

Search, matching, chains and house prices

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Abstract

The housing market is an asset market with some unusual features, as agents have idiosyncratic preferences for housing so that search is required, and all parties must make matches before a transaction can be finalised. We present a simple model that reflects these features and find that the search parameters - probability of matching, for example - have the expected effect on asset prices, but of second order magnitude. Large falls in the probability of matching (and hence long increases in mismatched duration) are likely to have small effects on house prices. This helps to explain the observed persistence in house prices in the face of large changes in turnover. We also show that the number of new entrants to the housing market may have a large influence on the probability of selling a property.

Keywords: house prices, search, matching, chains.

1 Introduction

The UK housing market has been characterised by unusual turbulence in recent years, with very large changes in real prices, and also in turnover. It seems clear that the market was characterised by an unstable speculative bubble in the mid to late 1980s, which collapsed in 1988. Consequently, turnover in the market roughly halved in the space of two years. The bubble is usually blamed on the process of financial deregulation that occurred between 1979 and 1985.

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The focus in this paper is on the relationship between turnover and prices. The reason why this is a key area for study stems from the fact that the housing market is an unusual one, combining features of asset and search markets. Most assets are characterised by a good deal of information about characteristics and value, so search costs and related phenomena are not generally considered to be relevant to the pricing decision. Houses are obviously substantial assets, and, as with other stores of wealth, it is plausible that information about individual houses is near complete. Specifically, the value of houses with particular characteristics (size, location, and so on) is well known. Nevertheless, there is an information problem. Where this arises is in the matching of buyers and sellers, in which regard housing is somewhat unusual, although similar processes may operate elsewhere, for example in the fine art market. But the unique feature of the market is that housing transactions require a sequence of trades to take place simultaneously. In particular, 'chains' of buyers and sellers must exist, where the chain begins with an entrant to the market and ends with an exit, a vacant property. This situation does not always apply with equal force, as some vendors move temporarily into the rented market while others may hold two properties; but these strategies are uncommon in the UK, although not in the US.¹

Given these features, it is surprising that the literature has not explored them more. There are only a small number of papers that explicitly consider the search process, and these tend to be lifted more or less directly from the established search literature where buyers are searching for properties below their reservation price among the houses posted by vendors. Models in this category include Turnbull and Sirmans (1993), Turnbull, Sirmans and Benjamin (1990) and Cronin (1982). All these papers are primarily empirically motivated. This one-sided search process ignores the matching issue, although this may be justified by their interest in the appropriate modelling of cross-sectional variation in prices. Zorn and Sackley (1991) also have a one-sided model. In their case, the probability of selling a house is affected by the price posted,

¹Another 'market' with similar characteristics from the search point of view is the marriage market. Here also, to complete a transaction both parties must conclude a unique transaction simultaneously, and cannot hold multiple marriages, in the absence of legal polygamy. However, marriage chains do not form (except in another, metaphorical, sense).

for 'as offering prices are reduced, prospective buyers are assumed to increase their intensity of search and, additionally, an increased number of consumers will become prospective buyers' (p 320). Even if this were true in equilibrium, it is hard to see how an individual vendor can engender this effect. The main effect of lowering the selling price is probably to make a capital loss. Some indirect evidence on the extent to which information is disseminated in this market is given by Turnbull and Sirmans (1993), who look for variation in prices among purchaser types, on the grounds that (say) new entrants have higher search costs and less complete information than other buyers. But they report that, to their evident surprise, 'we find no significant differences in housing prices across the various groups of buyers' (pp 556-7).² They ascribe this to the high quality information provided by housing market intermediaries. While this is certainly likely to constitute part of the explanation, another aspect, developed in this paper, is that varying search costs (which will affect search intensity and hence the probability of making a match) have only very small effects on prices compared to the 'fundamental' determinants (the hedonic characteristics they are able to measure).³

The richest published model is in Wheaton (1990). He does not perform any econometric tests, but states that his model mimics observed phenomenon. Wheaton recognises that in order to make a transaction, both parties must make a sale. However, instead of taking on board the existence of chains, he side-steps the issue by assuming that buyers will hold two properties while waiting for a sale to be completed. Indeed, this process requires that vendors have a vacant property before making a sale. This has rather profound implications. For example, if every household were mismatched but the number of properties exactly equalled the number of households so that there were no vacant properties, then no trades would ever occur. The number of vacancies is thus a crucial variable, but in Wheaton's model it is effectively a constant.⁴ It is certainly true that vacant properties play a key rôle in the market as chains have to end with a vacant property, but this precise condition may be somewhat restrictive. For example,

²They examined 800 transactions in late 1980s Baton Rouge, Louisiana.

