Explaining Life-Cycle Profiles of Home-Ownership and Labour Supply*

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Abstract

In this paper we show the extent that home ownership varies over the life-cycle and differs by cohort and by education. We explain these differences in a calibrated model of life-cycle behaviour where households choose labour supply and consumption and also home-ownbership status. Home-ownership is associated with greater labour supply both in the model and in the data. We use the model to show the effect that alternative assumptions on capital market imperfections make to home-ownership and to labour supply. Increases in downpayment requirements leads to delays in home ownership. Decreases in the permitted debt to income ratio lead to less home-ownership across the life-cycle.

JEL Codes: J22, D91.

Keywords: Housing, labour supply, life-cycle models, borrowing constraints.

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1 Introduction

For many households, housing wealth comprises a large fraction of total household wealth. For example, in the UK in 2000, housing wealth made up 80% of the non-pension wealth of households in the British Household Panel Survey. However, owning a home is often associated with large mortgage debt. By contrast, debt among non-home owners is small. Such differences in debt are likely to affect liquid savings, labour supply and non-durable consumption. The main aim of this paper is to explore these interactions, and in particular to focus on how labour supply, home ownership and debt interact.

The importance of labour supply in this context has been a particularly neglected area of research. Labour supply is likely to matter for a number of reasons: banks and other mortgage lenders have explicit policies that relate debt to current household earnings, and so greater labour supply increases the availability of debt. Further, the ability to vary labour supply once a household has a mortgage gives extra protection against interest rate uncertainty. At an empirical level, Bottazzi (2004) has studied some of these relationships, showing that women in households with greater mortgage commitments are more likely to participate in the labour force. Clearly labour supply, debt and home-ownership are jointly determined and we cannot treat the extent of the mortgage as exogenous. For example, individuals may have taken out greater debt knowing they were going to be working or they might have had to return to work because their debt payments were unexpectedly large. Our motivation in the current paper is to try to disentangle these effects by building a structural life-cycle model of labour supply and housing choices. A further motivation is to understand the timing of house purchases over the life-cycle. This will again

be affected by labour supply choices

In the structural model, liquidity constraints lead households who have not yet purchased a house to work more to increase savings and to bring forward the date at which they can afford to buy a house. Further, working more can help relax any income related constraint on mortgage borrowing. We calibrate our model to match the level of home ownership in the data and then simulate the model to address a number of questions: first, we show that the labour supply of home owners is greater than that of non-owners. Second, greater debt holdings leads to greater labour supply; this effect is small because the consumption elasticity of intertemporal substitution is greater than the labour supply intertemporal elasticity and so adjustment occurs more through consumption than hours worked. Third, we show that changes to the financial environment change home-ownership and labour supply patterns: reducing downpayment requirements leads to households buying their homes earlier in the life-cycle and also to lower labour supply; increasing the multiple of household income that households can borrow against leads to earlier home ownership, but negligible effect on labour supply.

The rest of the paper is structured as follows. Section 2 reports life-cycle patterns of home ownership and labour supply in the data. Section 3 presents the structural model. Section 4 discusses the calibration strategy and shows the calibrated solution. Section 5 addresses the question of how labour supply and home ownership interact and section 6 addresses the question of how changes to the capital market affect home ownership and labour supply. Section 7 concludes.

2 Data: Patterns of Home Ownership

The aim of this section is to highlight the main facts about home ownership that we want to understand using our model. We begin by showing how home owenership rates vary over the life-cycle and by education and by showing the probability of transition between different home-ownership states.

2.1 Data

We use the Family Expenditure Survey (FES) to construct pseudo-cohorts from which we can plot home-ownership proportions. For the home-ownership transitions, we use the British Household Panel Survey (BHPS) which is now a 12 year panel.

For the inputs into the calibrated model, we need to use data on wages, the house price process and the interest rate on the liquid asset. For the calibration, we need life-cycle profiles of home-ownership status and transition probailities between home-ownership states over the life cycle. To assess the calibration, we use data on labour supply choices over the life-cycle and labour supply conditional on being in debt.

