne prices. However, the specification is substantially improved by the inclusion of lagged Sydney house prices. Also, there is some evidence that Melbourne house prices were influenced by the money supply.

But it is not clear why Melbourne house prices would be influenced by the money supply if Sydney and Adelaide house prices were not, so this result should be regarded with caution. Generally there is little evidence for the view that the supply of either broad money or housing credit had an independent effect on house prices in the three cities.

Adelaide house prices were linked closely with Melbourne's for most of the period since 1970, until very recently, but it is not clear whether there is any causal relationship in this link. Adelaide house prices were also influenced by household incomes and interest rates.

ENDNOTES

(1) Only real capital gains from non-owner-occupied dwellings, purchased after 1984, are taxed.

(2) As noted in Chapter 5, the standard lagged adjustment model employed in this study implies that house prices adjust at a similar rate to changes in each explanatory variable. This may not be realistic.

(3) A 10 per cent increase in national immigrants increases the annual demand for houses in Sydney by about two per cent.

8 CAUSES OF HOUSE PRICE DIFFERENCES WITHIN SYDNEY, MELBOURNE AND ADELAIDE IN 1989 AND 1977

8.1 INTRODUCTION

The object of this chapter is to explain differences in median LGA house prices in Sydney, Melbourne and Adelaide. The analysis is made for the most recent year (1989) and the earliest year (1977) for which comparable data are available.

As we saw in Chapter 6, average LGA house prices may be explained in two main ways: by hedonic price models or by housing market models of the demand for, and supply of, housing in each LGA. The hedonic price approach has the advantages of focussing directly on the composition of house prices and practicality. The housing market approach provides a better understanding of the forces underlying house prices, but requires far more information for implementation. Consequently this study concentrates on hedonic price explanations. This is supplemented below (and in the next chapter) with some analysis of house prices and market characteristics based on readily available data.

The following section outlines the data collected. Full details of the data are given in Applied Economics (1991, Appendix F). Sections 8.3 and 8.4 describe the general results of the hedonic price models and the detailed results for the major explanatory variables respectively. Section 8.5 provides a brief look at house prices and some market characteristics. Section 8.6 provides further analysis of the relationship between household income and house prices. A final section summarises the findings of the chapter.

8.2 DATA ON POTENTIAL CAUSES OF HOUSE PRICE DIFFERENCES

Hedonic Price Models

Based on many hedonic models of house prices (see Appendix B), the following seven sets of factors constitute the important determinants of house prices:

- the size of land,
- the size of dwellings,
- the age and quality of dwellings,
- accessibility, especially to employment,
- environmental attributes,
- neighbourhood attributes other than the environment (e.g. crime/safety),
- fiscal variables.

A minority of studies also include household income or socio-economic status as an additional explanator (see Chapter 6).

In this study, I collected data on the first five factors plus income data for each of the three cities. Due to resource constraints, I collected no data for neighbourhood or fiscal variables, which seemed likely to be less important. Given the relatively small expenditures per capita of local government in these three cities (and the fiscal subsidies from state and commonwealth governments to less affluent LGAs), local differences in expenditure and tax levels are minor compared with the US.

The list below describes the data collected for each LGA. Where possible 1989 data were collected. However some data are based on the 1986 census, and for some housing information only 1976 census data were available.

LAND AND BUILDINGS

Typical lot size estimated on three point scale:

(1) Large - over 750 sq.m.

(2) Medium - 550 to 750 sq.m.

(3) Small - under 550 sq.m.

Note, in Melbourne a modified four point scale was used. Given the scale used, a negative coefficient is expected.

Average house size: proxied by average number of bedrooms (in 1976).

Note, the regression results shown are standardised on an average of 3.0 bedrooms per house.

Percentage of houses that are brick (in 1976).

Percentage of houses with mains sewer services (in 1976).

Age of typical house (estimated).

Based on decade of most building, e.g. 1910 or earlier = 1; 1910 to 1920 = 2; 1920 to 1930 = 3; etc.

ACCESSIBILITY

Distance (km) from centre of LGA to centre of CBD.

Distance (km) from centre of LGA to nearest regional centre.

Whether LGA contained a rail station in 1989 (dummy 1-0 variable).

Whether LGA received a ferry service in 1989 (Sydney, dummy 1-0 variable).

ENVIRONMENT

LGA environmental quality estimated on four point scale:

(1) Low quality, generally flat, with few views.

(2) Undulating with some local views.

(3) Undulating/rolling with some more extensive views.

(4) High quality landscapes with high quality views.

Note: these estimates were based on valuations by independent planners in each city; no attempt was made to achieve a common intercity standard.

Average distance (km) to the coast.

This reflects climatic comfort as well as access to recreation.

Whether LGA contained a major industrial area (dummy 1-0 variable).

This could be an access benefit or amenity disbenefit.

Population density (in 1986).

A possible environmental disamenity.

As remarked above, data collection was constrained by data availability and resources. In my detailed study of house prices in two Sydney suburbs (Abelson, 1977), for example, I obtained data on 27 variables for 1414 houses. In addition to data omissions, the data limitations of most concern in this study are the poor quality of the lot size data and the narrow and qualitative nature of the environmental variable. Despite these limitations, the hedonic models below explain house prices quite well.

Housing Market Models

To estimate some housing market equations, I collected the following additional data (mainly relating to household characteristics that might influence housing demand) for each LGA in the three cities from the 1986 Household Census.

Total population,
Adult population: per cent of population over 18 years,
Ethnic data: per cent of LGA born in overseas countries,
Income: median household income (estimated),
Employment: percentages of population employed and unemployed,
Vacancy rates for private dwellings,
Household size: average occupancy rates in private dwellings,
Home ownership: per cent of households who own their house,
Car ownership: cars per household,
Use of rail: per cent of labour force who commute to work by train.

8.3 HEDONIC PRICE MODELS: GENERAL RESULTS

Initially I adopted a linear model for all variables. Although many hedonic price studies adopt a log-linear specification, this was not appropriate with so many dummy variables. However for the crucial variable, distance from the CBD, I tested various non-linear transformations and found that the log form usually gave the best results.

Tables 8.1, 8.2 and 8.3 show the main results for each city. Each table shows six or seven regressions for 1989 and two for 1977.

The regressions for 1989 include equations with house prices estimated as linear, and non-linear, functions of distance from the CBD.

The 1977 regressions show two selected equations for each city in both 1977 and 1989 prices. The latter were estimated by factoring up LGA prices by the general house price inflation in each city between 1977 and 1989.

TABLE 8.1 SYDNEY HOUSE PRICES: DETERMINANTS OF DIFFERENCES BETWEEN LGAS

	1989			1989				1977 (a)			
	S1	S2	S3	S4	S5	S6	S7	S8a	S8b	S9a	S9b
CONSTANT	123800	94220	333280	381760	363570	355600	214900	34059	169614	55810	277934
CBD	-2504	-1211	-2642					-319	-1589		
	(-3.8)	(-1.4)	(-4.1)					(-4.0)	(-4.0)		
LOGCBD				-75856	-55675	-32677	-49379			-5801	-28889
				(-8.9)	(-5.2)	(-4.3)	(-2.7)			(-4.4)	(-4.4)
ENVIRON	42991	37787		28524	24144		36947	5453	27156	3152	15697
	(4.4)	(3.8)		(3.3)	(2.9)		(3.2)	(4.6)	(4.6)	(3.2)	(3.0)
COAST		-1569			-1575	-1878	-1392			-191	-951
		(-2.4)			(-2.8)	(-4.9)	(-2.2)			(-2.8)	(-2.8)
INDUSTRY			-80344				17391				
			(-3.3)				(0.8)				
LOTSIZE			-2803				7834				
			(-0.1)				(0.5)				
BED	187270	242221		296450	323350	358360	294930	37391	186207	51541	256674
	(3.4)	(4.2)		(5.9)	(6.8)	(11.3)	(5.1)	(5.5)	(5.5)	(9.0)	(9.0)
BRICK	840	627					172	40	199		
	(1.4)	(1.1)					(0.3)	(0.5)	(0.5)		
SEWER		675					675				
		(1.3)					(1.6)				
FERRY						88473					
						(5.2)					
SUBCENTRE						3135					
						(2.7)					
S.W.LGAS						-78348					
						(-4.3)					
R2	0.79	0.82	0.52	0.80	0.83	0.92	0.85	0.82	0.82	0.86	0.86

(a) S8a and S9a are in 1977 prices; S8b and S9b are 1989 prices (based on house price inflation).

Source: Author's research

8.2 MELBOURNE HOUSE PRICES: DETERMINANTS OF DIFFERENCES BETWEEN LGAS

	1989		1989				1977 (a)			
	M1	M2	M3	M4	M5	M6	M7a	M7b	M8a	M8b
CONSTANT	68153	178260	264050	278050	261410	136840	25653	105177	77684	318504
CBD	-1410	-2285					-128	-525		
	(-2.4)	(-4.6)					(-2.4)	(-2.4)		
LOGCBD			-55517	-48207	-41110	-15776			-4908	-20123
			(-7.0)	(-6.6)	(-3.8)	(-2.1)			(-7.2)	(-7.2)
ENVIRON	16923	18166	18642	12742	14297		2153	8827	2125	8713
	(2.5)	(2.6)	(3.1)	(2.28)	(2.5)		(3.5)	(3.5)	(4.0)	(4.0)
COAST					-950					
					(-1.6)					
INDUSTRY				-38780	-40464	-46913			-2812	-11529
				(-3.9)	(-4.0)	(-4.7)			(-3.0)	(-3.0)
LOTSIZE		-8032			1591					
		(-0.7)			(0.2)					
BED	42681	105930	222350	188780	210330		21646	88749	42026	172307
	(0.7)	(2.1)	(4.6)	(4.3)	(2.9)		(3.8)	(3.8)	(10.1)	(10.1)
BRICK	571				-160	846	110	451		
	(1.2)				(-0.4)	(2.9)	(2.5)	(2.3)		
SEWER	591				183	499	51	209		
	(2.3)				(0.7)	(2.5)	(2.2)	(2.2)		
R2	0.43	0.37	0.49	0.61	0.66	0.57	0.65	0.65	0.73	0.73

(a) M7a and M8a are in 1977 prices; M7b and M8b are in 1989 prices (based on house price inflation).

Source: Author's research

8.3 ADELAIDE HOUSE PRICES. DETERMINANTS OF DIFFERENCES BETWEEN LGAS

	1989		1989				1977 (a)			
	A1	A2	A3	A4	A5	A6	A7a	A7b	A8a	A8b
CONSTANT	196320	177850	177760	193320	226560	194490	48567	149101	42903	131712
CBD	−3440	−3391					−630	−1934		
	(−5.1)	(−6.7)					(−3.8)	(−3.8)		
LOGCBD			−41645	−38814	−30983	−39911			−5333	−16372
			(−6.8)	(−6.8)	(−6.6)	(−5.6)			(−3.4)	(−3.4)
ENVIRON	13300		11705	6130		3843	3489	10711	2942	9032
	(3.1)		(3.0)	(1.4)		(0.8)	(3.4)	(3.4)	(2.6)	(2.6)
COAST					−1366	−830				
					(−2.1)	(−1.0)				
INDUSTRY		−29244		−25267	−33911	−27392			−3566	−10948
		(−3.4)		(−2.5)	(−4.0)	(−2.5)			(−1.3)	(−1.3)
LOTSIZE						21631				
						(−1.6)				
BED	186230		136760	103920		149200	56249	172684	42456	130340
	(2.6)		(2.0)	(1.67)		(1.8)	(3.2)	(3.2)	(2.5)	(2.5)
BRICK	−1479					−667	−159	−488		
	(−3.3)					(−1.4)	(−1.4)	(−1.4)		
SEWER	445					296	−5	−15		
	(1.8)					(1.2)	(0.0)	(0.0)		
RAIL		−24114			−29433					
		(−2.7)			(−3.3)					
R2	0.70	0.73	0.65	0.72	0.78	0.81	0.61	0.61	0.55	0.55

(a) A7a and A8a are in 1977 prices; A7b and A8b are in 1989 prices (based on house price inflation).

Source: Author's research

As previously noted, for some variables (beds, brick and sewer) the only readily available data came from the 1976 census and these data had to be used in the 1989 regressions. In many areas, with only small changes in these variables over the 13 years, this would not matter. However, inaccuracies could arise in faster-growing (outlying) LGAs in 1989.

Generally the goodness-of-fit achieved by the equations was satisfactory for this type of analysis, with over two-thirds of the variations explained in most of the preferred equations.

Interestingly the best explanations, with R-squareds well over 0.80 in the better equations, were achieved in Sydney, despite its irregular topography and features. A possible explanation is that, due to the writer's greater familiarity with Sydney, the Sydney data were more accurate than the Melbourne and Adelaide data.

In Sydney I also experimented with introducing dummy variables for seven recognised sub-regions. The objective was to test the applicability of a single hedonic price structure to the city. Eq. (S7) shows that the variable SWLGAS (a dummmy variable for the outer south-western LGAs) is significant and adds to the explanation. However, an alternative explanation (to the hypothesis that a different price structure applies to the SW LGAs) is that some descriptor for the SW LGAs is inaccurate or omitted. No other regional variables entered significantly into the stepwise regression..

Overall, the most powerful explanators of house prices are distance from the CBD, environmental factors and house size (as proxied by the average number of bedrooms per house).

Other significant factors in one or more cities are distance from the coast, proximity to industry, the percentages of brick houses and houses with mains sewer services, and access to ferry services (in Sydney).

Generally insignificant variables were lot size, access to a subcentre, age of houses, access to rail (except in Adelaide where proximity to rail is negatively related to house prices) and population density.

Of course, these findings do not necessarily mean that these variables are not significant. For example, many studies have shown that lot size is a major determinant of house prices. However, in this study only crude estimates of average lot size in each LGA could be used and this probably caused this variable to show up as insignificant.

Moreover, as in most multivariate analysis, multicollinearity is an issue. For example, in all cities there is a significant positive correlation between distance from the CBD and the provision of mains sewer services, and between environmental quality and proximity to industry. In Sydney, there are strong correlations between distance to the CBD and distance to the coast and between environmental quality and access to ferry services. Where such collinearity occurs, judgment is required to determine the preferred explanation. For example, most of the value attributed to ferry services in (S6) should be attributed to the environmental quality of access to the Harbour rather than to availability of ferry services.

8.4 RESULTS FOR SIGNIFICANT VARIABLES

Distance to CBD: This is the most significant variable. For each city it provides a unifying explanation of house price differentials throughout the city.

Observation that the coefficient for linear distance from the CBD was higher for Adelaide than for Sydney (which was contrary to expectation) led me to experiment with a non-linear distance from CBD variable. I tested the log of distance (LOGCBD), the distance squared, and the inverse of distance.

In Sydney and Melbourne, LOGCBD improves the specification and the goodness-of-fit significantly; the coefficients for the non-linear measure are more significant than for the linear variable; and LOGCBD produces the expected ordering for the sizes of the coefficient (i.e highest for Sydney and lowest for Adelaide).

However, in Adelaide, the results for the linear distance variable may be considered as good as for the non-linear one. This is plausible in a smaller city with less reliance on rail.

The implication of the log form is that house prices fall sharply close to the CBD and less sharply as distance to the CBD increases. The change in house price with distance from the CBD (dHP/dDistance) is given by the coefficient on LOGCBD (b) divided by the distance:

$$dHP/dDistance = b/Distance \qquad (8.1)$$

Drawing on typical coefficients (see Section 10.3), it turns out that, between 5 and 10 km from the CBD, house prices in 1989 declined in each city by about three per cent per km. Between 10 and 20 km from the CBD, they declined by about two per cent per km. Between 20 and 30 km from the CBD, they fell by about 1.5 per cent per km. These declines are higher than the typical two per cent per mile in US cities estimated by Jackson (1979).

However, it should be observed that the Australian distance coefficients rose substantially between 1977 and 1989 (see comparisons using 1989 prices). In the preferred specifications for each city (S5 and S9b; M4 and M8b; and

A4 and A8b), the coefficients more than doubled in 13 years. The causes and implications of this are discussed in the following chapters.

Finally it may be observed that the Sydney house price gradient is consistent with estimated values of travel time savings. To show this, we have to work with rough average speeds for Sydney because more refined speed data for the Sydney road network (and data for Melbourne and Adelaide) are not readily available.

As shown in Table 9.2, in 1989, travel speeds for typical journeys to and from work in Sydney were about 30 kph. Allowing an average value of travel time of $7.5 per hour (see Hensher, 1989), the time cost of commuting 20 km would be $5. Add marginal vehicle operating costs of $3 per 20 km and the total commuting cost would be $8 per 20 km. The estimated annual cost for 20 km would be:

$8 * 2 (return trip) * 220 (days) = $3,250

Allowing a five per cent real rate of return on capital, this annual cost is equivalent to $3,250/0.05 = $70,400. This is almost exactly equal to the price premium for houses 10 km from the Sydney CBD compared with those 30 km from the CBD (see Table 10.2).[1]

Environment: The quality of the environment is highly significant in each city. Since a four point scale is used, the average environmental premium in a high quality LGA (level 4) compared with a low quality (level 1) LGA is three times the environmental coefficient. In Sydney this premium is in the order of $100,000 (depending on the preferred equation); in Melbourne it is about $45,000; in Adelaide about $30,000.

Again, the premium on the environment rose significantly in all three cities between 1977 and 1989.

House size/beds: House size (BED) is an important explanator of average house prices in Sydney and Melbourne, and also significant in Adelaide.

To interpret the estimated coefficient, note that the average number of bedrooms per house in an LGA is usually between 2.80 to 3.10. Thus given a coefficient of say $250,000, a 0.1 variation in average bed number implies an difference of $25,000 in the average house price. The coefficient for BEDS suggests that average house prices in LGAs with large houses are about $75,000 higher than those in LGAs with small houses. However, this variable may be picking up some value that should be attributed to lot size or house quality, or both.

Comparing similar specifications for 1977 and 1989, it can be seen that (unlike the coefficients for LOGCBD and environment) the coefficients for BED in each city did not change by much.

Distance to coast: In Sydney, distance to the coast is highly significant. Some of this significance is attributable to the related proximity to the CBD and environmental amenity, but the coefficient on distance to coast is significant in (S5), (S6) and (S7) with these other variables included. Actually, in (S2), distance to the coast is more significant than distance to the CBD, but equations with log of distance to the CBD are preferred.

Distance to the coast was also significant in Adelaide (A5) but not in Melbourne.

Proximity to industry: The presence of major industry in an LGA generally produces a substantial negative impact on house prices. However, proximity to industry was (inversely) correlated with the environmental index in each city and with proximity to the CBD in Melbourne, so that it is difficult to estimate the particular impact due to industry.

Percentage of brick houses: The coefficient for the percentage of brick houses was significant (and positive) for Melbourne in 1977. Otherwise it was statistically significant only for Adelaide in 1989, but in this case the coefficient was negative.

Percentage of houses with mains sewer: This variable appears to be significant for Melbourne and possibly for Adelaide in 1989, but not for Sydney (although the coefficient has the expected positive sign). The coefficient is around $600 in Melbourne and Sydney and $400 in Adelaide. A coefficient of $600 implies that a one per cent increase in the percentage of houses with mains sewer would increase average house prices in an LGA by $600. However sewer services are strongly related (negatively) to distance from the CBD and may pick up some distance effect.

8.5 HOUSE PRICES AND SOME MARKET CHARACTERISTICS

Table 8.4 shows some correlations between (1989) average LGA house prices and (mostly 1986) household and market characteristics.

As would be expected, in each city, average LGA house prices are positively correlated with adult population, median household income, and the proportion of the labour force in the population. However the correlation between house prices and median household income in Melbourne is weak. This may be explained by the presence of low income renters in some high priced areas. For example, in Prahran - Melbourne's most expensive LGA - 54 per cent of households are renters. These renter households would reduce average household income but not average house prices.

On the other hand, average LGA house prices are negatively correlated in each city with unemployment rates, household size and house ownership. The latter two results are slightly surprising. Certainly, other things being equal, house prices might be expected to increase with household size (as they do with the number of bedrooms). However, the coefficient on HHSIZE is also negative (for Melbourne) in Table 8.5. Also, house prices might be expected to be positively related with ownership. But, possibly, low prices encourage ownership.

The correlations between house prices and concentrations of ethnic populations and between house prices and vacancy rates are generally insignificant.

TABLE 8.4 CORRELATIONS OF HOUSE PRICES AND SOME MARKET CHARACTERISTICS

	Sydney	Melbourne	Adelaide
Adult % of pop'n.	0.55	0.46	0.60
Ethnic pop'n.	-0.18	-0.02	0.04
H'hold income	0.59	0.22	0.34
Lab. % of pop'n.	0.55	0.34	0.29
Unemp. % of pop'n.	-0.57	-0.11	-0.47
Vacancy rates	0.01	-0.06	0.19
Household size	-0.22	-0.50	-0.59
House ownership %	-0.20	-0.39	-0.10
Cars per h'hold.	-0.10	-0.26	-0.16
Commute % by train	-0.17	0.15	-0.50

Source: Author's estimates.

Some of the more plausible potential relationships are examined further in the multivariate regressions shown in Table 8.5. This shows that household income and the adult percentage of the population "explain" a high proportion of the variation in house prices in Adelaide, slightly less in Sydney, and about half the variation in Melbourne. Based on mean house prices and incomes, the estimated elasticity of house price with respect to household income is 1.67 in Sydney, 1.46 in Adelaide and (taking the average Melbourne result) 1.28 in Melbourne. However the ethnic variable is, again, not significant.

TABLE 8.5 HOUSE PRICES 1989: MARKET MODELS

	Adelaide	Melbourne	Melbourne	Sydney
Constant	-489570	-492475	89292	-879290
HHINC ('000)	7839 (10.0)	7322 (5.3)	10651 (9.0)	13435 (7.0)
ADULT (%)	5757 (12.3)	6400 (8.0)	2569 (2.8)	10249 (7.4)
ETHNIC	-1541 (-0.2)	-5614 (-0.52)		-22418 (-1.0)
HHSIZE			-127173 (-5.6)	
R^2	0.87	0.57	0.73	0.73

Source: Author's estimates.

8.6 THE HOUSEHOLD INCOME EFFECT FURTHER EXAMINED

In this section I test the hypothesis (discussed in Chapter 6) that household income (HHINC) can provide additional explanatory power in hedonic house price equations. Table 8.6 includes HHINC with preferred hedonic equations for each city (A3, M4, A4).

In none of the estimated equations (S10, M9, A9) did the inclusion of HHINC provide a significant increase in explanatory power or an improved specification (compared with S3, M4, A4). Although the coefficients for HHINC were positive, none was significant at the 95 per cent level.

For Melbourne, the coefficients on the other variables showed little change. For Adelaide, the coefficients on ENVIRON, INDUSTRY and BED (especially) fell. For Sydney, the coefficient for BED fell considerably but the other coefficients did not change by much.

Overall, inclusion of HHINC had most (negative) effect on the coefficient for BED (which would be expected) and no effect on the coefficient for LOGCBD. Separate investigation showed that, unlike in US cities, there was virtually no relationship between household income and distance from the CBD in any of the three cities.

TABLE 8.6 HEDONIC PRICE EQUATIONS WITH HOUSEHOLD INCOME

	S10	M9	A9
CONSTANT	285400	243928	156170
LOGCBD	-74633 (-8.8)	-44607 (-5.5)	-37422 (-6.5)
ENVIRON	27562 (3.2)	10832 (1.8)	2866 (0.6)
INDUSTRY		-38812 (-3.7)	-22841 (-2.2)
BED	216700 (2.8)	154886 (2.0)	55202 (0.75)
HHINC	3528 (1.4)	1103 (0.50)	1872 (1.2)
R^2	0.81	0.58	0.74

Source: Author's estimates.

8.7 CONCLUSIONS

Other studies have found that relative house prices are determined mainly by seven sets of factors, namely by lot and dwelling size, dwelling quality, accessibility, environmental and neighbourhood attributes, and fiscal factors. This study concentrates on the first five of these.

Overall, the hedonic price equations explained about 80 per cent of the variations in average LGA house prices in Sydney, and two-thirds of the variations in Adelaide and Melbourne.

Average LGA prices in each city were particularly strongly influenced by distance to the CBD, environmental quality, and house size.

In Sydney and Melbourne, house prices were explained better by the log of distance to the CBD than by a linear distance measure. In Adelaide, there was little to choose between the two forms of the distance variable.

In each city, (1989) house prices fell with distance to the CBD by about three per cent per km close to the CBD and by about 1.5 per cent per km some 20-30 km from the CBD. For Sydney, the decline in house prices with distance was shown to be broadly consistent with commuting costs. Although not demonstrated, a similar result would almost certainly be found for the other cities.

An important finding is that the premiums for access more than doubled in each city between 1977 and 1989.

Consistent with economic theory, which suggests that regional centres will affect wages rather than land rents (see Chapter 6), house prices were usually not influenced by access to regional centres.

Environmental factors explained variations in average LGA house prices in the order of $100,000 in Sydney (over 50 per cent of the median house price), $45,000 in Melbourne and $30,000 in Adelaide in 1989. The environmental premium also increased significantly between 1977 and 1989.

Other factors that were significant in one or more cities were distance to coast, proximity to industry (negatively), ferry services (possibly as a proxy for other variables), and the percentages of brick and sewered homes.

Because of multicollinearity, the precise contribution of each variable to house prices is difficult to determine.

