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ABSTRACT

This study extends recent work that developed and tested economic models of the joint decisions of household formation and homeownership. The cost of shelter is an important determinant of whether youth live independently (apart from parents and other nonrelated adults), and the cost of homeownership relative to renting is important to the tenure decision. Simulations suggest that the post-1985 decline and eventual removal of the Australian subsidy for first time homeowners has lowered the homeownership rate among young households by 23 percent, which is equivalent to slowing the time to first ownership by two years for such households.

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Earlier studies of household formation emphasized the impact of demographic factors (age, gender, race, and the presence of children) and personal income (Avery, Goldscheider, and Speare 1992; Santi 1990). Haurin, Hendershott, and Kim (HHK, 1993a) find in an analysis of U.S. youth that the cost of shelter is also an important additional explanatory variable.[1] Further, they argue that potential earnings in a full time job is an econometrically more appropriate measure of earnings capacity than current personal income, which is determined simultaneously with the household formation decision. Also, they argue that the presence of children in the household should be treated as an endogenous variable.

While prior studies of homeownership highlighted economic explanatory factors, especially relative price and income, their analyses have been limited to existing households rather than all potential households and they use income rather than earnings capacity. The sampling restriction results in possible sample selection bias. HHK (1993b) addressed this methodological problem and found that the cost of owning relative to renting influences

tenure choice (in both formulations), but the earnings capacity effect is greatly reduced once adjustments are made for the truncation of the sample.[2]

Our study extends the analyses of HHK by testing the household formation and tenure choice models using Australian data. Demographically, Australia has a greater percentage of its population concentrated in a few large cities, and economically it has a flatter wage-age profile than in the U.S. The tax and subsidy structure for owner-occupied housing also differs. For example, interest paid on home mortgages is deductible in the U.S. but not in Australia, and Australia had a subsidy that promoted first time homeownership during our study period while the U.S. did not. The subsidy is of special interest because the 1985 homeownership rates of Australians aged 20-23 were roughly 10 percentage points higher than those of their American counterparts, holding marital status constant. We test whether the tendency to own a home is affected by the subsidy and, finding the effect to be statistically significant, project that its elimination after 1986 has substantially lowered ownership rates of young Australian households.

We extend HHK's econometric model in three ways. First, we test explicitly whether the number of children is an exogenous explanatory variable in the household formation and tenure choice equations or is simultaneously determined. We find that children should be treated as exogenous to the living arrangement decision, but endogenous with respect to tenure choice. Second, we test whether the ratio of house price to rent, rather than the product of this ratio and user cost, is sufficient to capture price responses in the tenure decision. We find that the user cost exhibits a significant independent effect and that the estimates support using the theoretically correct product of the price ratio and user cost.[3] Finally, we test whether predicted wages (a measure of potential earnings) or actual wages (which incorporates temporary effects) better explain the decisions of youth employed full-time and find that the difference between actual and predicted wage does not add to the explanatory of predicted wage in either of the modeled decisions.

Before presenting the economic and econometric models, we provide a brief overview of the transitions to independent living and homeownership for Australian youth. Subsequent sections discuss

the Australian housing cost data, report estimation results, and compute an estimate of the impact of eliminating the Australian homeownership subsidy. A summary concludes the paper. Appendicies discuss measuring Australian real house prices and rents in the capital cities and estimating individual house values, loan-to-value ratios, and the tenure choice and marginal tax rates.

I. National Data on Young Australian Adults

We present descriptive results derived from weighted micro data using the 1985 Australian Longitudinal Survey (Social Science Data Archives, 1986, 1987). This data set contains information on employment, earnings, household and demographic characteristics of youth age, 16 to 25.[4]

Table 1 reports the percentages of Australian youth living independently. As expected, these percentages rise sharply with age. By age 25, about 40 percent of all Australian males and 55 percent of all females select an independent living arrangement. By way of comparison, the percentages for 25 year old American youth in 1987 were about ten percentage points higher.

The probability of independence varies greatly by marital status. The percentages of married youth

living alone is quite high (about 90%) as is the percentage of those with partners (75 to 80%), and neither result varies much with age. However, among single youth, the likelihood of independence is far lower and rises with age. The difference between independence likelihoods in Australia and the U.S. is concentated largely in singles, with two to four times as large a fraction of these Americans living independently.

