ISSN 1350-6722

*University College London*

# DISCUSSION PAPERS IN ECONOMICS

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by

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Discussion Paper 04-09

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December 2004

# House Price Volatility and Housing Ownership over the Life-Cycle

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**Acknowledgements:** The authors gratefully acknowledge the financial support of the Economic and Social Research Council through the research grant RES-000-22-0513. Blundell would like to thank the ESRC Centre for the Microeconomic Analysis of Fiscal Policy. James Smith's research was supported by a grant from the National Institute on Aging and benefited from the expert programming assistance of Patty St. Clair and David Rumpel. The usual disclaimer applies.

# House Price Volatility and Housing Ownership over the Life-Cycle

**Abstract**

We develop and test a model on the effects of spatial housing price risk on housing choice. Housing price risk can be substantial but, unlike other risky assets which people can avoid, most people want to eventually own their home thereby creating an insurance demand for housing ownership early in life. With increasing demographic needs over the life cycle, our model predicts that people living in places with higher housing price risk should own their first home at a younger age, should live in larger homes, and should be less likely to refinance. These predictions are shown to hold using comparable panel data from the United States and United Kingdom. (JEL D12, D91)

One of the most critical life-cycle consumption and investment decisions that individuals and families make involves the amount of housing services to consume and whether or not to combine consumption with ownership. Housing is an important component of consumption, but not simply because it absorbs a large fraction of the household budget—which it does. Where we live and how much we decide to spend on housing is basic to the amenities and life-style we have chosen for our families and ourselves. Housing, or more particularly housing wealth, can be even more critical as an investment as it is typically by far the biggest marketable asset in the household portfolio for most people. As a result, with increasing availability of appropriate panel data on wealth, there has been renewed interest in the study of housing wealth dynamics and its implications for other economic factors. Flavin and Yamshita (2002) look at the effect on household's optimal financial asset holding of integrating housing (i.e. both housing wealth and the associated consumption demand for housing services) into the portfolio model. In a more empirical study, Banks, Blundell and Smith (2003) show that housing wealth differentials between the US and the UK offset to some extent the differences in financial wealth observed between the two countries. But in spite of recognition of the dual importance of housing as both consumption and investment, the implications of the often-considerable housing price uncertainty for the life-cycle path of consumption and wealth are not well understood.

There are two key aspects to our treatment of housing in this paper. First, housing consumption is not modeled as a one-time consumption durable purchase but rather a series of purchase decisions or a housing ladder where the desired flow of housing services rises with family formation and growing family size over the life cycle. Second, in some geographic markets, housing can be quite a risky asset with high levels of unpredictable price volatility while in other places the prospect of capital gains or losses in housing are understandably not the subject of much social conversation. However, in contrast to other risky assets in which risk averse individuals can simply choose to avoid them, everyone must consume housing, and the vast majority of people desire to and eventually do end up owning their own home. The combination of these factors results in an insurance role for housing wealth in early life that drives the predictions we investigate in our empirical analysis.

In this paper, we derive and test the implications of the ladder and price volatility on the decision on when to become a homeowner, how much housing to consume, and whether to refinance out of housing equity. In the presence of volatility in house prices, housing has three roles—investment, consumption, and insurance against price fluctuations for future movements up the housing ladder. A simple model is developed to illustrate these effects, and the predictions of the model for home ownership, and housing wealth accumulation are drawn out. Because housing price volatility is spatially variable, we test the importance of the role of volatility in housing decisions empirically using comparable panel data from the US and the UK. There are significant differences in housing price variability between and within these two countries. But in addition there are also differences in the tax treatment of mortgage debt, the nature of mortgage arrangements, and even the level of geographic mobility of younger households. Consequently a test relying on between country differences is unlikely to isolate the effects of interest. In our analysis we show that, while the international differences are indeed in accordance with the predictions of our model, the model also performs well when estimated from within country variation in each of the countries we consider, despite their rather wide institutional differences.

The analysis in this paper is divided into five sections. Section 1 outlines and derives implications from a theoretical model of the impact of housing price variability on life-cycle choices regarding a set of related housing decisions. Section 2 first describes the principal data sources used in both the UK and US and then documents a critical and salient fact—a steep housing ladder with age that appears to be generated by some basic changing demographics over the life-cycle. Finally, this section documents not only the considerably different levels of housing price variability between the UK and US, but also the great spatial dispersion in housing price variability within both countries. In Section 3 we summarize the predictions to be tested and provide the results of the empirical tests of our model. These tests span implications concerning the age of initial home ownership, the decision to refinance, and the shape of housing wealth and the number of rooms. In the final section we summarize our conclusions.

**I. A Model of Housing Tenure Choice and Housing Equity**

In this section we derive the predictions of a simple model of the consumption of housing services when a household faces an increase in family size over the life cycle and has to make choices in the presence of house price uncertainty. First we consider the demand for housing consumption in the absence of house price risk, but where a simple demographic ladder describes the steps in family composition (see John Ermisch and David Pevalin (2004)). Then we look at the impact on the rent/own decision, and on the demand for owned housing, of introducing house price risk into this framework.[1] We utilise simple numerical solutions to an individual's dynamic programming problem that simultaneously allows us to consider flexible utility functions and to examine the sensitivity of our predictions to variation in the steepness of the housing ladder and the degree of risk aversion in preferences. We show that, with increasing demographic needs over the life cycle, increasing house price volatility will increase the both home ownership and housing demand earlier in the life cycle.

*I.a. Demographics and the Demand for Housing without House Price Risk*

We will consider a life-cycle model in which a household chooses consumption over periods s=t,….,T, of its remaining life cycle. We assume additive life-cycle utility is given by:

$$(2) \qquad V_t = \sum_{s=t}^{T} \beta_s U_s$$

and that utility is a function of both housing and other consumption. For the time being we assume within period utility has the Stone-Geary formulation and write:

$$(3) \qquad U_t = \alpha \ln(q_t - \overline{q}(D_t)) + (1-\alpha)\ln(c_t)$$

where $q_t$ is the consumption of housing services in period $t$, $D_t$ captures the demographic circumstances of the household, and all other consumption is summarized by $c_t$. The term $\bar{q}(D_t)$ reflects the minimum necessary level of consumption for each step on the demographic ladder.

Consumption of housing services in each period will be determined by solution of the maximization problem

$$\textbf{A1:}\ \max_{q_t}\left\{V_t = E_t \sum_{s=t}^{T} \beta_s U_s\right\}$$

subject to an inter-temporal budget constraint in the usual manner. That is, current demand for housing will be chosen to equalize the discounted marginal utility of housing between periods. Consequently housing demand will increase with wealth but will also adjust to reflect the minimum necessary level of consumption $\bar{q}(D_t)$. Defining $\overline{W_t}$ to be the present discounted value of lifetime wealth ***net*** of the discounted sum of minimum necessary levels of housing and other goods[2] and writing the real user cost of housing services as $rp_t$, within period utility (3) implies period $t$ demands can be written

$$\text{(4)}\qquad \begin{aligned} q_t &= \bar{q}(D_t) + \beta_t \alpha \frac{\overline{W}_t}{rp_t} \\ &= q(D_t, rp_t, \overline{W}_t). \end{aligned}$$

In this simple specification any future change in household demographic composition simply acts as a wealth effect through $\overline{W_t}$. While the consumption of housing services may involve the purchase of a house and an asset accumulation decision, by assuming perfect credit markets and certainty this aspect of housing consumption is not yet important. Housing as a durable asset becomes central to our generalization of this model to incorporate house price risk below.

To demonstrate the importance of this demographic evolution of the household on the demand for housing, we will assume the life-cycle profile can be represented by the following sequence of three discrete values for *D:*

**A2:** *The demographic ladder:* At stage $D = 1$ the individual is living with his or her parents, at stage $D = 2$ he or she partners to form an independent family unit, and at stage $D = 3$ the couple has completed its family size.

This is a simplified demographic profile but represents effectively the upside of the housing 'ladder' that we wish to capture in our model.[3] For further simplicity we will assume that the leaving home decision D=1 → D=2 simply concerns a decision over whether to rent or own in the light of the possible increase in family size associated with children D=2 → D=3.

One implication of the model and the demographic ladder assumption A2 is

(5) $$q(D=3, rp, W) > q(D=2, rp, W).$$

These properties on preferences capture the increasing demand for housing services as we move any household head through his or her 20s, 30s and 40s. The impact of increasing family size over the early period of the household's lifecycle is in accordance with our empirical evidence below, where there is a strong increase in the size of the house, as measured by the number of rooms, as the head of household grows older, flattening out around the age 40 but rising steeply from the 20s to the 30s.

Without price uncertainty the rent/own decision will be driven by transaction costs of ownership as well as the desire for mobility, the tax advantage of a mortgage, the down payment rules and multiple income constraints For a household that expects not to move for a reasonable length of time, in particular at D=3 (the top stage of the demographic ladder) owning can be the most efficient way of achieving a desired level (and type) of housing service. For example, with idiosyncratic tastes a renter can never commit to stay long enough to make it in the landlord's interest invest in the renter's idiosyncratic tastes. To reflect this limited commitment aspect of rental housing contracts we assume that the desired state by the time the demographic profile is $D = 3$ is to be an owner-occupier[4]:

**A3:** $\Pr[OWN = 1] = 1 \text{ if } D = 3$

Before turning to the introduction of house price risk, there are two aspects of the supply of housing services, which are relevant to our discussion. First, a more inelastic supply will induce a larger sensitivity of house prices to changes in demand and, in particular, to fluctuations in incomes of young first-time buyers. The second aspect relates to the rental market — imperfections and/or regulation of the private rental market may make it difficult for the young to use rental housing as the step between leaving the parental home and acquiring a house.

*I.b. House Price Uncertainty, Ownership and Housing Equity*

The introduction of house price uncertainty into the model adds an important distinction between ownership and renting which will enhance the desire to accumulate housing wealth and thus the need to become an owner earlier in the life cycle - house price risk generates an incentive to accumulate housing equity at $D=2$ before the family is complete. At first sight this may seem a puzzle since accumulation of a risky asset might normally be expected to decrease with the degree of risk for a household with risk averse preferences. In what follows below we show that the usual result does not hold because of the vital insurance role played by housing in early life in our framework.