The major surprise was the failure of the (three-point) lot size index to contribute to the explanatory equation. Almost certainly, this was due to weak data for this variable.

The study was also handicapped by having to rely on 1976 data for the bed, brick and sewer variables.

Most likely, the equations could be improved if more precise data could be obtained. It would also be desirable to include neighbourhood and fiscal variables.

Not surprisingly, house prices are correlated positively with household income, the percentage of adults in the LGA population, and the percentage employed in the population. Indeed the first two variables "explain" quite a high proportion of house price variations in each city. Also, plausible house price/household income elasticities are estimated.

However, the addition of household income to the hedonic price equations adds very little to their explanatory power and produces an inferior specification.

ENDNOTE

(1) As discussed in Chapter 6, commuting costs are a basic explanator of house prices. The non-linear relationship between house prices and distance to the CBD implies that between 5 and 10 km from the CBD travel speeds are about 50 per cent slower than between 10 and 20 km, and that between 10 and 20 km they are one-third slower than between 20 and 30 km. From casual observation, this could correspond with speeds of about 20, 30 and 40+ kph for each distance band respectively, which appears realistic for Sydney. However, without more precise data on travel speeds, it is not possible to relate house prices per single km precisely to travel costs. If more data were available on travel speeds, we could of course infer values of travel time from variations in house prices.

9 CAUSES OF CHANGES IN HOUSE PRICES WITHIN SYDNEY, MELBOURNE AND ADELAIDE BETWEEN 1977 AND 1989

9.1 INTRODUCTION

The aim of this chapter is to explain the changes in average LGA house prices in Sydney, Melbourne and Adelaide between 1977 and 1989, the earliest and latest years for which comparable price data are available (see Chapter 3).

As we saw in Chapter 6, relative house prices may change because of changes in the supply of housing services (including access and environmental attributes) or changes in the implicit prices of housing services. Several empirical (hedonic price) studies have estimated the effects of changes in supply by regressing house prices against independent (supply) variables. This is one of the approaches adopted below. Of course, this approach assumes implicitly that housing demands have not changed.

However, house prices may change without any changes in (local or city-wide) housing attributes because the demand for housing services changes and so do their implicit prices. If the supply of housing services is constant, we can test for changes in demand by regressing house price *levels* at different points in time against (the constant) attribute levels and interpret the changes in the coefficients as reflections of demand changes. In Chapter 8, we saw that the coefficients on the environment increased significantly between 1977 and 1989. Since the environmental rankings were held constant over the period, it may be inferred that the premiums attached to the environment increased.

Alternatively, we can regress *changes* in house prices against constant attribute levels and interpret a positive (negative) coefficient as indicating an increased (decreased) preference for that attribute. This test is adopted in this chapter.

However, if the demand for and supply of housing services change simultaneously, sorting out the various effects on the implicit prices becomes more complex. For example, the estimated changes in the access premiums (Chapter 8) could reflect increased premiums on access or more congested travel conditions, or both. In this chapter, I examine these access issues in more detail.

It is beyond the scope of this thesis to provide a comprehensive analysis of the separate and simultaneous impacts of changes in the demand for and supply of housing services on relative house prices. Rather, I have designed a number of partial tests to attempt to explain some of the observed changes in house prices.

In Section 9.2, I analyse the relationships between changes in house prices and housing attributes within a hedonic price model framework. Section 9.3 analyses the access effect in Sydney in more detail; these include analyses of traffic effects and of housing improvements as a function of distance from the CBD. Section 9.4 examines the relationships between house prices and selected aggregate housing demand and supply measures - these are an extension of the "housing market" models discussed in Chapter 8. The final section summarises my findings.

9.2 CHANGES IN RELATIVE HOUSE PRICES: HEDONIC MODELS

In this section, the hedonic price model is used to test whether the percentage changes in average LGA house prices were related:

- to the provision of specific (constant) housing services (implying some change in implicit prices), or

- to changes in the supply of local housing services.

To assess the second of these, I collected data on three key access and urban service attributes, namely improvements (if any) from a new rail service, a major road upgrade in the area, or a major urban development between 1977 and 1989. In each case the improvement was represented by a dummy variable. For data see Applied Economics (1991, Appendix F).

The main results of the hedonic equations are shown in Table 9.1.

TABLE 9.1 CAUSES OF CHANGES IN HOUSE PRICES 1977-89: ATTRIBUTE MODELS

	Adelaide			Melbourne			Sydney		
	A1	A2	A3	M1	M2	M3	S1[a]	S2	S3
Constant	117	65	-23	78	83	-37	41	113	48
CBD	-3.2	-3.1		-1.6	-1.4		-0.59	-0.91	
	(-6.2)	(-5.2)		(-5.5)	(-5.4)		(-2.1)	(-4.8)	
Price 77			0.0015			0.0026			0.0011
			(1.9)			(3.2)			(2.9)
Environ	2.1			8.3			3.2		
	(0.6)			(1.7)			(0.9)		
Brick	-0.8			-0.21			0.54		
	(-3.0)			(0.24)			(2.2)		
Newrail	-18.1	-9.9			-17.5	-22.7		-6.0	-14.0
	(-1.0)	(-0.4)			(-1.6)	(-1.7)		(-0.3)	(-0.7)
Road	-2.3	-2.6			3.8	7.4		-19.9	-25.5
	(-0.2)	(-0.2)			(0.3)	(0.6)		(-2.6)	(-2.9)
Urban	8.5	5.0			-4.6	-15.4		-0.2	4.1
	(0.8)	(0.4)			(-0.6)	(-1.5)		(0.2)	(0.5)
R2	0.64	0.54	0.15	0.38	0.38	0.18	0.56	0.57	0.44

(a) Based on house price changes adjusted for estimated alterations and additions.

Source: Author's research

The principal result is that percentage changes in house prices in each city were related strongly (and negatively) to distance from the CBD. A coefficient of - 1.0 for CBD in Table 9.1 implies that house prices rose by one per cent less per km of distance from the CBD. Interestingly, the coefficient was largest (about - 3) for Adelaide and lowest for Sydney (under - 1.0). This reflects the greater increase in the access premium in Adelaide (and Melbourne) than in Sydney between 1977 and 1989. It also reflects differences in city sizes.

The percentage changes in house prices were also related positively to house prices at the start of the period. But this relationship was less significant than the house price-access relationship.

Although the coefficients for environment were positive, as expected, none was significant at the 95 per cent level.

In Sydney the coefficient for brick houses was positive (as expected) and significant, but in the other two cities the coefficients for brick houses were negative.

No significant relationship was found in any city between house prices and local (rail, road or urban) improvements. This is not surprising. There were few major improvements in rail or road infrastruture between 1977 and 1989. Also the few improvements were not closely associated with particular LGAs. Moreover, most LGA specific urban improvements were on a comparatively minor scale. On the other hand, the NSW state government's billion dollar expenditure in Sydney's Darling Harbour, adjacent to the CBD, benefitted all the most accessible inner areas more than other areas.

9.3 ANALYSIS OF THE ACCESS EFFECT

Introduction

The observation that changes in house prices were strongly related to distance to the CBD does not in itself explain the changes. There are, indeed, many possible explanations for this observed relationship.

The most direct explanation is that access costs have themselves increased - because of increased congestion, higher valuations of travel time (as income increased), or increased vehicle operation costs (with for example changes in petrol prices), or some combination of these. Another possible explanation could be that housing improvements (alterations and additions) are inversely related to distance to the CBD (the gentrification factor). These two issues are considered in this section.

On the other hand, systematic changes in housing demand and supply could also change the house price gradient. These possibilities are considered in Section 9.4.

Access Costs

Table 9.2 shows average travel times and speeds for six major routes in Sydney in 1989 and 1983 (the earliest year for which comparable data are readily available).[1]

Taking an (unweighted) average of the six routes, travel times increased by an average 29 per cent in the a.m. peak and by 17 per cent in the p.m. peak between 1983 and 1989. Allowing for the longer travel times in the morning peak, travel times increased by some 25 per cent (or four per cent per annum) over this period.

TABLE 9.2 TRAVEL TIMES AND SPEEDS IN SYDNEY (a)

Trip	Route	Year	Dist. Km	a.m. peak (b) Time Mins.	a.m. peak (b) Speed KPH	p.m. peak (c) Time Mins	p.m. peak (c) Speed KPH
NORTH							
Hornsby	Pacific Hwy.	1983	25	47	32	39	38
to H.Bridge		1989	25	65	23	54	28
		Change (%)		(+38)	(-28)	(+38)	(-26)
NORTH-WEST							
Pennant Hills	Epping Rd.	1983	24	46	31	46	31
to H.Bridge		1989	24	60	24	54	27
		Change (%)		(+30)	(-22)	(+17)	(-13)
WEST							
Parramatta	Parramatta Rd.	1983	21	39	32	35	36
to Broadway		1989	21	57	22	42	30
		Change (%)		(+46)	(-31)	(+20)	(-17)
WEST							
Parramatta	Victoria Rd.	1983	24	52	28	35	41
to King.St.		1989	24	62	23	39	37
		Change (%)		(+19)	(-18)	(+11)	(-10)
SOUTH-WEST							
Liverpool	Hume Hwy.	1983	32	51	38	51	38
to Broadway		1989	32	68	28	56	34
		Change (%)		(+33)	(-26)	(+10)	(-10)
SOUTH							
Sutherland	Princes Hwy.	1983	24	44	33	39	37
to Broadway		1989	24	48	30	41	35
		Change (%)		(+9)	(-9)	(+5)	(-5)

(a) Based on average of 15 trips over year.
(b) Starting at 7.30 a.m.
(c) Starting at 5.00 p.m.

Source: Roads and Traffic Authority, NSW.

Without travel time data from 1977 to 1983, precise estimates of travel time increases between 1977 and 1989 cannot be made. However, based on first-hand experience of traffic conditions in Sydney from 1977 to 1983, the lack of major road projects, and the steady increases in car ownership, it is likely that traffic speeds also declined in this earlier six-year period. Although conjectural, an order-of-magnitude increase in travel times of one-third between 1977 and 1989 seems plausible.

Typically the value of commuting time is considered to be a constant percentage of (hourly) income and to rise proportionately with income. Accepting this, the value of travel time would have risen by about 25 per cent in the 12 years from 1977 to 1989.

The price of fuel is another major element in access costs. Evans and Beed (1986) argue that the increase in the fuel price between 1977 and 1981 was largely responsible for the increase in Melbourne's house price gradient over that period. Table 9.3 shows nominal petrol prices and their real index equivalent from 1970 to 1989. As can be seen, the real fuel price was at its lowest in 1977. By 1985 the real price had risen by 61 per cent. However, it then fell. Between 1977 and 1989 the real price of fuel increased by about one-quarter.

TABLE 9.3 NOMINAL AND REAL PETROL PRICES FROM 1970 TO 1989

	Cents/litre	Index (1970=100)
1970	9.5	100
1971	10.1	100
1972	10.5	97
1973	10.8	92
1974	12.3	92
1975	15.4	99
1976	16.8	96
1977	17.2	88
1978	19.0	90
1979	25.6	111
1980	31.1	121
1981	34.4	123
1982	39.4	127
1983	45.0	131
1984	48.1	136
1985	53.4	142
1986	52.5	128
1987	54.7	118
1988	53.0	110
1989	54.7	111

Source: National Roads and Motorists Association based on ABS data.

In 1989 fuel cost averaged about $0.16 per km.[2] Without the fuel price rise between 1977 and 1989, the fuel cost would have been about three cents per km. less in 1989. The annual saving on journey-to-work trips would have been about $13.2 per km. (6 cents per day @ 220 days per annum). Although $13.2 appears to be an insignificant annual saving, capitalised at a real rate of interest of say 7 per cent per annum, the capital value is $188 per km. This would represent about 7.5 per cent of the access cost per km. in Sydney in 1989 (see Eqs. S1 and S3 in Table 8.1).

Assuming that generalised travel costs are made up of 80 per cent travel time costs and 20 per cent fuel costs[3], that time costs rose by 60 per cent between 1977 and 1989 (the sum of slower trips and higher time values), and that fuel costs rose by 25 per cent, then generalised travel costs rose by about 55 per cent between 1977 and 1989 [(0.8 x 0.6) + (0.2 x 0.25)]. Thus increased travel costs accounted for about half of the increase in the access premiums between 1977 and 1989.

Housing Alterations and Additions

To test the gentrification effect, I collected data on alterations and additions (AA) expenditure for each Sydney LGA (similar data were not available for the other cities) for three years, 1985-86 to 1987-88.

Over these three years, the estimated average annual AA expenditure in 1989 dollars was $1474 per house. This was about 0.75 per cent of the Sydney median house price in 1989 (when prices were exceptionally high). Extrapolating this result and using average 1976-89 house prices, AA contributed an estimated 11.6 per cent to house values in 13 years.

However, there was considerable geographical variation in AA. In areas with high land values, and much old housing stock, high AA were recorded. For example, in the inner city areas of Woollahra, AA added over 20 per cent to house values over 13 years. On the other hand, in outer areas with low land values, such as Campbelltown, Fairfield and

Liverpool, AA added barely more than five per cent to house values in 13 years. The significantly smaller coefficient for CBD in (S1) in Table 9.1, which was based on house price changes adjusted for estimated AA, than in (S2) indicates that AA were responsibsle for a significant part (possibly one third) of the access effect on house price changes.

The following equations test the relationships between AA expenditure and distance from the CBD.

$$AAEXP = 2291 - \underset{(3.6)}{31.8}\ CBD \qquad R2 = 0.24 \qquad (9.1)$$

$$AAPER = 13.8 - \underset{(2.5)}{0.088}\ CBD \qquad R2 = 0.13 \qquad (9.2)$$

where AAEXP is estimated average annual AA expenditure per house in each LGA in 1989 dollars, AAPER is estimated AA expenditure over 12 years from 1977 to 1989 as a proportion of average house prices in each LGA, and CBD stands for distance in Km from the CBD

Eq. (9.1) and (9.2) show that AA expenditure fell significantly with distance. Capitalising $31.8 per house per km (from 9.1) at 7 per cent produces a capital value due to AA of some $450 per house per km, equal to nearly one-fifth of the Sydney access gradient. (9.2) indicates that, between 1971 and 1989, AA expenditure fell about 0.09 per cent of house price for each km of distance from the CBD. This explains about one-tenth of the estimated change in Sydney's house prices due to distance (see the coefficient of - 0.91 for CBD in S2 in Table 9.1).

9.4 CHANGES IN RELATIVE HOUSE PRICES: HOUSING MARKET EQUATIONS

We turn now to market models, employing changes in housing demand and supply in each LGA, to attempt to explain percentage changes in house prices.

Consistent with the theoretical explanations of house prices developed in Chapter 5, I collected data on changes in the primary housing demand variables, namely median household incomes and population, and on changes in the supply (number) of houses, in each LGA. I also collected readily available data on potential secondary demand variables, namely changes in employment and unemployment, the ethnic composition of each LGA, and changes in household ownership in each LGA between 1976 and 1986, as well as data on vacancy rates in 1976 (as an indicator of excess supply in 1976).

The main results are shown in Table 9.4. Demand factors are represented by the percentage changes in household income (CHHINC), population (CHPOP) and employment (CHEMP) and supply by the percentage change in houses (CHHOUSE). In these cases, the coefficients represent elasticities. I also examined the role of ethnic factors (ETHNIC stands for more than five per cent of LGA population coming from one overseas country), and the impact of the initial vacancy rate (which would be expected to be inversely related to changes in house prices).

As shown, in each city, house price changes are positively correlated with changes in household income (A4, M4, S4). This is consistent with some gentrification. However, a correlation between house prices and household income does not necessarily imply a cause and effect relationship. House prices may have risen, not because household incomes in the area increased, but because the areas became relatively more accessible and attractive and higher income households moved in as a result.

TABLE 9.4 CAUSES OF CHANGES IN HOUSE PRICES 1977-89: MARKET MODELS

	Adelaide			Melbourne			Sydney		
	A4	A5	A6	M4	M5	M6	S4	S5	S6
Constant	27	48	40	64	60	68	77	81	93
CHHINC	2.6			1.2			1.6		
	(5.6)			(2.7)			(3.2)		
CHPOP		1.64			-0.45			0.51	
		(2.2)			(-1.6)			(-1.17)	
CHEMP	-0.96			-.08			-0.3		
	(-2.24)			(-2.9)			(-1.0)		
CHHOUSE	0.51	-2.1	-0.39	0.003	-0.22	-0.55	-0.38	-0.29	-0.65
	(1.3)	(-4.1)	(-2.8)	(0.0)	(-0.9)	(-5.4)	(-1.3)	(-1.2)	(-5.3)
ETHNIC	16			-9.2			2.3		
	(1.8)			(-1.0)			(0.2)		
VAC76		1.67			0.78			1.4	
		(2.2)			(1.5)			(1.6)	
R2	0.71	0.58	0.22	0.47	0.40	0.35	0.53	0.45	0.40

Source: Author's research

Possibly more significant, strong negative bivariate relationships are found between changes in house prices and changes in the supply of housing (A6, M6, S6). An increase in the supply of housing on the fringe would reduce~~s~~ outer area prices. In Adelaide, this effect is compounded by the provision of cheap public housing in outlying areas. On the other hand, restrictions on new building within established areas in each city would increase house prices in these areas. The estimated price-supply elasticities of around -0.5 are plausible.

However, because of the strong correlation between increases in population and housing, equations with both variables as potential explanators of house price changes do not work well, except in Adelaide. Also, when changes in household income are added to the regressions (A4, M4, S4), CHHOUSE becomes insignificant.

No relationship was found between changes in house prices and the ethnic composition of the population or vacancy rates in 1976.

Some writers, for example Badcock and Cloher (1981) and Evans and Beed (1986) have suggested that other variables, such as the rise of two-income households, the ageing of the population, and the restructuring of urban economies toward the service sector, would increase the demand for inner city dwellings. While these views are plausible, I have not seen quantitative tests of them. Due to data constraints, I was not able to test these hypotheses.

9.5 CONCLUSIONS

Between 1977 and 1989, increases in house prices were strongly related to access to the CBD in each city. There was also some evidence (in the last chapter) that changes in local house prices reflected increased environmental premiums.

However, local improvements were not found to have a significant influence on local house prices. This presumably reflects the nature of city development over this period or measurement difficulties, rather than a fundamental lack of such relationships.

The access effect reflects various factors. The main one is the increased cost of access due to increased congestion, increased premiums attached to travel time, and higher real petrol prices. In Sydney, these were estimated to account for about a 55 per cent increase in the access gradient, which was about half the total increases in the access gradients. Second, housing improvements were inversely related to distance from the CBD and accounted for about another 10 per cent of the changes in the access gradient.

Third, house price changes in each city were shown to be inversely related to changes in the supply of houses. The greatest increases in supply occur in the outlying areas (despite the low price increases in these areas) and the smallest increases in established inner areas. The estimated average elasticity of house price to house supply was about -0.5.

Four, the changes in relative house prices may have reflected changes in location demands, due to population ageing, two-income households or employment changes for example. However, I was not able to measure these effects, if any.

House price increases were also correlated positively with high priced areas and with high increases in household incomes. However, the causal nature of the relationship between the house price and household income increases is not established.

ENDNOTES

(1) Road traffic, including buses, account for about 80 per cent of all journey-to-work trips in Sydney.

(2) Based on information in NSW Roads and Traffic Authority (1990).

(3) This ratio is typicallay found in estimates of road user benefits in road feasibility studies.

10 CAUSES OF DIFFERENCES IN HOUSE PRICES BETWEEN SYDNEY, MELBOURNE AND ADELAIDE

10.1 INTRODUCTION

This chapter seeks to explain the long-run differences in house prices between Sydney, Melbourne and Adelaide. These differences may be represented by the following stylised facts:

- In the 1980s, median house prices averaged about one-third more in Sydney than in Melbourne and were about 15 per cent higher in Melbourne than in Adelaide.

- At the top end of the market, house prices were often 50 per cent higher in Sydney than in Melbourne and 25 per cent higher in Melbourne than in Adelaide.

- At the bottom end of the market, Sydney house prices were typically only some 10 per cent higher than Melbourne's and Melbourne prices about 10 per cent higher than Adelaide's. However this differential increased greatly in the late 1980s.

- After allowing for quality changes, real house prices have risen since the early 1970s at an annual rate of about two per cent in Sydney and half a per cent in Melbourne, but fallen slightly in Adelaide.

In the following section, drawing on the theoretical discussions in Chapters 5 and 6, I summarise briefly the factors most likely to determine intercity house price differences in the long run. Section 10.3 seeks to explain the intercity house price differences in the 1980s. Section 10.4 discusses causes of the long-run changes in relative intercity house prices. The final section summarises the conclusions.

10.2 SUMMARY OF FACTORS DETERMINING INTERCITY HOUSE PRICE DIFFERENTIALS

Causes of Intercity House Price Differences

As discussed in Chapter 6, both average house prices and the distribution of house prices are determined by city size, the cost of houses at the fringe, and the access gradient (see Figure 6.6). The distribution of house prices is also determined by variations in local house prices, which depend on the quantity and quality of local housing services, including house size and environmental attributes.

Of course, city size, development and access costs are themselves functions of other variables. The major relationships are summarised in Table 10.1.

TABLE 10.1 SUMMARY OF MAJOR FACTORS DETERMINING INTERCITY HOUSE PRICE DIFFERENCES

Primary factors	Secondary factors (a)	Tertiary factors (b)
City Size	City population	Demand for labour Environmental amenity
	Population density	Household incomes Access costs Planning regulations (c)
	Supply of land for housing	Exogenous Planning regulations (d)
Development costs at city fringe	Land opportunity costs Topography Unit building costs	 Labour costs
Access costs	Land opportunity costs Topography Transport technology Private travel time costs	 Individual incomes

(a) Causes of primary factors.
(b) Causes of secondary factors.
(c) Regulations controlling the substitution of capital for land.
(d) Regulations controlling the supply of land for housing.

Causes of Long-Run Changes in Intercity House Price Differencies

In this thesis, two related theories of long-run house prices have been developed.

In Chapter 5, based on households and housing producers maximising utility and profit respectively in a non-spatial context, long-run house prices were shown to be determined by five main factors: household income, population, the price elasticity of demand for housing, the supply elasticity of land for housing, and the elasticity of substitution of capital for land in the supply of housing.

In Chapter 6, where spatial considerations were introduced explicitly, long-run city house prices were shown to depend on city size, development costs at the fringe, and access costs. However, in an open city model, with costless intercity mobility, changes in development and access costs in one city would not necessarily change intercity house price relativities because households would move to the lower cost cities.

Despite their apparent differences, the two theories are closely related because city size is determined by each of the five factors identified by the non-spatial (Chapter 5) theory of long-run house prices. Consequently, each of these needs to be taken into account in explaining long-run changes in relative intercity house prices. Moreover, consideration should be given to the possible effects of changes in access and development costs.

10.3 CAUSES OF INTERCITY HOUSE PRICE DIFFERENCES

In this section, I start by representing house prices in each city as a function of the three basic variables, house prices at the city boundaries, city size, and access costs. I then discuss why these variables differ between Sydney, Melbourne and Adelaide. Finally I discuss how local factors affect the distribution of house prices.

The Basic House Price Equations

Let house prices in a city be represented by equation (10.1).[1]

$$PH = a + b\ (CSIZE - CBDDIST) + cZ \qquad (10.1)$$

Ignoring local factors (Z), for the time being, house prices depend on house prices at the city boundary (a), access costs (b), city size, and house location relative to the CBD. Allowing access costs to be a non-linear (log) function of distance from the CBD, (10.1) becomes:

$$PH = a + b\ (LOG\ CSIZE - LOG\ CBDDIST) \qquad (10.2)$$

Eqs. (10.3), (10.4) and (10.5) are representative equations for standard quality three-bedroom houses in Sydney, Melbourne and Adelaide respectively in 1989 prices. House prices at the fringe are based on tables in Annex 3. The access parameters are based on estimates in Chapter 8. The city size numbers are approximate commuting boundaries of the cities.

Sydney $PH = 110{,}000 + 65{,}000\ (LOG\ 75 - LOG\ CBDDIST)$ (10.3)
Melbourne $PH = 95{,}000 + 50{,}000\ (LOG\ 50 - LOG\ CBDDIST)$ (10.4)
Adelaide $PH = 70{,}000 + 40{,}000\ (LOG\ 30 - LOG\ CBDDIST)$ (10.5)

These figures are order-of-magnitude numbers. For example, publicly-supplied low-cost houses and some privately-supplied two-bedroom houses sell for less than $70,000 in the outer areas of Adelaide. The access parameters represent central estimates from the preferred house price regressions. Also, some people, probably about two or three per cent of employees in the CBD, commute from outside the city "boundaries". Nevertheless, the parameters may be regarded as realistic middle of-the-range values for 1989.

Using (10.3), (10.4) and (10.5), Table 10.2 and Figure 10.1 show estimated house prices for a standard quality house in standard quality environments at various distances from the CBD in each city. The equations explain quite well the intercity differences in house prices.

To estimate median house prices it is necessary to allow for the different city sizes. The mean LGA distance from the CBD is 26 km in Sydney, 21 Km in Melbourne and 11 Km in Adelaide. At these distances, the price of a standard house would be $184,000 in Sydney, $139,000 in Melbourne, and $110,000 in Adelaide. These results are quite close to the actual median prices in 1989.[2]

TABLE 10.2 ESTIMATED PRICES OF STANDARD HOUSES IN 1989 ($000)

	DISTANCE FROM CBD (KM)						
	0	5	10	20	30	50	75
Sydney	391	287	242	196	170	137	110
Melbourne	291	211	176	141	121	95	na
Adelaide	206	142	114	86	70	na	na

Source: Author's estimates.

