AN AUSTRALIAN HOUSING MODEL

Ross A. Williams
Dept of Economics RSES
Australian National University

DISCUSSION PAPER NO. 58

December 1982

ISBN: 0 949838 58 6
ISBN: 0725-430X
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ABSTRACT

It is conventional in much Australian discussion to assume that the main determinant of cyclical fluctuations in dwelling construction is the value of loans granted to owner-occupiers. But if short-term dynamics are to be explained attention needs to be directed towards the economic agents who initiate construction. Loans to owner-occupiers for the construction of new dwellings now represents only about one-third of the number of new private commencements. It is the actions of speculative builders and investors which account for much of the short-term variability in dwelling activity.

It is argued in this paper that important determinants of private dwelling commencements are the asset price of the existing stock of dwellings including land (which exerts a positive influence), construction costs of new dwellings (a negative influence), and the number of unsold and vacant dwellings (a negative influence). These variables are found to be statistically significant when the commencements equation is fitted to quarterly Australian time-series data. The conventional demand factors--income, price and demography--enter through the excess supply variable.

The asset price of dwellings owned by persons is, in turn, explained by a portfolio choice or generalised asset adjustment model. Since in the short-run the housing stock is fixed, the asset price clears the market. The model is assumed to hold for all property-owning persons irrespective of domicile. Indeed the division of ownership between persons,
public enterprises and companies is seen as of more importance for modelling asset price and dwelling activity than is the division of ownership within the personal sector, that is, between owner-occupiers and households renting from other households.

The asset price is found to be positively related to income and the rate of return to housing relative to financial assets. Disequilibrium in holdings of financial assets by persons is found to depress housing prices. Attempts by households to restore the real value of their financial assets after the jump in inflation around 1974 would seem to explain much of the fall in real house prices in the second half of the 1970's. The paper contains new estimates of personal wealth in Australia and these suggest that the value of housing has remained relatively constant at 60 per cent of total assets since 1973-74. The equity ratio has always exceeded 60 per cent.

Restrictions on the availability of credit are assumed to affect the rate of adjustment by persons to their equilibrium holdings of assets and liabilities. However, no statistically significant results are obtained. It is conjectured that one effect of credit constraint (and inflation) may be to switch ownership of private dwellings from owner-occupiers to private landlords.
AN AUSTRALIAN HOUSING MODEL

1. INTRODUCTION

"At any instance of time the services of the housing stock are offered inelastically and the rental to housing is determined by the demand for these services; at the same time the existing stock of houses must be held in wealth owners' portfolios and the price for houses will be that price which just makes wealth owners content to hold the existing stock. Builders make their decision to supply new houses on the basis of the going market price. As these houses come onto the market, they will be absorbed into portfolios. If, however, at the existing price, the rate of change of stock demand is not equal to the flow supply, the price of houses will have to change over time to accommodate these increases in the stock."

Poley and Sidrauski, AER, 1970, p.55

In the long run the nation's stock of housing is (demand) determined primarily by demographic factors and income. In the short run lead information on the level of activity in the housing industry is provided by data on approvals for new dwellings. The most difficult and complex task is to explain behaviour in the housing industry in the medium term; to explain the pronounced cyclical movements in activity. This is because in the medium term factors such as expectations about future asset prices, government attempts to control the cost and

* The paper was written while on leave from the University of Melbourne. Jenny Andersen provided excellent research assistance. I have benefited greatly from discussions with W. Perris, A. Hall, J. Lyons, G. Monahan, M. Neutze, R. Silberberg and J. Yates.
availability of credit, and demand-supply imbalances are superimposed on the longer term demographic and income effects.

This paper sets out a model which attempts to capture the forces operating on the housing industry in the medium term. It is primarily concerned with private activity. But housing services are also supplied by the government sector and the interaction with private activity must be recognised in a full model. Increases in ownership of dwellings by government necessarily reduces the demand for housing services provided by persons. The division of ownership between persons, public enterprises and companies is seen as of more importance for modelling aggregate building activity than is the division of ownership within the personal sector, that is, between owner-occupiers and households renting from other households.

It is more than a decade since the appearance of seminal articles by Foley and Sidrauski (1970) and Brainard and Tobin (1968) on portfolio choice and investment behaviour, but the interrelationship between the portfolio choice of households and investment in housing has been neglected in empirical work. Private investment in housing has been modelled within a portfolio choice framework by Parkin et al. (1975), Purvis (1975) and Clements (1976) but in these studies asset prices are exogenous and the supply side is ignored. The link between asset price and new construction has been recognised in some empirical studies, but in these models household portfolio choice does not enter.

In this paper the asset price of the existing stock of housing (including land) is determined by the interaction of the portfolio allocation decisions of households and the stock of private housing. The asset price of existing stock is in turn an important determinant (together with construction costs) of new private construction activity. It is argued that recent trends in the Australian housing market necessitate such a model. The other main determinant of new construction is demand-supply imbalance, which incorporates demographic effects and changes in the stock of government-owned dwellings.

The plan of the paper is as follows. A brief overview of the proposed model is given in Section 2. Section 3 contains a discussion of recent trends in housing activity in Australia. The model is presented in more detail in Section 4 and empirical results given in Section 5. The paper concludes with a summary and suggestions for further work.

2. ASSETS AND SERVICES

In principle the decision of how much of housing services to consume is distinct from how much housing to own. Demand for the asset housing is part of the household's portfolio allocation decision. At any point in time the stock of dwellings (including residential land) owned by households is given and the asset price is such as to make households willing to hold the stock. The asset demands of government enterprises and companies
will be treated as exogenous. Ownership by companies in Australia seems to be undertaken largely to encourage a stable workforce and to confer tax advantages on their employees.

The household sector is the only sector which consumes housing services. Services are of two main types. Firstly, most households require for their main residence the full services provided by a single dwelling. Secondly, there are the services provided by holiday houses and flats and convenience dwellings such as inner-city flats. The second type of demand is for considerably less than full-time occupation of the dwelling.

The demand for housing services is a function of income, housing rent (implicit or explicit), demographic variables and leisure. The supply of housing services is related to the total stock of housing owned by government, companies and households. Rent for all housing and the asset price of dwellings owned by households are related, but the relationship is not an exact one owing to the different coverage of the two markets and adjustment lags.

Whether a household requiring housing services purchases or rents the asset depends on relative costs and the household's initial command of resources. Key factors in the choice are

2. The overseas sector may also own dwellings. Overseas ownership seems to have increased in recent years, but there is little quantitative evidence available.

3. Institutional arrangements may also be important. Thus the introduction of time-sharing ownership permits a choice between owning and renting the housing required for an annual holiday. A formal choice model is contained in Anstie (1981).
taxation provisions, the cost and availability of finance, expected changes in the asset price of housing and, determining transactions costs, the expected time the service will be required (defining service to include geographic location). Other things being equal, a more mobile population will result in a lower proportion of households owning their residence. This is not the same as households not investing in dwellings, either directly or indirectly. At least 7 per cent of Australian households who rent, own dwellings elsewhere.4

Gross additions to the private dwelling stock are postulated to depend to an important degree on the market price of the existing stock of housing (including land) and the cost of construction of new housing. Part of the motivation for using these two asset prices is Tobin's q ratio in investment theory, but the presence of the non-reproducible asset, land, differentiates housing investment from investment in plant and equipment.

The market price of existing dwellings sets an upper bound on the price at which new dwellings may be sold. It is an observed phenomenon that in outer-suburban localities speculative builders will reduce or abandon activity if they are unable, in their words, to build a dwelling "more cheaply" than the market price of existing dwellings. For small builders, who tend not to own vacant land in any quantity, this is to be interpreted as meaning that the total cost of buying vacant land and erecting a

4. See ABS, Survey of Home Rental and Ownership, November 1978, Table 4 (B718.8).
dwellings is not sufficiently below (it may exceed) the market price of comparable existing dwellings to provide an acceptable profit. (This suggests that decreases in the real price of vacant land tends to lag behind decreases in dwelling prices.) Larger speculative builders owning tracts of vacant land will not build if they consider existing market prices of dwellings to be temporarily low.

Increases in the asset price of the existing stock defined to include land will encourage the construction of new dwellings on cheaper outer-suburban land and the more intense use of existing inner-suburban land through the construction of town houses and multi-storey flats. Increases in the cost of construction of new dwellings will have the usual negative own-price effects on demand.