Table 2 shows the homeownership rates for all youth and youth living independently, cross-classified by marital status. Not surprisingly, these data also rise sharply with age, especially for marrieds. By age 25, over one-half of Australian married couples are homeowners. Of all youth living independently, 44 percent are homeowners by age 25. American ownership rates of those living independently are similar at age 25, but are roughly ten percentage points lower for those ages 22-24. The differences exist for all household types.

II. Economic and Econometric Models

Youth are assumed to choose labor supply, living arrangement, number of children, housing quantity, and the consumption level of other goods

so as to maximize utility. Our model features the choice of living arrangements; possibilities include living with parents, living with a group, and living alone or with a spouse or partner in either a rented or owned unit.[5]

Our model is a simple representation of these choices. Utility for individual i, at location j is:

$$(1) \quad U_{ij} = U(\ell_{ij}, k_{ij}, h_{ij}, x_{ij}, z_{ij}, S_i),$$

where h is housing, k is the number of children, ℓ is leisure time, x is a residual composite good, z is the quantity of privacy in the living arrangement, and S is a vector of taste shifters. Privacy is a function of the type of living arrangement (m), thus $z_{ij} = z_{ij}(m_i)$.

The budget constraint reflects exogenous price variations by locality and living arrangement:

$$(2) \quad w_{ij}(1-\ell_{ij}) = p^h{}_{ijm}h_{ij} + p^k{}_{jm}k_{ij} + p^x{}_j x_{ij}.$$

In (2), w is the market wage faced by individuals of varying abilities and in various locations. The price of the composite good may vary across

localities, and that for child rearing varies over location and living arrangement. The price of housing (a rental rate or annual cost for owners) varies over location and living arrangement and among individuals because of differing tax liabilities.

Utility maximization yields a set of demand equations for ℓ, k, h, x and privacy.[6] When the demand equations are inserted back into (1), the indirect utility function is derived and represented as:

(3) $U^*_{ij} = U^*(w_{ij}, p^k_{jm}, p^h_{ijm}, p^x_j, S_i, m_i)$.

Our study focuses on the choice of living arrangement. In the empirical model, we separate this choice into two decisions: whether to live independently (alone or with spouse) and whether to own or rent. Because the latter choice is only observed if youth live independently, our model must account for a partially censored sample. We also allow for correlation between the stochastic errors in these two choice equations. This model is chosen because H-H-K (1993a) found that the factors affecting the leave-parental-home and live-alone decisions were quite similar. The model avoids the

problem of simultaneously selecting among four outcomes, a framework that would, in practice, require a restrictive multinomial logit approach.

The overall structure of the econometric model is represented by equations (4)-(8). The tendency to live outside of the parents' home and alone (A) compared to living with parents or in a group (G) is:

$$(4) \quad I^*_{AGi} = I_{AG}[U^*_{ij}(A) - U^*_{ij}(G)].$$

In general, I^*_{AGi} is a function of the market wage the individual could earn,[7] taste variables, and the prices of housing and child rearing.[8] With the additional assumption that utility has a stochastic component, we summarize the model as:

$$(5) \quad I^*_{Agi} = X_{Agi}\beta_{AG} + \epsilon_{Agi}$$

where X_{AG} is the vector of explanatory variables listed in (3).

We expect increased respondent's wage to raise the likelihood of living independently based on our assumptions that increased earning capacity raises the demand for privacy and additional privacy is obtained by leaving the parental home and group

quarters. We also use the local unemployment rate as a measure of the probability of a youth finding employment in the locality (higher rates are thus expected to reduce the likelihood of living independently). We expect increased prices of renting and homeowning to reduce the likelihood of living independently, as would a decreased price of remaining in the parental home or a group. In addition, a higher per capita number of government subsidized housing units in the state of residence is expected to increase the probability of living independently. Respondents in poor health are assumed to face a higher cost of living independently.

While we can measure the prices of renting and owning, we must use proxies for the price of living at home or in a group. These proxies include measures of the number of siblings, whether the respondent is first-born or a step-child, and the economic well-being of one's parents, which is assumed to be related to the parents' nationality and an indicator of whether the respondent's mother worked when the respondent was age 14. Measures of tastes included in (5) include indicators of whether the respondent is a recent immigrant or has the

ability to speak English and the respondent's religion. Demographic variables include race, gender and age.[9] and the number of the respondent's children.[10]

The tendency to own a home (O) rather than rent (R) is:

$$(6) \quad I^*_{ORi} = I_{OR}[U^*_{ij}(O) - U^*_{ij}(R)] = X_{ORi}\beta_{OR} + \epsilon_{ORi}.$$