³Other relevant papers include Baryla and Zumpano (1995), Read (1991), Ronwendal (1988) and Sunwoong (1992).

⁴In the long-run supply increases to equate house prices with the marginal cost of supply.

Wheaton derives some counter-intuitive comparative static results. As the matching probability depends only on the vacancy rate and effort, an increase in the number of mismatched houses by itself has no impact on sales. A reduction in turnover, which might be thought to increase the value of owning a house, reduces house prices in his model, as the same number of vacancies are being sought by a smaller pool of people. For these reasons, we do not find his model a convincing description of the UK market.

Rosenthal (1997a) has a statistical model that simulates the build up of housing chains. In Rosenthal (1997b) he extends the model to incorporate a mechanical price adjustment process, but the focus remains on the statistical process.

Stein (1995) examines price and volumes in the housing market, but not within a search or matching framework, although he suggests (pp 401-2) that the model could incorporate search. What drives his model is liquidity and credit rationing. High prices allow access to higher deposits for movers, which generates higher turnover. The causality runs from prices to volume.⁵

The structure of the paper is as follows. In the next section, we set out an approach to the determination of house prices where agents must search for matching partners. In the following section, we characterise the flow equilibrium of the market. Then we attempt to calibrate the effects. The final section concludes.

2 The value of a house

We work in discrete time. There are k types ($k > 1$) of household, differing only in their taste for housing. There are also k corresponding types of houses. There are equal numbers of all types of households and houses. The felicity or flow utility derived from 'matched' home ownership is y in all cases. There is a cost associated with mismatch of m . The probability of becoming mismatched in any period is $\frac{1}{2}$; for simplicity we assume that once mismatched, households will remain mismatched while they are searching; they cannot move back into the matched state. Relaxing

⁵This is the same conclusion that we draw below.

this assumption increases the complexity of the problem with no qualitative changes. There is a discount rate δ . Households 'die' with probability e , where e indicates an 'exit' from the owner occupation market. 'Exits' happen when a household leaves the market - say by emigration, physical death, dissolution of the family unit or an exit into some other form of housing tenure. Thus if P is the number of households, the outflow from the market is eP . We consider steady states, so there is an equal number of births per period, B . It is easy to see that if household births exceed deaths then P will rise, and as long as the death rate is a constant, we will converge on the steady state. The probability of making a successful match is $\frac{1}{4}$. 'Successful' means that agents find matching purchaser and vendors, and also complete the market chain, so that all parties to the transaction are able to conclude the trade. We pay more attention to this probability in the next section; for the time being we treat it as an exogenous parameter. As a sale requires a simultaneous purchase, vendors and purchasers who are 'inside' the chain face precisely the same environment. A first time buyer has only to meet a vendor in a completed chain; he or she need not worry about simultaneously finding a purchaser. The probability of a match depends on search intensity, the number of mismatched households, and other parameters. We discuss these issues more fully in the next section. However, it is worth stressing at the outset that, as observed in the introduction, $\frac{1}{4}$ will not depend upon the posted price. In the housing market, lowering the offer price is unlikely to generate an increase in the probability of making a match.⁶ Even if it were to do so, the traded price is the outcome of a bargaining process after the match has been made and the original offer price is irrelevant in this process.⁷ There is evidence that bargaining matters. Evans (1995) discusses some relevant issues in the context of housing market efficiency. He notes (p 25) that there is no clear consensus in the literature about whether the level of prices is positively or negatively related to the speed of sale. He also observes that there is a market range, rather than a unique price. This is, of course, entirely

⁶Apart from the fact that information is widely available, a low price may be taken as a signal the house is a lemon. We do not discuss this further here.

⁷In England and Wales initial offer prices have no legal force on either side, as many house purchasers and vendors are only too well aware.

consistent with a bargaining process.

It should be clear that the search environment we have sketched here is quite different from the standard labour market search model, where once a match has been made, if the two parties are willing, a trade occurs.

Using a simple dynamic programming approach, the value of being matched U_T is given by

$$U_T = y + (1 - e) \frac{\frac{1}{2}U_S + (1 - \frac{1}{2})U_T}{1 + \cdot} \quad (1)$$