Speculative builders and investors will be the agents most influenced by movements in the existing asset price and costs of construction. But these prices may also be expected to affect potential owner-occupiers faced with the choice between constructing a new dwelling or buying an existing one.

For speculative builders, in particular, the expected short-term change in the price of existing dwellings is also a determinant of the level of building commencements. Information about future prices is assumed to be signalled to builders and potential owners by the stock of vacant dwellings.
Monetary variables are assumed to influence new construction indirectly through portfolio decisions of households and directly through the cost of new construction and the ability of builders (including potential owners) to finance new construction.

3. TRENDS IN THE AUSTRALIAN HOUSING MARKET

Ownership of the Stock

The total stock of dwellings and their sectoral ownership at census dates are given in Table 1. At the June 1981 census, about 93 per cent of the stock of dwellings was owned by households, nearly 5 per cent by government enterprises and the remainder by employers of households. The percentage of dwellings which are owned by households has remained relatively constant over the period 1961-81. The ratio of total dwellings to households rose from 0.985 in June 1961 to 1.649 in June 1981. This increase reflects the growth of second homes and movement out of improvised accommodation such as garages and caravans.

5. Ownership by companies other than for the provision of housing for employees appears to be negligible – see Bethune (1978). In 1979-80 only 1.1 per cent of the gross operating surplus arising from the ownership of dwellings accrued to companies, compared to 1.4 per cent accruing to public enterprises and 97.5 per cent to persons. The company sector has declined slightly in relative importance from the mid 1970's.

6. It is difficult to derive stocks of dwelling units from Australian censuses. The difficulty occurs with shared accommodation which has to be netted out. The figures in Table 1 would tend to overstate the number of dwelling units as defined in the (flow) statistics of building activity.
### TABLE 1
Ownership of Dwellings, Australia, 1961-81

<table>
<thead>
<tr>
<th>Census Date</th>
<th>Dwellings Owned by Households</th>
<th>Government</th>
<th>Companies</th>
<th>Total</th>
<th>Households</th>
<th>Household-owned Dwellings per household</th>
<th>Total dwellings per household</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) '000</td>
<td>(2) '000</td>
<td>(3) '000</td>
<td>(4) '000</td>
<td>(5) '000</td>
<td>(6) (1)</td>
<td>(7) (4)</td>
</tr>
<tr>
<td>June '61</td>
<td>2604.3</td>
<td>115.8</td>
<td>70.1</td>
<td>2790.3</td>
<td>2833.9</td>
<td>0.919</td>
<td>0.985</td>
</tr>
<tr>
<td>June '66</td>
<td>3027.0</td>
<td>163.2</td>
<td>80.8</td>
<td>3271.0</td>
<td>3208.5</td>
<td>0.943</td>
<td>1.019</td>
</tr>
<tr>
<td>June '71</td>
<td>3587.7</td>
<td>207.9</td>
<td>95.0</td>
<td>3890.6</td>
<td>3763.4</td>
<td>0.953</td>
<td>1.034</td>
</tr>
<tr>
<td>June '76</td>
<td>4164.3</td>
<td>211.1</td>
<td>99.0</td>
<td>4443.4</td>
<td>4270.3</td>
<td>0.975</td>
<td>1.048</td>
</tr>
<tr>
<td>June '81</td>
<td>4710.6</td>
<td>236.5</td>
<td>111.9</td>
<td>5059.0</td>
<td>4822.1</td>
<td>0.977</td>
<td>1.049</td>
</tr>
</tbody>
</table>

Data are extracted from the relevant censuses of Population and Housing. Figures in columns (1)-(4) relate to houses, flats, villas units etc. and exclude (1) improvised and mobile housing and (4) unoccupied dwellings awaiting demolition. Households in column (5) equal column (4) minus unoccupied dwellings except where the household is temporarily absent plus households occupying improvised, mobile and shared housing. The 1961, 1966 and 1981 censuses did not collect information on dwellings rented from employers; it was assumed that for 1961 and 1966 these dwellings represented the same proportion of the total dwellings stock as in June 1971, for 1981 the June 1976 proportion was used. Unoccupied dwellings where the household is temporarily absent have been allocated proportionally to the three ownership categories.
Estimates of the composition of the increase in the stock of dwellings are given in Table 2. Sales to households by public authorities fell from 7.9 per cent of the net increase in dwellings owned by persons in the 1961-66 intercensal period to 3.6 per cent in 1976-81.

**Gross Additions to the Stock**

The first column of Table 2 shows that completions of private dwellings peaked in the early 1970's, but the peak is much less noticeable if the real value of private completions is used. Since 1961 private dwelling completions have comprised an increasing share of total dwelling completions: rising from 83.8 per cent in the intercensal period 1961-66 to 90.4 per cent in the period 1976-81. Private and government completions tend to be, if anything, negatively correlated; using annual data for the period 1966-67 to 1980-81, \( r = -0.18 \).

The real value of the existing stock is also increased by alterations and additions to existing dwellings. Published figures for completions refer only to alterations and additions of over $10,000. If approvals for alterations of between $2,000 to $10,000 are included, additions and alterations have remained constant at around 17 to 18 per cent of the value of completions of new dwellings from 1975-76 (when the relevant data series were first published).
TABLE 2

Composition of Increase in Household Owned Stocks of Dwellings ('000 dwellings)

<table>
<thead>
<tr>
<th>Intercensal Period</th>
<th>Private Dwelling Completions(a)</th>
<th>Sales by Housing Authorities</th>
<th>Increase in Company owned housing</th>
<th>Demolitions</th>
<th>Residual (b)</th>
<th>Increase in Stock</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961-66</td>
<td>415.7</td>
<td>33.4</td>
<td>10.7</td>
<td>40</td>
<td>24.5</td>
<td>422.7</td>
</tr>
<tr>
<td>1966-71</td>
<td>566.5</td>
<td>31.7</td>
<td>14.2</td>
<td>64</td>
<td>40.5</td>
<td>560.7</td>
</tr>
<tr>
<td>1971-76</td>
<td>639.8</td>
<td>34.1</td>
<td>4.0</td>
<td>60</td>
<td>-33.5</td>
<td>576.6</td>
</tr>
<tr>
<td>1976-81</td>
<td>594.1</td>
<td>19.8</td>
<td>12.2</td>
<td>50</td>
<td>-4.7</td>
<td>546.3</td>
</tr>
</tbody>
</table>

Notes: (a) Figures to 1973-74 include major alterations and additions which in 1973-74 accounted for 2.5 per cent of completions plus additions.
(b) Includes conversions of dwelling structures.

Sources: column (1): ABS, Building Activity Australia, 8705.0
column (2): Department of Housing and Construction; Annual Reports of NT Housing Commission and National Capital Development Commission.
column (3): Guestimates based on census figures. (See footnote to Table 1)
column (6): Census data.
Initiators of New Construction

Within the household sector there is evidence of a change in the characteristics of new-dwelling buyers. In particular, first-time buyers seem to have declined in importance in recent years. Certainly there has been a change in the relationship between loans for new dwellings and activity in the building industry.

The household sector can finance the purchase of new dwellings in four principal ways: by obtaining an owner-occupier loan, by obtaining other types of loans, by selling an existing dwelling, or realising financial assets. First-time owner-occupiers depend more heavily on the first option than do investors and owner-occupiers changing their dwellings.