Explanatory variables in (6) include potential wage[11], the price of owning relative to renting, the predicted number of children present in the household (see footnote 10), the number of siblings, birth order, age, race, and separate indicators of whether the respondent is a single male or female head of household. The expected signs of the coefficients are: positive for wage, reflecting our assumption that owned housing provides greater privacy (Haurin, Hendershott, and Ling, 1988); negative for the relative cost variable; and negative for single males and females reflecting their higher rates of mobility and lack of time to commit to home maintenance (Haurin and Kamara, 1993). We anticipate that increased numbers of siblings will reduce the possible parental

contribution to a downpayment (deposit) on an owned home, reducing the likelihood of ownership.[12] An increase in the predicted number of children should increase the demand for privacy and hence ownership.

Neither I^*_{AGi} nor I^*_{ORi} is observed, rather, two indicator variables are:

$$(7) \quad I_{AGi} = 1 \text{ if } I^*_{AGi} > 0,$$
$$= 0 \text{ if } I^*_{AGi} \leq 0$$

and

$$(8) \quad I_{ORi} = 1 \text{ if } I^*_{ORi} > 0, \; I_{AGi} = 1$$
$$= 0 \text{ if } I^*_{ORi} \leq 0, \; I_{AGi} = 1$$
$$= \text{unobserved if } I_{AGi} = 0.$$

We assume that the stochastic errors in (5) and (6), ϵ_{AGi} and ϵ_{ORi}, are iid, standard bivariate normal with correlation coefficient ρ. A full information maximum likelihood technique is used to derive the estimates.[13]

III. Measuring Real Housing Costs

Our measure of constant-quality real rents and real house prices in Australia combines data from the Real Estate Institute of Australia and the Australian Bureau of Statistics. Details of the

derivation of real rents and prices for the seven capital cities are reported in Appendix A.[14]

For the ith household in the jth locality, the annual cost of owning is the annual user cost of owned housing multiplied by the local cost of purchasing a standard amount of structure and land (V_j) in locality j:

$$(9)\quad USERCOST_{ij} = \{[(1-t_{ij})(1-v_i)r + v_i i - \pi + d](1-s_i) + \tau_j\}$$

$$(10)\quad OWNERCOST_{ij} = V_j\ USERCOST_{ij}.$$

The user cost depends on an individual's tenure choice income tax rate (t_{ij}), the pretax financing rate (r), the loan-to-value ratio (v_i), the expected rate of house price inflation (π), the rate of depreciation and maintenance costs (d), the subsidy rate for first time home buyers (s_i), and the local property tax rate (τ_j). The subsidy rate is the present value of subsidy payments divided by V_j; other variables, including v_i, are expected annual rates over the household's holding period. We label this measure of v_i the "present-value equivalent" loan-to-value ratio (see Appendix B on the

calculation of this variable). Because the subsidy rate depends on income, an endogenous variable, we use a subsidy value predicted in a reduced form equation.

We set r equal to 0.115 in 1985, π equal to 0.07, and use the constant-quality house prices described in Appendix A. The property tax rate assigned to each capital city is the average for the state, computed from the 1986 Income Distribution Survey. We assume a depreciation and maintenance rate of 0.035.

In October 1983, Australia adopted the First Home Owners Scheme (FHOS). First time homeowners with taxable incomes less than 130 percent of average male weekly earnings who had two or more dependants received nearly $6000 in present value of benefits; without dependants, the benefit still exceeded $4000.[15] We compute the present value of the FHOS subsidy in 1984-85 for all qualifying Australian households (see Bourassa and Hendershott, 1992, Appendix B, for a discussion of this calculation).

The tenure choice tax rate is the average rate at which housing costs are expected to be deductible and is thus measured as the ratio of the extra tax

saving from owning a house to nontaxed housing costs (Hendershott and Slemrod, 1983):

$$(11) \quad t_{ij} = [TAXR_{ij} - TAXO_{ij}]/V^*_j(1-v_i)i.$$

In (11), $TAXR_{ij}$ is the income tax household i residing in locality j would pay if it rented a dwelling of value V^*_j and $TAXO_{ij}$ is the tax it would pay if it owned the same unit. The tax saving should reflect the expected saving over the period the household expects to reside in the house. A detailed discussion of these calculations is presented in Appendix C.

In the estimation of the tendency to live independently, we select as the dwelling cost variable, $OWNERCOST_{ij}$ rather than the cost of renting (R_j). The two variables are highly correlated (0.74), and it is not possible to determine independent impacts. In our results, the effect of the OWNERCOST variable is more precisely estimated (t-ratio of 3.8 compared to 1.4).