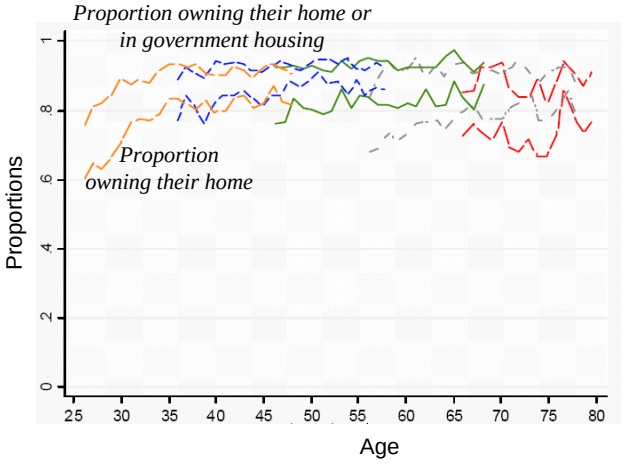
For data on house prices we use the Office of the Deputy Prime Minister (ODPM) national and regional house price series for the UK. For interest rates we will use the Bank of England base rates. For the wage process, we estimate deterministic wage growth from the Family Expenditure Survey (FES). Wage rate uncertainty is taken from Low, Meghir and Pistaferri (2005).

2.2 Life-cycle Profiles and Transitions

Figures 1 and 2 report home-ownership status by age and cohort for the high and low education groups (where high education means at least some college

education). The profiles are created from pseudo-cohorts in the UK Family Expenditure Survey. We report the proportion owning their home and the proportion either owning or in government housing. There appears substantial increases in home-ownership by age, particularly for the low educated. However, part of this increase is a year effect caused by the transfer of government owned housing into private ownership that took place in the 1980s. By including the total proportion either owning or in government housing, we can partially remove this effect. For the low educated, this combined proportion varies little by age or by cohort. For the high educated, there remains some age effect: the proportion owning their homes increases with age up to about age 35. There is relatively little decline in home-ownership as households age, but this may mask transitions to houses of smaller size.

Figure 1: Home-Ownership Status in the UK (High education)



The difficulty of interpreting the figures or regressions on home ownership is that they capture status at a particular point in time, whereas home-ownership is a very persistent state. This persistence is highlighted in Figure 3 where

Figure 2: Home-Ownership Status in the UK (Low Education)

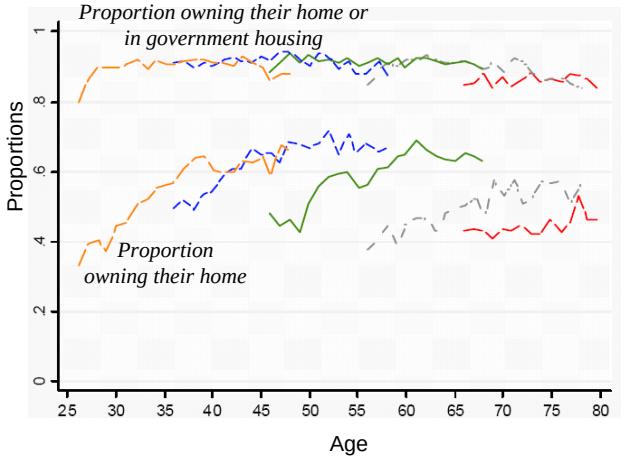
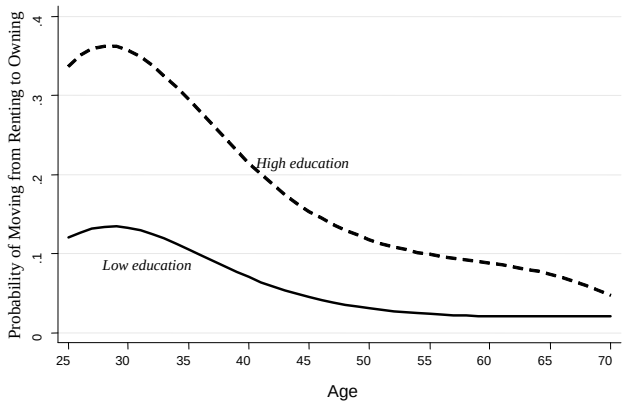


Figure 3: Transition Probabilities over the Life-Cycle



we report transitions from renting to owning. Table 1 reports estimates of the transition probabilities estimated by multinomial logit conditioning on a standard set of observable characteristics. The model in section 3 aims to match both home ownership rates and also these transition probabilities.