At $D = 2$ there are two choices: to own or to rent. If house prices are variable and uncertain then, given the expected increase demand as the household moves up the demographic ladder from $D=2$ to $D=3$, housing equity will be an important source of insurance against future house price risk. Indeed, in the absence of a financial instrument that could insure this house price risk (which may well be defined at a very local level), holding housing early in life may be the only insurance mechanism. The larger the uncertainty in house prices and the steeper the demand over the life cycle, the more important is the insurance aspect of housing equity. For example, with preferences (3), a sharp increase in $\overline{q}(D_t)$ as *D=2=>D=3,* implies that the household has an increased incentive to insure against house price risk at life cycle stage *D=2.*

The integration of housing price risk into a single theoretical framework is complex and even algebraic closed form solutions will only be possible under certain forms of preferences. Ideally, however, we want to use more flexible preferences that those in (3) above. Hence we turn to numerical methods in order to offer insight into the predictions of the model under various specifications for preferences, the steepness of the housing ladder, and the time-series process for the underlying uncertainty. Ultimately, many other extensions could be looked at with this approach, such as the sensitivity of predictions to rental premia, the cost of mortgage borrowing, the extension of the model to a greater number of time periods or the differences in predictions that emerge as we allow income uncertainty (with differing degrees of correlation between income and house price shocks). But we leave these extensions for further work since, at this stage, we want to make the model as simple as possible whilst still remaining sufficiently general to examine the specific predictions on which the empirical analyses in this paper are based.

The utility functions for an individual in each of the decision periods are assumed to be:

$$(6) \qquad U_t = \frac{1}{1-\gamma}\left[\left(q_t - \overline{q}_t\right)^{\alpha} c_t^{1-\alpha}\right]^{1/1-\gamma} \quad \text{for } t = 2,3.$$

These preferences retain the property of having a necessary level of housing consumption, $\overline{q}_t$, in each period to capture the housing ladder; but have been extended to the CRRA form to allow us to look at the impact of varying risk aversion on our predictions.

The numerical model has three periods, aimed at capturing the phases of the life cycle discussed above, rather than calendar years, quarters or even month. When building a numerical solution algorithm, the choice of units and parameter values forces one to think carefully about the relative length of periods. In taking numerical methods to our model we essentially need to think of periods of unequal length, in order to capture the sense in which period 2 (the middle rung on the housing ladder) is a transition to a more permanent state of completed family size and a ‘permanent’ family home. A convenient way in which to do this is to introduce factors $\delta_2$ and $\delta_3$, with $0 < \delta_t \leq 1,\ t = 2,3$ and $\delta_2 \leq \delta_3$, which describe the flow of consumption services $q_t$ from housing stock $H_t$, so that $q_t = \delta_t H_t$.

In accordance with the discussion of the previous section we constrain an individual to be a renter in period 1 and an owner in period 3. As such, the individual faces a simple decision to own or rent in period 2, in addition to their choices of $q_t$ and $c_t$ in each period. According to outcome of this decision the lifetime budget constraint will be given by:

(7a) [Owner]: $y_2 + y_3 + (p_3 - p_2)H_2 = c_2 + c_3 + p_2\delta_2 H_2 + p_3\delta_3 H_3$

(7b) [Renter]: $y_2 + y_3 = c_2 + c_3 + \tau p_2\delta_2 H_2 + p_3\delta_3 H_3$

depending on which tenure is chosen, where $y_t$ are discounted incomes, $p_t$ are discounted prices, $c_t$ are discounted consumptions, and $\tau$ is the rental premium.

Implicit in this set up is that an individual can borrow or save at the same (safe) rate of interest equal to the discount rate. Finally, we introduce house price uncertainty in period 3 by allowing $p_3$ to take the value $p_2(1+\pi)$ with probability ½ and $p_2(1-\pi)$ with probability ½. We then vary the variance of housing price uncertainty by solving the model for different values of $\pi$.

We solve the model by backward induction with a relatively straightforward numerical method that involves a discrete grid search across all possible paths for housing consumption in each period, $q$, consumption in each period, $c$, and the owner/renter decision in period 2. For the purposes of the solution, baseline values are set at:, $\tau = 1$, $\alpha = 0.3$, $\delta_2 = .5$, $\delta_3 = 1$, $\bar{q}_2 = 0$ $y_3 = 200$ and $y_2 = .5y_3$. The later equality equates the flow of income across the two periods given the choice of $\delta_2$ and $\delta_3$. The model is then solved under varying degrees of uncertainty for various values of the necessary level of housing in period 3, $\bar{q}_3$, and the risk aversion parameter, $\gamma$.

Figure 1a shows the difference between the expected utility of renting and owning in period 2, expressed as a fraction of the utility of renting, as the variance of housing prices increases and as the minimum level of housing required in period 3 increases. Increases in the minimum level of housing demand in period 3 result in an increase in the relative utility of owning at all positive levels of volatility. Similarly, for all levels of the minimum housing requirement in period 3, increasing volatility results in a stronger preference for owning — Increasing house price risk reduces expected utility for both renters or owners in period 2 but the impact is stronger on the rental option. Consequently there is a gain in expected utility terms from ownership in period 2 and this gain increases with risk. Figure 1b presents a complementary analysis but where we hold the housing ladder constant and vary the degree of risk aversion in preferences. As risk aversion increases the slopes of the profiles with respect to volatility steepen.

The key mechanism for these effects is the insurance role of housing in period 2. If prices turn out to fall or stay the same then ownership will not, *ex post*, dominate renting. Indeed if house prices fall there will be some loss to ownership. However, because of the strongly declining marginal utility of consumption, insuring the risk of house price rises is more important than avoiding the risk of a house price fall. To achieve this the consumer needs to hold an asset whose return is correlated with (local) housing prices. If such an asset is not available on the financial market the insurance can also be achieved by purchasing the asset itself. Consequently, other things equal, the higher the level of house price uncertainty the higher the incentive to become an owner-occupier. In this context, as illustrated in the two figures, increasing minimum housing requirements or increases in risk aversion are acting in a similar way to an increase in volatility. By a straightforward extension of these arguments, individuals will also stay away from endowment mortgages and refinancing of housing equity for non-housing consumption or investment purposes.[5]

In addition to the home ownership predictions the model also has predictions for the quantity of housing consumed. Figures 2a and 2b show the predictions for housing consumption in period 2 as the housing ladder steepens and as risk aversion increases. Figure 2a shows that, for any level of the minimum housing requirement in period 3, as volatility increases the quantity of housing demanded in period 2 increases — individuals buy more insurance as risk accumulates.[6]

If volatility is significant, a steeper housing ladder results in more housing consumption in period 2. This implies that not only will individuals be more likely to purchase a house in period 2, they will also be more likely to purchase a 'bigger' house. Note that for the very lowest value of the minimum housing requirement (D=10) the quantity of housing actually declines with volatility. At such a low value of the minimum (and given the relative preference for housing implied by our choice of α of 0.3) the housing ladder constraint is not effectively binding and therefore the predictions of the model are in accordance with the standard case: individuals choose less of a risky activity.

Figure 2b presents similar results by risk aversion coefficient. Once again, as risk aversion increases, the quantity demanded of housing in the second period increases. While not shown in these graphs, our model also has implications for non-housing consumption in period 2, which is generally declining in housing price volatility.

In summary, the decision to accumulate housing equity early in the life cycle will be an increasing function of volatility for risk averse households who expect an increase in family size. In the absence of an equity market in local housing assets, this demand for housing equity also enhances the decision to own.

One further extension needs to be discussed since we endeavor to control for it in the empirical analysis that follows, that is geographic mobility. If individuals anticipate residing in less volatile areas in period 3 then their demand for insurance is reduced (and the insurance value of their housing equity in period 2 will be reduced also to the extent that house prices are not perfectly correlated across regions). It is expected volatility at D=3 (from the point of view of D=2) that drives the insurance motive. In the case of individuals in D=2 anticipating moving to a 'safe' area at D=3, both these factors are likely to play a reduced role, although they could still be important to some extent.

## II. Background for the Empirical Analysis

In this section, the most relevant attributes of the data used in our analysis are highlighted. We also illustrate the steep age gradient to the housing ladder and the changing life cycle demographics that generate it. Finally, this section documents the considerable dispersion in housing price variability both between the UK and US and within each country.

### *II.A. Data Sources*

The PSID started in 1968 collecting information on a sample of roughly 5,000 (original) families. Of these, about 3,000 were representative of the US population as a whole (the core sample), and about 2,000 were low-income families (the Census Bureau's Survey of Economic Opportunities sample). Thereafter, both the original families and their split-offs (children of the original family forming a family of their own) have been followed giving a total of around 35,000 individuals. Panel members were interviewed each year until 1997 when a two-year periodicity rule was established. All original members of the 1968 households and their progeny are considered sample members and thus are part of the panel even if they move out of the original household. The US models presented in this paper include the SEO oversample although they were also estimated using only the core sample and our results regarding the effects of housing price volatility were not affected.

In each wave of the panel, the PSID asks detailed questions on individual and household income, family size and composition, schooling, education, age, and marital status. State of residence is available yearly and individuals are followed to new locations if they move. Unlike many other prominent American wealth surveys, the PSID is representative of the complete age distribution. Yearly housing tenure questions determine whether individuals currently own, rent or live with others. Questions on housing ownership, value, and mortgage were asked in each calendar year wave of the PSID.[7] Renters are asked the amount of rent they pay and both owners and renters are asked the total number of rooms in the residence.

In addition to the PSID, housing price data were obtained from the Office of Federal Housing Enterprise Oversight (OFHEO) House Price Index. These data contain quarterly and yearly price indexes for the value of single-family homes in the US in the individual states and the District of Columbia.[8] These data use repeat transactions for the same houses to obtain a quality constant index and is available for all years starting in 1974. All yearly housing prices by state are reported relative to those that prevailed in 1980. By 1995 there were almost 7 million repeat transactions in the data so that the number of observations for each state is reasonably large. No demographic data are available with this index.