In the tenure choice equation, our economic model calls for a measure of the cost of owning relative to that of renting, defined as:

$$(12) \quad RELCOST = OWNERCOST_{ij}/R_j = USERCOST_{ij}(V_j/R_j).$$

IV. Results

The model was tested using a sample of 3933 individuals aged 16 to 25 living in the seven capital cities.[16] Of these individuals, 841 lived independently and 307 were also homeowners. Full estimates of the bivariate probit model in equations (7) and (8) are reported in Table 3. The small (-0.055) and statistically insignificant correlation of errors in the two equations suggests that the bivariate results differ little from univariate ones.

Table 4 illustrates the ability of the equations to explain the data by reporting the percentage of respondents whose choices are correctly predicted for the total sample and two age classes.[17] The numbers in parentheses are the actual percentages of the relevant samples that are in the various categories. These percentages also equal the predicted percentages derived from a random assignment model, where the distribution of predicted outcomes equals the observed pattern. The economic model correctly predicts the living arrangement of 84 percent of the total sample (column 1) compared to the 67 percent correctly predicted by the random assignment (naive) model.

That is, the economic model explains half of the error in the random assignment model (17/33). The correct tenure decision is predicted for 71 percent of the sample of those living independently compared to 54 percent by the naive model. Here, the economic model explains 39 percent of the naive model error (17/46). The relative superiority of the economic model is similar for the two age classes. As would be expected, both models explain the dominant outcomes (living with parents or in groups and renting) better than the less usual outcomes (living alone and owning).

Previous studies report that socio-demographic variables are important determinants of independent living, and our results in Table 3 are corroborative. We find that variations in age and the number of children have large effects on the tendency to live alone, and the coefficients are precisely estimated with t-ratios of 10 and 22, respectively. Moreover, male respondents, aboriginals, and recent immigrants are all significantly less likely to be living alone, while youth who are Anglican, Protestant or who practice no religion are significantly more likely to be living alone than are Catholics and those of other

religious denominations. Lastly, youth who have step-mothers are also more likely to be living alone than are those with natural mothers.

Economic variables are also relevant, especially those relating to housing costs. As expected, the coefficient of the owner cost variable is negative and statistically significant (t ratio of about 4), and the availability of subsidized government housing has the expected positive coefficient with a t-ratio of 3. The respondent's potential wage and employment opportunities (local unemployment rate) variables are not statistically significant, but have the expected coefficient signs.[18] We also test whether the actual wage of those working full-time has any additional effect on household formation compared to our potential wage variable by including the difference between potential and actual wage for full-time workers only (WAGE DIF) in the estimation. Its t-ratio is only 0.3. In the tenure choice equation, we find that the two key economic variables are important and are estimated relatively precisely. The cost of owning relative to renting has the expected negative sign (t-ratio of 6), and the coefficient of the predicted wage is positive with a t-ratio of 3.5. The WAGE

DIF variable is again not significant (t=1.2). Moreover, the greater the number of siblings (the less likely are parents able to assist with the downpayment), the less likely is homeownership. (Neither the unemployment rate nor the government housing variable has an effect on tenure choice.) Of the "noneconomic variables," only the predicted number of children in the respondent's household has a statistically significant impact: the greater the predicted number, the greater the demand for privacy and the more likely is homeownership.

We test whether V_j/R_j and a fully specified user cost variable have independent effects on the tendency to own a home by splitting the relative cost variable into its components, V_j/R_j and $USERCOST_{ij}$, and including both in the estimation. The estimated coefficients are -0.17 and -27.5 and both are statistically different from zero (the price-rent ratio has a t-ratio of 5.2 and the user cost's is 2.7). Moreover, these coefficients are very similar to those implied by the equation using the aggregate relative cost variable. Given the -2.16 coefficient on the aggregate variable, the partial derivative with respect to V_j/R_i evaluated at the mean value of USERCOST is -2.16(0.074) = -0.16,

and that with respect to USERCOST is -2.16(14.73) = -31.8.[19]

A similar test is performed in the independent-living equation by splitting the ownercost variable into its components, V_j and $USERCOST_{ij}$. The estimated coefficients are -0.048 and -19.4, and both are statistically significant (house price has a t-ratio of 2.9 and the user cost's is 2.4). From the estimation using the aggregate ownercost variable, the partial derivative with respect to V_j evaluated at the mean value of USERCOST is -0.94(0.074) = -0.070, and that with respect to USERCOST at the mean value of V_j is -0.94(7.96) = -7.5. These partials are not as close to the components' estimates as was true for the tenure equation, but the differences are not statistically significant.