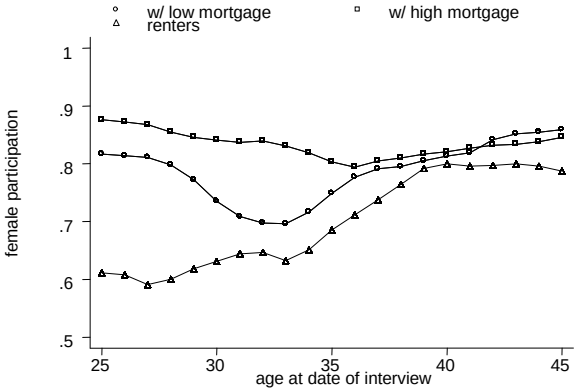
Table 1: Logit Regressions for Becoming a Home Owner

	High Education		*Low Education*	
Age	0.22	(1.96)	0.059	(3.08)
Age^2	-0.0075	(-1.94)	-0.0019	(-3.13)
Age^3	$1.06 * 10^{-4}$	(1.85)	$2.52 * 10^{-5}$	(3.03)
Age^4	$-5.47 * 10^{-7}$	(-1.77)	$1.18 * 10^{-7}$	(-2.88)
Couple	0.069	(4.67)	0.023	(5.76)
Children	0.052	(0.31)	0.0093	(0.24)
No. of Children	-0.19	(-2.15)	-0.056	(-2.71)
Children * Age	-0.0033	(-0.75)	$5.57 * 10^{-4}$	(-0.53)
No. of Children * Age	0.0052	(2.18)	0.0012	(2.03)
Conurbation	-0.024	(-1.59)	-0.011	(-2.79)
London/SE	$-3.8 * 10^{-4}$	(-0.03)	0.011	(2.56)
Number of obserations	2492		9963	
Mean Probability: Rent to Own	0.16		0.050	
Pseudo R^2	0.0695		0.0746	
$LR - \chi^2$	152.33		296.17	

Marginal effects (z-statistic of underlying coefficient). Dependent variable = 1 if the household moves from renting to home-ownership, 0 otherwise. The sample is households renting in t-1.
The measure of *Pseudo* R^2 is $1 - L_1/L_0$.

However, the main point of the model is to try to model the interaction between the housing choice and the labour supply choice. This interaction will depend crucially on the extent of mortgage debt held by the household. As shown by Bottazzi (2004) and reproduced in figure (4), women in households

Figure 4: Female Participation by Age and Housing Status



which own their homes are more likely to participate and those with greater mortgage debt are more likely to participate.

Participation is likely to be greater for those with greater debt firstly because of a wealth effect and secondly because mortgage repayments can be seen as committed expenditure. Of course, participation and debt are joint decisions and we cannot treat the extent of debt as exogenous. This is the reason we resort to calibration of a structural model of housing and labour supply: it enables us to model explicitly the labour supply decision when households are making a decision about housing.

3 Model of housing and labour supply

A household lives T periods. In every period $t \leq T$, the household maximises utility by choosing consumption $c_t \in R_+$, housing $h_t \in \{0, 1\}$ and the fraction of household time devoted to leisure[1] $l_t \in [0, 1]$. The household value function

[1] Our current model assumes a single household labor supply choice with one wage. This is clearly restrictive and was necessitated by computational feasibility.

in period t is given by

$$V_t\left(A_t, h_t, p_t, w_t\right) \max_{\{c_t, h_t, l_t\}} u\left(c_t, h_t, l_t\right) + \beta E V_{t+1}\left(A_{t+1}, h_{t+1}, p_{t+1}, w_{t+1}\right)$$

subject to

$$A_{t+1} = (1 + r_{t+1}) \begin{pmatrix} A_t + p_t h_{t-1}(1-F) \begin{bmatrix} I\{\delta = 1\} \\ +I\{h_t = 0, \delta = 0\} \end{bmatrix} \\ +w_t(L - l_t) - c_t \qquad if \quad h_{t-1} = 1 \\ \\ A_t - p_t h_t(1+F) + w_t(L - l_t) - c_t \\ \qquad if \quad h_{t-1} = 0 \end{pmatrix}$$

where A_t is the start of period asset stock and r_{t+1} is the interest rate on the liquid asset; δ is an indicator of having to sell the house, which occurs with an exogenous probability; p_t is the price of housing which is realised at the start of period t; F is the cost of selling or buying a house, which is proportional to the price; the household has a time endowment L which is allocated to leisure l_t or work at wage w_t per hour.