For the UK, we use the British Household Panel Survey (BHPS). The BHPS has been running annually since 1991 and, like the PSID, is also representative of the complete age distribution. The wave 1 sample consisted of some 5,500 households and 10,300 individuals, and continuing representativeness of the survey is maintained by following panel members wherever they move in the UK and also by including in the panel the new members of households formed by original panel members. The BHPS contains annual information on individual and household income and employment as well as a complete set of demographic variables. Like the PSID, data are collected annually on primary housing wealth, and on secondary housing wealth.[9]

In addition to the BHPS, regional house price data were obtained from the Nationwide Building Society House Price series, which is a quarterly regional house price series going back to 1974. Rather than use a repeat sales index, the prices are adjusted for changes in the mix of sales to approximate a composition constant index, and are also seasonally adjusted.

Throughout the paper we take care to define the unit of analysis as the benefit unit (i.e., singles or couples with dependent children) such that young individuals at the beginning of the life-cycle living in shared accommodation or with other family members are not lost from the analysis as subsidiary adults in households headed by other individuals. This is particularly important for older independent children who are still residing with parents and who would show up in middle-aged households in a conventional head of household based analysis. In both countries, housing wealth is allocated to the home owning benefit unit only. Hence a 25-year-old living with their parents in an owned property is not defined as an owner (unless they own the property jointly with their parents) and is assigned zero housing wealth.

We use several housing wealth concepts in this paper. The current value of the house is derived in both the PSID and BHPS by asking respondents to report the current market value of their home while housing equity is constructed by subtracting from the current house value the outstanding mortgage.

*II.B. The Housing Ladder*

Even without credit constraints or income uncertainty, individuals would not choose to consume the same flow of housing services at all times in their lives. People may start by moving out of the parental home into a small rented or purchased apartment or flat of their own. When they marry, they may know that two may well live more cheaply than one but they generally do not want to live in smaller places and often may want to own a bigger but still modest first home. Children then appear on the scene and eventually will age into rooms of their own—all of which requires a bigger if not better home.

A simple way of illustrating this point is to examine how the size of homes people live in changes with age. Table 1 shows the age profile of mean number of rooms of household heads for owners and renters alike in the US and UK. Note that the number of rooms in the UK excludes kitchens and bathrooms and so the number of rooms is not strictly comparable across the two countries. In the UK and in the US there is a strong increase in size of house as the head of household grows older, flattening out around the age 40 but rising steeply from the 20s to the 30s. The general shape of the ladder is similar in the two countries.[10] It is important to note that the steep part of the ladder is not simply the consequence of changing tenure status from renter to owner. While owned homes are always larger than rented ones on average, the steep early ladder characterizes both rented and owned properties.[11]

Another way of seeing this transition is to examine the increase in home size at the time of purchase among new and repeat buyers. This is shown in Table 2. New buyers are defined as those who were previously renters in the prior wave of PSID or BHPS so that especially at young ages this often will be their first owned home. Repeat buyers were previously also homeowners so that this change now reflects changes in the size of owner occupied housing. In the US, while the transition from renter to owner involves a larger increment in house size, people are also clearly trading up in the early part of the life cycle when they purchase their second and subsequent homes. This effect is even stronger in the UK—on average first time buyers purchase houses that are bigger comparable than their rented house, but bigger movements up the ladder, defined in terms of increments to the number of rooms, tend to take place for repeat buyers.

We view the shape of the ladder as demographically determined as individuals marry, form families with children growing, eventually complete their family building with the by now older children leaving home to go off on their own. Figures 3a and 3b plot the cumulative distribution of individuals who have completed their fertility by age.[12] The steepness of this cumulative distribution mimics closely the overall shape of the housing ladder—a steep incline during the 20s and 30s with a flattening out during the 40s. In fact, between ages 25 and the late 30s, this cumulative distribution of competed fertility is almost linear, with each year of age increasing the fraction that has finished childbearing by 5 percentage points. For example, around age 31, half of all American individuals have completed their fertility with three out of every four doing so by age 36. The shape, and level, of the profile corresponds extremely closely to that observed in the UK over the same ages.

Children turning 5 years old may be at a critical stage for housing decisions since parents may choose places to live with the quality of schools in mind and may want to stay longer in the same place. This could be another indicator of what we call D=3, arrival in the family home, in the previous section. With this in mind, Figures 3a and 3b also plot the cumulative fraction of individuals who ever had child at least 5 years old. Not surprisingly, compared to the cumulative completed fertility, this figure is shifted out to the right so that if age 5 is a useful marker, reaching the top of the ladder takes place for the median family in the mid to late thirties. Nevertheless, as with the completed family size profile, the proportion rises steeply over the life cycle up to age 40 in parallel to the sharp rise in the number of rooms demonstrated over the same ages. Finally, Figures 3a and 3b also plot the proportion with their own children aged 5 or over currently in the household, as a measure of contemporaneous housing needs. Again the similarities between US and UK are striking- in both countries after age forty there is a sharp decline in young children at home, an indication of an eventual demographic rationale for downsizing in later life.

*II.C. Housing Price Volatility*

Figure 4 shows real indices of average house prices for the US and UK over the period 1974 to 1998 with both series normalized to unity in 1980. Immediately apparent is the much larger volatility of housing prices in the UK, with real prices rising by 50% over the period 1980 to 1989 and then falling back to its previous value by 1992. Over the period as a whole, however, real returns were similar across the two countries.

Although such difference will be instructive when looking at differences in housing choices across the two countries, the majority of our testing will rely instead on within-country differences in house price volatility in each of the two countries. The UK and the US indexes both hide considerable differences across regions with some places being much more volatile in housing prices than others. In Figures 5a and 5b we present house prices from regional sub indices, grouped to show house price trends in the more and less volatile areas.

The variation across American states in housing price volatility is large. Using the standard deviation in real prices (relative to a 1980 base) as the index, Massachusetts ranks at the top with price swings between peak and trough over this period of more than two to one. At the other extreme lies South Carolina where the peak price exceeds the trough by only 15%. The most volatile states are concentrated in New England and along the North Eastern seaboard (Massachusetts, New York, New Jersey, Rhode Island, Connecticut, New Hampshire, and Maine) and in California and Hawaii. While we will use a continuous measure of volatility in our analyses below, for descriptive purposes we label these the volatile states.

To exploit regional and time series differences in volatility in house prices we construct indices of volatility by computing the standard deviation of the change in the log real house price index over the previous five years for each of the 50 US states and 12 UK regions for which we have house price indices. These indices, which measure percent volatility over the sample are plotted in Figures 6a and 6b, grouped by the same two 'volatile' and 'non-volatile' areas as before. Two things are important to note. First, the higher levels of volatility in the UK (even in the 'non-volatile' regions) are apparent. Second, in both countries, it will be the state/regional level volatility index, not an average across groups of regions that enters our empirical specifications.

## III. Tests of the Model

There are three principal predictions of our model that we test empirically in this paper: (1) other things being equal, individuals should buy homes earlier in more volatile areas; (2) young homeowners are less likely to consume capital gains on housing through refinancing in more volatile areas; and (3) young homeowners will consume 'more' housing in more volatile areas than their counterparts in less volatile areas. In the following subsections we deal with each of the above predictions in turn.

### *III.A. Age of Home Ownership*

In the presence of a housing ladder, individuals living in places with more volatile housing prices need to self-insure by buying their first home at a younger age. In the final column of Table 3, we list for both the UK and US the proportion of individuals who are homeowners, by age for a typical year—1994. These patterns do not depend critically on the year chosen. The data are also presented separately for the volatile and non-volatile areas in both countries. While average rates of home ownership are similar, there are striking differences by age between the two countries. Home ownership rates amongst young households are far higher in the UK than in the US, with differences of 10 percentage points for householders between ages 20-29 and 13 percentage points those between ages 30-39. However, through middle age, homeownership rates converge so quickly that US rates actually exceed those in the UK among older households.

Since prices are far more variable in the UK, these cross-country differences in home ownership rates are consistent with our theoretical implication that ownership should occur at a younger age in more price volatile housing markets. However, when we compare home ownership rates between the volatile and non-volatile areas within each country, the challenge to our theory becomes more apparent. In both countries, owning a home is somewhat less common among younger households in the volatile market.

However, there are other significant differences between these two markets in each country that will presumably strongly affect the decision to own. Tables 4a and 4b lists some of the more salient ones. Perhaps, most important, housing prices are much higher in the volatile markets. For example, the average price of a home in the more volatile states is almost twice that in the less volatile ones, which should certainly discourage home ownership among the young. While rental prices are also higher in the more volatile states, the percentage difference is 37% compared to 68% for housing prices. Young individuals living in the volatile states also have more education, household income, and are less likely to be married and to have children. All of these factors are obviously relevant to the housing tenure decision so the final verdict on the theory requires multivariate modeling.

In our multivariate analysis, we estimate a probit model of whether or not one is a homeowner using a sample of individuals who are between the ages of 21 and 30. In addition to our measure of housing price volatility described above, this model includes several relevant demographic attributes—a quadratic in age, indicator variables for whether one is married and whether one has children, the log income of the tax unit in which the individual participates, and measures capturing years of schooling. We measure area and age specific housing prices by using the PSID and BHPS to compute mean housing prices and mean rents in each state/region for owners and renters respectively, within broad age groups. These prices as well as benefit unit income are entered in logs.

The critical variable for testing our theory concerns housing price variability, which varies across space and time. We construct a five-year moving window of the standard deviation of the year-to- year differences in the log real housing prices in a region as described in the previous section. Since our US housing price series starts in 1974, this means that our PSID analysis starts with the 1980 PSID and extends to the 1997 PSID. To control for the possibility that the variability in housing prices across regions and states may simply be capturing unmeasured differences across states and regions, we estimated all models with and without state and region effects. A linear time trend is added to our models so our time series variation is relative to a common linear trend.