In the early 1970's the increase in the construction of dwellings was associated with an increase in loans for the purchase or construction of new dwellings. In the period 1970-71 to 1972-73, the real value of private commencements and loans for new dwellings each increased by $700 million in 1974-75 prices. Details are given in columns (2) and (3) of Table 3. Over the period 1975-76 to 1979-80, however, loans for new dwellings were constant at around $1400 million p.a. in 1974-75 prices, whereas the value of commencements fluctuated considerably. In 1980-81 loans for new dwellings fell 15 per cent in real terms but the value of commencements increased by 17 per cent. The

7. The switch from financial assets to housing may involve intra-sectoral flows, particularly intra-family flows.
8. Timing differences do not substantially alter this result. In 1980-81 real private investment in dwellings increased by 12 per cent.
### TABLE 3

Private Dwelling Commencements and Loans for Owner-Occupation, Australia, 1969-70 to 1980-81

<table>
<thead>
<tr>
<th>Year</th>
<th>Dwelling Loans Approved 1974-75 $m</th>
<th>Loans for New Dwellings (a) 1974-75 $m</th>
<th>Private Commencements 1974-75 $m</th>
<th>Loans for New Dwellings (a) 1974-75 $m</th>
<th>Private Commencements 1974-75 $m</th>
<th>Loans for New Dwellings (a) 1974-75 $m</th>
<th>Private Commencements 1974-75 $m</th>
<th>Loans for New Dwellings (a) 1974-75 $m</th>
<th>Private Commencements 1974-75 $m</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969-70</td>
<td>2028</td>
<td>907</td>
<td>2367</td>
<td>1002</td>
<td>2303</td>
<td>38.3</td>
<td>44.7</td>
<td>38.3</td>
<td>44.7</td>
</tr>
<tr>
<td>1970-71</td>
<td>2022</td>
<td>1202</td>
<td>2556</td>
<td>1202</td>
<td>3003</td>
<td>47.0</td>
<td>42.7</td>
<td>47.0</td>
<td>42.7</td>
</tr>
<tr>
<td>1971-72</td>
<td>2017</td>
<td>1202</td>
<td>2556</td>
<td>1202</td>
<td>3003</td>
<td>47.0</td>
<td>42.7</td>
<td>47.0</td>
<td>42.7</td>
</tr>
<tr>
<td>1972-73</td>
<td>4440</td>
<td>910</td>
<td>3918</td>
<td>2217</td>
<td>3918</td>
<td>56.8</td>
<td>38.4</td>
<td>36.1</td>
<td>37.0</td>
</tr>
<tr>
<td>1973-74</td>
<td>3289</td>
<td>2217</td>
<td>2950</td>
<td>2217</td>
<td>3003</td>
<td>31.2</td>
<td>31.2</td>
<td>31.2</td>
<td>31.2</td>
</tr>
<tr>
<td>1974-75</td>
<td>2912</td>
<td>2960</td>
<td>2015</td>
<td>2960</td>
<td>3003</td>
<td>41.1</td>
<td>37.0</td>
<td>41.1</td>
<td>37.0</td>
</tr>
<tr>
<td>1975-76</td>
<td>3839</td>
<td>2618</td>
<td>4048</td>
<td>2618</td>
<td>3003</td>
<td>37.6</td>
<td>29.6</td>
<td>37.6</td>
<td>29.6</td>
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<tr>
<td>1976-77</td>
<td>3839</td>
<td>1137</td>
<td>3200</td>
<td>1137</td>
<td>3200</td>
<td>32.0</td>
<td>29.6</td>
<td>32.0</td>
<td>29.6</td>
</tr>
<tr>
<td>1977-78</td>
<td>4567</td>
<td>2446</td>
<td>3498</td>
<td>2446</td>
<td>3498</td>
<td>48.7</td>
<td>34.7</td>
<td>48.7</td>
<td>34.7</td>
</tr>
<tr>
<td>1978-79</td>
<td>3993</td>
<td>2543</td>
<td>5056</td>
<td>2543</td>
<td>5056</td>
<td>34.3</td>
<td>34.3</td>
<td>34.3</td>
<td>34.3</td>
</tr>
<tr>
<td>1979-80</td>
<td>4000</td>
<td>2390</td>
<td>5098</td>
<td>2390</td>
<td>5098</td>
<td>31.8</td>
<td>30.8</td>
<td>31.8</td>
<td>30.8</td>
</tr>
<tr>
<td>1980-81</td>
<td>4578</td>
<td>3189</td>
<td>3588</td>
<td>3189</td>
<td>3588</td>
<td>37.6</td>
<td>27.6</td>
<td>37.6</td>
<td>27.6</td>
</tr>
</tbody>
</table>

(a) Both for purchases and construction. From 1976-77 the percentage of the total advanced for construction has been: 51.2, 49.8, 54.2, 37.4 and 58.9.

Notes: The deflator used is the implicit price index for investment in dwellings from the National Accounts.

In the upper half of the table commencements include alterations and additions (above $10,000); housing loans relate only to those provided by banks, permanent building societies and major life offices and include loans for alterations and additions. In the lower half of the table commencements exclude alterations and additions; loans relate to banks, all building societies, insurance companies, finance companies, government housing authorities and credit unions and exclude loans for alterations and additions. Some approximations are required in order to construct the 1973-76 overlap figures.

Sources: ABS, Housing Finance for Owner Occupation, Australia, 5609.0
ABS, Building Activity, Australia, 8705.0
RBA, Bulletin.
conclusion is that new private dwellings in recent years seem to have been increasingly purchased by investors and existing owner-occupiers. 9

The only direct evidence on who buys new private dwellings seems to be that available in the 1980 Survey of Housing Occupancy and Costs (Table 13). In the first 8 months of 1980 42.9 per cent of new dwellings were purchased by first-time buyers. The survey contains information on the status of dwellings (new or used) and their owner-occupiers (first house or not) classified by the length of time the household has owned the residence. The data are not inconsistent with a reduction over time in the proportion of new dwellings purchased by first-time buyers but it is impossible to quantify the effect without information on the mobility of households.

Of course first-time buyers who purchase used dwellings influence the housing market. All that is being argued is that a simple model in which the level of building activity in the short run is related to loans for new houses or the stock of potential first-time buyers is likely to be inadequate. A comparison of columns (1) and (3) of Table 3 also indicates that the relationship between total loans for owner-occupied dwellings and private commencements is somewhat irregular.

In ABS statistics of building activity, dwellings are classified as either houses (standing on a separate titled block of land) or other dwellings (flats, semi-detached, home units.

9. Some first-time buyers will obtain finance from sources, such as solicitors funds, which are not included in the ABS figures, but this is unlikely to change the overall conclusion.
villas units, etc.). Other dwellings intended for owner-occupation are typically built on a speculative basis, whereas house construction is part speculative and part building to contract.

Increases in the ratio of other dwellings to total dwellings imply an increase in the importance of speculative activity in the building industry. These ratios are presented in Table 4 on both a number and value basis for private commencements.

<table>
<thead>
<tr>
<th>Year</th>
<th>1969-70</th>
<th>70-71</th>
<th>71-72</th>
<th>72-73</th>
<th>73-74</th>
<th>74-75</th>
<th>75-76</th>
<th>76-77</th>
<th>77-78</th>
<th>78-79</th>
<th>79-80</th>
<th>80-81</th>
</tr>
</thead>
<tbody>
<tr>
<td>By Number</td>
<td>34.6</td>
<td>30.7</td>
<td>29.7</td>
<td>28.6</td>
<td>31.7</td>
<td>27.0</td>
<td>22.2</td>
<td>22.4</td>
<td>18.7</td>
<td>18.5</td>
<td>22.2</td>
<td>28.1</td>
</tr>
<tr>
<td>By Value</td>
<td>26.5</td>
<td>22.7</td>
<td>22.2</td>
<td>21.2</td>
<td>23.6</td>
<td>19.7</td>
<td>16.3</td>
<td>17.1</td>
<td>14.5</td>
<td>15.2</td>
<td>16.7</td>
<td>25.0</td>
</tr>
</tbody>
</table>

Source: ABS, Building Activity, Australia (8705.0)

Commencements of other dwellings fell to historically low levels in the period 1977 to 1979, but rose to 25.8 per cent of the value of all private commencements in 1980-81, the highest percentage since 1969-70. There has been a long-term tendency for the average value of other dwelling commencements to rise as a proportion of the average value of houses: from around

10. Unfortunately the classification by type of dwelling used in the 1976 census cannot be reconciled with the flow figures. This means that it is not possible to construct reliable time series of stocks of houses and stocks of other dwellings.

11. The number of loans made to owner-occupiers for the construction of new dwellings averaged 46,8 thousand per year over the period 1976-77 to 1980-81.
two-thirds in the first half of the 1970's to nearly 90 per cent in 1980-81. Much of the 1980-81 activity in other dwellings was speculative building on the Queensland coast and in Sydney.12

4. THE MODEL

The model outlined in Section 2 can be written as a system of 13 equations. The private asset market reduces to one equation by assuming that the market price equates demand and supply. In the service market demand and supply are separately specified and disequilibrium enters as vacant dwellings (other than holiday homes).13

The endogenous variables in the model relate to private asset price, the private rental price, household formation, vacancies, building activity in the private sector and the quality of the housing stock. Each equation will now be outlined in turn.