For households which are home-owners at the start of period t, liquid income in a particular period is given by liquid assets at the start of the period plus the value of the house if the household has been forced to sell ($\delta = 1$) or the household chose to sell ($\delta = 0, h_t = 0$) plus earnings from working. For households which are not home-owners at the start of period t, liquid income in a particular period is given by liquid assets at the start of the period minus the cost of buying a house if the household chooses to buy in period t plus earnings from working.

We impose the terminal condition$A_{T+1} = 0$. The specification of marginal utility becoming infinite at 0 consumption means this terminal condition pre-

vents households borrowing more than they can repay with certainty. In addition to this implicit borrowing constraint, we allow for two explicit constraints. The first is a constraint on the fraction of the value of a house that a household is able to borrow at the time of purchase. This implies a constraint on end of period assets, s_t, in the period that the house is bought:

$$s_t \geq -\lambda_h p_t h_t$$

The value $(1 - \lambda_h)$ can be thought of as a downpayment requirement.

The second constraint is on the the debt to income ratio. Individuals in period t are not able to borrow more than a multiple λ_y of their earnings in that period. This constraint is imposed whether or not house status changes in period t.

$$s_t \geq -\left(\lambda_y w_t \left(L - l_t\right)\right)$$

These constraints are on the stock of debt rather than only on new borrowing and are taken to be exogenous.

The house price follows an AR(1) process:

$$\ln p_t = d_t + \phi \ln p_{t-1} + \varepsilon_t \qquad \varepsilon_t \sim N\left(-\frac{\sigma_\varepsilon^2}{2}, \sigma_\varepsilon^2\right)$$

where d_t is the deterministic trend. We assume that house price risk is aggregate risk. The interest rate on liquid assets or debt is also an aggregate rate and follows an i.i.d process:

$$r_t = \bar{r} + \nu_t \qquad \nu_t \sim N\left(0, \sigma_\nu^2\right)$$

The wage process is idiosyncratic and follows a random walk:

$$\ln w_t = a_t + v_t \quad \text{where} \;\; v_t = v_{t-1} + \xi_t, \quad \xi_t \sim N\left(-\frac{\sigma_\xi^2}{2}, \sigma_\xi^2\right) \tag{1}$$

where a_t is the deterministic growth in wages.

4 Calibration

We begin this section by specifying exogenous parameters. We then report the results of the calibration and the simulated life-cycle profiles. We end the section by showing some implications of our baseline parameterisation.

Parameter values are summarised in table 2. Since the house price is treated as an aggregate shock, the particular realisation of the process is set to match the realisation for the particular cohort born in the 1940s. The deterministic component to wage growth is estimated from the FES separately by education group. We assume households exist from age 22 to 67.[2]

The within period utility function is specified as

$$u\left(c_t, h_t, l_t\right) = e^{\theta h_t} \frac{\left[c^\eta l^{1-\eta}\right]^{1-\gamma}}{1-\gamma}. \tag{2}$$

The preference parameters η and γ in the utility function are set to match estimated elasticities in the data: the consumption elasticity of intertemporal substitution is set at 0.7 (from Attanasio and Weber, 1995) and the hours of work elasticity of intertemporal substitution is set at 0.3 (from Pistaferri, 2003). These numbers correspond to $\gamma = 1.58$ and $\eta = 0.74$ for our within period utility function.

We select the preference parameter for housing[3] and the fixed cost of housing

[2] We do not model retirement behaviour. This has the implication that households run down all assets by age 65 and will lead to an overestimate of the amount of selling of homes towards the end of life.