The results are displayed in Tables 5a and 5b, which lists marginal effects and standard errors of all variables. In both countries, we find positive income effects (slightly higher in the UK) and education effects (a possible proxy for permanent income) on home-ownership. Not surprisingly, marriage in both countries encourages home ownership and at least in the US children do likewise. In the US, we also have statistically significant negative price effects on the probability of owning a home, but we estimate a statistically insignificant effect in the UK when we include the regional rental price. In both countries, high area-specific rents also discourage home ownership. While this may at first blush seem counter-intuitive, it is important to remember that there are three options open to young persons in terms of their housing choices—owner, renter, or living with others—especially parents. When we estimated models for whether one was a renter, higher rental prices discouraged both renting and home owning.

The price volatility variables represent the central test of our theory. In both the US and UK, we estimate statistically significant positive effects of price volatility indicating that as predicted individuals choose to own homes at a younger age in the more housing price volatile areas. When state/region dummy variables are included, these estimated effects are remarkably similar in the two countries so that on the margin Britons appear to react more only because volatility is some much higher there.

*III.B. The Decision to Refinance*

An implication of our model is that households in areas where housing prices are volatile should self-insure at young ages by holding more housing. However, buying a house and then refinancing to use the proceeds to finance consumption or to purchase risky assets would simply undo the safety housing provides. Although imperfect, our two datasets provide some measure of the extent to which individuals engage in such activities. With regard to the US, PSID data contain no direct questions in each year on refinancing, so we define an indicator of refinancing to take the value 1 if an individual's mortgage is observed to have risen by a specified amount between waves.[13] The problem with this measure is that individuals could well be using the extra finance to improve their home, which would not unravel the housing as price insurance mechanism, thus making it an imperfect measure for our purposes.

This implication can be directly addressed in the UK using BHPS data, where individuals are asked specific questions about whether they refinanced their housing equity between waves, and if so whether the purposes for which the resulting money was used. With such detailed questions we are able to construct a more precise indicator in the UK that takes the value 1 only if individuals refinance between waves and do not increase the quantity or quality of housing as a result.

Our results are summarized in Tables 6a and 6b. In addition to the non-price variables that were part of the home ownership model, we included a measure of home equity in the previous year to capture the amount available for refinancing. In both countries, using both measures of refinancing, the predictions of the theory are borne out—individuals in more risky areas are less likely to refinance, conditional on other characteristics and their initial level of net housing equity.

*III.C. Increased Consumption of Housing*

As pointed out in Section 2, one can insure against future housing price volatility in period D3 not only by purchasing a house in period D2 but also by consuming more owned housing than one might want given the objective demographic circumstances. Moreover, in the presence of borrowing constraints there is a possibility that, if prices rise more quickly than income, debt to income restrictions may prevent individuals being able to purchase a larger home at D=3. With this possibility on the horizon individuals, already more likely to be an owner-occupier as a result of the increased volatility, would also choose to increase their consumption of housing, since in the case of prices rising the capital gain will be higher and can be used as down payment on the final home in order to offset the debt to income restriction. Indeed, in the UK, the two conditions are often linked (since on a secured loan the consequences of default to the lender are reduced with a higher down payment) such that individuals with higher down payments can borrow a higher multiple of income.

In order to measure the consumption of housing, for the purposes of testing this prediction we use two variables—the number of rooms in the house, and the gross value of the house. Neither is perfect since the former omits possible quality effects and the latter may be contaminated by unmeasured price variation leading to uncontrolled for demand effects. Nevertheless, each provides a useful complementary test for the predictions of the model. For each of these measures of housing consumption, we use a standard Heckman type selectivity model to evaluate the predictions for home-owners only, using the probits reported in Tables 5a and 5b as the selection equations and omitting the rental price from the continuous part of the model.

Tables 7a and 7b report the results of estimating selection models for the number of rooms occupied by young homeowners. These estimates show significant positive effects of volatility on house size—young home owners in risky areas tend to consume more rooms than their counterparts in safer areas in order to partially insure themselves against housing price risk. Other estimated parameters accord with a priori intuition. The number of rooms increases with income, education, whether an individual is married, and with the presence of children, and decreases with the average price of housing per room in the area. While the magnitude of the demographic effects is similar in the two countries (marriage and children), income effects appear to be about twice as high in the US. Finally, those individuals moving from risky to safe areas have a reduced number of rooms, as would be predicted by their insurance motive being reduced, although not by enough to offset the volatility effect altogether.

In Tables 8a and 8b we repeat this analysis using gross house value as our measure of housing consumption. Again in both countries, as predicted by our theory individuals in risky areas choose to have higher housing wealth than those living in safe areas. This effect is reduced for those observed to move from risky to safe areas during the period of our data. Thus, those individuals who end up moving out of the risky housing price areas appear to insure less in the sense that they do not over consume housing when they are young. Once again, the principal demographic variables enter with the expected signs and in about the same magnitude in both countries- home values increase with marriage, children, and age (at least until middle age). Similarly, income and education effects are positive in both countries although our estimated current income elastic city is much higher in the US than in the UK.

The models estimated in Tables 7 and 8 are based on two alternative and imperfect measures of housing consumption. However, the general similarity of the estimated models across both specifications, and in particular the similar estimated effects of our measure housing price variability on housing consumption in both countries lends support to the predictions of our model.

*III.D Endowment Mortgages*

In the UK, a common financial instrument used to finance house purchase is an endowment mortgage. During the life of the mortgage, the borrower makes only interest payments on the loan, leaving the principal to be repaid at the end of the term of the mortgage. In addition to the interest, the borrower pays into a saving scheme, which is designed to mature and repay at least the value of the capital sum borrowed at the end of the period of the loan. Throughout the 1980s and 1990s these schemes were common, with the most common type of saving scheme being an endowment policy that is an investment product—essentially term life insurance with the fund invested in the stock market.

Because of the risky nature of this product, our model predicts that households who live in volatile areas should not choose this type of mortgage.[14] These predictions are borne out using the same framework as the tests presented above. In Table 9, we report results obtained from probits with the dependent variable being whether individuals finance their house purchase with an endowment mortgage. Since mortgage arrangements typically do not change over the term of the mortgage (and in the case of endowment policies the penalties for early termination are high), we are able to use homeowners of all ages for this test, thus also implicitly increasing the period over which are effects are apparent. Whether or not we include region dummies, British families who live in more volatile housing price areas are less likely to take out an endowment mortgage. This estimated effect is statistically significant.

## IV. Conclusions

Typically, risk averse individuals will avoid risky assets as volatility increases. In this paper we show that owner-occupied housing is an exception to this rule. The consumption role of housing wealth, coupled with increasing necessary levels of housing over the life cycle due to demographic changes, and the fact that individuals will typically prefer to own rather than rent, mean that individuals will expect to be consuming a risky commodity—owner occupied housing—in middle age. Since housing is a necessity the utility consequences of this risk might be expected to be relatively large. In the absence of suitable financial products to insure this risk, this will lead individuals to invest in housing early in the life cycle as a way of insuring future price fluctuations. Not only does this lead to higher owner-occupation rates, it also leads to more housing wealth and less propensity to realize capital gains on housing through refinancing to fund non-housing consumption.

Using micro data from two countries we have constructed tests of these predictions and all are borne out empirically. Cross-country differences between the US and UK correspond to the cross-country differences in volatility—the UK is more volatile and UK households own earlier, and have more of their portfolio in housing. Because this may be driven by other differences between countries, we use within country tests that rely on time-series and cross-sectional variation in volatility within and across states (in the US) or regions (in the UK) we continue to find empirical support for the predictions of the theory.

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**Endnotes**

[1] In a related framework, Francois Ortalo-Magne and Sven Rady (2002) have looked at the theoretical predictions of an equilibrium model of home-ownership when house prices are volatile.

[2] This wealth variable contains the current value of assets and the future stream of discounted income flows. Housing equity and other assets will be added in our discussion of uncertainty below.

[3] We ignore here older stages of the life cycle where the possibility of downsizing comes into play (see Stephen Venti and David Wise (2001) and Lousie Sheiner and David Weil (1992) for example).

[4] For our theoretical predictions, this can be weakened somewhat and simply require a finite probability of ownership at D=3.

[5] Borrowing constraints add further refinements to the model. They typically take two forms: a down payment constraint and a multiple income (or debt to income) constraint. The down payment is proportional to the house price. The multiple income constraint restricts the mortgage to be a multiple of current income. With such constraints in place, the potential downside of a house price rise between D=2 and D=3 for a non-owner enhances the insurance value of ownership at D=2. If house prices rise relative to incomes then the capital gain reduces the mortgage requirement and makes it more likely that the earnings to mortgage debt can be met. Such borrowing constraints add to the insurance value of ownership since an unexpected price increase at D3 considerably relieves the down payment constraint.

[6] Varying the minimum housing requirement and keeping life-time resources constant also generates a wealth effect. This is not important for our empirical tests since we will be examining demand for housing as volatility varies for a given steepness of the housing ladder. As a result we abstract from this wealth effect in this figure by normalizing the housing demand to its zero-volatility value in the two figures.

[7] Mortgages are not available in the PSID for years 1973, 1974, 1975, and 1982.

[8] For details on this data see Charles Calhoun (1996). The paper is available on the OFHEO website.

[9] Housing wealth and mortgages are not available in 1992.

[10] In the UK there is little evidence of cohort effects during the early part of the adult life cycle for the period 1968 -1998 (Banks, Blundell and Smith, 2003). This suggests the rise would be the same whether

we look at individual date of birth cohorts or pool across cohorts as in the tables here. In the US, there is some evidence of the number of rooms plateauing out at higher values among more recent cohorts.

[11] The profiles in Table 1 show some evidence of 'downsizing' at older ages as children move out and the parents transit into retirement. While this downsizing may be important especially for retired American households (see Venti and Wise ( 2001), it is not the focus of this paper, which concentrates instead on the implications of the steps up the ladder earlier in life and a full analysis would need to take into account the possible effects of cohort differences amongst older those at older ages on these profiles.