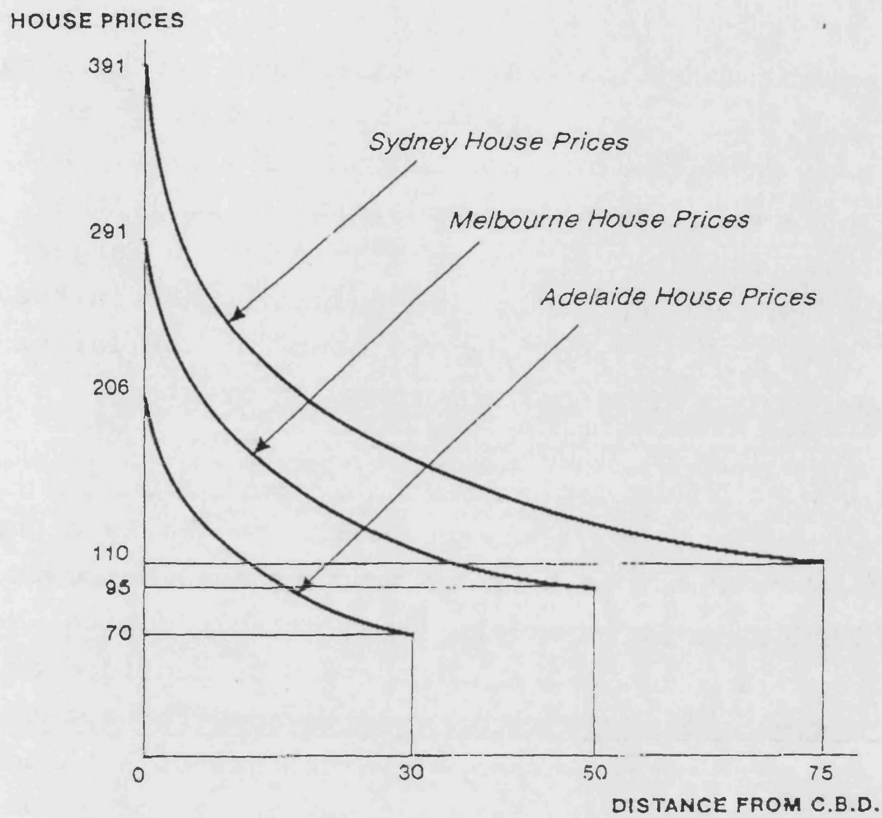


FIGURE 10.1 ESTIMATED REPRESENTATIVE HOUSE PRICES IN ADELAIDE, MELBOURNE AND SYNDEY

Differences in City Size

Table 10.3 shows the distribution of population in each city. In Sydney, over 50 per cent of the population live in LGAs whose centre is over 25 km from the CBD and 14 per cent live in LGAs whose centre is over 50km from the CBD. In Melbourne, the comparable figures are 32 and five per cent; for Adelaide, they are five per cent and zero.

TABLE 10.3 DISTRIBUTION OF POPULATION BY DISTANCE TO CBD (a)

Km to CBD	ADELAIDE No.(000)	%	MELBOURNE No.(000)	%	SYDNEY No.(000)	%
0 - 9	373.5	38.2	630.5	22.2	558.8	16.6
10 - 24	550.9	56.4	1309.2	46.2	983.1	29.3
25 - 49	52.8	5.4	793.3	28.0	1338.9	39.9
50 +	0.0	0.0	99.7	3.5	478.2	14.2

(a) Based on 1986 LGA populations.

Sources: ABS, 1986 Household Census, and Author's estimates.

The two main reasons for the differences in city size are differences in population and in usable land for housing. At June 1989, the estimated populations were 3.62m in Sydney, 3.04m in Melbourne, and 1.04m in Adelaide. What explains these population differentials? Clearly the demand for labour is likely to be higher in the larger cities. But are housing and access costs higher in the larger cities? And, if so, are residents of the larger cities compensated by higher incomes? Or are they compensated in non-monetary ways?

Of course house prices and access costs are easily highest in Sydney and lowest in Adelaide. However housing costs depend on other factors as well, most notably capital gains (see Eq.5.19). In fact (5.19) may itself be regarded as a simplification because it makes no allowance for access costs or for time-discounting of capital gains. Although I have not attempted to make detailed estimates of annual housing and access costs for each city, the simple calculations shown in Annex 10 indicate that when intercity differences in house price appreciation are taken into account, intercity differences in housing costs in some years are negligible. Nevertheless, the Annex examples imply that, in the long run, the sum of housing user costs and access costs are highest in Sydney and lowest in Adelaide.

In 1989, average weekly earnings were slightly higher in NSW than in Victoria and South Australia. For the third quarter 1989, the figures were $612, $590 and $538 respectively. Also, there was more employment in the large cities. In mid-1989, 49.4 per cent of the population in Melbourne was employed, compared with 47.0 per cent in Sydney and 45.8 per cent in Adelaide. The most recent figures for household income (from the 1986 Household Census) also show the higher incomes in the larger cities. In 1986, the median household income was $25,100 in Sydney, $25,000 in Melbourne, and $21,000 in Adelaide.

Drawing on my calculations in Annex 10, I conclude that the median Melbourne household has a higher net income (i.e. higher gross income less tax and housing and access costs) than the median Sydney and Adelaide households, which have approximately equal net incomes. These results imply that households require monetary compensation to live in Melbourne.

In the absence of data on the amount of usable land for housing in each city, some qualitative comments must suffice. Housing land in Sydney is restricted by many severe topographical constraints, including the coast to the east, the mountains to the west and north-west, three major river systems (the Georges River in the south, Parramatta River/Port Jackson in the centre, the Hawkesbury/Nepean Rivers in the north and west), and extensive rugged areas in the north and south which are devoted to the Kuringai and Royal National Parks.

Land for housing is also constrained in Melbourne by Phillip Bay in the south and the Dandenong Hills in the east. Moreover, the land to the west is inhospitable - flat, bleak and cold. However, Melbourne is much flatter than Sydney and has no comparable inland waterway constraints.

In Adelaide, Gulf St.Vincent in the west and the Adelaide Hills to the east restrict the supply of housing land. However, to the north and south there is ample, flat land for housing.

City size can also reflect population density. High income households tend to demand more housing and land, which produces lower densities (and larger cities).

However, population density is much higher in Sydney than Melbourne; and much higher in Melbourne than in Adelaide (see Table 10.4).[3] The higher densities also show up in a higher proportion of non-house dwellings in Sydney (32 per cent) than in Melbourne (26 per cent) or Adelaide (22 per cent). These population densities are inversely related to the supply of land for housing.

TABLE 10.4 POPULATION DENSITIES (1986)

	Adelaide	Melbourne	Sydney
Population (000)	977	2832	3359
Pop'n/km (avg.of LGAs)	1324	1657	2095
Avg.m^2/person	755	604	477

Sources: ABS. Census data; handbook of local statistics.

House Prices at the City Boundaries

The boundary house prices may be taken to represent either second-hand houses or new houses at the low end of the new house price spectrum. For our purposes, it is instructive to examine the structure of new houses costs, because in the long run the prices of new houses are likely to determine the prices of established houses of approximately equivalent overall quality.

Table 10.5 provides a breakdown of the main costs of producing new houses, based on a survey of recent housing developments conducted by Travers Morgan and Applied Economics (Travers Morgan, 1991a). Because of the variability in the survey responses, the figures should be treated again as order-of-magnitude figures.

The main intercity differences, and reasons for them, are:

- Land opportunity costs, usually rural residential land values, are higher on the fringes of the large cities where densities are higher. However, these costs may contain an element of surplus rent, especially in Sydney.

TABLE 10.5 MAJOR COST COMPONENTS OF LOW-PRICED HOUSES ON CITY FRINGES (1989 $s)

Cost Component	Adelaide	Melbourne	Sydney
Land opportunity costs (a)	6000	10000	14000
Public infrastructure costs (b)	3000	5000	8000
Public social costs (c)	1000	1000	4000
Private land development (d)	10000	13000	14000
Private building costs (e)	38000	50000	50000
Developer margins/overheads (f)	12000	16000	20000
Total costs	70000	95000	110000

(a) Often rural residential land values.
(b) Costs of access roads, water, sewerage etc. charged to the developer.
(c) Community charges, e.g. for open space or community facilities, levied on the developer.
(d) Land development costs incurred directly by the developer.
(e) House construction costs.
(f) Developer and builder margins, including overheads, profits and interest payments, are not always distinguishable from profits on land purchases.

Source: Travers Morgan, 1991a.

- The costs of public infrastructure and private land development are usually higher in Sydney because of topographical constraints, e.g. undulating land, flooding, drainage problems etc.

- Local councils in Sydney levy higher community charges on developers than do councils in Melbourne or Adelaide.

- Building costs are substantially lower in Adelaide because of flatter terrain, lower wages and more productive labour.

Access Costs

Access costs are determined mainly by traffic speeds. Average commuting speeds exceed 40 km/h in Adelaide, are about 35 km/h in Melbourne, and about 30 km/h in Sydney. Also, traffic routes are more circuitous in Sydney than in the other two cities.

Access costs also depend on subjective valuations of travel time. These valuations usually rise with household income. Moreover, when there is a shortage of land for housing within established areas, as in Sydney, competition for housing drives up its price and increases the access gradient.

The poor transport infrastructure in Sydney is a consequence, *inter alia*, of the rugged terrain and waterways and the high opportunity costs of land, which reflect the high population densities.

Local Environmental Standards

City-wide environmental amenities influence house prices by attracting population and thereby increasing city size. Also, local environmental amenities affect local house prices. They therefore influence the distribution of house prices and possibly the mean house price.

The estimated effects of environmental standards on house prices in each city were shown in Chapter 8. These standards, on a scale of 1 (low) to 4 (high), were estimated separately for each city. They were intended to be a relative intracity standard, not an intercity standard.

Like the distance coefficient, the environmental coefficient depends on the equation specification. However, given the range of values, realistic coefficients would be about $30,000 per rank in Sydney, $16,000 in Melbourne, and $11,000 in Adelaide (in 1989 dollars).

This implies that, compared with an LGA of environmental rank 1, a standard LGA with a rank of 2.5, would result in an increase in house prices by $45,000 in Sydney, $24,000 in Melbourne, and $16,000 in Adelaide. Of course, house prices would be considerably higher again in a LGA with rank 4. It may be noted, moreover, that the average environmental score was 2.80 for Sydney, 2.56 for Melbourne, and 2.40 for Adelaide. Therefore, the environmental premium applied to more areas in Sydney than in Melbourne and Adelaide.

Local Housing Standards

One might expect housing standards to be higher in high income cities. However, as shown in Table 10.6, housing standards are higher in Adelaide than in Melbourne or Sydney. This presumably reflects the lower price of housing in Adelaide, which encourages greater consumption of housing services.

TABLE 10.6 HOUSING STANDARDS (a)

	Adelaide	Melbourne	Sydney
Average bedrooms/house	3.00	2.98	2.94
Brick houses (%)	79.5	60.4	56.3
Houses with mains sewer (%)	90.0	75.4	81.8

(a) In 1976.

Source: ABS, Household Census, 1976.

However, the equations in Chapter 8 show that variations in local housing standards, especially in house size, do affect house prices and therefore the distribution of house prices.

Typically, average bedrooms per house in a LGA range from 2.80 to 3.20. Given the Melbourne coefficient of about $200,000 per bedroom, average house prices in a LGA with large (3.20 bedroom) houses would be $80,000 more than in a LGA with small (2.80 bedroom) houses. (The Sydney coefficient was higher; the Adelaide coefficient lower).

There was slight evidence that an additional one per cent of brick houses or houses with mains sewer in a LGA would be worth about $600 (in 1989 dollars). Therefore, an extra 10 per cent in bricked or sewered houses would add $6000 to average house prices.

10.4 CAUSES OF LONG-RUN CHANGES IN INTERCITY HOUSE PRICE DIFFERENCES

This section analyses potential housing demand and supply causes of long-run changes in intercity house price differences. The evidence confirms the *a priori* belief that supply factors are likely to be the more important determinants of long-run changes in house prices. However, it would be wrong to attribute all the changes to supply factors alone.

The Demand for Housing

Previous theoretical analysis has indicated that house prices are determined in the long run by population, income and the price elasticity of demand for housing.

Table 10.7 provides summary data on population, income and employment in the 1970s and 1980s. The years shown vary because of data constraints, e.g. household income is available only for census years and city employment data (as distinct from state data) are available in each city only from 1979.

It will be seen that the differences in the (housing demand) changes between the cities were small. The main differences were the greater growth in household income and employment in the large cities. But, despite the differences in employment growth, population growth rates were similar, at least between 1971 and 1989. (Sydney population grew faster between 1976 and 1989). Also, average weekly earnings rose at similar rates in the three cities.

TABLE 10.7 SUMMARY DATA ON DEMAND FOR HOUSING VARIABLES

		Adelaide	Melbourne	Sydney
Population ('000)	1971 June	843	2503	2977
	1976 June	924	2724	3144
	1989 June	1037	3039	3624
Pop'n change (%)	1971-89	23.0	21.4	21.7
	1976-89	12.2	11.6	15.3
Avr.weekly earnings ($)	1971 June	80.5	90.0	91.1
	1976 June	166.0	180.3	182.0
	1989 June	533.0	576.9	593.6
AWE change (%)	1971-89	562	541	552
	1976-89	221	220	226
Median household income ($)	1976	10195	11134	10965
	1986	21098	25029	25090
Hd.inc. change (%)	1976-86	107	125	128
Employment (000)	1979 Dec.	397	1220	1417
	1989 Dec.	481	1513	1745
Emp.change (%)	1979-89	21.1	24.0	23.2

Sources: ABS, Cat.Nos.3101.0, 6201.1, 6201.2, 6201.4, Labour Report, Household Censuses 1976 and 1986.

However, the population increased approximately as much in the large cities as in Adelaide despite the higher house price increases. Although I have no evidence on the price elasticity of demand for housing in Australian cities, it may be inferred that the underlying demand for housing increased by more in the large cities, but that some population growth was choked off by the higher house prices.[4]

The Supply of Housing

On the supply side, long-run house prices are determined by the supply elasticity of land for housing, the substitutability of capital for land in the supply of housing, land development costs, and access costs.

Unfortunately data on these variable are not readily available and, in some cases, not easy to obtain. For example, the supply elasticity of land for housing is closely related to development costs. There is little point in having an elastic supply of land for housing if development costs are prohibitively high.

In 1990 the Indicative Planning Council (IPC) for the Housing Industry conducted a substantial review of the availability of land for housing in Australian cities. This was the first major study of its kind and, not surprisingly, it was critical of the data available. The IPC concluded as follows. In Sydney, there are adequate gross broadhectares for land development in Sydney, but their geographical fragmentation and other factors could severely constrain their development. Likewise in Melbourne, there is an adequate supply of serviceable land, but severe shortages exist in the more desirable eastern areas. In Adelaide, there is a short-term problem in the supply of serviced land, in part because of concentration in the land development industry.

Of course these comments are only indirectly relevant to the historic supply of land for housing. In the absence of direct data on this and other factors determining the supply of housing, data on the supply of housing itself provides some general evidence of supply elasticities.

Table 10.8 shows the housing stock in the three cities in 1976 and 1986. As shown, the supply of both total private dwellings and of separate houses increased fastest in Adelaide and slowest in Sydney, despite the fact that house prices increased least in Adelaide and most in Sydney. This is consistent with our findings in Chapter 7 that the supply of housing is considerably more price elastic in Adelaide than in the two larger cities.

TABLE 10.8 HOUSING STOCKS

	Total private dwellings			Separate houses		
	Adelaide	Melbourne	Sydney	Adelaide	Melbourne	Sydney
1976	308,866	825,952	1,060,024	212,216	591,954	642,832
1986	370,664	1,039,351	1,225,257	263,310	730,617	777,027
Change (%)	20.0	17.3	15.6	24.1	23.4	20.9

Source: ABS, Household Censuses, 1976 and 1986.

Travers Morgan (1991a) shows that the development costs borne by housing producers have increased by more in Sydney than in the other cities because the NSW government increased charges for physical and social development by considerably more than the other state governments. On the other hand, the South Australian government has held down charges in an attempt to restrain house prices.

Travers Morgan and Applied Economics (Travers Morgan, 1991b) reviewed recent changes in urban planning policies, with particular regard to urban consolidation policies which would allow capital to be substituted more easily for land in the production of housing services as well as for the more efficient use of land in established areas. Although urban consolidation has been encouraged in each city, policy implementation to-date has been weak.

We also saw in Chapter 9 above how access costs have increased in recent years in Sydney. My information, from discussions with officers in the state traffic authorities, is that traffic speeds have also declined in Melbourne but by less than in Sydney, and that there has been little reduction in traffic speeds in Adelaide.

From this largely qualitative, but informed review, I conclude that the long-run increase in house prices in the larger cities, especially in Sydney, has been mainly due to inelasticity in the supply of land for housing, the low substitutability of capital for land in housing production, increasing land development costs, and increasing access costs.

10.5 CONCLUSIONS

This chapter seeks to explain why Sydney's median house price is typically one-third higher than Melbourne's, which is in turn typically 15 per cent higher than Adelaide's; why house price differentials are much greater at the top of the housing market and smaller at the bottom; and why house prices have increased most in Sydney and least in Adelaide.

These differences in house prices are explained quite well by differences in city size, in house prices at the city boundaries, and by access costs.

The differences in city size are in turn determined mainly by differences in population and the supply of usable land for housing. Although household incomes are slightly higher in the larger cities, population densities are also higher.

Differences in house prices at the city boundaries reflect higher land opportunity costs, development and building costs.

The distribution of house prices within each city also reflects the differences in environmental standards and house sizes within each city.

The higher long-run changes in house prices in the larger cities mainly reflect the elasticity of supply of land for housing, the low substitutability of capital for land in housing production, and changes in land development and access costs.

However, these costs can be converted into higher house prices only if the demand for housing is sufficiently strong. Despite the increases in house prices, population growth has been as high in Sydney as in the two smaller cities.

ENDNOTES

(1) This is the same as (6.16). See also Endnote 4, Chapter 6.

(2) It should be noted that Adelaide prices were relatively low in 1989, compared with the other cities.

(3) It is not easy to estimate the usable urban area in cities (see Rose, 1989). For example there are more sq.km. in the Blue Mountains and Wollondilly LGAs in Sydney than there are in the whole of Adelaide. Consequently, if the whole of the Blue Mountains and Wollondilly areas, as well as other extensive areas like Gosford and Hawkesbury, are included in Sydney's area, Sydney's overall population density would be significantly lower than Adelaide's. A more realistic comparison of population densities is obtained by estimating the average of the LGA population densities see Table 10.4. This reduces the weight attached to semi-wilderness or non-usable urban areas.

(4) The NSW Department of Planning (1990) has shown a positive relationship between out-migration from Sydney and in-migration to Sydney (especially from overseas). But the link through house price changes has not been formally established.

ANNEX 10: HOUSING USER COSTS, ACCESS COSTS AND REAL INCOMES

The objective of this annex is to investigate whether intercity differences in household income compensate for intercity diferences in housing and access costs. The annex is intended to be illustrative rather than definitive.

I show below some simple calculations of housing user costs and access costs in Adelaide, Melbourne and Sydney (A, M & S) in 1986 and 1988. Two years are chosen because the results differ markedly from one year to another. Housing user costs are simply a function of interest payments and capital gains discounted over a year. Maintenance and other housing expenditures are assumed constant between cities.

The following assumptions are made:

- Median house prices are used
- Inflation rate: 7 per cent per annum
- Mortgage rates: 16 per cent
- Foregone after-tax return on equity: 8 per cent
- Average gearing: 40 per cent
- Weighted after-tax cost of capital: 11 per cent
- Long-run annual real capital appreciation:
    - Sydney 1.75 per cent
    - Melbourne 0.5 per cent
    - Adelaide zero
- Annual real time-discount rate: 7 per cent
- Annual nominal time discount rate: 14 per cent
- Median house distance from CBD:
    - Sydney 26 km
    - Melbourne 21 km
    - Adelaide 11 km
- Marginal vehicle cost per km: $0.15
- Average travel speeds
    - Sydney 30 kph
    - Melbourne 35 kph
    - Adelaide 40 kph
- Average travel time cost per hour: $6-00

Annual Housing Costs for Median Priced Houses ($)
(Excluding maintenance expenditures and taxes)

	Interest costs	Capital gains time-discounted	Total
A 1986	(73500 * 0.11)	- [(73500 * 1.07) - 73500]/1.14	= 3572
1988	(80400 * 0.11)	- [(80400 * 1.07) - 80400]/1.14	= 3907
M 1986	(82125 * 0.11)	- [(82125 * 1.075) - 82125]/1.14	= 3630
1988	(109000 * 0.11)	- [(109000 * 1.075) - 109000]/1.14	= 4819
S 1986	(98400 * 0.11)	- [(98400 * 1.0875) - 98400]/1.14	= 3271
1988	(174300 * 0.11)	- [174300 * 1.0875) - 174300]/1.14	= 5802

Annual Access Costs ($)

			1986	1988
A	Veh.cost	11 * 2 * 220 = 4840 km * 0.15 =	726	835
	Time cost	4840 km/40kph = 121 hrs * 6.00 =	726	835
	Total cost	=	1452	1670
M	Veh.cost	21 * 2 * 220 = 9240 km * 0.15 =	1386	1593
	Time cost	9240 km/35kph = 264 hrs * 6.00 =	1584	1822
	Total cost	=	2970	3415
S	Veh.cost	26 * 2 * 220 = 11440 km * 0.15 =	1671	1921
	Time cost	11440 km/30kph = 381 hrs * 6.00 =	2286	2630
	Total cost	=	3957	4551

Total Housing and Access Costs ($)

	1986	1988	AVR.
A	5024	5577	5300
M	6600	8234	7417
S	7228	10353	8790

Household income (HINC) and housing and access costs ($)

	1986 Gross HINC	1986 Disp. HINC	1987 Disp. HINC	1987 Disp.HINC less Avr. 1986 & 1988 housing and access costs
A	21000	16800	18480	13180
M	26000	20150	22165	14748
S	26100	20215	22235	13445

Conclusions

Based on 1986 and 1988, the median Melbourne household has a higher net income (i.e. higher gross income less tax and housing and access costs) than the median Sydney and Adelaide households, which have approximately equal net incomes. These results imply that households require monetary compensation to live in Melbourne.

However, the calculations above show the importance of capital price appreciation to housing user costs, the variability of user costs, the importance of access costs, and the sensitivity of the results to the assumptions.

PART IV

HOUSE AND LAND PRICES IN SYDNEY FROM 1928 TO 1968: SPECIFIC EXPLANATIONS

11 CAUSES OF AVERAGE HOUSE AND LAND PRICES IN SYDNEY FROM 1928 TO 1968

11.1 INTRODUCTION

This chapter seeks to explain average house and land prices in Sydney from 1928 to 1968 (see Chapter 4).[1] House prices are represented by median house price and IV indices; land prices by uv/lot and uv/m².[2] Of course, over a 40 year period, especially one containing the Great Depression and the Second World War, the causal relationships between house prices and their determinants may change. The chapter therefore examines the determinants of house prices for selected sub-periods as well as over the whole period.

In Chapter 5, I discussed general explanations for average house and land prices. We saw there that:

- house prices are determined in the short run mainly by the demand for housing but that supply factors have a longer term impact on house prices;

- the housing market is usually viewed as operating recursively with supply pre-determined, so that house prices can be modeled with ordinary least squares (OLS) equations as a function of demand variables and the stock of housing, rather than as part of a simultaneous model of the whole housing market;

- the housing market may not be in equilibrium, a hypothesis supported by the empirical analysis of house prices since the mid-1960s described in Chapter 7;

Similar assumptions underlie the empirical analysis in this chapter, although there are minor differences of emphasis. For example, while concentrating on OLS house price regressions, the chapter also contains a simultaneous model of the housing market. Moreover, there is no presumption that the housing market was necessarily in disequilibrium during the study period.

The following section briefly outlines the main independent variables employed to explain house and land prices between 1928 and 1968. Section 11.3 provides an overview of the relationships between these independent variables and house and land prices for the main sub-periods.[3] Sections 11.4 to 11.6 describes the econometric analyses and results. There is a short concluding section.

11.2 INDEPENDENT VARIABLES

Consistent with the theory described in Chapter 5, data were collected for income, interest rates, the supply of credit, the price of substitutes (flats) and demographic variables, as well as for major housing supply variables. Data details are given in Abelson (1984).

Specifically the following housing demand variables are considered: the real average male adult weekly wage in New South Wales (NSW); real GNP per capita; the unemployment rate in NSW; mortgage and bond rates; the stock exchange index; the real value of housing loans per capita (from 1947); the real money supply (M3) per capita; the real rent index; a rent control dummy variable; marriages per capita and population in Sydney; and expected house and land prices.