Asset Market

(1) Asset price equation, $p^h$

12. Queensland and NSW accounted for 75 per cent of Australian other dwelling commencements in 1980-81. In Queensland the average value of other dwelling commencements was 18 per cent greater than the average value of houses commenced.

13. The dichotomy between the treatment of the asset and service markets reflects in part the institutional constraints on movements in rent. Lagged adjustment could be easily introduced into the asset price equation.
The asset price of private housing is assumed to be determined within a generalised asset adjustment model. Equilibrium holdings of financial and real assets are assumed to depend on a vector of expected rates of return, prices and income or wealth. Actual holdings of a given asset are a function of disequilibrium in the holdings of all assets. The dynamics may be derived from a quadratic adjustment cost model.

In general terms the model is

\begin{align}
\Delta p_{i1} &= X_{ki} \left( p_{i1}^* - (p_{i1})_{-1} \right) \quad (i, k = 1, \ldots, n) \\
(p_{i1})^* &= \sum_j \theta_{ij} x_j \quad (j = 1, \ldots, m)
\end{align}

where \( p_{i1} \) is the value of holdings of the \( i \) th asset, \( (p_{i1})^* \) represents target holdings, the \( x_j \) are determining variables and the \( \theta \) are adjustment coefficients.

It is conventional in portfolio allocation and generalised asset adjustment models to treat rates of return and prices as exogenous and the quantity of assets as endogenous. With housing, however, it is more appropriate to reverse this, and treat the price as endogenous. Because of construction lags the

14. The generalised asset adjustment model was first postulated by Zellner (1960) in the framework of consumer behaviour. In Brainard and Tobin (1968) the generalised adjustment approach was used to model the allocation of financial assets by all sectors of the economy. Within the context of household allocation there are ongoing debates on whether income or wealth should be used as a determinant of desired assets and on the treatment of consumption of non-durables; see Purvis (1975, 1978), Backus and Purvis (1980), Owen (1991).

end period stock of completed dwellings is known at the beginning of the period.\footnote{16}

Two "own rates" are candidates for inclusion as determinants of the value of assets held as housing. One approach is to treat housing as a good similar in nature to household durables and to use a price variable which exerts a negative effect on desired holdings. The appropriate price is the implicit rental price of housing calculated as \((i+\delta-p^{eqh})p^h\) where \(i\) is the opportunity cost of funds invested in housing, \(\delta\) is the rate of depreciation, rate payments etc., \(p^h\) is the asset price of housing and \(p^{eqh}\) its expected rate of increase.\footnote{17} A difficulty with this measure is the appropriate choice of \(i\), which should be the rate of return on a financial asset with the same degree of risk as housing.

The second approach, which is preferred here, is to treat housing and land in a similar manner to financial assets (including equities) and use the rate of return on housing as its "own rate". This variable will exert a positive influence on desired holdings. A measure of the rate of return on housing, \(\rho\) is

\[
\rho = \frac{R_{hp}}{p_{hp}} + p^{eqh}
\]

where \(R\) is the after tax net operating surplus accruing to

\footnote{16. The asset adjustment equation is perceived here as one in which at the beginning of the period households plan action on the basis of initial wealth and expected values of rates of return, income etc. - see Buitar (1980).}

\footnote{17. For a fuller discussion see Filmer and Silberberg (1978) and Pagan and Trivedi (1981, pp.26-31).}
dwellings owned by persons, and $p^{\text{HN}}$ is the market value of the stock of dwellings and residential land. This measure is the discount rate which equates the (infinite) stream of expected future rents to the present value of the asset when rents are assumed to increase in line with the asset price.\(^{18}\)

Supply restrictions on finance for housing may be introduced by either treating housing loans as part exogenous, or by lowering the speed of adjustment to the desired liability position. Other financial factors, such as changes in the size of annual repayments needed for loan servicing or changes in the size of the initial deposit can be introduced as (negative) determinants of equilibrium holdings of housing.

**Service Market**

\[(2) \quad \text{Volume of dwelling services demand, } qH^d\]

The demand for services is underpinned by household formation which is measured in units. Thus a link is needed between numbers of dwellings and the volume of dwelling services. The latter is proportional to quality adjusted stock. Specifically, the volume of dwelling services demanded is given

18. Let $p_0$ be the asset price at the beginning of period 1 and assume rents for the period are known in advance, then

$$p_0 = \sum_{t=1}^{\infty} \frac{R_t}{(1+i)T}, \quad R_t = R_1 R^e t^{-1}$$
by

$$qH^d = f_2(Y, r^h/p, W) \ N$$

where $H^d = \text{demand expressed in numbers of dwellings,}$
$q = \text{average quality of the stock,}$ $Y = \text{income,}$ $r^h/p = \text{real rents,}$ $W = \text{average yearly hours of work and} N = \text{number of households.}$ The ratio of dwelling services demanded to the number of households is postulated to depend positively on income and leisure (the converse of $W$) and negatively on the rental cost of housing. An increase in leisure time is likely to affect the demand for holiday homes, in particular.

(3) Household formation, $N$

$$N = f_3(Y, r^h/p, D)$$

where the only new variable is $D$, which represents demographic effects such as age distribution, immigration and age-specific headship rates. The last factor is heavily influenced by general social attributes.

(4) Volume of dwelling services provided, $qH^d$

The potential supply of services is proportional to the stock of all dwellings, irrespective of ownership.

(5) Vacancies, $V$

\[ V = n^s - h^d \]

(6) Asset and rental price link.

In equilibrium it is assumed that the ratio of the private rental price to the asset price is $(i+\delta-p^h)$. The actual ratio is assumed to adjust towards this (moving) equilibrium ratio. (Note that the $r^h$ variable is a weighted average of private and government rents.) As institutional factors alter it may be appropriate to vary the financial asset(s) whose rate of return is used for $r$.

**New Activity**

In order to provide necessary links with the rest of the model there is need for equations describing both the number and volume of new private dwellings constructed. (The distinction between households and companies is not appropriate here as builders may fall into either category.)

(7) Number of private starts, $S^P$

This equation provides a link between the asset price equation and economic activity.

\[ S^P = f_t(p^h, V, C, F)_{-1} \]
where $C$ represents construction costs of new dwellings and $F$ = financial variables. Starts are positively related to the price of the existing stock, $p^h$, and negatively related to construction costs and vacancies.\textsuperscript{20}

\textbf{(8) Gross investment in private dwellings, $I^p$}

Apart from the obvious lag effects, the relationship between the value of investment and the number of commencements depends upon the average value of new dwellings and additions and alterations to the existing stock. These in turn depend upon income levels and the set of variables which affect housing starts.

\textbf{(9) Private completions, $E^p$}

The number of completions is basically a distributed lag function of recent commencements, but economic variables may affect the speed of construction.\textsuperscript{21}

\textbf{Identities}

\textbf{(10) Number of dwellings owned by persons, $H^{op}$}

\textsuperscript{20} Note that in the asset price equation households are assumed to be willing holders of vacant dwellings. This occurs because in the short run they expect the asset price to increase by more than can be gained by holding assets in another form.

\textsuperscript{21} This also affects the investment equation. The matter is explored in Williams (1973) and Looker and Carland (1980).
\[ H^{SP} = H^{SP}_{-1} + E^P + SCG - PD \]

where \( SCG = \) net sales to persons by companies and public enterprises, \( PD = \) private demolitions. Company "purchases" include new completions of company housing.

(11) Total number of dwellings, \( H^S \)

\[ H^S = H^S_{-1} + \Delta H^{SP} + \Delta H^{SCG} \]

where \( \Delta H^{SCG} = \) change in stock of dwellings owned by companies and public enterprises.

(12) Depreciated total stock, \( DH^S \)

\[ DH^S = DH^S_{-1} + I^P + I^G - DD \]

where \( I^G = \) gross investment in dwellings by companies and public enterprises; \( DD = \) demolitions and depreciation.

(13) Average quality of stock, \( q \)

\[ q = \frac{DH^S}{H^S} \]

To illustrate the interrelationships of the full model, suppose there occurs an increase in the rate of return on housing relative to returns on financial assets. In the short run this will tend to raise the asset price of the existing stock. This,
in turn, will increase the level of new dwelling commencements. If the demand for housing services were to remain unaltered, the new activity would on completion create excess supply which would lower the asset price. However the demand for housing services will not remain fixed because of changes in the private rental price. Changes in rents then react back on the rate of return to housing and so on. Quantitative results can be obtained only by estimating the full system and solving.