[12] Completed family size is computed by taking individuals aged 50 or over and assuming they will not have any more children. We then look back through their fertility history and find the age at which their final child was born, and call this age the age of completed family size.

[13] In practice, small rises could simply be a result of measurement error, so we choose a variety of thresholds above which we assert a change in mortgage can be interpreted as a refinance. The specification in Table 6a uses a definition of mortgage rising by at least 30% or $5000, whichever is the greater.

[14] One complication in testing this prediction is that particularly in the 1980's (and early 1990's), there is some evidence that mis-selling of this type of mortgage took place by mortgage providers. In particular, there is the possibility that consumers were not fully informed of the nature of other choices of mortgage arrangements available or about the risky nature of the endowment policy. Assuming such effects were constant across regions, however, we might still expect those living in more volatile regions to be less likely to take out such mortgages.

**Table 1. The Number of Rooms by age of head of household**

| | Age of head of household | | | | | | |
|---|---|---|---|---|---|---|---|
| | < 25 | 25-34 | 35-44 | 45-54 | 55-64 | 65+ | All |
| **US** | | | | | | | |
| Owners and Renters | 3.89 | 4.97 | 5.99 | 6.40 | 6.16 | 5.34 | 5.61 |
| Owners Only | 5.22 | 6.16 | 6.82 | 6.89 | 6.56 | 5.99 | 6.48 |
| **UK** | | | | | | | |
| Owners and Renters | 3.02 | 3.66 | 4.41 | 4.94 | 4.84 | 4.00 | 4.34 |
| Owners Only | 4.25 | 3.87 | 4.64 | 5.20 | 5.12 | 4.50 | 4.73 |

Pooled data from the PSID and BHPS. US data excludes bathrooms, UK data excludes kitchens and bathrooms.

**Table 2. Changes in rooms for movers, by type of buyer**

| | Age of head of benefit unit | | | | | | |
|---|---|---|---|---|---|---|---|
| | < 25 | 25-34 | 35-44 | 45-54 | 55-64 | 65+ | All |
| **US** | | | | | | | |
| First Time Buyers - Before | 3.86 | 4.66 | 4.95 | 4.87 | 4.99 | 4.01 | 4.70 |
| First Time Buyers - After | 5.51 | 6.61 | 6.24 | 5.91 | 5.72 | 4.63 | 5.98 |
| First Time - Difference | 1.62 | 1.45 | 1.28 | 1.05 | 0.71 | 0.61 | 1.27 |
| Repeat Buyers - Before | 4.84 | 5.91 | 6.56 | 6.87 | 6.56 | 5.92 | 6.32 |
| Repeat Buyers - After | 5.49 | 6.72 | 7.27 | 6.94 | 5.99 | 5.48 | 6.66 |
| Repeat - Difference | 0.65 | 0.81 | 0.71 | 0.07 | -0.57 | -0.43 | 0.30 |
| **UK** | | | | | | | |
| First Time Buyers - Before | - | 3.38 | 3.80 | 4.27 | 4.11 | 3.98 | 3.80 |
| First Time Buyers - After | - | 3.83 | 4.34 | 4.78 | 4.48 | 3.94 | 4.21 |
| First Time - Difference | - | 0.45 | 0.54 | 0.50 | 0.38 | -0.04 | 0.42 |
| Repeat Buyers - Before | - | 3.59 | 4.33 | 4.84 | 5.23 | 4.87 | 4.50 |
| Repeat Buyers - After | - | 4.49 | 5.31 | 5.33 | 4.95 | 4.03 | 4.97 |
| Repeat – Difference | - | 0.90 | 0.98 | 0.49 | -0.28 | -0.84 | 0.47 |

**Note:** pooled PSID and BHPS data from 1990-1999 and 1991-2000 respectively. First time buyers restricted to those previously living in rented accommodation. Cellsizes too small in UK for age < 25.

**Table 3: Proportion of individuals who are homeowners in 1994**

| | Age | 'Volatile' | Non-volatile | All |
|---|---|---|---|---|
| **UK** | | | | |
| | 20-29 | 0.336 | 0.398 | 0.358 |
| | 30-39 | 0.717 | 0.755 | 0.731 |
| | 40-49 | 0.799 | 0.784 | 0.794 |
| | 50-59 | 0.801 | 0.723 | 0.775 |
| | 60-69 | 0.755 | 0.667 | 0.723 |
| | 70+ | 0.602 | 0.547 | 0.583 |
| | *All* | 0.652 | 0.642 | 0.648 |
| **US** | | | | |
| | 20-29 | 0.187 | 0.273 | 0.253 |
| | 30-39 | 0.528 | 0.612 | 0.590 |
| | 40-49 | 0.691 | 0.748 | 0.736 |
| | 50-59 | 0.825 | 0.830 | 0.828 |
| | 60-69 | 0.784 | 0.875 | 0.850 |
| | 70+ | 0.683 | 0.723 | 0.714 |
| | *All* | *0.583* | *0.649* | *0.633* |

Data are from the 1994 BHPS and PSID.

**Table 4a: Differences across broad regions, 21-30 year olds, US**

| | Non-volatile | Volatile |
|---|---|---|
| Fraction of population (2000) | 0.73 | 0.27 |
| Owns home | 0.32 | 0.21 |
| Rents | 0.41 | 0.46 |
| Ever had a child | 0.49 | 0.35 |
| Years of education | 12.86 | 13.45 |
| Log income in 1995$ | 9.38 | 9.48 |
| Mean PSID house value | 65,990 | 126,814 |
| Mean PSID annual rent | 3,845 | 5,710 |

**Table 4b: Differences across broad regions, 21-30 year olds, UK**

| | Non-volatile | Volatile |
|---|---|---|
| Fraction of population (2000) | 0.34 | 0.66 |
| Owns home | 0.42 | 0.39 |
| Rents | 0.26 | 0.29 |
| Ever had a child | 0.33 | 0.29 |
| Education – low | 0.48 | 0.47 |
| Education – medium | 0.26 | 0.25 |
| Education – high | 0.26 | 0.28 |
| Ln income (in £ 2000) | 9.22 | 9.29 |
| Mean BHPS house value (£) | 58,403 | 72,003 |
| Mean BHPS weekly rent (£) | 61.22 | 76.03 |

Source- PSID and BHPS.

**Table 5a Probability of Home-Ownership, US**

| | (1) | | (2) | |
|---|---|---|---|---|
| | dF/ dx | Std. Err | dF/ dx | Std. Err |
| Price Volatility Index | 0.5245 | 0.1284 | 0.3267 | 0.1553 |
| Age | -0.0071 | 0.0177 | -0.0049 | 0.0177 |
| Age Squared | 0.0006 | 0.0003 | 0.0006 | 0.0002 |
| Married | 0.2185 | 0.0066 | 0.2156 | 0.0067 |
| Ever have a child | 0.0468 | 0.0053 | 0.0529 | 0.0053 |
| Education | 0.0049 | 0.0013 | 0.0049 | 0.0013 |
| Ln Income | 0.2058 | 0.0039 | 0.2090 | 0.0039 |
| Ln Housing Prices | -0.0576 | 0.0066 | -0.0218 | 0.0094 |
| Ln Rental prices | -0.0596 | 0.0093 | 0.0049 | 0.0111 |
| Move A-B | -0.1276 | 0.0176 | -0.1012 | 0.0180 |
| Move B-A | -0.1174 | 0.0191 | -0.1370 | 0.0194 |
| State dummies | No | | Yes | |

Ages 21-30. Models also control for city size, missing values, trend and number of waves

**Table 5b Probability of Home-ownership, UK**

| | (1) | | (2) | | (3) | |
|---|---|---|---|---|---|---|
| | dF/ dx | Std. Err | dF/ dx | Std. Err | dF/ dx | Std. Err |
| Price Volatility | 0.4254 | 0.1542 | 0.2011 | 0.1574 | 0.3021 | 0.1624 |
| Age | 0.0666 | 0.0344 | 0.0647 | 0.0344 | 0.0628 | 0.0344 |
| Age Squared | -0.0006 | 0.0007 | -0.0006 | 0.0007 | -0.0005 | 0.0007 |
| Married | 0.4788 | 0.0083 | 0.4776 | 0.0083 | 0.4772 | 0.0083 |
| Has children | -0.0083 | 0.0126 | -0.0085 | 0.0126 | -0.0073 | 0.0126 |
| Educ - low | -0.0285 | 0.0121 | -0.0296 | 0.0121 | -0.0276 | 0.0121 |
| Educ - medium | 0.0337 | 0.0135 | 0.0328 | 0.0135 | 0.0335 | 0.0136 |
| Ln Income | 0.3058 | 0.0087 | 0.3096 | 0.0087 | 0.3097 | 0.0088 |
| Ln House Prices | -0.1742 | 0.0194 | -0.0212 | 0.0287 | -0.0316 | 0.0306 |
| Ln Rental prices | - | - | -0.1717 | 0.0237 | -0.1641 | 0.0262 |
| Move A-B | -0.1871 | 0.0287 | -0.1741 | 0.0300 | -0.1722 | 0.0302 |
| Move B-A | 0.0160 | 0.0421 | -0.0074 | 0.0414 | -0.0074 | 0.0414 |
| Regional dummies | No | | No | | Yes | |

Ages 21-30. Models include controls for living in a big city, number of waves observed in panel and trend

**Table 6a. Probability of Refinancing a US Home**

| | (1) | | (2) | |
|---|---|---|---|---|
| | dF/ dx | Std. Err | dF/ dx | Std. Err |
| Price Volatility Index | -0.5747 | 0.1837 | -0.4439 | 0.2284 |
| Age | -0.0374 | 0.0273 | -0.0384 | 0.0265 |
| Age Squared | 0.0007 | 0.0005 | 0.0007 | 0.0005 |
| Married | 0.0056 | 0.0102 | 0.0044 | 0.0100 |
| Ever have a child | 0.0169 | 0.0077 | 0.0158 | 0.0076 |
| Education | -0.0058 | 0.0020 | -0.0058 | 0.0020 |
| Ln Income | -0.0229 | 0.0056 | -0.0183 | 0.0057 |
| Ln House Equityt-1 | 0.0385 | 0.0032 | 0.0386 | 0.0033 |
| Move A-B | 0.0325 | 0.0377 | 0.0432 | 0.0369 |
| Move B-A | -0.0670 | 0.0485 | -0.0788 | 0.0495 |
| State dummies | No | | Yes | |

Ages 21-30. Models also city size controls, missing value dummies.