The first two of these variables are alternative measures of income. Likewise the interest rate variables should be regarded as alternatives. Housing loans and the money supply are alternative attempts to capture the influence of credit availability. The rent index is included as flats are a substitute for houses. A dummy variable is included for rent control from 1939 to 1948, the high period of rent control, but rent controls persisted in existing tenancies.[4] Marriages and population reflect the demographic influence on housing demand. In Abelson (1985) I allowed expected house and land prices to be represented by lagged values of the dependent variable. I now consider that a significant coefficient on a lagged dependent variable is better regarded as an indication of disequilibrium. In this study, expected house prices are represented by actual future values.[5]

The supply-side variables tested were estimated Sydney housing stock per capita, house completions per capita in Sydney, and the real building materials index. Note, also, that interest rates may be interpreted as a supply rather than as a demand variables.

To reflect changes in the quality of the services from houses or land, a trend variable was included in some equations.

11.3 AN OVERVIEW OF PAIRWISE RELATIONSHIPS

Percentage changes in selected variables for 4 sub-periods (1927-37, 1938-48, 1949-60 and 1961-69) are summarised in Table 11.1.

Correlation matrices for the 1927-47 and 1948-68 periods are given in Tables 11.2 and 11.3. Of course, correlations may suggest the existence of causal relationships which cannot be substantiated by more detailed multivariate analysis. Nevertheless they provide a useful initial picture of potential relationships.

Contrary to theory, in our first 2 sub-periods, real estate values and the consumer price index (CPI) tended to move in opposite directions. Between 1938 and 1948 especially, real property prices fell substantially despite the rise in the CPI. After 1948 the situation changed and there was a high correlation between the CPI and all four property price indices (Table 11.3). Between 1949 and 1960, real property prices more than doubled while the CPI also doubled. In the 1960s, real property prices rose by 50 per cent and the CPI by about 20 per cent.

Turning to income, up to 1948 there is no direct evidence of any positive relationship between real income (real weekly earnings or real GNP/capita) and real property prices (Tables 11.1 and 11.2.). However, over this period real weekly earnings were relatively flat (unlike real GNP/capita which rose with the growth in employment). After 1948 there was a strong correlation between income variables and real property prices (Table 11.1). To some extent this may reflect a strong upward trend in both variables. It may also be noted (Table 3) that unlike real property prices, real incomes rose significantly faster in the 1960s than in the 1950s.

On the other hand, there is no evidence of the expected negative relationship between real property prices and unemployment rates. Between 1938 and 1948, unemployment fell sharply, as did real property prices. In the 1950s, unemployment rose significantly when real property prices were rising fastest.

Contrary to expectation, the relationships between annual property prices and interest rates (mortgage and bond rates) were generally positive (see Tables 11.2 and 11.3). Between the 1920s and the 1940s interest rates fell by 2-3 percentage points and real property prices also fell. Then, real mortgage rates rose from around 3 per cent in the mid-1950s to around 6 per cent in the 1960s when real property prices were rising quite sharply. Possibly, property prices were insensitive to small changes in interest rates but not to large ones. Between 1930 and 1932 real interest rates exceeded 10 per cent and subsequently real property prices fell. Between 1948 and 1953, real interest rates fluctuated between -5 and -20 per cent and real property prices boomed.

TABLE 11.1 PERCENTAGE CHANGES IN SELECTED VARIABLES[a]

	1927-37	1938-48	1949-60	1961-69
Real house prices[b]	0	-30	120	50
Real land prices[c]	0	-20	125	50
CPI	-13	44	97	22
Real weekly earnings[d]	-2	8	13	19
Real GNP/capita	4	32	22	33
Unemployment (%)	109	-77	33[e]	-37
Mortgage rates	-21	-19	88	11
Bond rates	-30	-13	55	0[f]
Real housing loans/capita	na	na	224	330
Real money supply/capita	20	40	-22	36
Real rent index	5	-28	-9	19
Marriages per '000 persons	3	5	-20	25
Population of Sydney	19	17[g]	35	18
Housing stock/capita	-3	-6	10	8
Completions/capita	-39	49	29	15
Real building materials index	15	30	10	1

(a) Changes are positive unless otherwise indicated.
(b) These figures are rounded to indicate orders of magnitude. The 1927-37 figure is based on the repeat IV index as there were few house sales. Figures for the other three periods are rounded averages of the median house price index. However, for the 1949-60 period, I used the 1950 index number for house prices as it was more consistent with the IV index than the 1949 index number.
(c) These rounded figures are based on the repeat UV per lot index. The zero figure for 1927 to 1937 is consistent with the index in 1936 and 1938.
(d) Based on movements in minimum wages.
(e) Based on average for 1947-48-49 as base figure.
(f) Based on average for 1960-61-62 as base figure.
(g) To 1947. The 1948 figure is much higher.

Source: Author's research.

As shown in Table 11.1, there was a major expansion of housing finance in the post-war period which may have fuelled the demand for housing (and hence house prices). Table 11.2 indicates a high positive correlation between housing credit and real property prices. But the extent to which housing finance is an exogenous factor in the housing market is not clear. There is no evidence of a positive relationship between our other credit variable, the real supply of money per capita, and real property prices (Tables 11.1, 11.2 and 11.3).

Between 1938 and 1948 the real rent index (reflecting rent controls) fell significantly and presumably pulled down real land and house prices. Although the real rent index was lower in 1960 than in 1948, it rose between 1952 and 1960. And it continued to rise between 1961 and 1969. Overall, there appears to have been a significant positive relationship between real property prices and the real rent index (Tables 11.2 and 11.3).

Population may also have had a significant positive effect on real property prices in the post-war period but not pre-war (Tables 11.2 and 11.3). Between 1949 and 1960, the population of Sydney increased at an annual average rate of 2.8 per cent compared with an annual average rate of 2.1 per cent between 1961 and 1969 and a rate of 1.7 per cent between 1927 and 1947. But marriage rates do not appear to influence real property prices (see the negative correlations in Tables 11.2 and 11.3). Marriage rates were especially high in the late 1930s and in the first half of the 1940s, but they fell off when real property prices were rising in the 1950s and early 1960s.

Between 1925 and 1947 house completions per head of population followed an erratic path. They were around 5 per thousand persons 1925 and 1930 and from 1938 and 1942, but they fell between 1931 to 1937 and between 1943 to 1946. Overall between 1927 and 1948, the estimated housing stock per capita fell from 0.262 to 0.239. On an annual basis there was little correlation of any kind between real property prices and house completions over this period (Table 11.2). Taking the period as a whole, however, declining real property prices were probably responsible in part for the fall in the housing stock.

TABLE 11.2 CORRELATION MATRIX 1927-47

	Real House Price	Real IV	Real UV/lot	Real UV/m²	Unemployment	Real Wages	Mortgage rate	Bond Rate	Real Building Materials Index
Real IV	0.39								
Real UV/lot	0.25	0.67							
Real UV/m²	0.49	0.88	0.75						
Unemployment	0.72	0.70	0.39	0.66					
Real Wages	-0.05	-0.54	-0.49	0.54	-0.25				
Mortgage Rate	0.52	0.55	0.16	0.52	0.63	0.18			
Bond Rate	0.53	0.53	0.16	0.51	0.62	0.20	0.99		
Real Bldg. Mat. Index	-0.36	-0.89	-0.55	-0.84	-0.59	0.73	-0.34	-0.32	
Real Rent Index	0.51	0.73	0.61	0.80	0.57	-0.66	-0.23	-0.87	-0.87
Real GNP/cap	-0.62	-0.86	-0.42	-0.80	-0.89	0.49	-0.68	-0.66	0.82
Marriages/cap.	-0.46	-0.75	-0.24	-0.62	-0.72	0.06	-0.85	-0.84	-0.54
Real Money Supply/cap	-0.34	-0.71	-0.45	-0.72	-0.52	0.78	-0.31	-0.29	0.84
Completions/cap	-0.11	0.09	0.17	0.14	-0.32	-0.40	-0.42	-0.41	-0.35
Housing Stocks/cap	-0.30	-0.27	-0.06	-0.08	-0.30	-0.09	-0.34	-0.35	0.09
Population	-0.26	-0.85	-0.44	-0.82	-0.56	-0.62	-0.52	-0.50	0.88
CPI	-0.62	-0.70	-0.48	-0.73	-0.87	0.50	-0.39	-0.37	0.71

	Real Rent Index	Real GNP/cap	Marriages cap	Real Money Supply/cap	Completions/cap	Housing stock cap	Population
Real GNP/cap	-0.67						
Marriages/cap	-0.36	0.78					
Real Money Supply/cap	-0.77	0.77	0.41				
Completions/cap	0.31	0.09	0.41	-0.26			
Housing Stock/cap	0.06	0.26	0.52	0.38	0.38		
Population	-0.71	0.83	0.63	0.87	-0.18	-0.07	
CPI	-0.82	0.79	0.55	0.61	0.16	0.13	0.61

Source: Author's research.

In the post-war period, completions per head of population rose steadily from around 7 per thousand in the late 1940s, to an average 8.1 per thousand in the first half of the 1950s, to 11.0 per thousand in the second half of the 1960s. The housing stock rose from 0.251 per person in 1956 to 0.297 per person in 1970. Over this period there was a significant positive correlation between real property prices and house completions (Table 11.3). Apparently, the escalation of property prices in the 1950s reflected the backlog of demand and the housing shortage of

TABLE 11.3 CORRELATION MATRIX 1948-68

	Real House Price	Real IV	Real UV/ lot	Real UV/m²	Unem-ployment	Wages	Mort-gage rate	Real Bond Rate	Real Building Materials Index
Real IV	0.97								
Real UV/lot	0.84	0.85							
Real UV/m²	0.91	0.89	0.85						
Unemployment	0.02	0.00	-0.17	-0.04					
Real Wages	0.76	0.74	0.65	0.66	-0.30				
Real Mortgage Rate	0.67	0.73	0.54	0.62	0.33	0.28			
Real Bond Rate	0.55	0.63	0.44	0.50	0.37	0.18	0.99		
Real Bldg. Mat. Index	0.15	0.20	0.11	0.05	0.10	0.22	-0.11	-0.11	
Real Rent Index	0.50	0.48	0.57	0.66	-0.16	0.20	0.45	0.35	-0.48
Real GNP/cap	0.92	0.91	0.88	0.89	-0.27	0.85	0.54	0.42	0.07
Marriages/cap.	-0.70	-0.72	-0.43	-0.54	-0.42	-0.38	-0.78	-0.75	-0.23
Real Money Supply/cap	-0.16	-0.20	0.09	0.03	-0.59	0.05	-0.33	-0.37	-0.48
Completions/cap	0.75	0.77	0.67	0.69	0.03	0.56	0.55	0.50	0.26
Housing Stocks/cap	0.41	0.53	0.33	0.24	0.00	0.47	0.54	0.58	0.39
Population	0.98	0.98	0.86	0.92	0.01	0.75	0.70	0.58	0.13
CPI	0.89	0.94	0.74	0.75	0.13	0.71	0.71	0.64	0.41
Real Housing Loans/cap	0.90	0.93	0.80	0.81	-0.07	0.76	0.63	0.54	0.30

	Real Rent Index	Real GNP/ cap	Marriages/ cap	Real Money Supply/ cap	Comple-tions/ cap	Housing stock/ cap	Population	CPI
Real GNP/cap	0.61							
Marriages/cap	-0.03	-0.45						
Real Money Supply/cap	0.52	0.17	0.74					
Completions/cap	0.21	0.67	-0.62	-0.30				
Housing Stock/cap	-0.25	0.37	-0.60	-0.48	0.56			
Population	0.55	0.93	-0.69	-0.14	0.77	0.44		
CPI	0.20	0.78	-0.83	-0.46	0.82	0.72	0.91	
Real Housing Loans/cap	0.39	0.89	-0.63	-0.16	0.87	0.60	0.93	0.92

Source: Author's research.

the early post-war years. The increase in completions was then not sufficient to reduce real property prices. On the contrary, increasing prices encouraged construction.

The real building materials index also seems to have had little effect on real property prices. Between 1927 and 1947, the real index fell by 47 per cent and was negatively correlated with real property prices (Table 11.2). Between 1947 and 1960, the real index rose by only 11 per cent and the correlation between it and real property prices was low (Table 11.3).

To summarise, the conventional economic variables suggested by theory appear to provide little explanation of the movements in real property prices between 1927 and 1948. Between 1927 and 1937, the real increase in the money supply, the rise in population and the slump in completions per capita might have been expected to raise real property prices. That they did not is presumably attributable to the depressed state of real earnings and expectations and to the high real interest rates in the early 1930s.

The significant fall in real property prices between 1938 and 1948 is also inexplicable by conventional economic variables. Real interest rates were still falling and the real money supply rising, the population and GNP/capita rose significantly, and there was a housing shortage, with the real building materials index up significantly over the period. But during this period, largely as a result of rent controls, the real rent index fell by 28 per cent. Declining rents along with depressed expectations about capital gains, as a result of the Great Depression, the 1939-45 war and possibly the post-war Labour Government, appear to have caused the downward movements in real property prices.

The take-off of real property prices between 1949 and 1960 was associated with a high rate of inflation, negative real interest rates, and increases in real incomes and population. Also it was probably a reaction to the depressed rent-controlled prices of the 1940s. The price rise occurred despite a real fall in the money supply, declining marriage rates, and a boom in completions.

In the 1960s, real property prices continued to rise though at a slower rate. Possible causes include the increase in incomes, the fall in unemployment, the large increases in housing credit and the real money supply, and the increase in marriage rates. Real prices increased despite rising real interest rates and an increase in completions per capita.

11.4 HOUSE PRICES: MULTIVARIATE ANALYSIS

Abelson (1985) reported the results of linear regressions, using both house prices and IV measures of house prices as dependent variables, for the periods 1926-69, 1927-47 and 1948-68. The main results are reproduced in Annex 11.

I concluded then that post-war house prices were related positively to real incomes, population, the inflation rate, the rent index (which is not fully independent), expected house prices and house quality (as indicated by a trend variable) and negatively to housing stock per capita. However, mostly the relationships were weak. Moreover, house prices appeared uninfluenced by interest rates, credit variables, unemployment or marriage. Completions were positively related to house prices, which suggested that completions might be endogenous.

In the earlier period, house prices appeared significantly related only to population and the real rent index. Evidently the earlier period was quite unusual and attempts to model the whole period with one equation were not successful.

In my recent analysis, reported below, I altered the approach in some respects. Consistent with the analysis earlier in the thesis, I adopted a log-linear specification. Also I added the stock exchange index as a potential explanator. Third, I changed the sub-periods to 1928-49 and 1950-68, to exclude idiosyncratic immediate post-war effects in the second sub-period.

My new regressions confirmed that the 1928-68 period could not be modeled as a whole - the coefficients were insignificant, wrongly signed etc. Therefore, I report below only the results for the sub-periods.

Table 11.4 gives the main revised results. For the post-war period, Eqs.(11.1) and (11.2) provide the best results. In these equations, house prices are related positively to income, population, inflation and the stock exchange index and negatively to the housing stock.

However the explanators have varying degrees of significance. The rate of inflation and the stock exchange index are the most robustly significant at the 95 per cent level; population and the housing stock are often significant; but income is only sometimes significant. 1X

The elasticities of house prices to these variables are usually plausible orders of magnitude. Based on (11.1), the elasticities would be about 1.2 for inflation; 0.5 for the stock exchange index; 1.8 for population; -1.25 for the housing stock; and 0.7 for income.

Other variables were less significant. Leading house prices (PHLEAD) could help, via expectations, to explain house prices (see 11.5). However the coefficient is barely significant, serial correlation increases, and PHLEAD make little difference to the explanation provided by the other variables.

Mortgage interest rates were found to be positively related to house prices and not significant (see 11.3). Lagged house prices were negatively related to house prices and also not significant. Unreported results confirmed my earlier findings that house prices were not significantly related to the supply of credit, marriage rates, or unemployment.

Econometric analysis of the 1928-49 period is severely hampered by the poor data on house prices. The estimated house price series is highly volatile, in large part because of the small, unrepresentative sample, and cannot be considered reliable from year to year. On the other hand the estimated repeat IV series appears to be smoothed. This is why the R^2 is higher in the equations based on IVs (11.6 and 11.7) than in (11.8) which is based on house prices.

My new regressions also confirmed that house prices from 1928 to 1949 could not be modeled in a single equation using conventional explanators. The only conventional explanator with a significant coefficient and the expected sign in the IV equations was the housing stock, but the sign changes in the house price equation (11.8).

In such a turbulent period, it would be reasonable to expect some disequilibrium, and especially some slow adjustment to market changes. However, the coefficient for the lagged dependent variable is not significantly different from zero (which would imply instant adjustment) in (11.7) or (11.8).

On the other hand, the negative coefficient on inflation could indicate some disequilibrium. It seems that households were not prepared to reduce their nominal house prices, even when general prices were falling in the early 1930s. Nor did they increase their house prices in line with rising prices in the 1940s, so that real prices fell during inflation. The negative inflation coefficient was particularly strong in the house price equation (11.8) compared with the IV- based equations (11.6) or (11.7).

Further analysis of the data threw no more econometric light on possible determinants of house prices in this earlier period. All other variables in the data set were insignificant or wrongly signed, or both.

TABLE 11.4 HOUSE PRICES: OLS REGRESSIONS

Period	1950-68	1950-68	1950-68	1950-68	1950-68	1928-49 (a)	1928-49 (a)	1928-49
Eq.No.	11.1	11.2	11.3	11.4	11.5	11.6	11.7	11.8
Constant	16	-4	-4	-20	-7	14	13	0
GDP/cap	0.30	0.47	0.96	0.47	0.54	0.03	0.04	-1.01
	(0.69)	(1.00)	(2.60)	(1.08)	(1.25)	(0.27)	(0.35)	(-1.71)
Pop'n	1.82	4.27	0.86	2.85	1.89	0.15	0.15	-0.51
	(1.28)	(5.38)	(0.83)	(1.83)	(1.41)	(0.14)	(0.54)	(-0.42)
CPI	1.21	0.99	1.02	1.83	1.41	-0.15	-0.13	-0.75
	(2.43)	(1.85)	(2.84)	(2.78)	(2.91)	(-1.54)	(-1.40)	(-1.57)
Hse.	-1.25	-2.96	-1.76	-2.33	-2.28	-0.84	-0.80	1.64
stock	(-0.88)	(-2.36)	(-1.76)	-(1.48)	(-1.54)	(-2.69)	(-2.39)	(1.09)
St.Ex.	0.53		0.61	0.57	0.39			
index	(2.02)		(2.27)	(2.22)	(1.48)			
M.rates			0.11					
			(1.18)					
PHLAG				-0.27			0.10	-0.11
				(-1.38)			(0.46)	(-0.2)
PHLEAD					0.26			
					(1.18)			
R^2	0.97	0.97	0.98	0.98	0.98	0.87	0.87	0.63
DW	1.60	1.46	2.65	1.57	2.52	1.93	2.07	1.77

(a) Based on repeat IV series.

Source: Author's research.

11.5 LAND PRICES: MULTIVARIATE ANALYSIS

Residential land prices generally reflect residual values, i.e house prices less building costs. In a free market, the residual values, demand prices, equal the supply price of land, its opportunity cost. In a regulated market, residual values usually exceed the supply price.

It follows that land prices can be represented as a function of house prices, or of their determinants, and building costs.

In Abelson (1985) I reported regression results for land prices with house price determinants and building costs as potential (linear) explanators. Annex 11 shows the main results for UV per lot.

For the post-war period, significant positive relationships between real UVs and real incomes, the real rent index, population, and credit supply were found. But again interest rates and marriages were found to be insignificant. However, I discovered no plausible econometric explanation for land values between 1926 and 1947.

For this study, I re-estimated these land price equations, in log-linear form, concentrating on UV/m^2 which is the basic measure of land value. Additionally, I estimated equations with land prices a function of rents and of house prices themselves. The main results are shown in Table 11.5.

In fact, I discovered no new relationships between land prices and house price determinants. As before, the coefficients were usually insignificant or perverse, or both. Consequently, only one equation of this kind (11.9) is reported in Table 11.5.

Table 11.5 does show, however, that land prices in both study periods are significantly related to house prices and to rents. Also, in the earlier period, they are negatively related to the real costs of building materials. Moreover, generally the coefficients are plausible. For example, land prices have an estimated elasticity of about 1.3 with respect to house prices and -0.4 with respect to building materials.

However, the substantial serial correlation in all the reported equations means that they are not correctly specified. And, except in (11.11), inclusion of the lagged dependent variable as an explanator does not improve the equation.

TABLE 11.5 LAND PRICES: OLS REGRESSIONS

Period	1950-68	1950-68	1950-68	1950-68	1928-49	1928-49	1928-49
Eq.No.	11.9	11.10	11.11	11.12	11.13	11.14	11.15
Constant	-51	2	-18	-2	11	4	4
GDP/cap	0.81 (0.98)				0.36 (1.51)		
Pop'n	5.19 (1.76)				0.15 (0.32)		
CPI	0.81 (0.98)				0.36 (1.51)		
Hse. stock	-1.85 (-1.41)				-0.54 (-1.07)		
PH		1.29 (4.37)		1.37 (10.32)		0.18 (2.37)	
Rents			3.56 (2.57)				0.63 (2.15)
Building mat. costs		-0.82 (-0.74)	1.30 (0.84)	-0.34 (-0.47)		-0.42 (-2.95)	-0.32 (-1.94)
Real money				0.53 (1.06)			
Bond rate					0.06 (2.28)		
R^2	0.90	0.87	0.80	0.88	0.83	0.76	0.74
DW	2.88	2.77	2.42	2.77	2.96	2.69	2.01

Source: Author's research.

11.6 THE HOUSING MARKET AND REAL HOUSE PRICES

As we have seen at various points in this thesis, house prices may be better explained within a simultaneous model of the housing market than by OLS equations. In this section I report the results of a simultaneous model and estimated price equations for the whole period 1926-69.[6]

see p. 233

Table 11.6 shows the results of four two-stage least squares (TSLS) linear regressions run with various demand and supply variables. In each case the demand (H^d) and supply (H^s) equations are shown as well as the real house price equations (on the assumption of equilibrium).[7]

The demand equations suggest that the demand for housing is inversely related to the price of housing. However, using crude average values for the variables (and assuming a coefficient with respect to house price of -0.2), the estimated elasticity of demand for housing stock was low (around -0.1). The demand for housing also appears positively related to real incomes, expected house prices, rent control, and the quality of housing (the trend variable). It does not appear to be influenced by mortgage rates or population.

On the other hand, the supply equations suggest that the supply of housing may be influenced positively by the price of housing. Again using crude average values for the variables (and assuming a coefficient with respect to house prices of 0.1), the elasticity of the supply of the housing stock would be low (around 0.05). Of course, because 97 per cent of the housing stock in any year is made up of existing houses, the housing stock supply (and demand) price elasticities are likely to be low. Also, as would be expected, the supply of housing is related positively to the supply of housing and negatively to the bond rate in the previous year. But it does not appear to be influenced by the real building materials index or the real wage rate in the previous year.

According to the price equations, real house prices were positively related to real incomes, the quality of housing (the trend variable), current interest rates (perversely), and to the lagged dependent variable. No clear relationship emerged between house prices and rent controls, lagged real building materials costs or lagged interest rates.

TABLE 11.6 TSLS REGRESSIONS: HOUSES AND HOUSE PRICES

Eq No	60a	60b	60c	61a	61b	61c	62a	62b	62c	63a	63b	63c
Dep. var*	H^d	H^s	P^h	H^d	H^s	P^h	H^d	H^s	P^h	H^d	H^s	P^h
Constant	229	55	3040	361	536	307	233	60	576	221	193	−288
P^h	−0.021	0.78		−0.864	0.067		−0.199	0.093		−0.039	0.085	
	(−0.29)	(1.63)		(−5.67)	(1.44)		(−2.06)	(1.95)		(−11.93)	(0.69)	
Real GNP	0.245		0.42							0.033		0.34
per capita	(2.70)									(74.58)		
Real							0.861		3.0			
wage							(1.21)					
Real Mortgage	0.145		2.46				0.400		1.34	0.680		7.01
rate	(0.37)						(1.19)			(38.15)		
Rent	−4.738		−82.4							9.77		100.72
control	(−1.0)									(143.8)		
Housing stock		787.4	−13684		787.9	−787		785.4	−2616			
per $capita_{t-1}$		(7.66)			(7.65)			(7.74)				
Bond	−0.428	−1.79		−0.395		0.39	−0.470		1.67			
$rate_{t-1}$	(−1.79)			(−1.66)			(−1.98)					
Bond											0.408	4.21
$rate_t$											(1.12)	
Real building		0.072	0.65		0.070	−0.069		0.090	−0.34		0.147	1.52
materials $index_{t-1}$		(0.65)			(0.64)			(0.81)			(0.84)	
Real	−0.315		5.62	−0.227		0.22			−0.483	1.67	1.22	12.6
$wage_{t-1}$	(−0.50)			(0.39)					(−0.77)		(1.22)	
Pop'n ('000)			−0.053			−0.500						
			(−5.12)									
P_{t-1}			0.269			0.260						
			(3.02)									
Trend			8.75			8.73	2.41		8.0			
variable			(7.68)				(2.82)					
r^2	0.62	0.84	0.82	0.84	na	0.70	0.86	na	0.99		0.63	na

*H^d and H^s are housing stock in thousands.

Source: Abelson, 1985.

11.7 CONCLUSIONS

In this chapter I have tried to explain house and land prices from 1928 to 1968 by examination of pairwise relationships between the dependent variables and potentially important explanators and by development of multivariate models.