The estimation results can be converted into elasticities, which we evaluate at sample means for 25 year olds. The cost elasticities are -0.38 for the tendency to live alone and -2.38 for the tendency to own. Comparable values derived from a similar analysis of youth in the U.S. are -0.20 and -0.86. Thus, we find that Australian youth are two to three times more sensitive to shelter cost and

the relative cost of homeowning than are American youth.

The wage elasticities for Australian youth are 0.22 for living alone and 1.13 for the tendency to own. Comparable values found in the U.S. study are 0.48 and 0.28. That is, Australian youth are less sensitive in their living alone decision but more sensitive in their tenure decision.

V. Elimination of the FHOS

The value of the first time homeowners subsidy eroded throughout the second half of the 1980s, and the program was eliminated in 1990. We estimate the impact of this loss by first computing the changes in shelter cost and the relative owner cost that occur when s_i in equation (9) is set equal to zero. The average ownercost and relative cost rise by 7.0% for youth age 16-25: 8.4% for those age 16-20, and 5.7% for those age 21-25. The increase declines with age because older respondents have higher incomes, on average, and thus receive smaller subsidies.

The impact of eliminating the subsidy is computed by first predicting which youth would live independently and would be homeowners based on whether their predicted probabilities are above 0.5.

Then we recalculate the probabilities for the no subsidy case. We restrict ourselves to those over age 20 because the predicted headship rate for those under age 21 is only one percent and the predicted ownership rate is only two percent (it becomes zero with removal of the FHOS).

The impact on independent living is negligible, but that on ownership is large. For those age 21-25, the predicted headship rate declines from 15.5 to 15.0, a reduction of only 3 percent. In contrast, the ownership rate with the subsidy is 37.1 and without it is 28.5, a 23 percent decline. This 8.6 percentage point difference roughly matches the observed difference in ownership rates between 22-24 year old Australians and Americans (who were not eligible for a FHOS) in the middle 1980s. Because eligibility for the FHOS varies inversely with income, we anticipate that the impact is greater for lower income households. Using $20,000 for families and $10,000 for others as the division between low and high income in 1985, removal of the subsidy reduces the ownership rate for higher income owners by 19 percent versus 31 percent for lower income owners.

An alternative measure of the impact of the subsidy program is to consider the growth path of ownership with increasing age. Elimination of FHOS slows the time to ownership by two years for Australian households age 21-25.

VI. Conclusion

We have confirmed that a combined economic and socio-demographic model of household formation and tenure choice is successful in describing the behavior of Australian youth. Young Australians are more likely to live independently (either alone or with spouse) the lower the real cost of shelter. The cost of owning is a better explanatory variable than the cost of renting, and a proxy for the availability of subsidized government housing is also a statistically significant explanatory variable. Further, if the cost of owner housing is low relative to the cost of rental housing, young Australians are more likely to own their housing. Tests indicate that both the user cost and the house price (household formations) or price/rent ratio (tenure choice) are important explanatory variables. Also, the more siblings one has (the less likely are parents able to assist with the downpayment), the less likely is homeownership. Overall, the

responses to variations in the cost of shelter of young Australians are two to three times as large as that of young Americans.

The independent influence of the user cost implies that an individual's tax and housing subsidy affect housing decisions. Using the estimated relationship, we simulate the impact of removal of the first time homeowners scheme on homeownership of youth and find a 23 percentage point decrease in the rate of households age 21 to 25 (the rate declines from 37.1 to 28.5).

A youth's earnings capacity (predicted wage rate if a full-time worker) has only a marginal impact on his/her independent living decision but a major impact on the tenure decision (somewhat the reverse of the U.S.). Finally, our results indicate that the choice of family size (number of children) is made simultaneously with the choice of tenure, but can be treated as exogenous to the household formation decision.

FOOTNOTES

1. Other studies of household formation based on economic models include Moffitt (1992) and Winkler (1992), both focusing on the choices of welfare recipients. An early study of the impact of housing costs on household formation in the U.S. was by Borsch-Supan (1986). A monograph by Young (1987) describes household formation in Australia in the socio-demographic tradition.