**Table 6b Probability of refinancing a UK home**

| | (1) | | (2) | |
|---|---|---|---|---|
| | dF/ dx | Std. Err | dF/ dx | Std. Err |
| Price Volatility | -0.3070 | 0.1187 | -0.4524 | 0.1185 |
| Age | 0.0437 | 0.0218 | 0.0444 | 0.0195 |
| Age Squared | -0.0008 | 0.0004 | -0.0008 | 0.0004 |
| Married | -0.0180 | 0.0133 | -0.0187 | 0.0129 |
| Has children | 0.0100 | 0.0053 | 0.0115 | 0.0050 |
| Educ - low | 0.0115 | 0.0061 | 0.0094 | 0.0054 |
| Educ - medium | 0.0076 | 0.0068 | 0.0059 | 0.0059 |
| Ln Income | 0.0071 | 0.0043 | 0.0058 | 0.0038 |
| Ln equity t-1 | 0.0067 | 0.0020 | 0.0046 | 0.0018 |
| Regional dummies | No | | Yes | |

Ages 21-30. Models include controls for living in a big city, number of waves observed in panel, trend, tax unit composition change between waves t-1 and t

**Table 7a. Number of rooms in US**

| | (1) | | (2) | |
|---|---|---|---|---|
| | coeff | Std. Err | coeff | Std. Err |
| Intercept | -22.1524 | 2.4086 | -21.426 | 2.6791 |
| Price Volatility Index | 2.4792 | 1.0438 | 1.4090 | 1.2373 |
| Age | 0.2502 | 0.1464 | 0.2310 | 0.1441 |
| Age Squared | -0.0012 | 0.0028 | -0.0009 | 0.0027 |
| Married | 1.3593 | 0.1214 | 1.3280 | 0.1060 |
| Ever have a child | 0.5746 | 0.0470 | 0.6244 | 0.0472 |
| Education | 0.1043 | 0.0105 | 0.1038 | 0.0105 |
| Ln Income | 1.7069 | 0.0771 | 1.6593 | 0.0998 |
| Ln Housing Prices | -0.6211 | 0.0592 | -0.4984 | 0.0764 |
| Move A-B | -0.9381 | 0.1711 | -0.6586 | 0.1670 |
| Move B-A | -0.4324 | 0.1804 | -0.6600 | 0.1833 |
| Mills ratio | 2.9707 | 0.2271 | 2.9070 | 0.2177 |
| State dummies | No | | Yes | |

Ages 21-30. Models also city size controls, trend, missing value dummies, number of waves observed in panel. Selection equation is reported in Table 4.1a. rental price omitted from rooms equation.

**Table 7b Number of rooms in the UK**

| | (1) | | (2) | |
|---|---|---|---|---|
| | coeff | Std. Err | coeff | Std. Err |
| Intercept | -4.1461 | 2.6502 | -3.7657 | 2.7546 |
| Price Volatility | 5.3342 | 0.7157 | 5.1871 | 0.7174 |
| Age | 0.3143 | 0.1711 | 0.3122 | 0.1670 |
| Age Squared | -0.0033 | 0.0033 | -0.0033 | 0.0032 |
| Married | 1.9941 | 0.1699 | 1.9492 | 0.1668 |
| Has children | 0.6972 | 0.0558 | 0.6921 | 0.0545 |
| Educ - low | -0.3370 | 0.0551 | -0.3396 | 0.0539 |
| Educ - medium | -0.0850 | 0.0605 | -0.0925 | 0.0591 |
| Ln Income | 1.0981 | 0.0954 | 1.0757 | 0.0939 |
| Ln House Price | -1.3159 | 0.1032 | -1.3144 | 0.1275 |
| Move A-B | -0.8006 | 0.2078 | -0.7966 | 0.1937 |
| Move B-A | -0.0635 | 0.2001 | -0.0593 | 0.2032 |
| Mills ratio | 2.0186 | 0.1750 | 1.9700 | 0.1722 |
| Regional dummies | No | | Yes | |

Ages 21-30. Model also includes controls for city, trend, number of waves observed in panel. Selection equation is reported in Table 4.1a. rental price omitted from rooms equation.

## Table 8a Gross housing wealth in the US

| | (1) | | (2) | |
|---|---|---|---|---|
| | Coeff | Std. Err | Coeff | Std. Err |
| Intercept | -9.7116 | 1.0887 | -8.7637 | 1.2631 |
| Price Volatility Index | 3.2031 | 0.5221 | 1.2252 | 0.5674 |
| Age | 0.2946 | 0.0737 | 0.2861 | 0.0664 |
| Age Squared | -0.0038 | 0.0014 | -0.0037 | 0.0013 |
| Married | 0.8475 | 0.0702 | 0.7190 | 0.0614 |
| Ever have a child | 0.1355 | 0.0245 | 0.1219 | 0.0225 |
| Education | 0.0898 | 0.0053 | 0.0907 | 0.0048 |
| Ln Income | 1.0994 | 0.0492 | 1.0187 | 0.0447 |
| Ln Housing Prices | 0.3607 | 0.0292 | 0.3427 | 0.0351 |
| Move A-B | -0.4798 | 0.0857 | -0.4236 | 0.0771 |
| Move B-A | -0.1305 | 0.0903 | -0.1385 | 0.0841 |
| Mills ratio | 1.5121 | 0.1083 | 1.3239 | 0.0957 |
| State dummies | No | | Yes | |

Ages 21-30. Models also city size controls, trend, missing value dummies, number of waves observed in panel. Selection equation is reported in Table 4.1a. rental price omitted from rooms equation.

## Table 8b Gross housing wealth in the UK

| | (1) | | (2) | |
|---|---|---|---|---|
| | Coeff | Std. Err | Coeff | Std. Err |
| Intercept | -3.4939 | 0.8638 | -2.8523 | 0.8707 |
| Price Volatility | 1.6702 | 0.2331 | 1.5330 | 0.2261 |
| Age | 0.1572 | 0.0560 | 0.1553 | 0.0529 |
| Age Squared | -0.0020 | 0.0011 | -0.0020 | 0.0010 |
| Married | 0.7112 | 0.0569 | 0.6772 | 0.0541 |
| Has children | 0.1801 | 0.0182 | 0.1784 | 0.0172 |
| Educ - low | -0.1219 | 0.0180 | -0.1240 | 0.0171 |
| Educ – medium | -0.0036 | 0.0198 | -0.0087 | 0.0187 |
| Ln Income | 0.4936 | 0.0311 | 0.4765 | 0.0296 |
| Ln House Prices | 0.5427 | 0.0338 | 0.5078 | 0.0403 |
| Move A-B | -0.2159 | 0.0676 | -0.2141 | 0.0638 |
| Move B-A | 0.0203 | 0.0649 | 0.0296 | 0.0614 |
| Mills ratio | 0.6567 | 0.0569 | 0.6206 | 0.0542 |
| Regional dummies | No | | Yes | |

Ages 21-30 only. Models also includes controls for city, trend, number of waves observed in panel. Selection equation is reported in Table 4.1a. rental price omitted from rooms equation.

**Table 9: Probability of holding endowment mortgage, home owners in UK only**

| | (1) | | (2) | |
|---|---|---|---|---|
| | dF/ dx | Std. Err | dF/ dx | Std. Err |
| Price Volatility | -0.6869 | 0.1012 | -0.3512 | 0.1068 |
| Age | 0.0175 | 0.0017 | 0.0179 | 0.0017 |
| Age Squared | -0.0002 | 0.0000 | -0.0003 | 0.0000 |
| Married | 0.0432 | 0.0092 | 0.0400 | 0.0091 |
| Has children | 0.0393 | 0.0066 | 0.0423 | 0.0066 |
| Education - low | 0.0358 | 0.0070 | 0.0370 | 0.0070 |
| Education - medium | 0.0144 | 0.0080 | 0.0147 | 0.0080 |
| Ln Income | -0.0063 | 0.0053 | -0.0004 | 0.0053 |
| Move A-B | 0.0627 | 0.0479 | 0.0748 | 0.0464 |
| Move B-A | -0.0601 | 0.0561 | -0.0831 | 0.0571 |
| Regional dummies | no | | yes | |

All ages. Models also include number of waves observed in panel, city trend

**Figure 1a: Relative utility of owner occupation when young by variance of house prices and steepness of housing ladder**