The formal analysis is handicapped by the poor nature of the property price data before about 1948 and by the extraordinary nature of economic and political events between 1928 and 1948. This has two consequences. First, I found no overall model which would satisfactorily explain property prices through the whole period and so I concentrated on explaining two main sub-periods, 1928-49 and 1950-68. However, despite considerable experimentation, it also proved difficult to obtain satisfactory formal models for the earlier period by itself. Second, the formal analysis has to be supplemented by more judgmental interpretation than is usually the case.

In the pre-war period, house prices fell by less than other prices so that real house prices rose. The subsequent decline in real house prices in the late 1930s and first half of the 1940s can be attributed to a lagged response to the earlier fall in the general price level and the very high real rates of interest in the early 1930s, depressed rent levels due to rent controls, and depressed expectations due to the war. Real house prices fell between 1938 and 1948 despite the rise in GDP per capita, low real interest rates, high marriage rates, and a housing shortage.

The initial rapid increase in real house prices after the war can be explained by the relaxation of rent controls, negative real interest rates in the early 1950s, and the housing shortage. The subsequent increases in real prices in the 1950s and 1960s were due to increasing population and income, rising equity prices, and rising expectations, especially related to increases in inflation. Plausible elasticities of house prices were estimated with respect to inflation (about 1.2); the stock exchange index (0.5); population (1.8); GDP/capita (0.7); and the housing stock (-1.25).

As has been found in other studies, in reduced form equations, real house prices tend to be positively related to house completions, which suggests that completions may better be regarded as an endogenous variable in a simultaneous system. My TSLS models indicated that house prices generally had a small negative influence on the demand for housing and a small positive influence on the supply of housing. But evidently the increase in the housing stock was not sufficient to restrain the large real increases in house prices.

Land prices, for which there were fewer data than for house prices, were more difficult to model. The best results were obtained when land prices were related to house prices or rents and building costs rather than to the independent determinants of housing demand. In both study periods, land prices were significantly and positively related to house prices and to rents. Also in the earlier period, they were negatively related to the real costs of building materials. Moreover, generally the coefficients were plausible. For example, land prices had an estimated elasticity of about 1.3 with respect to house prices and -0.4 with respect to building materials costs.

ENDNOTES

(1) House and land price data were available from 1926 to 1970. However, the first and last year data were regarded as unreliable. Because lagged and leading prices were required as independent variables, the dependent variables ran from 1928 to 1968.

(2) As noted in Chapter 4, unimproved valuations include services to the land in the land values.

(3) In this study I adopted 1928-49 and 1950-68 as the two main sub-periods. Abelson (1985) used 1927-47 and 1948-68 as the two main sub-periods.

(4) In Abelson (1985), I extended the rent dummy variable to 1954 and also included a dummy variable for the war years. However, surprisingly, neither variable was significant. In this chapter, the rent dummy variable corresponds closely to the war years.

(5) For the reasons given in Chapter 7, this assumption is not very satisfactory. However, no better measure of expected house prices was available.

(6) As previously noted, the structure of the housing market may have changed over the period. However, there are barely sufficient observations in the sub-periods to warrant the construction of separate simultaneous models for each sub-period.

(7) Standard errors and goodness-of-fit statistics are not available for the price equations.

ANNEX 11 ALTERNATIVE LINEAR MODELS OF HOUSE AND LAND PRICES

TABLE 11.1 LINEAR OLS REGRESSION EQUATIONS: MEDIAN REAL HOUSE PRICES

Period	1926 –1969	1926 –1969	1926 –1969	1926 –1969	1926 –1969	1927 –1947	1927 –1947	1927 –1947	1948 –1968	1948 –1968	1948 –1968	1948 –1968
Eq No	16	17	18	19	20	21	22	23	24	25	26	27
Constant	−136	−41	66	−637	−94	38	14	−100	−136	−112	−639	200
Real				11.56							8.67	
Wages				(10.77)							(4.87)	
Real				1.95								−0.414
Mortgage				(2.78)								(−0.75)
Rate												
Real	0.755		0.436	1.25	0.25			0.655	0.272	−1.117	1.99	
rent	(2.55)		(3.07)	(5.12)	(1.51)			(2.32)	(0.47)	(−1.42)	(3.78)	
index												
Rent						2.94						
control						(0.32)						
Housing			−321.9	387.9								−658.3
stock per capita			(1.32)	(1.05)								(−2.99)
War dummy			−0.386									
variable			(−0.06)									
P^h_{t-1}	0.647	0.886							0.413			
	(4.15)	(7.75)							(1.94)			
P^h_{t+1}			0.301		0.555		0.097					
			(2.57)		(5.72)		(0.46)					
Trend			5.81						2.46			9.48
variable			(4.74)						(0.31)			(15.2)
Real GNP	0.019	−0.024			0.68	−0.131	−0.122	−0.103	0.071			
per capita	(1.02)	(−0.74)			(2.99)	(−4.46)	(−4.02)	(−4.65)	(2.20)			
Unemployment					2.41						23.00	
(%)					(2.75)						(2.45)	
Population		0.060				0.122	0.128	0.137		0.194		
('000)		(1.34)				(2.59)	(3.09)	(3.72)		(2.36)		
CPI	29.58	−7.25							23.82	−32.85		
	(2.32)	(−0.58)							(1.68)	(−0.82)		
Completions						1.215	1.356				13.23	
per capita						(0.98)	(1.15)				(3.03)	
r^2	0.93	0.92	0.94	0.87	0.92	0.62	0.62	0.68	0.94	0.96	0.87	0.96
dw	1.54	1.81	1.99	1.94	1.78	1.90	2.11	2.10	1.56	1.85	1.78	1.84

Source: Abelson, 1985

A11.2 LINEAR OLS REGRESSION EQUATIONS: UV/LOT.

Period	1926 –1969	1926 –1969	1926 –1969	1926 –1969	1948 –1968	1948 –1968	1948 –1968
Eq no	40	41	42	43	47	48	49
Constant	−822	−161	−378	−328	−986	−852	−1191
Real Wages				8.75 (2.45)			
Real GNP per capita	0.176 (2.63)	−0.061 (−0.52)	0.340 (6.58)			0.449 (2.70)	0.418 (2.06)
Unemployment (%)			9.19 (2.55)				
Real Mortgage rate			5.03 (2.21)	3.78 (1.45)			
Real money supply							0.336 (2.02)
Real rent index	4.31 (5.30)				3.114 (1.21)		
Rent control							−10.75 (−0.17)
Population ('000)		0.225 (1.51)				0.208 (0.93)	0.511 (4.06)
Marriages per capita				5.20 (0.67)			
CPI	121.1 (3.88)	−24.33 (−0.50)			69.36 (1.46)	−9.60 (−0.15)	
UV_{t-1}	−0.082 (−0.48)	0.466 (2.85)		0.42 (3.25)	−0.262 (−1.17)	−0.239 (−1.06)	−0.327 (−1.37)
Housing stock per capita			58.0 (0.05)				
War variable			22.4 (0.65)				
r^2	0.83	0.73	0.75	0.69	0.81	0.80	0.80
dw	2.03	2.10	2.01	1.28	2.29	2.20	2.07

Source: Abelson, 1985

12 CAUSES OF HOUSE AND LAND PRICES DIFFERENCES IN SYDNEY FROM 1931 TO 1968

12.1 INTRODUCTION

This chapter aims to explain the spatial distribution of house and land prices in Sydney from 1931 to 1968 (see Chapter 4). The focus is slightly more on land prices because they vary more than house prices and because I have no data specifically on house characteristics, such as house size or age.

It is necessary at the outset to recall some limitations of the data. The sample was based on only 22 out of the (current) 42 LGAs in Sydney. Moreover, less than half the 1968 sample existed as houses in 1931. Some areas that were urban in 1968 were rural in 1931. In some outlying areas, where land values were very low in the early 1930s, the estimated percentage increases over the study period were especially high. Although these orders of magnitude are doubtless correct, the figures should not be considered precise. Also, fewer data are available for potential explanatory variables, such as household income and employment, than for more recent periods. (For further discussion of data limitations, see Chapter 4).

In Chapter 6, I discussed general explanations for the spatial distribution of house and land prices. Chapters 8 and 9 provided empirical analyses of the distribution of house prices in Sydney (and Adelaide and Melbourne) since 1977. A key finding, in theory and practice, was the relationship between residential property prices and access to the CBD. The following section analyses the relationships between access to the CBD and house and land prices in Sydney from 1931 to 1968.

Section 12.3 analyses the causes of changes in relative land prices in Sydney from 1931 to 1968.

Obvious questions to emerge are: were the changes in relative property prices in Sydney between 1931 and 1968 similar to later changes in relative prices ? And,if not, why not? Because the data base for this part of the study is different from that for the earlier part, inter-period comparisons must be treated cautiously. However, Section 12.4 provides further evidence that whereas house and land price gradients became flatter between 1931 and 1968, they had become steeper again by the early 1980s.

Section 12.5 sumarises the main findings of this chapter.

12.2 RESIDENTIAL PROPERTY VALUES AND ACCESS TO THE CBD

This section starts with a description of house and land values in four rings around the CBD (0-8km, 8-16km, 16-24km and 24+km to the CBD) identified in Chapter 4. I then show the results of regressions between average LGA residential property values and distance to the CBD. Finally land prices for individual lots are regressed against CBD access. In each case, results are given for 1931, 1948 and 1968, the key years shown in Chapter 4.

Table 12.1 shows the median land and house values in the selected years in then current prices. Table 12.2 shows the real changes in values that occurred.

TABLE 12.1 MEDIAN VALUES IN SELECTED YEARS: CURRENT $s (a)

Distance to CBD	UV/m2 1931	UV/m2 1948	UV/m2 1968	UV/lot 1931	UV/lot 1948	UV/lot 1968	IV/lot 1931	IV/lot 1948	IV/lot 1968
0-8 km	1.58	1.64	18.23	436	522	5980	1483	1523	8122
8-16 km	0.72	0.78	11.19	417	460	6522	1649	2034	13333
16-24 km	0.29	0.35	7.36	214	264	5135	1345	1533	12173
24+ km	0.24	0.25	7.15	171	189	5058	823	1090	11941
All Sydney	0.92	1.02	9.95	360	410	5100	1400	1650	11920

(a) The median values for each distance band are the median LGA values shown in Annex 4 weighted by the occupied houses or lots in each LGA in each year. The figures for the whole of Sydney are the true medians.

Source: Annex 4.

TABLE 12.2 REAL CHANGES IN MEDIAN VALUES

Distance to CBD	UV/m^2 1931-48	UV/m^2 1948-68	UV/lot 1931-48	UV/lot 1948-68	IV/lot 1931-48	IV/lot 1948-68
0-8 km	-27	+331	-17	+350	-18	+108
8-16 km	-24	+457	-23	+453	-14	+156
16-24 km	-16	+723	-14	+662	-20	+209
24+ km	-27	+1013	-23	+948	-8	+330
All Sydney	-22	+274	-20	+382	-18	+182

Source: Nominal values in Table 12.1 deflated by CPI.

Table 12.1 shows that, in each selected year, land values (UV/m^2) declined from the centre at a decreasing rate. Whereas there were sharp declines in values between the two inner areas, the differences between the two outer areas were small.

The table also shows that the land value gradient fell between 1931 and 1968. In the earlier year, average central area land values were about 6.5 times outer area land values; by the later year, the ratio had fallen to about 2.5.

These results are confirmed by Table 12.2. This shows that the real changes in land values (between 1948 and 1968) were much higher with distance to the CBD. The table also illustrates how property values may rise by more in each part of the city than they do on average for the whole city as the centre of (residential) gravity moves away from the CBD.

As shown in Table 12.1, residential lot values also tended to fall with distance from the CBD. But since lot size usually increased substantially with distance (see Annex 4), the lot price gradients were much shallower than the land price gradients.

Over time, from 1931 to 1968, prices of residential lots and land prices rose at similar rates within each area as lot sizes in most suburbs remained fairly constant. However, as the city expanded, average lot size increased from 407 m^2 in 1931 to 513 m^2 in 1968. Consequently, the median lot value for the whole of Sydney rose faster than the median value per m^2.

House prices (IVs) were like land prices in some respects. They declined from the second ring (8-16km) outwards. Also, outer area house prices increased by more than inner area prices. Thus the house price gradient flattened considerably between 1931 and 1968.

On the other hand, inner area house prices were lower than those in the second ring. The house price gradient was always significantly flatter than the land price gradient. And house prices rose more slowly than land prices. How can these differences between house and land price gradients be explained?

Chapter 6 (Eq.6.10) showed that the land rent gradient would be steeper than the price gradient for a (standard) unit of housing services because it would be approximately the product of the inverse of the share of land and the housing price gradient. An additional reason for the relatively flat house price gradient is that the size and quality of housing usually rise with distance from the CBD.

There are two main reasons why house prices appreciated more slowly than land prices. First, since houses are produced by land and non-land factors, it follows that if house prices inflate faster (slower) than non-land factor costs, house prices will inflate slower (faster) than land prices. Data for building materials (one non-land factor) indicate that this occurred. Between 1931 and 1948 the real building materials index increased, and land prices fell by more than house prices. Between 1948 and 1968 the real building materials index was approximately constant and land prices rose by more than house prices.

Second, before land is developed with housing, it provides few (if any) services and its price is the present value of (discounted) future services. In the long run, prices for such land must rise relative to house prices by the real rate of interest to compensate for the lack of present consumption benefits. The three per cent per annum differential between land and house price appreciation in the post-war period is consistent with the average real (risk-free) rate of interest over that period.

Table 12.3 provides a breadown of property price increases by geographical sector and distance from the CBD. The specific results need to be treated cautiously as some figures reflect only one LGA (for each measure of property value, 12 figures are recorded from a total of 22 LGAs). Nevertheless, the table provides strong sectoral support for the previous finding that property values increased faster further from the CBD. The only exception occurred in the outer part of the West/N-W sector where land values in the relatively inaccessible and inhospitable inland areas rose by less than in more accessible areas.

TABLE 12.3 REAL INCREASES IN PROPERTY VALUES BY SECTOR

Percentage increases between 1931 and 1968

Distance to CBD (km)	UV/m2 Inner-East	S-SW	W-NW	N	UV/lot Inner-East	S-SW	W-NW	N	IV/lot Inner-East	S-SW	W-NW	N
0-8	292	276	-	340	376	282	-	332	254	187	-	187
8-16	-	378	555	424	-	376	501	462	-	222	210	226
16-24	-	615	1202	702	-	608	993	736	-	252	313	241
24+	-	1152	897	732	-	1051	790	854	-	474	342	400

Sources: Annex 4 and CPI data.

We embark now on more quantitative analysis. Specifically, we would like to know how much of the variations in property prices can be explained by distance from the CBD? How precisely did the land and house price gradients change? And, how much of the changes in property prices can be explained by distance from the CBD?

As usual, the answers depend on the functional form of the explanatory equations. In Chapter 8, house prices were best explained as a function of the log of distance to the CBD. However, as seen in Chapter 6, to explain land prices, most analysts adopt a negative exponential form of equation as in (12.1) or its equivalent (12.2).

$$Y = ae^{-bx} \qquad (12.1)$$

$$\text{Log } Y = \text{Log } A - bx \qquad (12.2)$$

where Y is land price, e is 2.718, x is distance from the CBD and a and b are parameters to be estimated.

In (12.1) the parameter 'a' has an economic meaning - it is the value of land at the centre of the city (when x = 0). The parameter 'b' is the percentage change in land price per km from the CBD.

For the 1931, 1948 and 1968 data, I tested linear, negative exponential, and semi-log relationships between land prices and distance to the CBD and found that the negative exponential equation usually gave the best results. Accordingly these results are presented in the main text below. Another advantage of (12.1) is that the b coefficient provides a direct measure of the slope of the price gradient independently of the price units. For comparative purposes, house and land prices are shown as a function of LOGCBD in Annex 12A.

TABLE 12.4 RESIDENTIAL PROPERTY PRICES AND DISTANCE FROM THE CBD (a)

	UV/m^2 a	UV/m^2 b	UV/m^2 R^2	IV a	IV b	IV R^2
1931	1.60	-0.061 (-6.9)	0.71	1808	-0.018 (-3.1)	0.33
1948	1.68	-0.058 (-7.1)	0.71	1808	-0.012 (-1.47)	0.16
1968	18.92	-0.036 (-9.4)	0.81	13359	-0.0065 (-1.51)	0.11

(a) Based on 22 average LGA values, using (12.1).

Source: Author's estimates.

As shown in Table 12.4, distance alone explains a remarkably high percentage of the variation in average LGA land prices; the b coefficients in the land equations are highly significant; and the land price gradient fell significantly between 1948 and 1968. In 1931 and 1948 land prices fell with distance from the CBD by an estimated six per cent per km; in 1968 they fell by about three and a half per cent per km.

In 1931, distance from the CBD explained about a third of the variations in average LGA house prices. After that, the house price gradient declined and distance, though still exerting a negative influence on house prices, became barely significant and explained only 10 to 15 per cent of the variations in house prices. (However, as shown in Section 12.4, these results are sensitive to the selection of LGAs in the sample). In 1931 house prices fell with distance from the CBD by about two cent per km; in 1968 they fell by about half a per cent per km.

To test the importance of distance on changes in relative land and house prices, I regressed the estimated changes in average LGA prices on LOGCBD (as in Chapter 9):

$$CHUV/m^2 = 101 + \underset{(2.94)}{267}\ LOGCBD \qquad R^2 = 0.30 \qquad (12.3)$$

$$CHIV = 37 + \underset{(1.71)}{55.4}\ LOGCBD \qquad R^2 = 0.13 \qquad (12.4)$$

where CH stands for the percentage change in (land or house) prices between 1931 and 1968.

The equations show that changes in land and house prices were positively related to distance, but the change in house price/distance relationship in (12.4) was weak.

Table 12.5 provides a more detailed statistical analysis of the relationships between land values and access to the CBD in each sector, based on all properties in the sample, in 1931, 1948 and 1968. The equations are again in negative exponential form (12.1). The main results are:

(i) The value of `a' - the imputed current value of residential land close tothe CBD - rose over time in each geographical sector.

(ii) The b parameter is always negative and highly significant: i.e. in each sector, in each year, the land price gradient can be represented by a negative exponential function.

(iii) In all sectors except the Eastern one (which has some unusual characteristics) the value of b declined significantly between 1948 and 1968: i.e. in each sector but one the land price gradient flattened.[1]

(iv) In all sectors, except the East, the value of R^2 fell between 1948 and 1968. This indicates that distance from the CBD became less important influence on land values.

(v) Similar results were obtained for Sydney as a whole. Despite the marked diferences between sectoral environments in Sydney, distance from the CBD "explained" over 50 per cent of the differences in land values in Sydney in 1931 and 1948 and 28 per cent in 1968.

(vi) The estimated land price gradients in 1931 and 1948, based on individual lot assessments, were higher than those based on average LGA figures in Table 12.4. Since the former embody more information, they would generally be preferred.

However, it may be noticed that the gradients for individual sectors are usually lower than for all Sydney. This suggests that the aggregate equation may contain some aggregation bias. Of course this would also apply to the equations in Table 12.4.

Finally, an international comparison may be of interest. In Chicago, one of the few cities for which comparable data exists, the estimated land rent gradient was just over 20 per cent per mile in 1928 and 11 per cent per mile in the 1960s (Mills, 1969). Converting the figures in Table 12.5 from km to miles, the comparable figures for Sydney are approximately 15 per cent per mile in 1931 and 5 per cent per mile in 1968. Sydney's lower rent gradients reflected its smaller population, which was less than half that of Chicago between 1928 and 1968, and its lower population density.

TABLE 12.5 LAND VALUES AND DISTANCE FROM THE CBD (a)

	1931			1948			1968		
	a	b	R^2	a	b	R^2	a	b	R^2
North	0.39	-0.055	0.20	1.35	-0.063	0.33	59.7	-0.012	0.13
		(-10.4)	409		(-20.9)	878		(-3.98)	1123
West	0.40	-0.075	0.31	0.84	-0.049	0.36	49.4	-0.029	0.32
		(-13.0)	387		(-18.7)	625		(-23.4)	1181
South	0.64	-0.092	0.44	2.16	-0.092	0.59	67.4	-0.021	0.13
		(-16.0)	327		(-32.9)	764		(-12.3)	991
East	0.58	-0.033	0.02	1.78	-0.057	0.06	19.1	-0.071	0.12
		(-2.9)	320		(-5.0)	361		(-7.4)	393
Inner	1.73	-0.030	0.30	3.69	-0.024	0.19	83.1	-0.120	0.11
		(-11.5)	313		(-9.1)	350		(-0.75)	430
All	0.65	-0.094	0.55	1.75	-0.078	0.53	69.4	-0.032	0.28
		(-46.3)	1756		(-58.4)	2987		(-40.1)	4118

(a) Negative exponential form. Figures shown below R^2 are sample sizes.

Source: Author's estimates.

12.3 CAUSES OF CHANGES IN RELATIVE LAND VALUES

Chapters 6 and 9 showed that many factors cause changes in relative house and land values. These include changes in housing demand, in the geographical supply of housing, and in local housing attributes, especially in access costs.

On the demand side, rising income increases the demand for housing space and environmental amenities. This usually translates into higher demand for fringe properties where land is cheap and environmental conditions good. Also decentralisation of employment reduces the demand for inner city housing. On the supply side, it is easier to improve undeveloped areas, for example by improving urban services, than established areas. Also transport improvements, which are generally radial in design, usually benefit fringe areas more than established areas.

However, there may be countervailing factors. Increased values of travel time and greater congestion, as well as supply constraints in established areas, raise relative inner city prices. And as the city expands to its natural limits, development costs rise and land values fall.

It is not possible to provide here a comprehensive explanation of changes in the distribution of Sydney land prices from 1931 to 1968. This would require large amounts of data on housing and local area attributes and on socio-economic variables that are not readily available. For example there are no data on income levels or employment in each LGA.

However, a partial analysis is possible. In this section, I start by observing some of the underlying changes that occurred and presumably drove the changes in relative property prices. I then examine in some detail the changes in the transport system (road and rail) and changes in urban services as proxied by changes in the provision of sewerage services.

Increased population and income, along with increased ownership and use of the motor car, were major causes of the rise in the demand for housing and the rise in land values in outer urban areas. Betweeen 1930 and 1970, the population of Sydney more than doubled from 1.3 to 2.8 million (an average annual rate of growth of over two per cent per anum). Most of this growth occurred after 1940 - the population grew by 10 per cent in the 1930s, 34 per cent in the 1940, 28 per cent in the 1950s, and 24 per cent in the 1960s. Over the whole period 1928 to 1968, per capita income in Australia rose by 150 per cent (i.e., by nearly three per cent per annum).

In 1931, 145,000 motor cars were registered in New South Wales. By 1948, the number was 188,000 (about one in three housholds owned cars). By 1970, 1.11 million cars were registered (over one car by houshold). By the time of the 1971 census, car trips accounted for 72 per cent of all trips to work.

Muth (1975. p.73) comments:

> "Empirically, differences in marginal transport costs, as reflected in car registrations per capita, are the other major factors in addition to population differences leading to differences in the degree of population dispersion at a given time. More important, though, the increase in car registrations per capita that took place in the fifties decreased the relative rate of decline in population densities by more than one half. These same changes caused the land area occupied by cities to increase by about 45 per cent, and central city populations fell by about 10 per cent. Thus there is good economic reason why the suburban parts of cities grew so rapidly during the 1950s."

The upsurge in car usage in Sydney was facilited by the end of petrol rationing in 1950, the decline in the real price of petrol in the 1950s and 1960s, and the large road construction program.

Between the mid-1950s and the late 1960s, the real price of petrol fell by about 20 per cent (see Table 12.6). This would have had a small effect on house prices. If the petrol price had risen with inflation, in the late 1960s it would have been an extra two cents per litre. For a 20 km commute by car to the CBD, typical costs would have risen by about 10 cents per day or $22 per annum (allowing 220 working days). Allowing a real five per cent rate of discount, the capital value equivalent would have been about $440.[2] This would have represented about 4.4 per cent of a typical house price or 9 per cent of land value (including improvements to land) in the outer areas of Sydney in the late 1960s.

TABLE 12.6 NOMINAL AND REAL PETROL PRICES FROM 1956 TO 1970

	Cents/litre	Index (1970=100)
1956	8.4	124
1957	8.8	124
1958	8.5	118
1959	8.4	116
1960	8.3	111
1961	8.1	105
1962	8.0	105
1963	8.0	104
1964	7.9	101
1965	8.0	99
1966	8.6	106
1967	8.9	106
1968	9.1	103
1969	9.1	100
1970	9.5	100

Source: National Roads and Motorists Association based on ABS data.

Major road and bridge construction from the mid-1920s to the late 1960s is outlined in Annex 12B. Before the NSW Main Roads Board was created in 1924, local authorities were responsible for all road construction. After 1924, large expenditures were committed to the four major city radials (the Great Northern Highway, the Great Western Highway, the Hume Highway to the south-west, and the Princes Highway to the south). Bridges constructed included the Sydney Harbour bridge (completed 1932), Iron Cove bridge (1954), Cook's River Bridge (1962), Gladesville bridge (1964), Captain Cook bridge (1965), and Roseville bridge (1966). The main beneficiaries of these improvements were commuters to the CBD and property owners in the outer areas.