[3] Since the estimates of the intertemporal elasticities are taken from papers which do not condition on home ownership, there is a possible bias.

Table 2: Parameter Values

Parameter	*Low Education*	*High Education*
Calibrated Parameters		
F	0.03	0.03
θ	-0.03	-0.03
Exogenous Parameters		
λ_y	3.0	
λ_h	0.9	
γ	1.58	
η	0.74	
ϕ	0.94	
σ_ϵ	0.089	
σ_ξ	0.122	
σ_ν	0.046	
$\bar{r}$	0.015	

for each education group through calibration, matching average life-cycle home-ownership rates and the transition probability from ownership into renting.

Table 3: Calibration Statistics

Statistic	High Education		Low Education	
	Data	Model	Data	Model
Ownership Rate Age $26-35$	0.74	0.64	0.58	0.53
Ownership Rate Age $36-60$	0.84	0.85	0.66	0.67
Probability of Moving Age $26-60$	1.54	2.90	1.49	4.10
$\frac{Median \quad p_t}{Median \quad w_t(L-l_t)}$ Age $22-26$	3.5	2.8	3.5	2.9

Home ownership rates are measured across families (as defined for the purposes of assessing benefit eligibility) in the British Family Expenditure Survey (FES), and data come from the years 1991-2000. Data from the years prior to 1991 are discarded because of the effect of large-scale selling off of local authority housing. Probabilities for moving from owning to renting are the proportion of home owning families in the BHPS (1991-2002) who become non-owners between years of the panel survey.

We turn now to showing variables which have not been used in the calibration to assess the validity of the model. We begin by showing in Figure 6 simulated and actual transition probabilities between renting to owning. The actual transitions are calculated from the BHPS. We match these transition paths fairly closely, with slight underpredicting of the transition probability when young. What we overestimate in our simulations is the transition back from owning to renting: as shown in Table 3, too many households sell their houses in our simulations, particularly when old.

Figure 7 reports simulated mean asset to mean income profiles. The definition of assets are all liquid assets which is liquid wealth minus outstanding debt.

Figure 5: Simulated Homeownership Rates

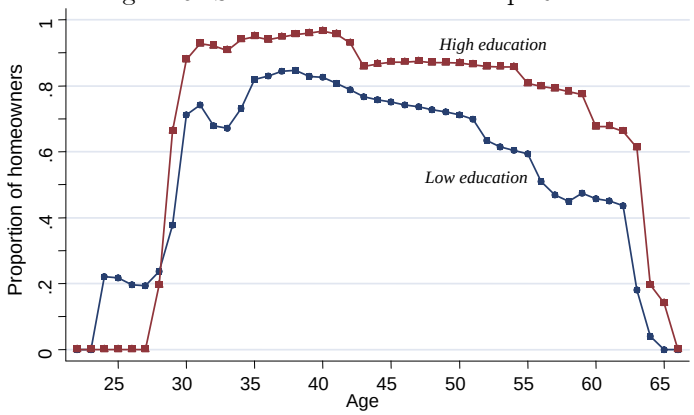


Figure 6: Simulated Transition Probabilities

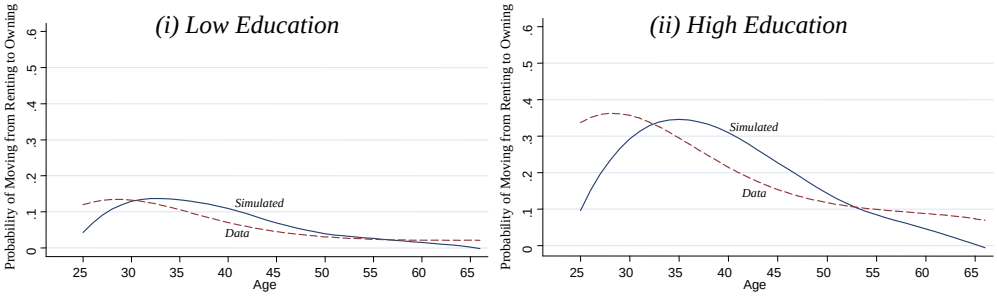
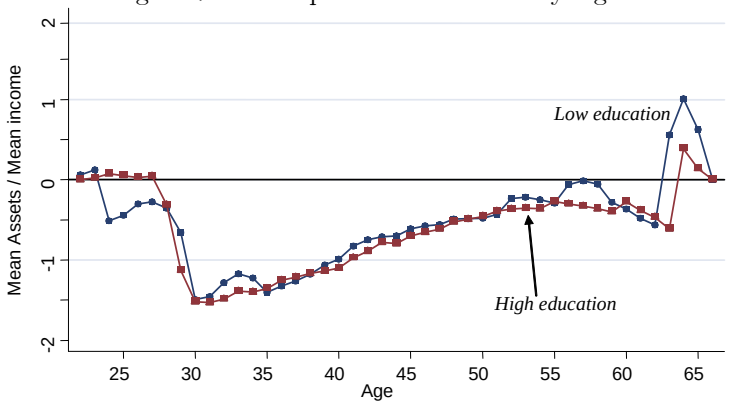