5. EMPIRICAL RESULTS

Unfortunately data deficiencies prevent complete estimation of the model given in section 4. In particular, quarterly time series data are not available on the number of households. Estimation will be confined to two key equations, namely those for the asset price of the existing stock of private dwellings and private commencements. Some attempt will be made to introduce demand-supply imbalance by the construction of an aggregate measure of vacancies.

The estimation period is 1967(3) to 1981(2), which yields 56 observations. All data are in logarithmic form and seasonally unadjusted (seasonal dummies are used).
5.1 Asset Price Equation

The asset price of private housing is determined by a generalised asset adjustment equation. Total personal assets are the sum of financial assets, reserves of pension and insurance funds, equities, durable goods and dwellings (including associated land) owned by persons. Net wealth is total assets less loans outstanding for owner-occupied housing and other advances. Net wealth of unincorporated enterprises is excluded as are farm assets (including land) and liabilities. Data sources and methods of construction of variables are given in the Data Appendix.

In a model which is concerned with explaining the asset price of dwellings owned by persons, irrespective of the nature of the occupancy, the distinction between loans for owner-occupied housing and other loans is not a useful one. In the absence of data on all loans granted for the purchase of dwellings, all personal liabilities are aggregated. Such an aggregate variable is relevant on its own account insofar as non-housing loans, by relaxing the immediate budget constraint faced by households, permit additional finance to be devoted to housing.

Movements in component shares of total assets and the wealth income ratio are given in Table 5. The share of total assets held as housing has risen from around 52 per cent in the late 1960’s to 60 per cent from the mid 1970’s. This increasing share

22. Note that in the national accounts an estimate is made of interest payments on all inter-sector loans for housing.
<table>
<thead>
<tr>
<th>Year</th>
<th>Housing Total Assets (per cent)</th>
<th>Financial Assets Total Assets (per cent)</th>
<th>Liabilities Total Assets (per cent)</th>
<th>Net Wealth Income</th>
<th>Housing Income</th>
<th>Financial Assets Income</th>
<th>Liabilities Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966-67</td>
<td>51.6</td>
<td>19.7</td>
<td>10.5</td>
<td>3.51</td>
<td>2.02</td>
<td>0.77</td>
<td>0.41</td>
</tr>
<tr>
<td>67-68</td>
<td>51.8</td>
<td>19.5</td>
<td>10.4</td>
<td>3.72</td>
<td>2.15</td>
<td>0.81</td>
<td>0.43</td>
</tr>
<tr>
<td>68-69</td>
<td>51.0</td>
<td>19.0</td>
<td>10.6</td>
<td>3.64</td>
<td>2.07</td>
<td>0.77</td>
<td>0.43</td>
</tr>
<tr>
<td>69-70</td>
<td>52.0</td>
<td>18.4</td>
<td>10.5</td>
<td>3.77</td>
<td>2.19</td>
<td>0.77</td>
<td>0.44</td>
</tr>
<tr>
<td>70-71</td>
<td>54.3</td>
<td>18.4</td>
<td>10.7</td>
<td>3.68</td>
<td>2.24</td>
<td>0.76</td>
<td>0.44</td>
</tr>
<tr>
<td>71-72</td>
<td>55.3</td>
<td>18.4</td>
<td>10.8</td>
<td>3.66</td>
<td>2.27</td>
<td>0.76</td>
<td>0.44</td>
</tr>
<tr>
<td>72-73</td>
<td>54.6</td>
<td>18.4</td>
<td>10.7</td>
<td>3.74</td>
<td>2.28</td>
<td>0.77</td>
<td>0.45</td>
</tr>
<tr>
<td>73-74</td>
<td>59.6</td>
<td>17.8</td>
<td>11.0</td>
<td>3.72</td>
<td>2.49</td>
<td>0.75</td>
<td>0.46</td>
</tr>
<tr>
<td>74-75</td>
<td>61.7</td>
<td>17.6</td>
<td>10.7</td>
<td>3.50</td>
<td>2.42</td>
<td>0.69</td>
<td>0.42</td>
</tr>
<tr>
<td>75-76</td>
<td>60.5</td>
<td>18.2</td>
<td>10.8</td>
<td>3.52</td>
<td>2.39</td>
<td>0.72</td>
<td>0.42</td>
</tr>
<tr>
<td>76-77</td>
<td>60.6</td>
<td>18.7</td>
<td>11.4</td>
<td>3.54</td>
<td>2.42</td>
<td>0.75</td>
<td>0.46</td>
</tr>
<tr>
<td>77-78</td>
<td>59.7</td>
<td>19.2</td>
<td>11.9</td>
<td>3.58</td>
<td>2.42</td>
<td>0.78</td>
<td>0.48</td>
</tr>
<tr>
<td>78-79</td>
<td>58.8</td>
<td>19.8</td>
<td>12.2</td>
<td>3.49</td>
<td>2.33</td>
<td>0.79</td>
<td>0.48</td>
</tr>
<tr>
<td>79-80</td>
<td>59.9</td>
<td>19.7</td>
<td>12.1</td>
<td>3.61</td>
<td>2.46</td>
<td>0.81</td>
<td>0.50</td>
</tr>
<tr>
<td>80-81</td>
<td>59.9</td>
<td>19.5</td>
<td>11.9</td>
<td>3.67</td>
<td>2.50</td>
<td>0.81</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Notes: All asset values are at 31st December.

- Total Assets = financial assets+reserves of pension and superannuation funds+equities+durables (including cars)+dwellings and associated land.
- Liabilities = loans outstanding for owner-occupied housing+other loans outstanding.
- Net Wealth = total assets - liabilities.
- Income = annual personal disposable income.
has been mainly at the expense of equities, whose share has fallen from 12 per cent in the late 1960's to 5 per cent from the second half of 1974 onwards. Liabilities have marginally increased as a share of total assets from 18.5 per cent in 1966-67 to 12 per cent in 1980-81. The ratio of net wealth to annual income has remained remarkably stable at around 3.6 over the past 15 years.

The ratio of liabilities to the value of housing may be obtained by dividing column (3) in Table 5 by column (1). It is constant at 0.20 except for 1974 and 1975 where it falls to nearly 0.17. Advances to owner-occupiers represent around 78 per cent of total liabilities of persons (falling from 74 per cent in the late 1960's to 69 per cent in 1980-81). It follows that over the sample period the bounds on the equity ratio for dwellings owned by persons are 38 to 86 per cent. These figures are very similar to cross-section estimates for owner-occupiers derived by Yates (1982, p.185) from the 1968-68 Macquarie Survey. In a 1977 survey of 171 Melbourne landlords undertaken by the Australian Housing Research Council (1982), equity in properties exceeded 70 per cent in 54.8 per cent of cases; equity was less than 50 per cent for only 22.5 per cent of landlords.

It is assumed that desired asset levels are a function of normal income rather than wealth. The constancy of the wealth-income ratio makes this choice relatively unimportant empirically. Two measures of normal income are used: four-quarter moving averages of (i) personal disposable income and (ii) post-tax labour income. The labour income measure
excludes that part of income which is determined by (endogenous) wealth holdings.

All asset values and measures of income are expressed in real terms by dividing by the implicit price index for non-durable goods. By dividing the initial stock of assets by current prices capital losses on financial assets are explicitly introduced. Rates of return are entered in nominal terms (after tax where relevant) and the rate of inflation added as an additional variable. It follows that the coefficients on nominal rates are measuring the effects of changes in real rates.

In order to make the analysis more tractable, a maximum number of three asset groupings (plus liabilities) were used in estimation. One asset was necessarily housing, the other groupings considered were: financial assets; financial assets and other assets (durables and equities); and total non-housing assets. Reserves of pension and life funds were treated as a determinant of desired asset holdings since they largely represent contractual saving for the provision of future income.