Casual examination of land value increases and road developments suggests that the two were related. In the 8-16 km ring, Ryde land owners experienced the highest appreciation of land values between 1931 and 1968 and (arguably) the greatest benefits of road programs. On the other hand, in the absence of significant road programs in their areas, Canterbury's relative access advantage and property prices declined in the pre-war period, and

Strathfield's access advantage and relative prices declined in the post-war period. In the 16-24 km ring, the largest relative increases in land values (in Parramatta over the whole period, in Kuringai between 1927 and 1948, and in Bankstown between 1948 and 1968) corresponded with relatively large road programs. Also, in the 24+ km ring, the largest rises in land values (in Sutherland and Baulkam Hills) occurred in areas which apparently benefited most from road improvements. Land values appreciated less in Hornsby, Liverpool and Penrith where there were fewer direct improvements in access.

Unlike the road infrastructure, Sydney's rail infrastructure was nearly complete by the mid-1920s. The major exception was the rail link over the Harbour bridge completed in 1932, which introduced rail to North Sydney and shortened the rail journey to other line-of-rail northern suburbs. However, as shown in Annex 12B, between 1930 and 1970, peak hour rail travel times to the CBD from most areas in Sydney stayed constant or increased. Moreover, although the frequency of peak hour services to inner city areas tended to decline and the frequency to other areas generally increased, the changes in service frequency were usually smaller than the population changes.

Of more significance for land values, many real rail fares fell, in several cases by over 25 per cent, except on services to the north. In absolute terms, fare reductions were greatest for longer journeys. For some areas, real fares fell by a dollar or more per week (in 1970 $s). With a real interest rate of five per cent, a $50 per annum saving would represent a capital value of $1000. This would have represented a 10 per cent increase in house prices and a 20 per cent increase in land values in outer urban areas in the late 1960s.

Table 12.7 summarises the increase in the provision of mains sewer services in Sydney between 1931 and 1970 (for further details see Annex 12B).

TABLE 12.7 PROPERTIES WITH MAINS SEWER SERVICE

Distance from CBD	1931 (%)	1968 (%)	1931-68 Change in %
0-8 km	92	100	8
8-16 km	50	93	43
16-24 km	22	90	68
24+ km	3	37	34

Source: Sydney Water Board.

Again, casual examination suggests that land values were related to the provision of sewerage services, with increases in both land values and sewer services generally greater with distance from the CBD. Admittedly land values increased most in the outer ring, where there was less improvement in sewerage services than in the two central areas. However, by the late 1960s, most outer urban residents expected to receive sewer services within the next 10 or so years. Within the 8-16 km ring, land values increased significantly more in Ryde, where two-thirds of the houses received mains sewer between 1931 and 1968, than in Canterbury or Strathfield where most properties had sewer services by 1931. In the 16-24 km ring, land values rose much faster in Kuringai, which was largely sewered between 1931 and 1968, than in Kogarah, an older suburb with over half its houses sewered by 1931. Of course, improvements in sewer services are often related to improvements in drainage and kerb and guttering, so that the separate effects on land values are difficult to isolate.

In an attempt to quantify the separate influences (if any) of distance, improved roads and sewerage services, I regressed the percentage increases in land values (CHUV/m^2) on LOGCBD, dummy variables for road improvements (1 for significant improvements and 2 for very large improvements - see Annex 12B), and the increase in the percentage of properties receiving mains sewer services. The results were as follows:

$$\underset{(31-48)}{CHUV/m^2} = -34 + \underset{(0.66)}{2.0\ LOGCBD} + \underset{(2.21)}{8.59\ RD} + \underset{(0.64)}{0.11\ SEW} \qquad R^2 = 0.32 \qquad (12.5)$$

$$\underset{(48-68)}{CHUV/m^2} = 18 + \underset{(1.24)}{155\ LOGCBD} + \underset{(2.12)}{379\ RD} - \underset{(-0.10)}{0.38\ SEW} \qquad R^2 = 0.45 \qquad (12.6)$$

$$\underset{(31-68)}{CHUV/m^2} = -161 + \underset{(1.84)}{184\ LOGCBD} + \underset{(2.49)}{308\ RD} - \underset{(-1.36)}{3.39\ SEW} \qquad R^2 = 0.49 \qquad (12.7)$$

where RD and SEW are road and sewerage improvements respectively.

The results provide strong support for the view that road improvements have a major effect on land prices. The level of explanation is significantly higher in (12.7) than in (12.3) where LOGCBD is the only explanator. In fact, with road improvements included, LOGCBD is not significant in the two sub-periods. On the other hand the sewerage coefficient is twice negative and never significant. Excluding LOGCBD from the equations reduced their explanatory power and did not make the sewerage coefficient significant.

Finally, a brief observation on the impact of regulatory policies on land values. During the study period, local authorities held main responsibility for land use zoning policies. Generally they adopted conservative and exclusionary policies. These effectively prevented the substitution of capital for land and retained lot sizes at historic levels (see the constancy of lot sizes in most suburbs - Annex 4). Consequently, lot sizes in the inner areas were almost certainly larger than they would have been in a freer market. Although these policies increase house prices in established areas, they reduce land prices (per m^2). Therefore, land use controls reduced the land rent gradient below that which would have occured in a less regulated market.

12.4 A COMPARISON WITH POST-1970 HOUSE AND LAND PRICES

The flattening of Sydney's land and house price gradients between 1931 and 1968 was in marked contrast to the increase in the house price gradient since the mid-1970s. I did not have comparable detailed land prices for this later period, but it may be inferred that the land price gradient also became steeper after 1969 (see the discussion of relative house and land price gradients in Chapter 6). The main purpose of this section is to add some statistical observations to bridge the gap between the two sets of empirical findings.

First, land prices. Drawing on my data set and obtaining UVs in 1983, Kirwan (1989) estimated the following equations, in negative exponential form, for 1983:

(22 LGAs: 1983)

$$UV/m^2 = \underset{}{215} - \underset{(-7.7)}{0.048}\ DIST \qquad R^2 = 0.75 \qquad (12.8)$$

(2349 observations: 1983)

$$UV/m^2 = 221 - \underset{(-52.4)}{0.052}\ DIST \qquad R^2 = 0.54 \qquad (12.9)$$

where DIST stands for (linear) distance in km from the CBD. The coefficients for DIST in (12.8) and (12.9) are significantly higher than the coefficients (the bs) in the equivalent 1968 equations shown in Tables 12.4 and 12.5. This indicates that the land price gradient did become steeper between 1968 and 1983.

Second, house prices. Drawing on estimated average house prices in 1983 for the sample of 22 LGAs (AE, 1991, Appendix B), I estimated the following negative exponential equation:

(22 LGAs: 1983)

$$PH = 109987 - \underset{(1.77)}{0.0083}\ DIST \qquad R^2 = 0.13 \qquad (12.10)$$

where PH stands for house prices (not valuations). Again, the coefficient for DIST in (12.10) is higher than the b coefficient in the equivalent 1968 equation in Table 12.4.

However, by changing only three LGAs in the sample of 22, I obtain (12.11), which indicates both a much higher coefficient for DIST and a higher R^2. Evidently the results are sensitive to the sample chosen.

(22 LGAs sample adjusted: 1983)

$$PH = 121510 - 0.0143\ DIST \qquad R^2 = 0.36 \qquad (12.11)$$

The main point, however, is that extrapolation of the 1931-68 LGA sample set to 1983 confirms that house and land price gradients became steeper at some point after 1970, whereas in the earlier period they had become flatter.

12.5 CONCLUSIONS

Throughout the 1928 to 1968 period, land and house prices in Sydney declined with distance from the CBD. However, both price gradients became flatter over the period, especially after 1948.

Drawing on the preferred results shown in Table 12.5, land prices fell with distance from the CBD by an estimated nine per cent per km in 1931, by eight per cent per km in 1948, and by just over three per cent per km in 1968.

Detailed results were also estimated for five geographical sectors. Although the parameters varied, in each case the land price gradients were significantly negative and flattened over time.

House prices were related less uniformly to distance to the CBD. Nevertheless the negative exponential equations indicated that house prices fell significantly with distance from the CBD by about two per cent per km in 1931, one per cent per km in 1948, and half a per cent per km in 1968.

The negative exponential gradients are consistent with the theory of urban housing and land prices described in Chapter 6.

The small and irregular house price gradient is consistent with the theory that although the price gradient for standard units of housing is likely to be negative (to compensate households for the extra costs of longer work commutes and inferior access to city facilities), price gradients for actual house prices (the dependant variable in this chapter) may not decline because households further from the CBD purchase more housing units (larger houses).

Also, the land price gradient was predicted to be the product of the housing price gradient and the inverse of the share of land in housing. Thus, given a typical land share of say 20 per cent, the land price gradient would be five times the house price gradient. This is approximately the result obtained.[3]

This chapter then sought to explain why the gradients became flatter between 1928 and 1968 by analysing some major elements of the demand for housing and the supply of transport and urban services.

Where possible, quantitative causal relationships were estimated. However, because of data constraints, the analysis was mainly qualitative.

Large increases in population and income (especially after 1940) raised substantially the demand for housing and land. Moreover, the increase in car ownership between 1948 and 1968 (from one car per three households to one car per household) greatly raised the demand for land further from the CBD. The 25 per cent fall in real petrol prices between the mid-1950s and late 1960s also increased housing demand in outer areas, and increased outer area house prices by an estimated five per cent.

Between 1925 and 1970 the government constructed several major bridges and hundreds of km of major arterial roads. Indeed this was the major road and bridge building period in Sydney's history. Although travel time data for this period are not available, there can be no doubt that travel times per km were greatly reduced.

Most of Sydney's rail infrastructure was established by 1925. However, reductions in real rail fares between 1931 and 1968 could have increased outer area house prices by an estimated 10 per cent in 1968.[4]

Statistical analysis showed that about half the variations in average LGA land price changes could be explained by distance to the CBD and by specific road or bridge improvements.

However, contrary to my expectation, no statistical relationship was found between changes in land prices and improvements in urban services, as proxied by the provision of mains sewer services.

Finally I noted that land use zoning policies prevented the substitution of capital for land in established areas, thereby increasing house prices but reducing land prices in these areas. These policies therefore flattened the land rent gradient over time.

ENDNOTES

(1) The Eastern sector is a short one which traditionally enjoyed good access to the CBD.

(2) Real interest rates appear to have been lower in the 1960s than in the 1980s.

(3) This result is only approximate. As noted, we do not have a measure of the housing price gradient (as distinct from the house price gradient). Also, although the land prices (UV per m^2) are standardised for area, they include the implicit values of urban services.

(4) Of course, the petrol price and rail fare impacts on house prices must be regarded as alternative rather than additive impacts.

ANNEX 12A: RESIDENTIAL PROPERTY PRICES AND LOGCBD

This annex reports the results of property price regressions for house and land prices with LOGCBD as the explanatory variable, as in Chapter 8. Note however that the regressions in Chapter 8 are based on average house prices in all Sydney LGAs. Comparisons may be made more directly with the results of the negative exponential equations shown in this chapter.

UV/m^2 (1931)	= 2.48 - 0.65 LOGCBD (-8.2)	$R^2 = 0.81$
UV/m^2 (1948)	= 2.54 - 0.66 LOGCBD (-8.8)	$R^2 = 0.79$
UV/m^2 (1968)	= 25.4 - 5.44 LOGCBD (-5.6)	$R^2 = 0.61$
IV (1931)	= 1926 - 226 LODCBD (-1.85)	$R^2 = 0.15$
IV (1948)	= 2001 - 150 LOGCBD (-1.0)	$R^2 = 0.05$
IV (1968)	= 13903 - 596 LOGCBD (-0.72)	$R^2 = 0.03$

ANNEX 12B: DATA ON ROAD, RAIL AND URBAN SEWERAGE IMPROVEMENTS

TABLE A12.1 MAJOR ROAD AND BRIDGE IMPROVEMENTS

Area[a]	Improvement	Year commenced	Year completed
Auburn (1, 0, 1)[b]	Great Western Highway (Parramatta Road)	1925	1928
Bankstown (1, 1, 1)	Hume Highway	1945	1950
	Canterbury Road	1954	1959
Baulkham Hills (1, 1, 1)	Great Western Highway	1925	1929
	Victoria Road	1932	1937
	Iron Cove Bridge	1949	1954
	Gladesville Bridge	1959	1964
Canterbury (0, 1, 1)	Hume Highway	1945	1950
	Canterbury Road	1954	1959
Hornsby (2, 1, 1)	Harbour Bridge	1927	1932
	Pacific Highway	1928	1933
	Epping Highway	1934	1939
	Warringah Freeway	1964	1969
Kogarah (1, 1, 1)	Princes Highway	1924	1929
	Cook's River Bridge	1957	1962
Kuringai (2, 1, 2)	Harbour Bridge	1929	1932
	Pacific Highway	1928	1933
	Roseville Bridge	1941	1946
	Warringah Freeway	1964	1969
Leichardt (1, 0, 0)	Parramatta Road	1924	1929
	Iron Cove Bridge	1949	1954
Liverpool (0, 1, 1)	Hume Highway	1945	1950
	Canterbury Road	1954	1959
Manly (1, 0, 1)	Harbour Bridge	1927	1932
Marrickville (1, 1, 1)	Princes Highway	1924	1929
	Canterbury Road	1954	1959

TABLE A12.1 MAJOR ROAD AND BRIDGE IMPROVEMENTS cont'd

Area	Improvement	Year commenced	Year completed
North Sydney (2, 1, 1)	Harbour Bridge	1929	1932
	Pacific Highway	1928	1933
Parramatta (2, 1, 2)	Great Western Highway	1924	1929
	Victoria Road	1932	1937
	Iron Cove Bridge	1949	1954
	Gladesville Bridge	1959	1964
Penrith (1, 0, 1)	Great Western Highway	1924	1937
Ryde (1, 1, 2)	Victoria Road	1932	1937
	Epping Highway	1934	1939
	Iron Cove Bridge	1949	1954
	Gladesville Bridge	1959	1964
Strathfield (1, 1, 1)	Parramatta Road	1924	1929
	Hume Highway	1945	1950
Sutherland (1, 2, 2)	Princes Highway	1924	1929
	Cook's River Bridge	1957	1962
	Captain Cook Bridge	1960	1965
Warringah (1, 1, 1)	Habour Bridge	1927	1932
	Parkway	1941	1946
Willoughby (2, 1, 2)	Harbour Bridge	1927	1932
	Pacific Highway	1928	1933
	Warringah Freeway	1964	1969

(a) Randwick, S. Sydney and Woolahra are not included because there were no road improvements in these areas.

(b) Dummy variables representing the scale of road improvements between 1931 and 1948, 1948 and 1968, and 1931 and 1968, respectively.

Sources: Department of Main Roads, NSW *The Roadmakers: A History of Main Roads in NSW*, 1976; *Main Roads Journal*, 1929-1970.

TABLE A12.2 RAIL SERVICES, TIMES AND SPEEDS (7.0 - 9.0 am)

Area	1930			1950			1930		
0-8 km/CBD	No. of services	Time to Central Station (mins)	Single fare (cents)[a]	No. of services	Time to Central Station (mins)	Single fare (cents)[a]	No. of services	Time to Central Station (mins)	Single fare (cents
Leichardt	-	-	-	-	-	-	-	-	-
Marrickville	19	11	19	21	14	16	22	19	16
N. Sydney	-	-	-	25	7	16	26	6	16
Randwick	-	-	-	-	-	-	-	-	-
S. Sydney	32	4	7	60	5	9	64	5	5
Wollahra	-	-	-	-	-	-	-	-	-
8-16 km/CBD									
Canterbury	22	17	26	22	21	21	15	22	19
Manly	-	-	-	-	-	-	-	-	-
Ryde	13	21	45	17	32	36	17	31	34
Strathfield	61	23	30	62	14	25	58	23	22
Willoughby	17	29[a]	23	22	22	30	25	25	26
16-24 km/CBD									
Auburn	17	26	45	18	26	26	17	33	34
Bankstown	12	30	45	13	35	36	12	40	34
Kogarah	14	26	30	24	19	62	21	25	22
Kuringai	8	37[a]	33	19	30	36	18	27	33
Parramatta	13	31	50	17	35	41	18	42	37
24 km+.CBD									
Baulkham Hills	2	70	66	-	-	-	-	-	-
Hornsby	18	49[b]	49-69[c]	26	45-50[c]	50-62[c]	24	41-60[c]	42-61
Liverpool	-	-	-	-	-	-	-	-	-
Penrith	4	94	106	4	84	96	9	70	74
Sutherland	6	37	52	11	40	46	18	41	39
Warringah	-	-	-	-	-	-	-	-	-

(a) In 1970 money values.
(b) Excludes waiting time for connections.
(c) Depended on choice of route.

Source: State Rail Authority timetables and record.

TABLE A12.3 PERCENTAGE OF HOUSES IN SAMPLE WITH MAINS SEWERAGE SERVICES[a]

Area	1931	1948	1968
0-8 km/CBD			
Leichardt	100	100	100
Marrickville	100	100	100
N. Sydney	100	100	100
Randwick	50	82	100
S. Sydney	100	100	100
Wollahra	100	100	100
8-16 km/CBD			
Canterbury	81	81	100
Manly	59	61	100
Ryde	0	32	67
Strathfield	75	92	96
Willoughby	37	55	100
16-24 km/CBD			
Auburn	0	52	91
Bankstown	0	0	100
Kogarah	55	63	89
Kuringai	1	18	88
Parramatta	55	58	84
24 km+.CBD			
Baulkham Hills	0	0	17
Hornsby	19	32	70
Liverpool	1	1	30
Penrith	0	0	13
Sutherland	0	0	23
Warringah	0	0	70

(a) Rounded to nearest percentage.

Source: Metropolitan Water Sewerage and Drainage Board records.

PART V

CONCLUSIONS OF STUDY

13 CONCLUSIONS OF STUDY

13.1 INTRODUCTION

In this thesis, I have sought to describe and explain:

- average house prices, and the distribution of house prices, in Sydney, Melbourne and Adelaide in the 1970s and 1980s; and

- average house and land prices, and the distribution of house and land prices, in Sydney from about 1925 to 1970.

This chapter summarises the main findings. It follows the order of discussion in the thesis (except in 13.4 below) and draws on the conclusions of each chapter.

Section 13.2 summarises the major trends and patterns in house and land prices over the study periods.

Section 13.3 outlines the theoretical basis for the empirical analysis of house and land prices.

Section 13.4 explains long-run house prices in Sydney, Melbourne and Adelaide and inter-city house price differences; the causes of short-term movements in house prices since about 1970; and the distribution of house prices within each city.

Section 13.5 explains average house and land prices, and their spatial distribution, in Sydney from 1925 to 1970.

Section 13.6 provides some concluding observations.

13.2 HOUSE PRICE TRENDS AND PATTERNS

Average House Prices in Sydney, Melbourne and Adelaide from about 1970

In the 1970s and 1980s, on average, the median house price was about 33 per cent higher in Sydney than in Melbourne and 10 per cent higher in Melbourne than in Adelaide.

These house price differences increased in the 1980s because house prices rose most in Sydney and least in Adelaide. Over the period, real median house prices rose (before quality adjustment) at an average annual rate of nearly three per cent in Sydney, one and a half per cent per annum in Melbourne, and were about constant in Adelaide.

However, of the real increases in house prices, an estimated one per cent per annum was attributable to improvements in housing quality.

Also, because the trade-weighted value of the A$ fell by about two per cent per annum from the early 1970s, the real (quality adjusted) price of housing, even in Sydney, did not rise relative to international prices.

House prices generally moved in cycles. In each city, real prices rose in the first half of the 1970s and fell in the second half. Although house price patterns diverged in the early 1980s, house prices rose generally in the second half of the 1980s.

Until the late 1980s, Melbourne and Adelaide prices moved closely together. Apart from the early 1980s, both price series tended to follow Sydney.

Although nominal house price rarely fell, real house prices were volatile with annual changes in each city averaging about seven per cent. Within the up-cycles, there were several two year periods in each city when real house prices rose by over 10 per cent in successive years.

Until recently, average prices of new houses in each city were higher than average prices of established houses. Recent evidence suggests that new house prices are determined in the short run by established house prices rather than by production costs.

Also, prices of flats generally followed house price patterns. However, real flat prices rose by approximately one per cent per annum less than real house prices due in part, at least, to higher capital/land ratios and fewer improvements.

Finally, we observed that changes in Australian real house prices followed similar patterns to those overseas, notably in the UK.

The Distribution of House Prices in Sydney, Melbourne and Sydney: 1977 to 1989

The thesis examined the distributions of house prices in the three cities in some detail for the earliest and latest years, 1977 and 1989, for which comparable detailed data were available.

Because of the volatility of house prices, generalisations about intercity differences must be made cautiously. However, the following main points emerged:

- The range of house prices is greatest in Sydney and least in Adelaide. The standard deviation of LGA house prices in 1989 was $102,000 in Sydney, $52,000 in Melbourne, and $38,000 in Adelaide.

- House price differences were much greater at the top of the market than at the bottom.

- In the more expensive local authority areas, house prices were often 50 per cent higher in Sydney than in Melbourne and 25 per cent higher in Melbourne than in Adelaide.

- In the least expensive areas, house price differences between Sydney and Melbourne were typically only about 10 per cent. Likewise, between Melbourne and Adelaide, the differences were also only about 10 per cent, until recently when the gap widened considerably.

- In each city, house prices tend to decline with distance from the CBD.

- Also, between 1977 and 1989, house price increases were inversely related to distance from the CBD.

House and Land Prices in Sydney: 1925 to 1970

Between 1930 and 1969, average real house prices in Sydney rose by some 150 to 200 per cent (depending on the index chosen).

There was little change in real house prices in Sydney between the late 1920s and late 1930s. Then, real house prices fell by around 30 per cent between 1938 and 1948. However, they more than doubled between 1948 and 1960 and rose by nearly 50 per cent in the 1960s.

Remarkably, the long-run (1930 to 1969) average annual rate of growth in real Sydney house prices, before quality adjustment, was about two and a half per cent, which was similar to the rate of increase after 1970. However, prices from 1930 to 1970 were less prone to the sharp short cycles of the last two decades.

Between 1930 and 1969, real land values per lot rose by nearly 300 per cent. This reflected in part a 25 per cent increase in average lot size. The long-run increase in the real price of land per m^2 was only slightly greater than the increase in real house prices.

Real land values followed a similar pattern to house prices. But they fell by slightly less between 1938 and 1948 and rose faster in the post-war period.

Throughout the period, 1931 to 1968, house and land prices in Sydney tended to decline with distance from the CBD. However, they appreciated more with distance from the CBD so that the price gradients flattened. This pattern is quite different from that of the last 15 years when the house price gradient (and by inference the land price gradient) became much steeper.

13.3 GENERAL EXPLANATIONS FOR HOUSE AND LAND PRICES

Models of Average House Prices

Drawing on a neo-classical model with utility-maximising households and profit-maximising housing producers, long-run house prices were shown to depend on household income, population, the price elasticity of demand for houses, the price of land, and the elasticity of substitution of non-land factors for land in the supply of housing. This assumes that, after allowing for productivity gains, non-land factor costs rise broadly in line with inflation.

In the short run, using a conventional equilibrium model in a competitive economy, house prices are determined mainly by the demand for housing, notably by household income, interest rates and expected changes in house prices. In principle, short-run house prices may also be determined by demographic factors and the size of the housing stock. But these factors usually change slowly and may have little short-run impact.

Allowing for a more complex economic environment, including market imperfections, we find that house prices may also be influenced by other variables, including the availability of credit, employment, relative city house prices, inflation, household formation, the age composition of the local population, migrants, household wealth, the return on equities, and by policy variables, such as housing subsidies and capital gains taxes.

Moreover, the housing market may sometimes, possibly often, be in disequilibrium, with people either under-adjusting or over-adjusting to changes in economic phenomena. Whether this is so is an empirical question.

Finally, to set a practical agenda for the econometric analysis, seven sets of hypotheses for short-run house price determination were established. These were the "standard" explanation (emphasising income, interest rates and expected capital gains or inflation); the demographic effect; the international angle (migrants or foreign investment); supply side effects; credit effects; the stock market crash; and the impacts of housing policies.

Models of the Distribution of House Prices

To develop models of the distribution of house prices, I drew on economic theories of urban structure and hedonic house prices.

In a city with a strong employment centre, the price of housing (p^h) must fall with distance from the CBD to offset increasing transport costs. However as housing prices fall, households substitute housing for other goods, so that house prices ($p^h h$) do not necessarily fall with distance to the CBD.

A positive correlation between household income and distance from the CBD would further flatten, or even reverse, the house price gradient. However, there is little relationship of any kind between household income and distance from the CBD in Australian cities.

Given the plausible assumption that non-land factor costs are invariant across a city, the land price gradient is the product of the housing price gradient and the inverse of the share of land in house prices. Since the land share is typically about 20 per cent of house price, the land price gradient is much steeper than the housing price gradient.

The land price gradient is steeper closer to the CBD, where capital is substituted for land, and can be represented as a negative exponential function of distance from the CBD. However, because the decline in land price encourages land consumption, the lot price gradient is flatter than the land price gradient.

Ignoring differences between houses, urban housing prices are determined basically by city size, land opportunity and development costs at the fringe, and access costs.

City size in turn is determined by population, household income, the supply of land for housing, and transport technology and costs. However, population and income are related. Cities offering high incomes attract labour and, in an open city model, factor incomes tend to converge (though not to complete equality) across cities.

Within the city, numerous local factors account for house price differentials. These include specific house attributes, such as age and size, and local access, environmental and neighbourhood attributes. Also, the level of local household incomes may affect local house prices.

Empirically, the distribution of house prices within a city can be explained either by market models of the demand for, and supply of, houses in each area or by hedonic price models. The former method requires considerable data and has rarely been adopted. On the other hand, there have been many hedonic house price studies.