2. Attempts to model the effects of economic and demographic variables on independent living and housing decisions of Australians include the long-term projections of the Indicative Planning Council for the Housing Industry (1989) and the National Housing Strategy (1991). Neither study appropriately specifies the housing cost measure because the effects of taxes and expected appreciation are excluded. Moreover, neither model is based on micro-level data.

3. Note the analogy to the Eisner-Jorgenson debate on the independent effects of the income growth rate and the user cost on business investment. When the variable impacts were estimated separately there, only the growth rate seemed to matter (Eisner, 1969). For a summary of this debate and evidence that the user cost has an independent effect on equipment orders, see Hendershott and Hu (1981).

4. The data are corrected for a recent error discovered in ALS "created variables."

5. Respondents who indicate they are de facto married are categorized as living with a partner. In the following discussion, we treat de facto married respondents as married.

6. Note that we do not allow location to be chosen, thus intercity migration is not modeled. The existing literature on internal migration considers this question; however, it generally ignores locational differences in the cost of shelter (Greenwood 1985).

7. Note that labor income, the variable used in most prior studies, is not appropriate. Because leisure is a choice variable, we select the potential market wage as the measure of earning capacity. Our estimate of potential wage must account for the many youth with no observed wage and for part-time workers where the observed wage differs from the wage that would be earned in full-time employment. We use a two-step selection bias correction technique (Heckman, 1979), first estimating a probit equation on the choice of whether to work full-time, then estimating a selection corrected OLS equation for wage. Potential wage rates are calculated for all respondents and their spouses (results for these reduced form equations are available from the authors).

8. The price of the net-of-shelter composite good appears to be invariant across Australian capital cities.

9. The respondent's marital status is not directly included because it is likely determined simultaneously with the decision of living independently (HHK 1993a). Thus, our estimate of the impact of the explanatory variables includes both the direct effect on the tendency to live independently and the indirect effect through the tendency to marry.

10. We test for the exogeneity of the number of children using the method of Rivers and Vuong (1988). First, we estimate a reduced form OLS equation that predicts the number of children. We then include both the actual number of children and the difference between the predicted and observed number in a univariate probit model explaining a household decision. When these two variables are included in the living-alone probit the coefficient of the difference variable is not significantly different from zero, and thus the number of children is appropriately treated as exogenous. When these two variables are included in the tenure-choice probit, the difference variable is significantly different from zero and thus the number of children is treated as endogenous (the predicted number of children is included in the tenure equation).

11. We include the spouse's potential wage (if the respondent is married) in our measure of household earnings capacity following HHK (1993b). This choice, in effect, treats the marriage decision as exogenous to the repondent's choice of tenure.

12. Being first-born may particularly reduce the amount of parental contribution given that other siblings are likely to still be in the parental home; alternatively, parents may favor their first born (Pfouts 1980).

13. The statistical package is LIMDEP, which produces correct standard errors for this censored estimation problem.

14. The only omitted capital city is Darwin, the smallest among the eight capital cities. Australian youth (like all Australians) are highly concentrated in capital cities; e.g. in 1986, 65% of youth aged 15 to 24 lived in these areas.

15. These data are from Hendershott (1989). The FHOS substantially increased benefits relative to the earlier Homes Savings Grant and Home Deposit Assistance Schemes passed in 1964 (with major changes in 1976) and 1982, respectively, and made single-person households eligible for a grant.

16. The sample excludes all youth currently enrolled full-time in school or a training program.

17. The estimating equations produce z scores that can be translated into probabilities. We assume the event occurs if the predicted probability of the event is 0.5 or higher and that it does not occur if the predicted probability is less than 0.5.

18. If we use a wage variable that includes spouse's potential earnings, the coefficient becomes nine times larger and the t-ratio is 33. The other economic variables remain significant, but the coefficient of AGE in the household formation equation becomes negative and is marginally significant. In the tenure choice equation, the wage coefficient nearly doubles with this change in measurement of wage in the household formation equation. Clearly, either a marriage dummy variable or a variable that indicates the economic consequences of marriage is highly correlated with leaving home; but, is likely simultaneously determined.

19. In a 1988 paper, Goodman used the V_j/R_j variable and a "value-rent" ratio calculated for each dwelling unit. He argues that the latter variable reflects expectations about capital gains which is part of user cost. However, a full user cost measure is not included in his estimate.

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Appendix A: Real House Prices and Rents

The Real Estate Institute of Australia (REIA) has reported rental costs and asset prices for three-bedroom houses in the capital cities other than Darwin and Hobart since 1979 (prices) and 1982 (rents). Hobart prices were added in 1984. The Australian Bureau of Statistics (ABS) publishes CPI rent and, since September 1986, constant-quality asset price indexes for the capital cities. These indexes likely provide more accurate relations for individual cities over time, but the REIA data must be used to obtain cross-sectional estimates of house price variation.