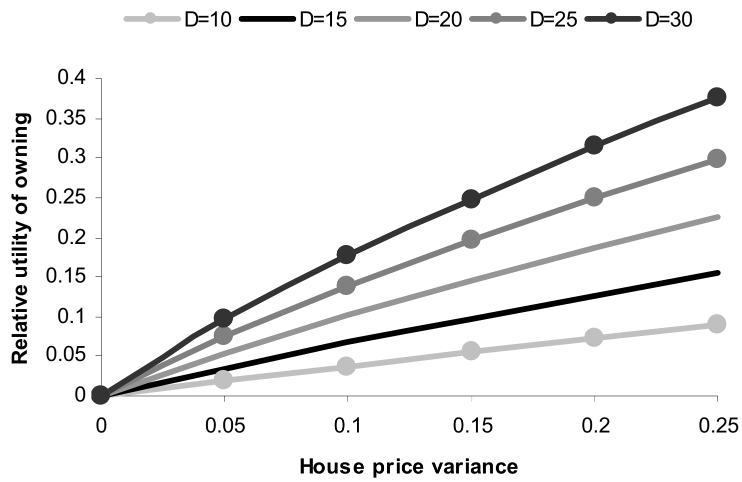


**Figure 1b: Relative utility of owner occupation when young by variance of house prices and degree of risk aversion**

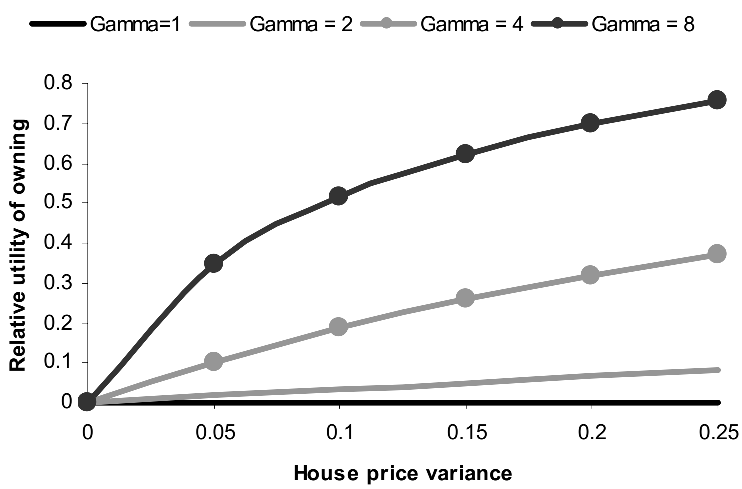

**Figure 2a: Consumption of housing when young by variance of house prices and steepness of housing ladder**

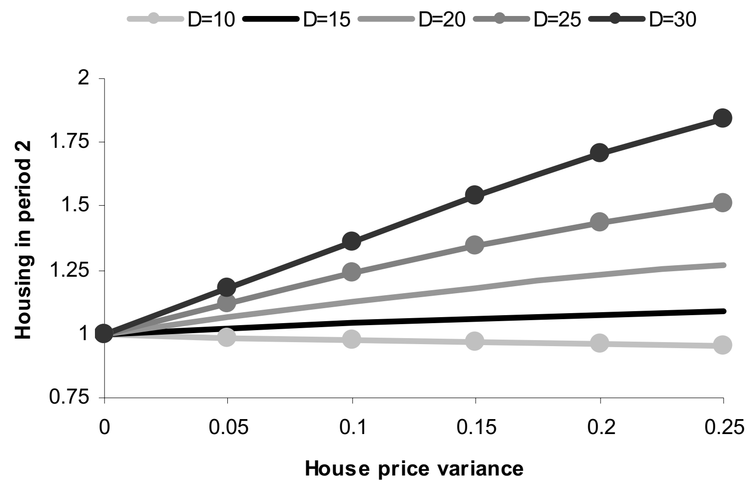


**Figure 2b: Consumption of housing when young by variance of house prices and degree of risk aversion**

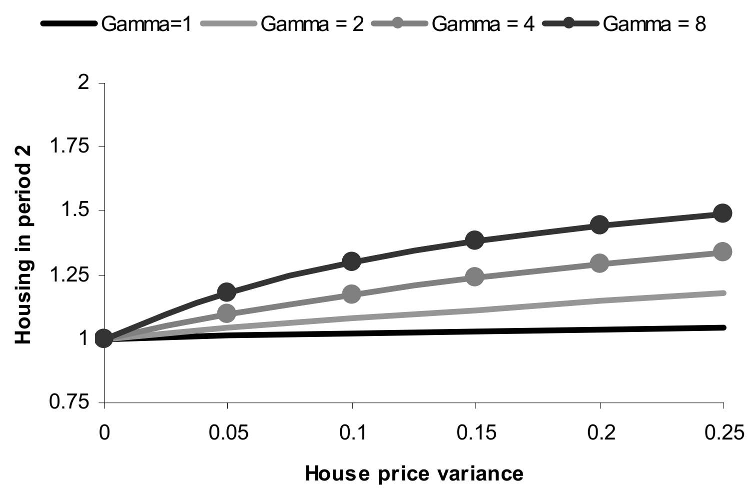

**Figure 3a: The demographic ladder, US**

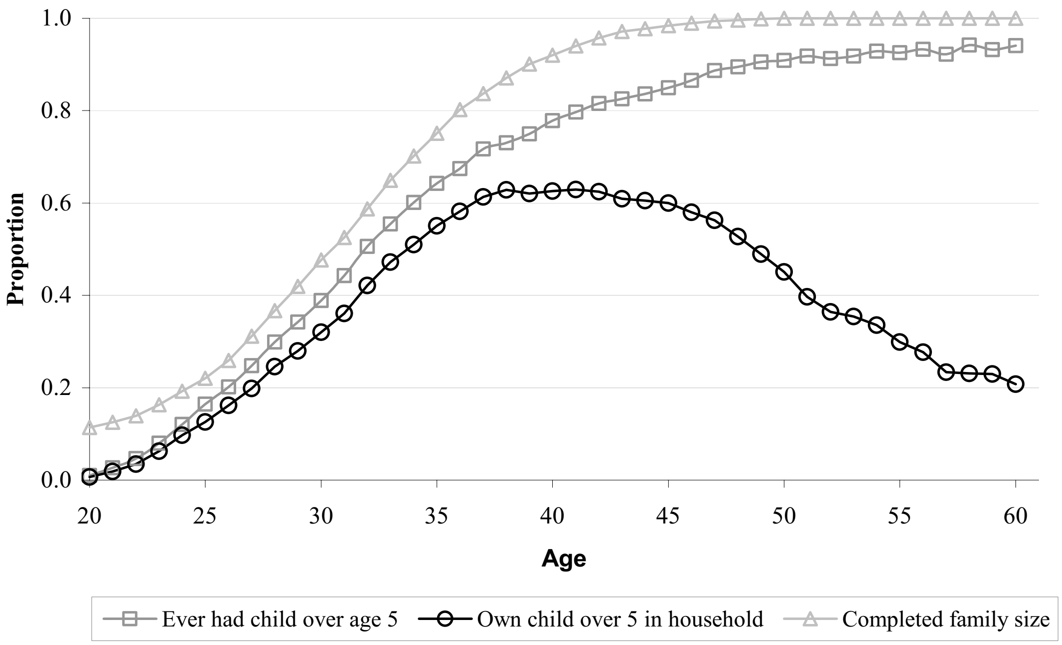


**Figure 3b: The demographic ladder, UK**

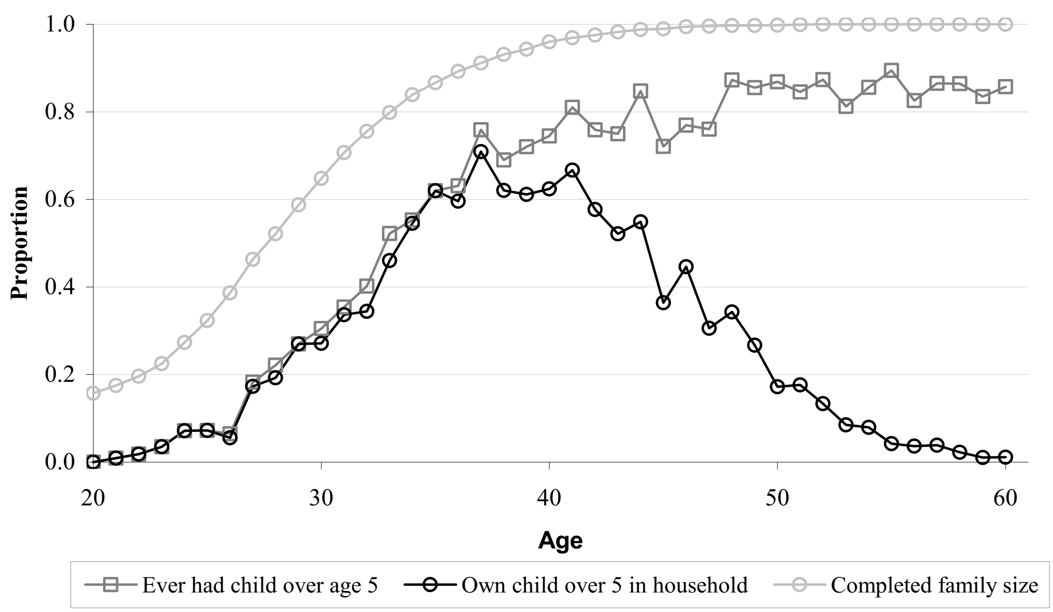


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**Figure 4. Comparison of UK and US house prices**