From equations (4.1) and (4.2), the estimating equation for the asset price of housing (asset 1) is of the form

\[ \Delta p_1 y_1 = \sum_{j=1}^{n} \gamma_j x_j - \sum_{i=1}^{n} \lambda_i (p_i y_i)_{-1} \]  

(5.1)

\[ = \sum_{j=1}^{n} \gamma_j x_j - \sum_{i=1}^{n} \lambda_i (p_i y_i)_{-1} \]  

(5.2)
In the context of a system of generalised asset adjustment equations the coefficients \( \gamma_{ij} \) on the \( x \) variables (rates of return, income, etc.) are weighted averages of the \( \tilde{\beta}_{ij} \) coefficients in the equilibrium asset equations. The coefficients on lagged assets, \( \lambda_{ii} \), are directly interpretable as adjustment coefficients. However, only one equation of the system is of direct interest here, namely the housing equation, and it is designed to explain the asset price of housing only in the short run. Therefore an alternative approach is to treat the estimating equation for housing as a single equation and be interested in the \( Y \)-values per se rather than their component parts (\( \lambda \) and \( \beta \)).

Ordinary least squares estimates of equation (5.2) showed disequilibrium in holdings of financial assets to be the dominant non-housing asset. The results using the two income measures (personal disposable income (PDIY) and labour income) are given in Table 6.23 (The constant and seasonal coefficients have been omitted from the table). The choice of an income measure does not exert an undue influence on the overall results but the PDIY term has a larger (positive) coefficient and \( t \)-value than does the labour income term.

23. The coefficient on reserves of pension and life funds was small and highly insignificant (both for \( \gamma_{ij} \) and \( \tilde{\beta}_{ij} \)) and the variable was omitted.
TABLE 6: Asset Price Equation for Housing.

<table>
<thead>
<tr>
<th></th>
<th>λ_{14} (adjustment coefficients)</th>
<th>y_{14} (rates of return etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PDI</td>
<td>Labour Income</td>
</tr>
<tr>
<td>Housing</td>
<td>0.353</td>
<td>0.306</td>
</tr>
<tr>
<td></td>
<td>(0.118)</td>
<td>(0.138)</td>
</tr>
<tr>
<td>Loans</td>
<td>0.428</td>
<td>0.431</td>
</tr>
<tr>
<td></td>
<td>(0.112)</td>
<td>(0.116)</td>
</tr>
<tr>
<td>Financial Assets</td>
<td>-0.870</td>
<td>-0.934</td>
</tr>
<tr>
<td></td>
<td>(0.156)</td>
<td>(0.159)</td>
</tr>
<tr>
<td>Inflation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>r^2</th>
<th>s</th>
<th>h_1</th>
<th>h_2</th>
<th>h_3</th>
<th>h_4</th>
<th>h_5</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDI</td>
<td>0.9951</td>
<td>0.01264</td>
<td>-0.80</td>
<td>-1.94</td>
<td>1.75</td>
<td>-2.07</td>
<td>-1.68</td>
</tr>
<tr>
<td>Labour Inc.</td>
<td>0.9948</td>
<td>0.01245</td>
<td>-0.62</td>
<td>-1.65</td>
<td>1.51</td>
<td>-2.23</td>
<td>-1.69</td>
</tr>
</tbody>
</table>

Notes: Dependent variable is real value of housing stock at end of quarter. Standard errors are given in parentheses. hₐ-Lagrange multiplier test statistic for 1st-order autocorrelation in the residuals (distributed as the unit normal).

Some of the Lagrange multiplier test statistics (see Breusch and Pagan (1980)) for autocorrelation in the residuals border on significance at conventional levels. However, when autoregressive and moving-average error structures were appended to the model there were no great changes in parameter estimates or in their standard errors and some hₐ-statistics remained around the critical values.

24. The exception was the coefficient on the return on financial assets which became smaller, but from Table 6 the coefficient is clearly badly determined.
All the adjustment coefficients given in Table 6 are well determined. The adjustment coefficient on financial assets is not significantly different from minus one, which implies that the asset price of housing is depressed by the same percentage as the change in the disequilibrium in financial assets. Attempts by householders to restore the real values of their financial assets have a markedly depressing effect on house prices. This would have been most noticeable in the mid-1970's.

As expected, loans to persons and investment of funds in housing are complements. If, for example, the desired level of loans outstanding is less than actual then the asset price of housing will fall. The point estimates imply that for each percent change in liability disequilibrium the asset price of housing will change by around 0.43 per cent. As beginning-of-period loans enter with a negative coefficient in the regression equation the results favour an asset adjustment approach over an availability-of-funds approach. The adjustment coefficient, λ, on housing itself is estimated to be around one-third.

The (real) rate of return to housing is seen to exert a significantly positive (net) effect on dwelling prices. In the short-run the asset price is estimated to increase by about 0.8 per cent for each 10 per cent increase in the rate of return on housing. The sign of this coefficient and of the average rate of interest on loans (negative) is consistent with the own-rate effects dominating in a generalised asset adjustment equation for housing. However, this is not so for the positive coefficient
observed on the return to financial assets. The latter coefficient is, however, very poorly determined.

The coefficient on inflation is significantly positive, but when PDY is the income variable the point estimate is almost exactly equal to the sum of the coefficients on the rates of return. This result implies that if nominal returns are fully adjusted for inflation, the latter does not exert a separate (net) influence. Inflation exerts a small separate positive effect when labour income is used as an explanatory variable.

Unscrambling the $\beta_{ij}$ coefficients on desired asset holdings requires estimation of the full three-equation system. (The two non-housing equations are obtained by varying the subscript $l$ in equations (5.1) and (5.2)). The danger with this approach is that the equations for financial assets and loans may be misspecified. An obvious possible misspecification is the omission from the loan adjustment equation of any disequilibrium in holdings of durable goods. When added, however, the term was unimportant and it appears satisfactory to express liabilities outstanding as a function of its own disequilibrium and disequilibrium in holdings of housing and financial assets.

The financial asset equation, however, yielded very poor results and was clearly misspecified. To overcome this problem use was made of the observed relative constancy of the ratio of liquid assets to income over recent years in Australia. Since the model is in logarithmic form it is possible to write $p_{y_j} = k + x_m$ where $k$ is the logarithm of the ratio of

financial assets to income and $x$ is the logarithm of income. The $k$ term can be absorbed into the intercept term and the estimating equations for housing and loans written as

\[
\Delta p_{k} = \sum_{j=1}^{n} \gamma_{kj} x_j - \sum_{i=1}^{2} \lambda_{ki} (p_{1y_{-1}^{i}} - \lambda (p_{3y_{-1}^{i}} - 1), k=1,2
\]

where \( \gamma_{kj} = \sum_{i=1}^{n} \lambda_{ki} \beta_{ij} \)

The adjustment coefficients (\( \lambda_{ki} \)), and their standard errors, obtained from OLS estimation of equation (5.3) will be identical with those obtained from equations of the form (5.2) (and the estimates for housing given in Table 6). The coefficients of the desired stocks, \( \beta_{ij} \), may be most conveniently obtained using two-stage least squares, along the lines outlined by Bewley (1979). The estimates for desired holdings of housing are given in Table 7, for each of the two income measures used.

<table>
<thead>
<tr>
<th>TABLE 7: Equilibrium Holdings of Housing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>FDY</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Labour Income</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

26. The actual ratio is given in Table 5. It has fluctuated from between 0.75 and 0.81 except for a fall in 1974 and 1975. The assumption made is that this fall was due to non-instantaneous adjustments in asset holdings (including holdings of financial assets).
The main determinants of equilibrium investment in housing are income and the rate of return on housing. The income elasticity is around unity for both FOC and labour income. A one per cent increase in the rate of return on housing is estimated to increase equilibrium holdings by around 0.16 per cent. Interest rates on loans have the expected negative sign, but the coefficient is not well-determined, especially when labour income is used. The estimates of the coefficient on the rate of return to financial assets are positive but insignificant. Not much reliance should be placed on estimates of this coefficient because of the simplified treatment of financial assets in the model. Finally, inflation is estimated to increase the asset price of housing.

In obtaining all the results given above it has been assumed that adjustment rates are constant. This is an assumption that needs to be examined when one of the assets is loans to households. Insofar as monetary policy is capable of restricting the volume of loans granted to persons, adjustment rates will be a function of credit tightness.

The variable used to measure the availability of credit is the four-quarter change in primary liquidity, \( \dot{m} \), where \( m \) is real

27. If the desired ratio of financial assets to income is made a function of the rate of interest on financial assets then only the coefficient on the latter variable is affected in the housing equation.
private sector LGS assets plus SRD accounts of trading banks.\textsuperscript{26} The main determinants of \( m \) are the budget deficit and net monetary movements in the balance of payments.