Hedonic price models have been applied most often to individual house prices in particular markets within the city. Applications of the model to average LGA house prices across a city require that houses and households within an LGA are reasonably homogeneous and that implicit hedonic prices are stable across the city.

The hedonic price model can also be employed to determine the causes of changes in relative house prices. However, in this case it is important to test for changes in implicit prices as well as for the effects of changes in housing attributes on house prices.

13.4 EXPLANATIONS FOR HOUSE PRICES IN SYDNEY, MELBOURNE AND ADELAIDE FROM ABOUT 1970

Long-run Differences in House Prices Between the Cities

The observed differences in house prices are well explained by differences in city size, the costs of producing houses at the city boundaries, and the premium for access to the city centre, (see Eq. 10.1 and Figure 10.1)

Sydney is the most expensive city because it is the largest (approximately 75 km from the CBD to the fringe); it has the most expensive new houses at the fringe; and it has the highest access premium per km.

Conversely, Adelaide has the cheapest housing because it is the smallest city (about 30 km to the fringe); it has the least expensive new houses at the fringe; and it has the lowest access premium per km.

The differences in city size are determined mainly by differences in population and the supply (or lack of supply) of usable land for housing. Although household incomes are slightly higher in the larger cities, population densities (capital-land ratios) are also higher.

Differences in house prices at the city boundaries reflect higher land opportunity costs, development and building costs.

The high access costs in Sydney reflect the low travel speeds and circuitous routes. These are caused by the shortage of road space, rugged terrain, high land costs, and high population densities.

Differences in long-run changes in house prices were mainly caused by the relative elasticities of supply of land for housing and changes in land development and access costs.

However, these costs were translated into higher house prices only because the demand for housing was sufficiently strong. Despite the increases in house prices, population growth was as high in Sydney as in the two smaller cities.

Short-run Changes in Average House Prices

The models presented in this report explain over 90 per cent of short-run house price levels, and about two-thirds of the annual changes, in the 1970s and 1980s.

The main factors that caused short-run house prices to move around their long-run real levels in each city were:

changes in real income and wealth, interest rates, migration, expected changes in real house prices, and inter-city house prices.

Usually changes in these factors had both an impact (within the year) effect and a longer term effect. The estimated full effect for most variables was 2.5 times the impact effect in Melbourne and Sydney and 1.75 times the impact effect in Adelaide.

These delayed (disequilibrium) impacts reflected the time that households took to adjust to changes in income, interest rates etc. However, sometimes, households over-reacted to outside events and drove up house prices in anticipation of very high house price increases that were not sustainable. Like other models. our models did not pick up all these disequilibrium effects.

Changes in real income had an estimated impact elasticity on real house prices of about 0.8 in Sydney and Melbourne and (in the preferred specification) about 1.1 in Adelaide. This produces similar long-run income elasticities of about two in all three cities.

Wealth effects were proxied by changes in the stock exchange index. As expected a high index, indicating high wealth and low yields, was positively related to house prices. The index had an impact elasticity of 0.2 in Sydney. Notwithstanding this general result, the stock market crash in 1987 may have caused households to substitute housing for equities and influenced the house price inflation in 1988/89.

House prices were related negatively to interest rates in each city. But the estimated impacts were small. A one point change in interest rates had an estimated full effect of only 0.10 per cent on real house prices. A posible explanation for the small effect is that, nominal interest rates were correlated with inflation and that when interest rates are high, households expected high increase in house prices to offset the disadvantages of high rates.

International immigration had a statistically significant impact elasticity of 0.2 on real house prices in Sydney, and a less significant impact elasticity of 0.1 in Melbourne. However, in this case, the long-run effects were probably less than the impact effects because, at least in Sydney, following high immigration and higher house prices, some resident population emigrated to other parts of Australia.

Overall, total city population was not a strong explanator of short-term house prices in the three cities. Although the coefficient for population was significant in some regressions, the inclusion of population in our models does not enhance overall goodness-of-fit and it reduces the significance of other explanatory variables.

House prices in Melbourne were found to be related to house prices in Sydney lagged one year - the elasticity was 0.3. Also Adelaide house prices were strongly related to Melbourne prices.

There was also slight econometric evidence that the high level of public assistance for housing in the mid-1970s raised Sydney house prices and that the disallowance of negative gearing in the mid-1980s reduced house prices. But the tests were crude and the results must be treated cautiously.

The study found no evidence that the number of housing commencements had short-term effects on house prices (see further discussion below).

Unlike some overseas studies, I found no evidence that real house prices were related to the rate of inflation. There was also little evidence that house prices were determined by the supply of money or credit.

Finally , my study found that house commencements did not reduce short-run house prices. In practice, commencements were positively related to house prices. In Sydney and Melbourne, the estimated impact elasticity of commencements with respect to house prices was about 0.35 and the long-run elasticity was 0.65. In Adelaide, responsiveness of commencements was higher - the impact elasticity was 1.54 and the long-run elasticity was 1.85. Conceivably a simultaneous model of the housing market could produce a contrary finding, but there is no evidence that it would.

House Price Differences Within Sydney, Melbourne and Adelaide in 1989

Other studies have found that relative house prices are determined mainly by seven sets of factors, namely by lot and dwelling size, dwelling quality, accessibility, environmental and neighbourhood attributes, and fiscal factors. This study concentrated on the first five of these.

Overall, our hedonic price equations explained about 80 per cent of the variations in average LGA house prices in Sydney, and two-thirds of the variations in Adelaide and Melbourne.

Average LGA prices in each city were particularly strongly influenced by distance to the CBD, environmental quality, and house size.

In Sydney and Melbourne, house prices were explained better by the non-linear variable, log of distance to the CBD, than by a linear distance measure. In Adelaide, there was little to choose between the two forms of the distance variable.

In each city, (1989) house prices fell with distance to the CBD by about three per cent per km close to the CBD and by about 1.5 per cent per km some 20-30 km from the CBD. For Sydney, the decline in house prices with distance was shown to be broadly consistent with commuting costs. Although not demonstrated, a similar result would most likely be found for the other cities.

Consistent with economic theory that urban sub-centres will affect local wages rather than house prices, house prices were usually not influenced by access to sub-centres.

On the other hand, environmental factors explained variations in average LGA house prices in the order of of $100,000 in Sydney (over 50 per cent of the median house price), $45,000 in Melbourne and $30,000 in Adelaide in 1989.

Other factors that were significant in one or more cities were distance to coast, proximity to industry (negatively), ferry services (possibly as a proxy for other variables), and the percentages of brick and sewered homes.

Surprisingly, the (three-point) lot size index did not contribute to the explanatory equations. This was probably due to poor lot-size data.

The study was also handicapped by having to rely on 1976 data for the bed, brick and sewer variables.

Most likely, the equations could be improved if more precise data could be obtained. It would also be desirable to include neighbourhood and fiscal variables.

Not surprisingly, house prices are correlated positively with household income, the percentage of adults in the LGA population, and the percentage employed in the population.

Indeed the first two variables "explain" quite a high proportion of house price variations in each city. Also, plausible house price/household income elasticities, ranging from 1.3 in Melbourne to 1.7 in Sydney, were estimated.

However, adding household income as an explanator to the hedonic price equations added very little to their explanatory power and produced an inferior specification.

Changes in House Price Differences within the Cities between 1977 and 1989

Between 1977 and 1989, increases in house prices were strongly related to access to the CBD in each city. In each city, the real access premiums doubled in 12 years.

Also, changes in local house prices in Sydney and Melbourne were positively related to better environmental areas and reflected increased environmental premiums.

However, local urban improvements were not found to have a significant influence on local house prices. This could reflect the lack of major local projects over this period or measurement difficulties, or both.

The change in the access gradient reflected various factors. The main one is the increased cost of access due to increased increased congestion; increased premiums attached to travel time; and higher real petrol costs. In Sydney, these accounted for an estimated 55 per cent increase (about half the total increase) in the access gradient.

Second, housing improvements were inversely related to distance from the CBD, and accounted for another 10 per cent change in the access gradient.

Third, house price changes in each city were inversely related to changes in the supply of houses. The greatest increases in supply occurred in the outlying areas (despite the low price increases in these areas) and the smallest increases in established inner areas. The estimated average elasticity of house price to house supply was -0.5.

Fourth, the changes in relative house prices may have reflected changes in residential location demands due to population ageing, increases in two-income households, and structural changes in the economy (as the service sector has become more important). However this study did not measure these effects, if any.

House price increases were also correlated positively with high priced areas and with high increases in household incomes. However, the causal nature of the relationship between house price and household income increases is not established.

13.5 EXPLANATIONS FOR HOUSE AND LAND PRICES IN SYDNEY FROM 1928 TO 1968

Changes in Average House and Land Prices

No overall model was found to satisfactorily explain Sydney property prices from 1928 to 1968. Consequently, I concentrated on explaining two main sub-periods, 1928-49 and 1950-68.

Despite considerable experimentation, it also proved difficult to obtain satisfactory formal models for land or house prices in the earlier period by itself. This was not surprising given the extraordinary nature of this period, the inherent limitations of econometric modelling, and the weakness of some of the data. However, by supplementing the formal analysis with careful appraisal of the data, plausible explanations for property price changes were found.

In the early 1930s, house prices were sticky and fell by less than other prices. The subsequent decline in real house prices in the late 1930s and first half of the 1940s can be attributed to a lagged response to the earlier fall in the general price level and the very high real rates of interest in the early 1930s, depressed rent levels due to rent controls after 1939, and depressed expectations due to the war. Real house prices fell between 1938 and 1948 despite the rise in GDP per capita, low real interest rates, high marriage rates, and a housing shortage.

The initial rapid increase in real house prices after the war can be explained by the relaxation of rent controls, negative real interest rates in the early 1950s, and the housing shortage. The subsequent increases in real prices in the 1950s and 1960s were due to increasing population and income, rising equity prices, and rising expectations, especially related to increases in inflation. Plausible house prices elasticities were estimated with respect to inflation (about 1.2); the stock exchange index (0.5); population (1.8); GDP/capita (0.7); and the housing stock (-1.25).

As has been found in other studies, in reduced form equations, real house prices tend to be positively related to house completions, which suggests that completions may better be regarded as an endogenous variable in a simultaneous system. My estimated two stage least squares models indicated that house prices generally had a small negative influence on the demand for housing and a small positive influence on the supply of housing. But evidently the increase in the housing stock was not sufficient to restrain the large real increases in house prices.
Land prices, for which there were fewer data than for house

prices, were more difficult to model. The best results were obtained when land prices were related to house prices or rents and building costs rather than to the independent determinants of housing demand. In both study periods, land prices were significantly and positively related to house prices and to rents. Also in the earlier period, they were negatively related to the real costs of building materials. Moreover, generally the coefficients were plausible. For example, land prices had an estimated elasticity of about 1.3 with respect to house prices and -0.4 with respect to building materials costs.

The Distribution of House and Land Prices

Throughout the 1928 to 1968 period, land and house prices in Sydney declined with distance from the CBD. However, both price gradients became flatter over the period, especially after 1948.

Drawing on the preferred results, land prices fell with distance from the CBD by an estimated nine per cent per km in 1931, by eight per cent per km in 1948, and by just over three per cent per km in 1968.

Detailed results were also estimated for five geographical sectors. Although the parameters varied, in each case the land price gradients were significantly negative and flattened over time.

House prices were related less uniformly to distance to the CBD. Nevertheless house prices fell significantly with distance from the CBD by about two per cent per km in 1931, one per cent per km in 1948, and half a per cent per km in 1968. (As we saw above, by 1989 the house price gradient had risen back to about 1.5 per cent for a median house some 20 to 30 km from the CBD).

The flatter and more irregular house price gradient is consistent with the theory that although the price gradient for standard units of housing is likely to be negative (to compensate households for the extra costs of longer work commutes and inferior access to city facilities), price gradients for actual house prices may not decline because households further from the CBD purchase more housing.

Also, the land price gradient was predicted to be the product of the housing price gradient and the inverse of the share of land in housing. Thus, given a typical land share of say 20 per cent, the land price gradient would be five times the house price gradient. This is approximately the result obtained.

I also sought to explain why the gradients became flatter between 1928 and 1968. Where possible, quantitative causal relationships were estimated. However, because of data constraints, the analysis was mainly qualitative.

Large increases in population and income (especially after 1940) substantially raised the demand for housing and land. The very large increase in car ownership per household between 1948 and 1968 (from an average of one car per three households to one car per household) greatly raised the demand for housing further from the CBD. Also, the 25 per cent fall in real petrol prices between the mid-1950s and late 1960s increased housing demand and house prices in outer areas.

Between 1925 and 1970 the government constructed several major bridges and hundreds of km of major arterial roads. Although travel time data for this period are not available, there can be no doubt that travel times per km were greatly reduced.

Although most of Sydney's rail infrastructure was established by 1925, the significant real fall in rail fares between 1928 and 1968 also increased house prices by relatively more in outer areas.

Statistical analysis showed that about half the changes in average LGA land prices could be explained by distance to the CBD and by specific road or bridge improvements.

However, contrary to my expectation, no statistical relationship was found between changes in land prices and improvements in urban services, as proxied by the provision of mains sewer services.

Finally I noted that land use zoning policies prevented the substitution of capital for land in established areas, thereby increasing house prices but reducing land prices in these areas. These policies therefore flattened the land rent gradient over time.

13.6 FINAL OBSERVATIONS

In his review of econometrics, Johnstone (1991) comments that "the infant had a lofty ambition: to find a quantitative resolution of the mysteries of the universe, or at least some parts thereof". In the search for this resolution, Johnstone notes that the econometrician has been handicapped by incompletely specified theoretical models, published data that bears no necessary relationship to the theoretical constructs, and inference procedures that do not apply to non-experimental economic data. Despite these problems applied econometric work "has quantified many aspects of, at least, the industrialised economies".

Similar claims and caveats apply to this thesis. I have sought to provide a comprehensive explanation of house prices in the three major Australian cities, covering nearly half the Australian population, over the last two decades, and to explain land and house prices in Australia's largest city for a further 45 years back to the mid-1920s. To do this, I drew on a well-established body of theory of house prices and many previous house price studies in other countries. The theory provided numerous possible explanations for house prices which required testing. To test these explanations I developed an extensive, though necessarily incomplete, data set on house prices and potential explanators, ran numerous statistical tests, and supplemented the econometric results with qualitative reasoning. Although the findings vary in robustness, and much remains to be determined, I believe that the thesis explains most of the observed major house price phenomena.

APPENDICES

APPENDIX A   REQUIREMENTS OF THE Ph.D. THESIS

Section 6 of Regulations and Syllabuses 1988-89 External Students states 16 requirements of a thesis, of which 15 relate to Ph.D theses. Some of these are administrative requirements and have been complied with. However, there are essentially two intellectual requirements on which comments are appropriate.

First, section 6.1 states that "the Ph.D must form a distinct contribution to the knowledge of the subject" and section 6.4 states that "the candidate ... must indicate in the thesis in what respect they (his investigations) appear to him to advance the study of the subject".

Second, the thesis "must consist of the candidate's own account of his investigations" (section 6.4) and, where work involves some fellow research workers, the candidate must state "clearly his own personal share in the investigation".

Contribution to Knowledge of the Subject

When I started to work on house prices in Australia in the mid-1970s, there were few data on house prices and no econometric studies of house prices in Australia. Over the last 15 years I have been responsible for a high proportion of the serious analytical work on house prices in Australia. Evidence for this can be found in Bibliography: Housing Studies by CSIRO (Commonwealth Scientific and Industrial Research Organisation, Division of Building, Construction and Engineering, 1989). This bibliography contains over 2000 world-wide references dealing with the economic and social isues in housing. In the sections relating to house prices (pp.44-9) the CSIRO cites only nine Australian studies of which five are by the candidate.

The thesis is intended as a coherent and comprehensive description and explanation of average house prices, and the distribution of house prices, in the short and long run, in Sydney, Melbourne and Adelaide. It should, I believe, be judged as a whole as well as for its parts. As far as I am aware, such a comprehensive analysis, of house prices in a group of cities has rarely been done anywhere and certainly not in Australia.

The major specific contributions of this thesis are the development of house price data and indices for Sydney from 1925 to 1989 (in Chapters 2 to 4) and all the empirical analysis of Australian house and land prices in Chapters 7 through to 12. None of this has been done elsewhere other than by the author.

In addition to the thesis itself, I have made a number of contributions to the understanding of house prices as evidenced by the annotated bibliography in Appendix C. These contributions include analyses of: the determinants of individual house prices (based on the first and largest hedonic house price study made in Austrlaia); the relationships between house prices and valuations; and the relationships between house prices and environmental factors; the analysis of land values in Woollongong (a large city to the south of Sydney); and the interpretation of implicit hedonic prices of housing attributes, especially in a dynamic environment.

Candidate's Contribution

The candidate is the sole author of the whole thesis except for Annex 5, which was written jointly with Dr.R.Cooper (Associate Professor, University of Western Sydney) and which was initially an appendix in Abelson and Alcordo (1986).

I wrote the thesis concurrently with directing and writing nearly all of a consultancy study, entitled "The Determinants of Established House Prices". The thesis refers to this study as Applied Economics (1991). In 1989, the Commonwealth Department of Industry, Technology and Commerce commissioned my consulting company Applied Economics Pty Ltd. and Travers Morgan Pty. Ltd. to conduct three related studies of housing costs and prices (see the Preface). I was the sole author of 12 of the 14 chapters in Applied Economics (1991) and co-author with Dr.Cooper of the other two chapters. These two chapters have been re-written as Chapter 7 of the thesis and so Dr.Cooper may be considered to be indirectly a co-author of that chapter also.

As described in the Preface, a number of research grants have enabled me to employ research assistants mainly to collect data, but also to provide some computing assistance. Under my direction, Mr.Roger Tomkin (lecturer, Macquarie University) ran some of the regressions reported in Chapters 8 to 10.

I was the sole author of nearly all the supplementary papers cited in Appendix C.

APPENDIX B: OVERVIEW OF HOUSE PRICE LITERATURE

B.1 INTRODUCTION

This overview of the house price literature is intended as an adjunct to the thesis rather than as a comprehensive review of the literature. Moreover, it concentrates on empirical applications rather than on the pure theory of house price determination. There are two main reasons for this approach.

First, the thesis is intended to be a complete entity in itself and to contain the main references required to explain house prices. A comprehensive literature review in this appendix would involve unnecessary repetition.

Second, a very large number of papers on housing markets have been published over the last 20 years. In a recent major survey of economic models of housing markets, Smith et.al (1988) cite 201 housing studies. Even more extensively, the Division of Building, Construction and Engineering of CSIRO (Commonwealth Scientific and Industrial Research Organisation) has completed a bibiographic listing of housing studies which cites over 2000 studies. Of these over 150 references were catalogued under "house prices, demand and supply" (CSIRO, 1989, pp.44-9). A full review of all the issues raised in these papers would require a further thesis.

In this appendix I briefly review the main themes and issues. To simplify the exposition I distinguish three main topics, namely:

(i) Average national house prices over time;

(ii) Average city house prices over time and differences in intercity house prices; and

(iii) Differences in intracity house prices, including the determinants of individual house prices.

As will be seen, topics (1) and (ii) are closely linked. Both analyses draw on demand and supply models of housing markets. On the other hand, topic (iii) draws mainly on hedonic models of house prices.

Section B.2 discusses models of average national house prices, though some examples of regional and city house price models are also quoted. Section B.3 focusses more directly on city house price models and on intercity house price differences. Section B.4 discusses models of individual house prices and intraurban house prices.

B.2 AVERAGE NATIONAL HOUSE PRICES OVER TIME

National (and some city) house price models are generally based on a model of the housing market as a whole. However, there are many models of the housing market which may for convenience be divided here into three main groups.

In the first group, the housing market is assumed to be in equilibrium; the demand for housing depends upon its user cost and other factors; and the supply of housing is fixed or predetermined independently of the current price. In this case, house prices (PH) are modeled with a reduced form equation such as Eq.B.1.

$$PH = f(DV,H,) \qquad (B.1)$$

where DV stands for demand variables and H for the stock of housing (or house completions).

This general approach is the most common one and was used by most of the studies cited in Table B.1. In some of these the view was taken that, given the usually small changes in the housing stock, `H' could be dropped from the equation and PH made a function only of DV.

Second, while the equilibrium assumption may be retained, it may be assumed that the supply of housing (or of house completions) does depend *inter alia* upon the current price of housing. When the supply of housing and its price are determined simultaneously, (B.1) produces biased answers. In this case an instrumental variables estimation procedure, such as two stage least squares, is required. In my review of the house price literature, I found only two studies which attempted this (i.e. Buckley and Ermisch, 1981, and Abelson and Alcordo, 1986), and neither produced results which improved on the first approach.

Third, some studies have dropped the equilibrium assumption. There are various kinds of disequilibrium. Strictly speaking, disequilibrium means that house prices do not clear the market so that there are unsold stocks. Kearl (1978) used a vacancy variable to represent disequilibrium. Also, Smith and Rosen (1983) suggest that rents respond to variations around a natural vacancy rate which varies between cities. Alternatively, sale times and transactions may vary and prices change only slowly in response to changes in demand. Krashinsky and Milne (1987) employed waiting times to help to explain house price changes in Toronto.

Under another version of disequilibrium, participants in the market make various mistakes - their actions lag behind events or conversely there is excessive speculation. Upcher and Walters (1978) and Markandya and Pemberton (1984) explore the implications of this kind of disequilibrium in the housing market but the studies are more concerned with the impact on housing starts than on house prices. Buckley and Ermisch (1981) and Ericsson and Hendry (1985) use distributed lag models which allowed for adjustments in house prices to take a considerable time.

In their survey, Smith et.al (1988) conclude that

> "despite the evident significance of vacancy rates, there has been little modelling of the microfoundations to specify what determines the quantity traded, what determines price expectations and the rate of price change, what defines the optimum level of vacancies, and more fundamentally, why the market adjusts through vacancies rather than purely through price."

It should be noted that, in all three approaches, so long as the user costs of housing are specified correctly, housing is treated as both a consumption good and an investment good. All the models are essentially estimating the asset price of housing and may be regarded *inter alia* as asset price models.

However some studies (e.g. Spellman, 1981) have placed special emphasis on the nature of housing as an asset. Simplifying Spellman, we may write,

$$PH = R/C \qquad (B.2)$$

where R is housing rent (determined by the demand and supply of housing) and C is the housing price-rent multiple, which varies and requires explanation. Such an approach may highlight the relationship between PH and R, but if C is explained by interest rates and expected capital gains (B2) is similar to (B.1).

In addition to these various theories of house price determination, there are numerous possible explanators. Potential demand variables include income, wealth, population and other demographic factors, interest rates (real and nominal) and the return on other assets, credit availability, inflation (and marginal tax rates), expected capital gains, and the price and availability of alternative dwellings. Supply variables may include the quantity of the housing stock, land and building costs, and interest rates.

Usually data are available only in discrete time periods which have no necessary connection with the theory. Expectations and permanent income are difficult to measure. Detailed short-run data on households or on unsold stocks may not be available. And when estimating nominal price equations, there is generally a significant problem of multicollinearity.

Another issue is functional form. Most studies employ a log-linear form, although neither this nor any other functional form can be derived directly from economic theory. Thus Ericsson and Hendry (1985), who place strong emphasis on including all possible variables with up to four lags in their (new house) price equation, adopt a log-linear, equilibrium specification by assumption.

Not surprisingly, empirical results have been mixed. Many studies have experienced difficulty with auto-correlation and most have reported several insignificant or unexpected results (see Abelson, 1982). There is no agreement on functional form. McAvinchey and McClennan (1981) find that only the linear model explains four of their U.K. regions, only the log-linear model explains three regions, and that either model would explain the other four regions.

Some leading models have had poor predictive qualities. For example Muth (1981), an acknowledged expert in housing and econometrics, predicted that "real housing prices (in the U.S.) despite their rapid rise from 1975 to 1979, give no indication of a speculative bubble about to burst"; this turned out to be wrong. Likewise the Hendry (1984) model adopted by the UK Department of Environment was a poor predictor (Dicks, 1990).

The results of several studies are summarised qualitatively in Table B.1. Two asterisks indicate that the variable usually had the expected sign and a significant coefficient at the 95% confidence level. One asterisk indicates that the sign is usually correct but that the coefficient is only sometimes significant. A blank indicates that the variable was not used (or not reported).

Unfortunately since several equations are in levels of the variables or their first differences, or in first differences of the logs of the variables, and few elasticities are reported, conparison of the results in more detail is not possible and only limited conclusions can be drawn. However, using the data available, tentative estimates of some elasticities are made below. Moreover, in analysing the influence of each variable separately on house prices, it must be recognised that definitions may differ between studies and that it is risky to assess the implication for each variable ouside of the model in which it was estimated.

As shown in Table B.1, a measure of income (current or permanent, nominal or real, but nearly always gross rather than disposable income) was significant in every study in which it was employed. Pozdena (1980) and Scheffman and Slade (1981) both report income elasticities between 1.6 and 2.1. Wilkinson's (1981) estimates vary from 0.8 to 2.1. Abelson (1983) suggested that in the 1970s in Australia income elasticities tended to lie between 0.5 and 1.0, but that this may have reflected lower increases in real house prices in Australia that in the UK and North America in the 1970s. However the higher estimates of income elasticities may also reflect a failure to allow for the effect of inflationary expectations on house prices in the 1970s.