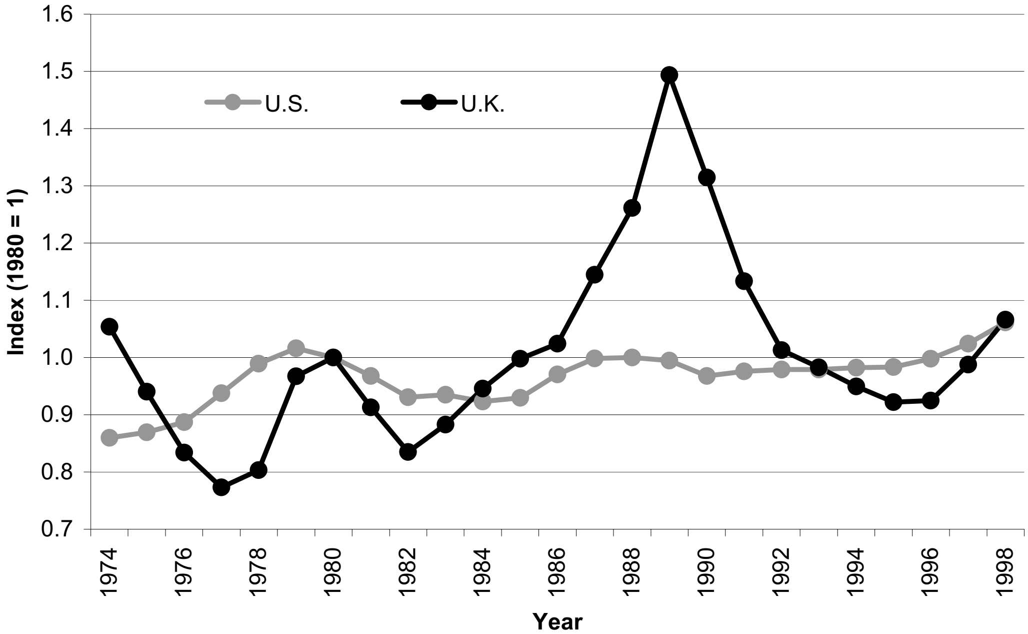


**Figure 5a: US mean house price index by area, 1980-1997**

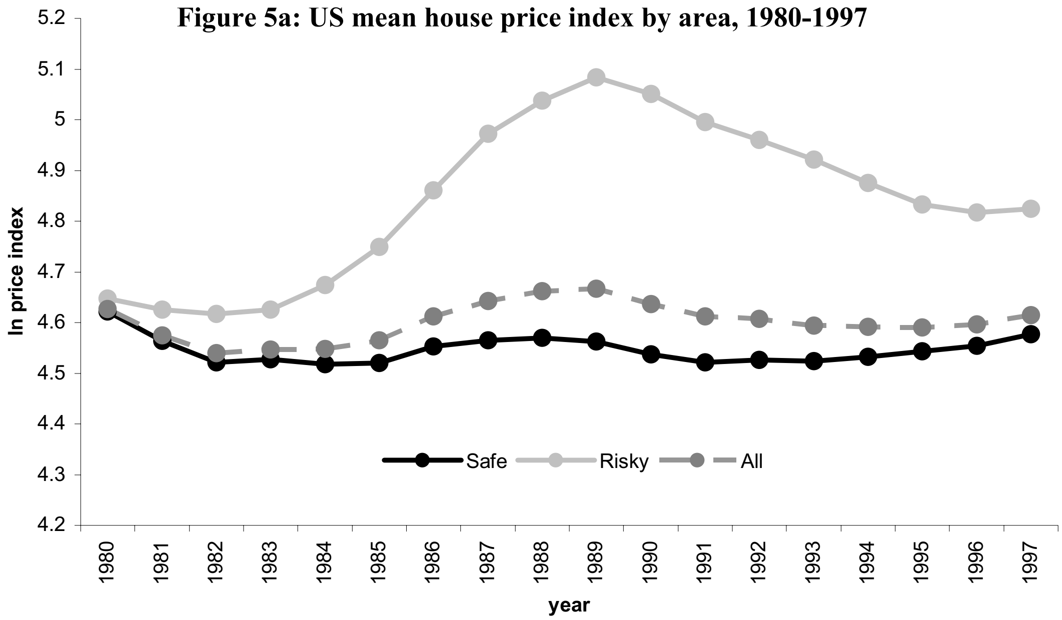



**Figure 5b: UK mean house price index by area, 1980-2000**

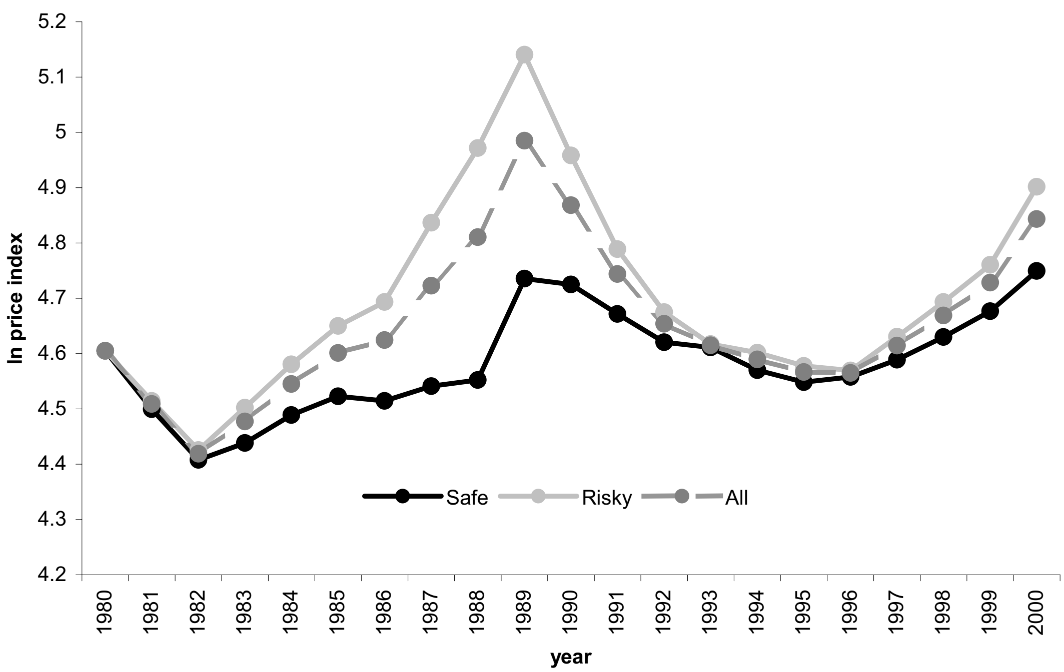


**Figure 6a. Regional volatility indices, US, 1980-1997, by area**

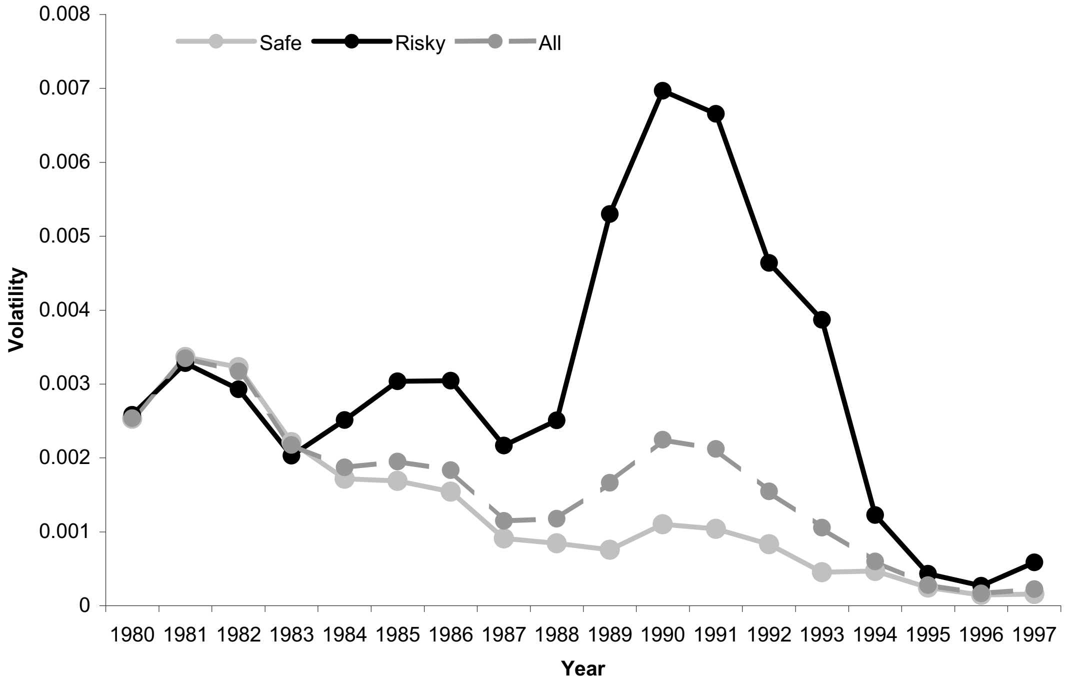
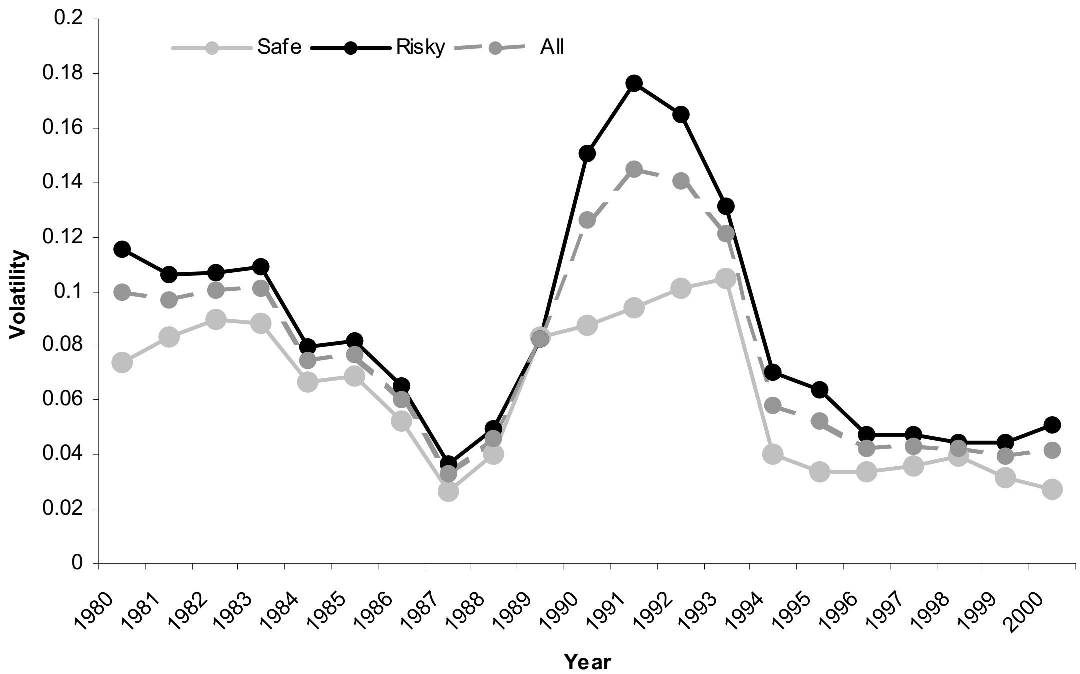



**Figure 6b. Regional volatility indices, UK, 1980-2000, by area**



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