The REIA series are far more volatile than the ABS indexes. For example, between March 1985 and September 1987, the REIA series in Sydney and Canberra rose by 68 and 5 percent, respectively, while the ABS indexes rose by 33 and 23 percent. In contrast, between September 1987 and June 1992, the REIA series fell by 4 percent in Sydney and rose by 34 percent in Canberra, while the ABS indexes rose by 39 and 24 percent, respectively. Thus, which period we take the REIA data from matters.

We have chosen the fiscal year 1989-90 averages because we believe they give the most plausible rent relationships between the cities over the entire 1985-91 period. Multiplying each of

these averages by the ratio of the December 1984 ABS CPI rent index for the city to the 1989-90 ABS CPI rent index for the same city converts these to December 1984 equivalents. The second half 1987 data for Hobart were converted to a December 1984 number in a similar manner. Because the nonhousing cost of living does not appear to vary across capital cities (the net-of-shelter consumer price indexes for the capital cities move almost identically), no deflation is necessary. For asset prices, we use the average REIA prices for the year ending in June 1985.

Appendix B: Estimating House Values and LTV Ratios

These estimates are based on a sample of 321 homeowning married couples under age 30 in the 1986 Australian Income Distribution Survey. For the house value, we estimate:

$$\ln V_{ij} = \underset{(26.7)}{10.0} + \underset{(2.6)}{0.02}\ (\ln y^*_i) + \underset{(1.8)}{0.065}\ (\ln[y_i - y^*_i]) + \underset{(4.5)}{0.385}\ (V_j/V)$$

where V_{ij} is the asset value of the i-th couple's house in location j, y_i^* and y_i are their investment income and total income, V_j is the constant quality

asset price of houses in area j, and V is the weighted average of house prices in all capital cities. The t-ratios are given in parentheses.

For the loan-to-value ratio, we estimate:

$$\underset{}{LTV_{ij}} = \underset{(18.0)}{0.65} - \underset{(4.5)}{0.17}\ (OLDER) - \underset{(3.0)}{5.5}\ (y^*_i/V_{ij})$$

where OLDER is a dummy variable equaling 1 if the household head (defined as the husband) is age 25-29, and 0 otherwise. We assume a representative age of 27.5 years for the older group and 23 years for the younger group. The LTV for 23 year old youth is 0.65; for 27.5 year olds it is 0.48. Thus the LTV declines by 0.17/4.5, or about 0.038 per year of age. The 27.5 year old has likely owned for about four years on average, and the 23 year old for about one year. These LTVs are consistent with an initial LTV of 0.7 and regular amortization plus annual extra repayments of 2 percent of the loan beginning in the second year. That is, with a 20-year, 11.5 percent loan and 5.5 percent annual rise in nominal house value, this scenario yields the correct LTVs, assuming no investment income. With investment income, the initial LTV is lower. For the current LTV, we represent the estimated equation as:

$$LTV_{ij} = \max[0, \min[0.75,\ 0.65 - 0.038(AGE - 23) - 5.5(y^*_i/V_{ij})]]$$

where AGE is the age of the household head.

For the present value equivalent LTV (v_{ij}^*), we solve for the single LTV that would, if maintained over the household's holding period, yield the same present value interest earned on equity invested in the house that the household would earn with our projected declining LTV_{ij} (LTV_{ijt}). That is, we solve for:

$$(A\text{-}4) \qquad \sum_{t=1}^{N} \frac{(1-v_{ij}^*)\, rV_{ij}}{(1+r)^t} = \sum_{t=1}^{N} \frac{(1-LTV_{ijt})\, rV_{ij}}{(1+r)^t}$$

for v_{ij}^*. We assume that N = 10 and set r = 0.115. Next, we set $LTV_{ijt} = LTV_{ijt}' - 5.5(y_i^*/V_{ij})$, where the LTV_{ijt}'s are, running from 1 to 10: 0.7, 0.655, 0.59, 0.53, 0.47, 0.41, 0.35, 0.29, 0.23, and 0.17. These are consistent with the assumed house price appreciation rate and repayment schedule.