The adjustment terms in the generalised asset model are now of the form \( (\lambda_{ki} + \phi_{ki} y_t) \) and the system contains non-linear restrictions across equations. In estimation the equilibrium level of financial assets was again made proportional to income (only PDY was used). The estimated values of \( \phi \) were small and statistically insignificant.\textsuperscript{29} The largest t-values were around unity; these occurred in the loans equation on the disequilibrium in financial assets and housing. The \( \phi \)-coefficient on loans in the housing equation was 0.0043 with a standard error of 0.0147 (\( \hat{\phi} \) ranges from -19 to 11 per cent). Thus there is no evidence that changes in primary liquidity exert much of an influence on house prices. It is important to remember that in this analysis loans are defined as total liabilities of persons, not just loans for owner-occupation of dwellings. A tight monetary policy might simply result in a relative switch in ownership of dwellings from owner-occupiers to investors. (Also, in times of high inflation the tax deductibility of nominal interest payments for investors means that they are better able to meet initial repayments on loans.

\textsuperscript{26} Some experimentation was carried out using quarterly changes, M3, and LGS assets. The report of the Priorities Review Staff (1975) on housing noted the close correspondence between annual movements in primary liquidity (with or without SRDs) and mortgage approvals.

\textsuperscript{29} Other coefficients in the model were relatively unaffected. The desired ratio of financial assets to (quarterly) PDY was put at 3.8, which is approximately the average of the actual values over the sample period.
5.2 Private Commencements, $S^P$

The number of private commencements in a quarter is postulated to be primarily a function of the real asset price of the existing stock ($p^h$), the real cost of construction of new dwellings ($c$) and a measure of excess supply ($v$) in thousands of dwellings. The price deflator used is again that for non-durable consumption. Precise details of the series are contained in the Data Appendix.

Quarterly movements in the $p^h$ and $c$ series are given in Figure 1. The real asset price of the existing stock rose by 55 per cent between the beginning of the sample period, 1967(3), and mid 1974. It then declined fairly steadily until mid 1979 but by the end of the sample period, 1981(2), the index was nearly back to the peak reached in mid 1974. Real construction costs were relatively stable until 1973 then increased sharply, peaking at the end of 1976.

On estimation of the model, lags were found to be short but there was marked serial correlation in the errors. In the preferred equation commencements depend on the asset price and construction costs in the previous quarter and on excess supply at the beginning of the previous quarter. The errors exhibit first and fourth order serial correlation. The results, with standard errors in parentheses, are as follows:

38. Private commencements include construction by companies, mainly in resource development areas. Conceptually these are exogenous to the model and should be netted out.
\[(5.4)\]
\[
\ln S = 5.01 + 1.287 \ln p^h - 1.306 \ln C_{-1} - 1.107 \ln V_{-2} \\
\quad \quad \quad \quad (0.71) \quad (0.281) \quad (0.595) \quad (0.469)
\]
\[
+ 0.027 \ z_2 + 0.054 \ z_3 + 0.067 \ z_4 + 0.919 \ u_{-1} - 0.291 \ u_{-4} \\
\quad \quad \quad \quad (0.013) \quad (0.014) \quad (0.013) \quad (0.079) \quad (0.079)
\]
\[R^2=0.866, \ h_1=-1.29, \ h_2=-1.52, \ h_3=0.52, \ h_4=1.02, \ h_5=0.29\]

where the \(Z_i\) are seasonal dummies for the \(i\)th quarter and the \(u\) are disturbances.

The coefficients on \(p^h\), \(C\) and \(V\) are all significantly different from zero at the five per cent level. The price elasticities are opposite in sign as expected: 1.29 for asset price, \(-1.31\) for construction costs. By comparison, in the Bank of Canada's (1983) ROXP model the estimated elasticities are 1.64 for \(p^h\) and \(-1.23\) for \(C\). The strength of the excess supply effect (elasticity of \(-1.11\)) is crucially dependent on the inclusion in the measure of dwellings under construction.

All responses are short run. In the long run changes in commencements are followed by changes in the capital stock with resultant effects on asset price and excess supply. Financial variables were introduced in the form of the interest rate on finance company loans to builders, and changes in liquidity but these proved to be unimportant.

The presence of serial correlation considerably reduces the usefulness of the equation for policy purposes. Without the autoregressive error structure the \(R^2\)-value is only 0.52 and the equation overpredicts in periods of recession and underpredicts in booms. Serial correlation is prevalent in many
Figure 1 - Real House Prices, Australia
1967(3) to 1981(2) - 1974-75=1.000

Real House Prices - 1974-75=1.0

Existing

Construction
Costs
studies of housing commencements and reflects the range of variables which affect activity in the housing industry. For example, in the Bank of Canada's (1980) equation for commencements the first-order autoregressive coefficient is 0.658 with a t-value of 5.4. In Williams (1982) it is suggested that the NIF-10 equation for housing commencements in Australia also exhibits a high-order error structure which is masked by the use of a lagged dependent variable. The negative coefficient on housing commencements lagged three periods in Filmer and Silberberg (1980, p.83) is again suggestive of serially correlated disturbances.

6. CONCLUDING REMARKS

In this paper the Australian housing market has been studied in a wider context than is usual in econometric studies. In particular, attention has been focussed on the links between portfolio choice, housing prices and new construction. By recognising that three sectors of the economy construct and own housing (persons, public enterprises and companies) but only persons demand housing services, the relationship between housing as an asset and housing as a service has been clarified.

The generalised asset adjustment model provides a good explanation of the asset price of the existing stock of privately-owned dwellings (and associated land). Disequilibrium

31. The NIF-10 equation is documented in Looker and Garland (1980) and Department of the Treasury (1981). The explanatory variables are loans for owner-occupiers and a general measure of liquidity. The NIF-10 equation is compared with the asset price approach in Williams (1982).
in holdings of financial assets depresses house prices and helps to explain the fall in the real price of dwellings in the second half of the 1970's when consumers acted to restore the real value of their financial assets. The rate of return to housing, which depends critically on expectations about future housing prices, exerts a significant influence on the price of dwellings.

Supply constraints on advances were found to be unimportant. This result presumably arises from the consideration of all advances to persons not just loans for owner-occupation of dwellings. In our model constraints on (low interest) lending by banks and building societies for owner-occupier loans depresses the asset price of dwellings by increasing the average rate of interest on loans. The fall in the asset price then feeds through to lower the level of commencements below what it would otherwise have been.

The elasticity of commencements with respect to the asset price of the existing stock is estimated to be 1.3. This result neatly summarises the policy dilemma of governments that wish to hold down the cost of housing for first-time owner-occupiers and at the same time wish to encourage activity in the building construction industry. For a given level of asset prices new construction can be stimulated by lowering its cost. The other significant variable to enter the construction equation is a measure of excess supply of dwellings. The traditional demographic variables enter the model in this manner.
It is significant that data deficiencies limit the extent to which the full model can be estimated. These data deficiencies arise in part because the paper departs from the conventional view of housing in Australia where owner-occupation is emphasised. The major data gaps are total loans for housing, unsold or vacant houses, and details on the characteristics of buyers of new dwellings. But even the concept of a "dwelling" as used in the census differs from the concept used in deriving building statistics.

The model developed in this paper could be expected to yield richer results if estimated for regions. The concept of an average value of dwellings in Australia has obvious limitations. House prices in Sydney and Melbourne, for example, have exhibited pronounced differences in their cyclical movements. Another field for future research would be the effect of changes in patterns of household formation. What, for example, happens to holdings of the asset housing with divorce and subsequent regrouping? How much is this an explanation for the observed phenomenon of households living in rented accommodation but owning elsewhere?

Finally, the effects of government activity on private construction have only been outlined in this paper. Full quantification would require the complete model to be estimated and solved. In the very short run government construction of dwellings will increase activity. But the offset effect on private construction comes after one to two quarters through the excess supply term in the commencements equation. The sale of
government housing to persons has two effects on the asset price. By increasing the stock of private dwellings it tends to lower the price, but if sales are to households who would not otherwise invest in housing this increases the flow of private funds into housing which, of itself, will tend to raise the asset price.
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Data Appendix

Definitions of variables and sources of data used in the econometric estimation are contained in this appendix. Figures in brackets refer to sources listed at the end. Data are published quarterly except where indicated. Annual and biannual figures are interpolated linearly.