Few econometric studies have employed demographic variables perhaps because they are considered inappropriate in short-run models or because less than annual population data do not exist. When used explicitly, population has generally been a significant factor in house prices. More recently, using a cross-section model of the demand for housing by age, Mankiw and Weil (MW, 1989) argued that the 1950s baby boom was responsible for the inflation of house prices in the 19~~8~~70s and 1980s and that the baby bust of the 1970s would lead to a decline in house prices twenty years on. However, the MW model is under-specified (see Chapter 5).

Most studies reported a significant (negative) relationship between nominal interest rates and house prices, but in several studies (Abelson 1982, Hendry 1980, and McAvinchey and McClennan 1982 for example) the estimated relationship was weak and in others no relationship found. Based on Abelson, Muth, Pozdena, and Scheffman and Slade the elasticity would appear to be low, of the order of -0.1 to -0.3. Surprisingly few studies employed real interest rates.

As a generalisation, housing credit supply variables tend to be significant in UK studies but not in North American studies, presumably because of the greater financial regulation until recently in the UK. Abelson (1982) estimated that the elasticity of house prices to the number of mortgage advances in Australian cities ranged from 0.1 to 0.4. However credit supply to housing is not a completely exogenous variable and is difficult to predict other than within a demand for housing framework.

On the other hand, American studies (e.g., Pozdena, 1980; Manchester, 1987) have emphasized the importance of actual and expected inflation more than British studies have. This may reflect the comparative experiences since increases in real house prices were a continuing experience in the US in the 1970s but intermittent experiences (albeit sharp ones) in the UK. Tuccillo and Villani (1981) summarised the results of their edited book on US house prices as follows: "The key to explaining the simultaneous occurrance of record home sales and extraordinarily high house prices lies in understanding the interplay of inflation and the tax treatment of housing." The Smith et al. (1988) survey reached a similar conclusion, although they note that, with inflation, the "tilt" effect (equal regular nominal mortgage payments and declining real payments) may cause cash flow problems and constrain housing demand.

Econometrically it is difficult to disentangle the effects of inflation expectations from nominal income changes, changes in building costs or, more especially, expectations of changes in house prices. Thus a number of studies, both UK and US, have employed lagged house prices to represent expected house prices and have generally found these to be highly significant, as did Abelson (1982) in Australia.

Inflation or more accurately house price expectations (which are themselves a function amongst other things of inflation expectations) appear important even after allowing for changes in nominal incomes. American studies (e.g. Summers, 1981; Schwab, 1982; and Manchester, 1987), and Williams (1982) in Australia have attributed the increase in housing in household portfolios to the relatively high after-tax returns in housing in an inflationary environment. Quantitative assessment is difficult however because of the multicollinearity and serial correlation that often arises in house price equations. In one of the more interesting results, Pozdena (1980) estimates a (US) house price elasticity of 0.6 for inflation (as well as one of 1.7 for income) but this would appear high when the inflation rate is falling.

Surprisingly few studies have attempted to take into account the effect of either the quantity of public housing or of flats, or of rents, on house prices. Buckley and Ermisch (1981) found evidence of a negative relationship between house prices and public housing completions in the UK, but Mayes (1979) found the relationship to be insignificant.

Most American house price studies have included a housing stock variable and most British studies a house completions variable. In about half the studies the housing stock or completion variable was found to be negative and significant and in half positive or not significant. Similar inconclusive results were found in Australia. Various reasons can be advanced for the perverse results. One is that expected future completions may be discounted in current house prices. A second would be that the impact of new completions is felt in unsold stocks or vacancies, as Kearl (1979) finds. Both these reasons allow completions to affect house prices. In the first case house prices fall before completions reach the market. In the second case they fall some time after the completions. Again, models may find it difficult to show precisely what is happening. Pozdena estimates the elasticity of house price with respect to the housing stock per household as -2.8. Abelson (1982) estimated the elasticity with respect to house completions in Australia was -0.1, which is not inconsistent with Pozdena's estimated stock elasticity.

On the other hand, if new houses are higher quality than existing houses, an increase in completions could be associated with higher prices. Quality has several dimensions. In large cities new houses in inaccessible locations may sell at below average prices, whereas in small cities they may raise average prices. For whole countries, assessment of the effect would require careful examination.

The problem of changes in the quality of existing housing is more general in that houses tend either to depreciate or to be renovated and improved. It appears that the quality of houses in the US rose on average by around 15 per cent in the 1970s explaining around 40 per cent of the real increase in house prices. While Muth (1981) allows for this by deflating the house price variables and Ferri and McGee (1979) use an exogeous quality variable, other authors do not appear to allow for quality changes.

While the foregoing list of explanations contains the major elements of house price determination, other factors are held by various analysts to be important. For example, Grebler and Mittelbach (1979), find that seasonality affects house prices in the US although Nellis and Longbottom (1981) find it does not do so in the UK. Brenac and Shepherd (1981) along with most members of the Australian housing industry argue that building costs are important. As discussed in Abelson (1983) this depends partly on the operation of the land market. It also depends upon the interaction of existing and new house prices. In the short run, new house prices presumably depend upon existing house prices rather than the reverse, which may be why most analysts using short-term models have ignored the impact of building costs on existing house prices. In the longer run, existing house prices would depend partly upon replacement costs (i.e. new house prices) and hence building costs.

To summarise: although the econometric results of house price studies are not clear-cut they provide general support for theoretical and popular expectations. Housing markets are often in some disequilibrium in that unsold stocks, vacancy rates and selling times vary considerably. The most important causes of house price appreciation in the short run appear to be expected changes in house prices (often related to inflationary expectations and tax structures), interest rates, and incomes. In the longer run, population changes and land and building costs are important. However, many other variables can influence house prices (see Table B.1).

TABLE B.1 SOME SIGNIFICANT FACTORS IN HOUSE PRICE DETERMINATION A SUMMARY OF SOME ECONOMETRIC RESULTS (a)

VARIABLES	Scheffman US UK Canada	Smith Canada	Krasinsky Canada	Grebler US	Ferri US	Pozdena US	Muth US	Kearl US
Current inc.	**	*			**			
Permanent inc.				**		**		
Pop'n/h'holds		ns						
Nom.int.rates		ns	**	ns	**	**	**	
Real int.rates	*							
Credit supply	ns	ns		ns	ns			
Inflation rate		**	**	**	ns			
Expected inf.				ns		**		**
Lagged PH				**			**	
Public housing								
Rents		ns						
H.stock		**		ns	**	**	ns	
H.completions	ns				**			
Building costs								
Seasonality				**	*			
H.quality					**			
Vacancies								**
Waiting times			**					

VARIABLES	Mayes UK	Buckley UK	Hendry UK	Nellis UK	Wilkinson UK	McAvinchey UK	Brenac Aust.	Abelson Aust.
Current inc.	**			**	**	*		**
Permanent inc.		**	**					
Pop'n/h'holds		**				*	**	*
Nom.int.rates	**	**	*	**	*	*		*
Real int.rates								*
Credit supply	**	**		*	ns	**	*	*
Inflation rate	ns							*
Expected inf.								
Lagged PH	**	ns	**	**				**
Public housing	ns	**						
Rents								
H.stock				ns				
H.completions	**			ns	**	ns		
Building costs			**			*	**	*
Seasonality				ns				

Housing quality, vacancies, waiting times not tested in UK/Australia.

(a) Only first-named authors shown here (except for Hendry which refers to Ericsson and Hendry). All studies can be found in text and references.

** Signs generally correct and significant at 95% confidence level.
* Signs sometimes correct and significant at 95% confidence level.
ns Not significant.

B.3 INTERCITY HOUSE PRICES

Average regional or city house prices are generally modeled in a similar way to national house prices, drawing on housing demand and supply variables appropriate to the region or city. For example, Krashinsky and Milne (1987) modeled house price changes in Toronto in terms of mortgage and inflation rates, and transaction times (a disequilibrium variable).

In the UK, Rosenthal (1986) argued that regional house prices were determined principally by common national economic trends and factors. However, the various regional markets were also found to be linked and some areas tended to follow others.

On the other hand, in an earlier UK study, McAvinchey and Maclennan (1982) argue that regional house price differentials are explained by regional factors, including building costs, marriages, housing starts and income. But the results were mixed and paper "reports more questions than answers".

An early paper discussing regional variations in house price changes in the US is Browne (1982). Browne concluded that in the 1970s, regional US house prices were driven up by demographic pressures, inflationary expectations and tax-free capital gains. In the early 1980s, high interest rates affected affordability and depressed house prices, although creative financing techniques helped to sustain house prices.

Diamond (1984) argued that house prices are determined primarily by the cost of producing new houses. He supported this proposition by examination of annual changes in house prices in 12 subregions in the United States.

Manning (1986) used housing demand and supply variables to explain interurban variations in house price appreciation in the US. He found that high house price appreciation was associated with high population and income growth, and high building and land costs. He also found that urban areas with fewer municipal authorities were more likely to adopt land use controls and to increase develop costs.

On the other hand, in a detailed study, Ozanne and Thibodeau (OT, 1983) adopted a cross-section approach to explain intercity house price differences. First, OT used a hedonic price equation to standardise house prices for 54 metropolitan areas in the US. They then explained the variations by differences in average income per household, the number of households, the percentages of households non-elderly and single, metropolitan location next to ocean or Great Lake, the number of municipal households per 100,000 households, a construction cost index, and an index of wages and utility costs. OT claimed, apparently justifiably, that "No one has previously attempted a comprehensive measurement or explanation of these housing price differences". However, they succeeded in explaining less than 60 per cent of the estimated intercity house price differences.

Although this appendix is not principally concerned with land prices, reference should perhaps be made to the recent authoritiative study of intercity land price differentials in the US (Capozza and Helsley, CH, 1989). CH attribute the price of urban land to four additive components: the value of agricultural land rent, the cost of conversion, the value of accessibility, and the value of expected future rent increases - a growth premium. CH estimates that, in rapidly growing cities, the growth premium may account for half of the average price of land and may create a large gap between the price of land at the boundary (minus conversion cost) and the value of agricultural land.

The main Australian paper on intercity house price differences (apart from the author's own works, see Appendix C) appears to be Neville et al. (1984). Drawing mainly on Bis-Shrapnel and ABS data the paper aimed to provide factual background on the house price differentials between Sydney and Melbourne (rather than explain the causes) and draw policy conclusions. The paper concluded that Sydney households spend more on average on housing those in Melbourne, but get lower quality housing and are more likely to rent, and from 1968 to 1984 they received lower capital gains.

There are two main ways in which the above general approach, based on housing demand and supply variables to explain average city house prices, may be regarded as deficient. First, the underlying model is a partial equilibrium one in which the labour market is implicitly (or sometimes explicitly) regarded as exogenous. Many papers (e.g. Hoch and Drake, 1974; Izraeli, 1977; Kelley, 1977; Rosen, 1979) have discussed the general equilibrium relationships between economic welfare, real wages, the costs of tradable and non-tradable goods, and local environments. However, the main thrust of these papers is to consider how intercity real wages, rather than real house prices, are determined. Second, intercity house price differentials cannot be fully explained without refererence to the distribution of house prices and to the determinants of those distributions, e.g. city size and transport costs. These issues are well discussed in Mills and Hamilton (1989) and I have tried to do justice to them in Chapter 6 of the thesis.

B.4 INTRACITY HOUSE PRICES

The main approach to modelling intracity house prices, given the heterogeneous nature of housing, is based on the assumption that households value goods for their characteristics (Lancaster, 1966). The general characteristics approach was developed by Griliches (1971) and Rosen (1974), amongst others. Under this approach, a house is described by a number of characteristics, such as lot size, size of house, age of house, garages, accessibility to work, schools etc., environmental attributes and so on. Each characteristic is presumed to command an implicit market price, known as an hedonic price. Empirically, these hedonic prices can be determined from regressions of house prices on characteristics. The price of a house is then the sum of the products of the house's characteristics and their implicit prices.

In its extensive bibliography of housing studies, CSIRO (1989) devotes a separate section to hedonic price studies and cites 37 references. Of these, 27 refer to studies published in the 1980s.

The basic characteristics approach to explaining house prices has gained wide acceptance as a result of both the plausibility of the theory and the many successful empirical applications. However some issues are subject to ongoing debate. These include the most appropriate functional form, the interpretation of the implicit prices themselves, the posible inclusion of socio-economic variables in hedonic price models, and the applicability of the model to local areas rather than to individual houses (see Goodman, 1989; and discussion in Chapter 6). Empirically, the issues of most interest have been the relationships between house prices and accessibility, environmental variables, race, and land use zoning.

Econometric studies of the determinants of individual house prices predate econometric studies of average house prices. Ball (1972) surveyed 11 hedonic price studies (including three which used group data). All but two of the studies showed an R^2 greater than 0.70. Most studies showed that locational and environmental factors, as well as house related variables, significantly influenced house prices.

The classic study, in which the theory of intracity determination of house prices was developed, was Muth (1969). In this study, Muth estimated the housing price gradient for Chicago, attempting to control for factors that might affect the price gradient (such as proximity to public transportation and shopping centres). In fact neither the distance variable nor the proximity variables were very significant.

Another important early study was Strazsheim (1973). Strazsheim estimated the prices of housing characteristics in San Francisco and used the analysis to assess house price gradients and the existence of sub-markets. Standardising for house age etc, the author found significant negative exponential gradients, but when houses were not standardised there was an upward gradient function with distance. Housing sub-markets were found to exist with significantly different prices for the same housing characteristics in different areas. This appeared to be mainly due to the race factor.

Greather and Mieszkowski (1974) conducted a detailed empirical study of the determinants of real estate values in the New Haven (US) metropolitan area. A feature of this study was its special interest in the impacts of neighbourhood features which could be controlled by local governments.

Unlike Strazsheim, Ball and Kirwan (1977) found, in the Bristol (UK) housing market, that although spatial clusters of households and housing types clearly emerged, these spatial structures did not produce separate sub-markets with independent price structures. Also, although housing prices declined with distance from the centre, these effects were relatively minor.

In a detailed study of house prices in Milwaukee (US), Jackson (1979) found that accessibility had a significant effect on housing prices. However, this result depended on the functional (double power) representation of accessibility. Bender and Hwang (1983) also found a negative price gradient in Chicago once the area was sub-divided into three appropriate geographical sub-sectors.

On the other hand, Dubin and Sung (1987) found that employment and amenity centres, whether CBD or suburban, exert influences on housing prices within a relatively limited area of 1 to 1.5 mile radius. They claimed that, because of non-CBD peaks, estimation of area wide rent gradients may be misleading. The CBD does not dominate the rent gradient along any ray.

Freeman (1979) provides a detailed survey of the relationship between residential property values and air pollution. Nelson (1982) surveys the relationship between property values and highway noise.

The major hedonic housing price study in Australia was by Abelson (1977), based on 1414 houses in Marrickville and Rockdale (below average income areas) in Sydney. In this study, housing and land attributes, such as age of house, number of rooms and length of frontage, were the most important determinants of house prices. But road and aircraft noise also affected house prices.

Nearly all these and other hedonic price studies have been cross-sectional studies of prices at a given point in time. However, Mark and Goldberg (1986) examine how various zoning classifications and land uses affect sale prices of houses in Vancouver over a 24 year period. The authors conclude that zoning can affect sale prices but that the effects (positive or negative) are not consistent over time; the effects of multiple dwelling developments on house prices can be positive or negative; and the effects of rezoning on land values are diverse.

Evans and Beed (1986) analyse the effects of changes in fuel prices on intracity house prices in Melbourne from 1970 to 1982. However they regress property price changes only on an accessibility proxy for commuting costs and little weight can be placed on the results, which are not strongly significant.

Nearly all of the limited attention paid to changes in hedonic prices over time has focussed on changes in the land or house price gradient (the coefficient on accessibility). See for example, Mills (1969), Kau and Sirman (1979), and Clark (1982). Doubtless this partly reflects the lack of data on other house characteristics over time. However, as discusssed in this thesis (Chapters 6 and 9), little attention has been paid to the theory of changes in implicit hedonic rents over time (see Abelson and Markandya, 1985).

B.5 CONCLUSIONS

The theory of average national house price determination is well-established. However, the theory does not provide tight empirical specifications and many possible variables may be included in house price equations. Although empirical results generally support the theory, they tend to be fragile, time and place specific, and to be only moderately successful when used to provide house price forecasts.

There are fewer studies of average city house prices, which are usually depicted (like national house prices) as dependent on housing demand and supply factors. Most studies have been time-series analyses of relative rates of house price appreciation. Few studies have attempted to explain cross-section, or long-run, intercity (or international) differences in house prices.

There have now been numerous studies of intraurban property values based on the hedonic price methodology. The most important determinants of individual house prices are lot size, major housing characteristics (e.g. house age, size and condition) and location (e.g. accessibility and environmental attributes). However, in one or other study, nearly every possible attribute has been included as a potential determinant of house price. On the other hand, there have been few studies of how and why implicit hedonic prices change over time.

APPENDIX C AUTHOR'S PUBLICATIONS ON HOUSE AND LAND PRICES AND RELATED TOPICS: ANNOTATED BIBLIOGRAPHY

1977: "The Impact of Environmental Factors on Relative House Prices", Occasional Paper No. 7, Bureau of Transport Economics, Canberra, 50 pp.

The study analysed the determinants of house prices in two Sydney suburbs, Marrickville (592 houses) and Rockdale (822 houses). Data on 26 potential independent variables were collected. House prices were explained using the hedonic price method. The main equations explained nearly 70 per cent of house price variations in Marrickville and over 60 per cent in Rockdale. The most important explanatory variables were found to be the number of rooms, frontage and depth of land (measured separately), type of construction and type of property, external condition, and possession of a garage. The study also found that house prices were affected by a large number of environmental factors, including aircraft and road traffic noise, road widening, the quality of the view, and the level of the house compared with the road.

1979: "Property Prices and the Value of Amenities", Journal of Environmental Economics and Management, Vol. 17, No. 2, 150-162.

This paper developed the above 1977 study into an academic publication, concentrating on the implicit values of environmental amenities revealed through house prices. The paper recognised that hedonic prices are the response at the margin to supply as well as to demand factors and do not necessarily represent average willingness-to-pay prices. However the paper concludes that the estimated hedonic prices provide a basis for valuing benefits in benefit-cost studies.

1979: "A Study of Property Valuations in Relation to Market Prices and the Characteristics of Properties", Economic Record, Vol. 55, No. 131, December 1979, pp. 328-338.

Using the same data set as Abelson (1977), this paper examines the extent to which valuations reflect market prices and the characteristics of properties. It finds that valuations of houses are poorly related to market prices. Furthermore, although valuations of houses can be explained in terms of property characteristics, they are found to be less sensitive than market prices to variations in these characteristics. Land valuations are also analysed and it is shown that these can be explained by "land" characteristics including environmental factors. The paper concludes that quantitiative hedonic models, relating valutions to property characteristics could be used to reduce the arbitrary nature of valuations.

1981: "Land and House Prices in the 1980s - What can be learned from national data sources", Macquarie University Research Paper No. 240. November 1981.

In this paper I reviewed the major sources of data for land and house prices for the major Australian cities and provided the best available sets of land and house prices for each city. The paper provided information in an organised and comprehensive form that was not readily available elsewhere.

1982: "Models of Short-Term Movement in House Prices", 82nd Conference of the Australian and New Zealand Association for the Advancement of Science (ANZAAS), Sydney.

This paper starts with a review of the theory of house price determination and the results of overseas studies of house prices. It then provides detailed information on house prices in Australian capital cities other than Perth. House price equations were developed to explain quarterly house prices in these cities. The most significant variables were income, housing finance, and in some equations, real interest rates and house completions. However, many equations suffered from serial correlation problems and the paper concluded that further work was required to produce more robust models of house prices.

1982: "Housing Costs, Causes and Ways to Reduce Them", Australian Housing Conference, Sydney.

This short paper criticises the major 1978 <u>Report of the Committee of Inquiry into Housing Costs</u> for its failure to distinguish between house prices and housing user costs. It points out that house price can be reduced by reducing house quality or by suppressing the demand for housing. However, most socially worthwhile policies will be aimed at reducing housing supply costs.

1982: "Prices of Petrol and Housing: A Questionable Relationship", <u>Australian Planner</u>, August, pp. 111-113.

Australian petrol prices rose by 25 per cent between 1970 and 1980, with all the rises occurring in the last three years. House prices increased faster in the inner areas of Melbourne than in the outer areas. But the reverse was true in Adelaide. There were no clear house price trends in Brisbane and Sydney. The paper concluded that the rise in petrol prices, and the widespread belief in the 1970s that petrol prices would rise, had not significantly influenced house prices by 1980.

1982: "The Interpretation of Capitalised Hedonic Prices in a Dynamic Environment", Macquarie University Research Paper No. 259.

In this paper, I showed that hedonic prices are often interpreted wrongly because they make no allowance for changes in the explanatory variables or in preferences. The paper develops a set of equations to enable the analyst to make allowances for expected changes. It is shown that failure to allow for expectations leads to biased estimates of the true costs or value of attributes, for example for noise or travel time. Furthermore, it is shown that by taking expectations into account, a large proprtions of the estimated ranges in values that have been made for these attributes can be explained.

1983: "The Determination and Prediction of House Prices", Bulletin of Money, Banking and Finance, 1982-83: No.3, 36-68.

This paper describes trends in house prices in Australian capital cities and overseas. It summarises briefly the theory of house price determination and surveys the empirical results of overseas studies. These results, along with Australian data, are used to interpret trends in Australian house prices. Finally the paper predicts that in the medium term real house prices will rise in Sydney and Brisbane, be constant in Melburne and Hobart, and fall in Adelaide and Canberra. Except for Hobart, these predictions were correct.

1983: "Land Prices in Wollongong", with R.Cardew, <u>Economic Analysis and Policy</u>, Vol. 13, No. 3, 159-76.

This paper was based on data collected by Cardew for his masters thesis. I analysed the data and was sole writer of the published paper. Real land prices in Wollongong (a city of some 150,000 persons about 100 km south of Sydney) doubled between 1956 and 1962, fell by 10 per cent bwtween 1962 and 1968, and then rose again by 90 per cent between 1968 and 1972. Major influences on land prices were changes in population and dwelling construction, the general rate of inflation, expectations of capital gains, and the level of unsold stocks. Interest rates and building costs also had short-term effects on land prices.

1985: "House and Land Prices in Sydney: 1925 to 1970", <u>Urban Studies</u>, Vol. 22, 521-34.

The paper describes and explains house and land prices in Sydney from 1925 to 1970. Between the late 1920s and the late 1940s, real estate values fell in real terms by around 20 per cent. Depressed incomes and expectations and rent control held down prices despite the fall in real interest rates, the real increase in the money supply, the increase in the population and the slump in new house completions. In the post-war period, real land values rose by around 250 per cent and real house prices by 200 per cent. These real increases are explained by negative real interest rates and the relaxation of rent control in the early 1950s, increasing incomes and expectations of capital gains, increases in the population and the rising quality of houses. The increase in the housing stock was insufficient to restrain the increase in real prices of houses.

1985: "The Interpretation of Capitalised Hedonic Prices in a Dynamic Environment", with A. Markandya, Journal of Environmental Economics and Management, Vol. 12, No.3, 195-206.

This paper developed my 1982 paper with the same title. Markandya was responsible for most of the developments. The paper showed that using only the current values of environmental variables in hedonic price estimates can seriously bias the measure of the true effect of that variable when the future is changing. Although the bias can be in either direction, most plausible examples considered show that such prices tend to be underestimated. The results are sensitive to econometric specification. A discussion of the relation between rental and capital value of hedonic prices follows from the distinction between present and future levels of environmental effects.

1986: "House Prices in Australian Capital Cities", with E. Alcordo, 15th Conference of Australian and New Zealand Economists, Melbourne.

This paper developed work reported first in the paper on house price models given at the 1982 ANZAAS conference. Under my direction, Alcordo updated the data and did the computer runs; I developed the analysis and was sole writer of the paper. The paper provided an analysis of house prices in all Australian capital cities, other than Perth, from 1970 to 1983. The paper reviewed the main theories, and developed a formal model, of house price determination. It also provided detailed econometric results for the six cities, based on quarterly data. The empirical analysis suggested that house prices were determined by employment and real income, real interest rates, the supply of housing finance and expected capital gains. However, the econometric results were not robust, because of difficulties associated with modeling the supply of housing, expectations (speculation) and disequilibrium, all on a quarterly basis.

1990: "House Prices: Past and Future", 1989-90 Presidential Address to the Economic Society of Australia, NSW Branch, Sydney.

This paper outlined trends in real house prices and in the ratios of house prices to average earnings in Adelaide, Brisbane, Melbourne and Sydney and provided general explanations for these trends. The paper argued that the then (early 1990) current house price/earnings ratios were unsustainable and forecast that real house prices would fall in the short run - as they have done.

1991: "Commercial Rents and the Demand for Office Space in the Sydney CBD", with R.Cooper, forthcoming, Journal of the American Real Estate and Urban Economics Association.

This paper develops models to explain the demand for office space and comercial rents in Sydney between 1961 and 1987. During this period, office stock in Sydney doubled. Real rents rose by 40 per cent in the 1960s, halved in the 1970s, and more than doubled in the 1980s. The demand for office space is well explained by a partial adjustment model with real rents and employment in finance, property and business services (EFPB) as the explanators. Real rents are also well explained by a partial adjustment model and either the stock of office space and EFPB, or vacancy rates, as the explanators.

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