Canceling the rV_{ij} and substituting for the LTV_{ijt}, we have:

$$(A\text{-}5) \qquad (1-v_{ij}^*) = \frac{\sum_{t=1}^{10} \frac{(1-LTV_{ijt})}{1.115^t}}{\sum_{t=1}^{10} \frac{1}{1.115^t}} + 5.5(y_i^*/V_{ij}).$$

The result is $v_{ij}^* = \max[0.5 - 5.5(y_i^*/V_{ij}),\ 0]$.

Appendix C: Computation of the Australian Tax Rates

Tenure Choice Tax Rate

For current renters, we first calculate gross taxes owed, attributing half of nonwage income to each spouse (if married), using the General Revenue and Medicare tax schedules. We then calculate rebates for married couples and single household heads with children. The tax as a renter is the difference between the gross tax of the household and its rebates (described later in this appendix). To compute the taxes renters would owe if they were owners requires an estimate of the amount taxable income would be reduced (split equally between spouses) owing to the nontaxable equity invested in the house rather than in taxable investment assets. This equity equals the product of: the quantity of housing that would be purchased, unity less the present-value equivalent LTV, and the interest rate they could earn on an equally risky investment (which we take to be 11.5 in 1985). The tax of current renters when treated as owners is then computed. Finally, their tenure choice tax rate is derived following eqn. (11).

For current owners, taxable income as renters is computed by adding an estimate of the additional investment income they would have, had they not invested in their house. This amount is the product

of their estimated house value, unity less the estimated current (not the present-value equivalent) LTV, and the interest rate. The "permanent" taxable income of owners is their income as renters less the product of: house value, unity less their present-value equivalent LTV, and the interest rate. Again, the tenure choice tax rate is derived.

Current income is not representative of the earnings in full-time work for much of the sample. Thus, similar to our procedure for wages, we estimate a tenure choice tax rate equation using a sample limited to full-time workers, correcting for sample selection bias. The predicted values of t_{ij} from this equation are used in the calculation of $OWNERCOST_{ij}$ for all youth. (Results of this estimation are available from the authors.)

Income Tax Rates

Income taxes for individuals (not households) in Australia are calculated in two steps. First, gross taxes are computed by applying the general revenue and Medicare tax schedules to reported income. Second, rebates are computed. Total taxes paid are gross taxes less rebates. The general revenue and Medicare income tax rate schedules for 1984-85 were:

General Revenue		Medicare	
Income range	Marg. rate	Income range	Marg. rate
$0-4595	0	$0- 7110	0
4596-12500	0.2667	7111- 7484	0.20
12501-19500	0.30	7485-73332	0.01
19501-28000	0.46	73333+	0
28001-35000	0.4733		
35001-35788	0.5533		
35789+	0.60		

Taxable income under both schedules includes, among other things: income from wages, salaries, businesses, and partnerships; net dividends, interest, and rents (investment income); social security pensions and benefits, and unemployment benefits. For married couples with combined income above $73,332, the maximum combined Medicare levy is $733. The maximum levy per person is $733, less the minimum of either the levy that would be owed by his or her spouse ignoring this adjustment or $366.

For married couples, tax rebates include the dependant spouse rebate (includes de facto wife or husband) of $830 (or $1,030 if there are also dependant children under 16 years of age or under 25 years of age and engaged in full-time education at a school, college, or university). This rebate is reduced by $1 for every $4 by which the spouse's separate net income exceeds $282. Sole parents of a

child or children meeting the above criteria were eligible for tax rebates of up to $780. Married couples and sole parents with dependant children and with incomes less than $11,830 plus $1,330 times the number of dependent children paid no Medicare levy. With incomes greater than this limit, some households were eligible for a rebate of the Medicare levy. This rebate is calculated as:

$$\text{Rebate} = \max \{0.01[11830 + 1330(\text{Dep.Child})] - 0.19[\text{HHY} - (11830 + 1330(\text{Dep.Child}))],0\}$$

where HHY refers to the spouses' combined incomes. This rebate is split between the spouses in proportion to their incomes.

A number of additional rebates were allowed in 1984-85, but are ignored in this study. These include rebates for dependent parents and invalid relatives of taxpayers, and rebates for recipients of pensions, unemployment and sickness benefits. We assume that these rebates benefitted only small numbers of young adults. Also, in some circumstances, limited "concessional rebates" were allowed for medical and funeral expenses, insurance and superannuation premiums, educational expenses, and property taxes on principal residences. Only a small percentage of taxpayers of all ages (less than

six percent) received these concessional rebates, and their average value was quite low ($194). Similarly, deductions from taxable income would have been quite low for individuals in our sample and were therefore ignored.