Figure 7: Net Liquid Asset Position by Age



In our model, the rate of interest is the same on debt and liquid wealth and so we can concentrate on the net position. The large fall in the net position occurs when households buy their homes, the gradual subsequent reduction in debt is the repayment of the mortgage.

5 Labour Supply and Home Ownership

One of the main aims of our model is to analyse the interaction between labour supply and housing choices. The key question is how labour supply varies by home-ownership. In Figure 8 and in Table 4, we report labour supply by home-ownership status: home owners work longer hours than those renting, in a similar way to the evidence in Bottazzi (2004) and discussed above. This effect of greater labour supply among home-owners is driven primarily by greater debt holdings: greater debt means lower total expenditure in the current period, but when the home-owner ages and releases capital from the house, consumption and leisure both rise. In other words, the option of home-ownership raises expected lifetime utility, but it induces intertemporal substitution: households

buy their homes, forfeiting current consumption and leisure, in order to profit from the fast house price growth and high consumption and leisure in the future. Since the consumption elasticity intertemporal substitution is larger than the labour supply intertemporal elasticity, more of the adjustment will occur through consumption.

Table 4: Mortgage-Debt and Labour Supply

Statistic	High Education		Low Education	
	Data	Model	Data	Model
Homeowners Age $26-35$	37.2	0.77	36.0	0.76
Non-Homeowners Age $26-35$	32.4	0.74	30.2	0.75
Homeowners Age $36-60$	33.0	0.74	32.7	0.74
Non-Homeowners Age $36-60$	29.2	0.72	28.8	0.72

For the data columns, we report average male hours per week. For the simulations, we report the fraction of time that the household allocates to labour supply.

An alternative way of exploring the relation between labour supply and home ownership is to calculate home ownership profiles over the life-cycle for the case where labour supply is fixed at the life-cycle mean value and the case where labour supply is flexible, as in our baseline. Figure **??** makes this comparison.

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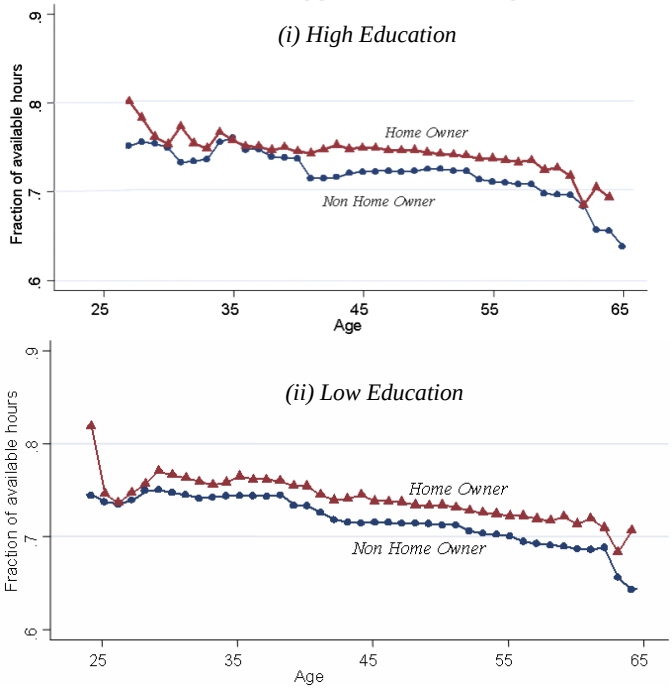
Figure 8: Labour Supply by Ownership Status