1. Asset Price of Dwellings

From 1973(1) the basic data used are the average values of all houses sold in state capital cities (excluding Perth) in a quarter. The data were provided by the (then) Department of Housing and Construction (DHC). Prior to 1973(1) sales data for Sydney, Melbourne and Adelaide only have been used. DHC data were available for Melbourne and Adelaide for some of the pre-1973(1) period, otherwise the data relate to the average value of the reported sales of houses as collected by Philip Shrapnel (as do the Sydney figures for 1973-75). Census estimates of dwelling stock in each capital city were used to weight the sales data.

A price index calculated from the above data was applied to the estimated average value of dwellings at 30 June 1976 to obtain a value series. The 30 June 1976 average value of $32,100 was arrived at using the reports of the State Valuers-General. Differences in average values of urban and rural dwellings and houses and flats were allowed for. Weights were obtained from the 1976 Census.

2. Expected Rate of Increase in Asset Price of Dwellings

The price expectations term for housing is derived from surveys undertaken by the Melbourne Institute of Applied Economic and Social Research in conjunction with the Roy Morgan Research Centre. Households are asked what would be the wisest thing to do with new savings. "Real estate" is one of the options listed, along with bank deposits, shares etc. Data are quarterly, commence in 1975(4) and are available separately for Sydney and Melbourne. The responses differ noticeably between the two cities over time: Melbourne households giving a higher rating than Sydney households to real estate in 1976 and 1977, Sydney households giving the higher rating from 1979 onwards. As interest rates and other monetary variables tend to be constant across Australia, it is postulated that the difference in the responses between Melbourne and Sydney depends on expectations about housing prices, which in turn are a function of past movements in actual housing prices in each city. Rates of population growth in N.S.W. and Victoria were also considered but were insignificant in the regression equations. The most acceptable estimates were found by fitting a second-order Almon polynomial to annual rates of change in dwelling prices.
dy_t = \sum_{i=1}^{5} w_i \Delta p_{t-i} \quad R^2 = 0.871, \quad DW = 1.96

w_1 = 0.133 \quad w_2 = 0.191 \quad w_3 = 0.219 \quad w_4 = 0.218 \quad w_5 = 0.188
\quad \quad (0.156) \quad (0.078) \quad (0.134) \quad (0.076) \quad (0.167)

where \( dy = yS - yM, \Delta p = \Delta S - \Delta M \), \( y \) is the percentage, regarding "real estate" as the wisest form of saving, \( p \) is the annual change in the asset price of dwellings \((p_{t-4} - 1)\), and \( S \) and \( M \) stand for Sydney and Melbourne, respectively.

Standardising the weights to sum to unity gives: \( w'_1 = 0.14, w'_2 = 0.28, w'_3 = 0.23, w'_4 = 0.23 \) and \( w'_5 = 0.28 \), which are then used to generate the price expectations series for Australia, i.e.
\[ p^{eh} = \sum_{i=1}^{5} w'_i \Delta p_{t-i} \]

3. Asset Values and Liabilities

All asset values are at end-of-quarter, except that the price series for dwellings is an average quarter measure.

3.1 Housing

The market value of the stock of dwellings owned by households is obtained by multiplying the average value of dwellings series by the stock of dwellings owned by persons (see Table 2 in text for details and sources of stock estimates).

3.2 Financial Assets

(i) Public's holdings of notes and coins [13]
(ii) Depositors' balances with Savings Banks [13]
(iii) Deposits by persons with Major Trading Banks [13]
(iv) Total outstandings of Permanent Building Societies [13]
(v) Special/Savings Bonds Outstanding [13]
(vi) Household sector holdings of Semi-Government Securities [8,14,15] (annual)
(vii) Household sector holdings of debentures, notes and deposits [8,14,15] (annual).

3.3 Reserves of Life Offices and Pension Funds [14,15]
3.4 Equities

Value at 30th June calculated as annual dividend income to households [2] divided by average yield on Sydney Stock Exchange at 30th June [13] plus one-half net annual purchases by households during the year [14,15]. (It is assumed that net purchases are evenly spread through the financial year.) Quarterly figures are obtained by interpolating the end-of-year figure using the ASE All Ordinaries Index [9].

3.5 Durable

Sum of estimates for cars and household durables calculated by the perpetual inventory method from quarterly national accounts consumption data using initial stock values and depreciation rates given in [11].

3.6 Liabilities: Loans Outstanding for Owner-Occupied Housing

(i) Savings Banks [13]
(ii) Major Trading Banks [13] (biannual)
(iii) Minor Trading Banks [7] (annual)
(iv) Permanent Building Societies [13]
(v) Terminating Building Societies [14,15] (annual)
(vi) Friendly Societies [14,15] (annual)
(vii) Life Insurance Offices [13]
(viii) Finance Companies [13]
(ix) Credit Unions [14,15] (annual)
(x) Defence Service Homes [7] (annual)
(xi) Government Housing Commissions [7] (annual)

3.7 Liabilities: Other Advances Outstanding to Persons

(i) Trading Banks [13] (biannual)
(ii) Instalment Credit [4]
(iii) Bankcard [13]
(iv) Credit Unions [14,15] (annual)
(v) Finance Company (personal loans) [13]
(vi) Life Insurance Offices [3]

4. Rates of Return

Tax rates used to convert to after-tax rate of return are the marginal rate on average weekly earnings [12].

4.1 Housing

The gross operating surplus accruing to dwellings owned by households is available on an annual basis in [2]. Gross operating surplus from ownership of dwellings is calculated as actual and imputed rents paid by households less rates.
insurance, maintenance and miscellaneous (including commissions). From this is deducted the operating surplus accruing to companies and public enterprises. Depreciation estimates used to derive net operating surplus are taken from [12]. Annual net operating surplus is assumed to be centred at 30th December and is interpolated linearly. Division by market value of dwellings owned by persons at beginning of quarter gives rate of return to which is added the expected rate of increase in the asset price of dwellings.

4.2 Financial Assets

Interest received by households for financial year [2] divided by value of financial assets at 31st March gives rate of return which is interpolated using one-year rate paid on debentures. [13]

4.3 Loans for Owner-Occupancy

Interest paid by households on these loans for financial year [2] divided by loans outstanding at 30 December gives mid-year rate of interest which is interpolated using the average rate charged on housing loans by Permanent Building Societies [13].

4.4 Other Loans

Consumer debt interest paid [5] divided by loans outstanding at beginning of quarter and converted to an annual rate.

5. Prices

5.1 Price Level

Implicit national accounts consumption deflator after taking out durables and rent [5].

5.2 Inflation

The four-quarter percentage change in 5.1.

5.3 Implicit Rental Price of Durables

Defined as \((1+\delta)(1-i)p_d\), where \(p_d\) is the implicit price deflator for cars and household durables [5], \(p_d\) is the four-quarter change in \(p_d\), \(i\) is the after-tax average rate of interest paid by permanent building societies [13] and \(\delta\) is the annual rate of depreciation taken from [11].

6. Liquidity

Private holdings of LGS [13], SRD's of Trading Banks [13], M3 [13].
7. Income

7.1 Personal disposable income [5].

7.2 Labour Income

Defined as $k \times (wages, \text{ salaries and supplement} - \text{PAYE taxation}) + \text{transfer payments from government to households.} The mark-up factor $k$ is the estimated total weekly hours of work by all of the work force divided by the estimated total weekly hours of work by wage and salary earners, i.e., it imputes a wage to the labour of self-employed and employers. Sources: [5,6].

8. Construction of Dwellings

8.1 Commencements [3].

8.2 Cost of Construction

Implicit national accounts deflator for investment in private dwellings [5]. The house component is an index of house construction costs; the flat component an index of building and construction wage rates and material prices. The index is converted to real terms by dividing by the price index defined in 5.1.

9. Excess Supply of Dwellings, $V$

$V = S - D$ where $S$ = total stock of dwellings (including those under construction) and $D = g \times$ number of households, where $g$ is dwellings demanded per household. The $g$ factor increases over time because of movement out of mobile and improvised housing and increased demand for second homes. Demand at census dates is taken to be the total stock less those unoccupied dwellings which are for sale, to let, new awaiting occupancy or vacant for repair. The values of $g$ at census dates were 1.0023(1966), 1.0070(1971), 1.0285(1976) and 1.0242(1981). A linear trend was fitted to these numbers and used to construct a quarterly series for $g$. The number of households is obtained by interpolating census estimates by population movements [1] assuming a linear change in the average household size between censuses. All data are end of quarter.

Sources


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