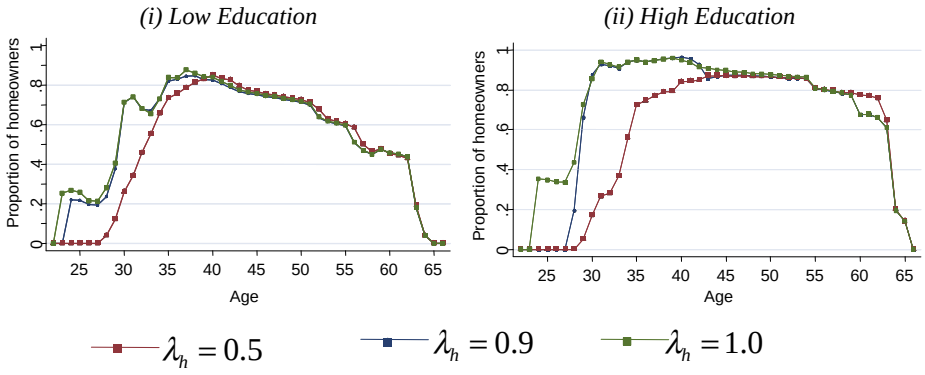
6 Implications of Incomplete Markets

In our baseline, the financial enviornment was set up to mimic the UK housing and capital market. In this section, we highlight the effect that changes in the capital market have on home-ownership patterns and on labour supply. We show first the effects of varying the size of downpayment needed to purchase a house, $(1-\lambda_h)$. Second, we vary the multiple of household income that households can borrow against, λ_y.

6.1 Varying downpayment requirements

We assume households can borrow only a fraction λ_h of the house value. Figure 9 shows the effect of varying λ_h on home ownership holding other parameters at their baseline values, and Figure **??** shows the effect on labour supply. Reducing downpayment requirements (increasing λ_h) leads to households buying their homes earlier in the life-cycle. Changes in λ_h have very little effect on labour supply and very little difference to behaviour later in the life-cycle.

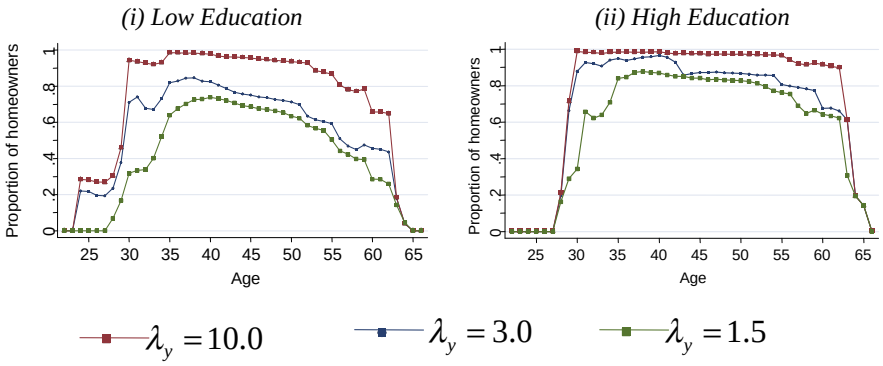
Figure 9: Homeownership Varying Downpayment Requirements



6.2 Varying debt to income requirements

We assume that there is a restriction on the debt to income ratio, λ_y, that households can hold. This is a common institutional feature in the UK and elsewhere (Survey of Mortgage Lenders). Figure 10 shows the effect of varying λ_y on home ownership holding other parameters at their baseline values. We do not show the effect on labour supply: a lower λ_y leads to very small increase in labour supply for both education groups, but the effect is negligible. Increasing the permissible debt to income ratio leads to earlier home ownership and to a higher proportion of households owning their homes. The effects on labour supply are negligible.

Figure 10: Homeownership varying the Maximum Debt to Income Ratio



7 Conclusion

To be added.

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