$(1 - e)$ is the probability of surviving to the next period. This can be simplified by defining $r = \cdot + e$, so the the discount rate implicitly incorporates the probability of death:

$$U_T = y + \frac{\frac{1}{2}U_S + (1 - \frac{1}{2})U_T}{1 + r} \quad (2)$$

The value of searching U_S is given by

$$U_S = y - m + \frac{\frac{1}{4}U_T + (1 - \frac{1}{4})U_S}{1 + r} \quad (3)$$

Thus the value of a matched house to a household is given by

$$U_T = \frac{1 + r}{r\mu} y + \frac{(y - m)\frac{1}{2}}{r + \frac{1}{4}} \quad (4)$$

where

$$\mu = \frac{r + \frac{1}{4} + \frac{1}{2}}{r + \frac{1}{4}} \quad (5)$$

It is easy to show the effect on the value of a house of changing $\frac{1}{4}$ and $\frac{1}{2}$. For $m > 0$, these are

$$\frac{\pm U_T}{\pm \frac{1}{4}} = \frac{1 + r}{r} \frac{m\frac{1}{2}}{(r + \frac{1}{4} + \frac{1}{2})^2 (r + \frac{1}{4})} > 0 \quad (6)$$

and

$$\frac{\pm U_T}{\pm \frac{1}{2}} = - \frac{1 + r}{r} \frac{m(r + \frac{1}{4})}{(r + \frac{1}{4} + \frac{1}{2})} < 0 \quad (7)$$

For $m = 0$, $\frac{\pm U_T}{\pm \frac{1}{2}} = \frac{\pm U_T}{\pm \frac{1}{4}} = 0$, as we would expect. Thus if there is a cost to mismatch, an increase in the probability of becoming mismatched lowers the value of a house; if the chances of finding a match increase, the value rises. This leaves open the determination

of the market price. If a buyer matches with a vendor and the chain can be closed by this link, then there is a rent to be bargained over that depends on the difference between U_T and U_S for each party. We have assumed all agents are identical, so both sides face the same loss. There is no credible threat open to either bargainer. It seems natural simply to assume the symmetric Nash solution, and the surplus is divided equally. This implies that U_T is also the transacted market price.⁸

3 Equilibrium

The next step is to examine the possibility of an equilibrium in the housing market. In the steady state, 'in°ows' of prospective purchasers must equal 'out°ows'. The in°ows consist of newly mismatched households and new entrants. In the steady state the number of new entrants B per period equals the number of exits. M is the number of mismatched households, T the number of transactions and P the total number of households. We have two steady state relationships,

$$E + \frac{1}{4}M = \frac{1}{2}P + B \quad (8)$$

and

$$E = B: \quad (9)$$

Also,

$$T = \frac{1}{2}P + B: \quad (10)$$

(8) and (9) imply that the steady state equilibrium condition for $\frac{1}{4}$ is

$$\frac{1}{4} = \frac{\frac{1}{2}P}{M}: \quad (11)$$

Assuming that no chains are circular, all sets of transactions must begin with a new entrant to the market and end with an exit. The steady state number of chains is simply given by the number of entrants, so average chain length L (where the length

⁸In practice some parties will have greater mismatch costs m than others so the model can support a distribution of observed prices.

of a chain is measured by the number of properties involved) is $T=B$, where B will be proportional to N (by (18) below). Thus

$$L = \frac{\frac{1}{2}P + B}{B}; \quad (12)$$

Next we look at the matching technology, or the probability of making a match. We need to specify the search technology. There are no definitive functional forms to apply.⁹ Beginning with a very general formulation, we suppose that the probability of making a successful match with a party in a completed chain depends on the number of mismatched properties and (negatively) on chain length. The chain length is negatively related to N by (12). It is plausible that a rise in M raises the probability of matching although this need not hold. Thus

$$\frac{1}{4} = \frac{1}{4}(N; M); \quad \frac{1}{4}_N > 0; \frac{1}{4}_M > 0; \quad (13)$$

The probability also depends on effort e , but we will not endogenise it and therefore suppress the term. This requires some discussion. In Wheaton (1990) search intensity is a choice variable that affects the matching probability. But in our model, households simply start to search when they become mismatched. This is a realistic simplifying assumption, as search costs are likely to be trivial. The main cost is borne by the vendor's estate agent who is paid a fixed fee on completion of a sale. These fees are substantial, typically 2.5% of the sale value, plus taxes. Direct search costs by the purchaser are largely time and shoe leather, and are probably small, as estate agents are effective providers of information.¹⁰ Thus it is legitimate to disregard them. Indeed, it would be wrong to argue that endogenous search costs play a significant rôle in the housing market.

We can illustrate the issues by making a simple but realistic characterisation of the problem which ties the technology down to a specific form. Firstly, we assume all

⁹The seminal paper on these matters is Diamond (1982). Pissarides (1990) is an exhaustive treatment of the equilibrium unemployment problem.

¹⁰This is not to say that estate agents provide perfect information; there is plenty of evidence that information about the residential property market is imperfect and slow to disseminate: Evans (1995) and Barkham and Geltner (1996). However, the point is that professional negotiators (estate agents) effectively disseminate what information there is.

matches must be made within the period. If $\frac{1}{4}^e$ is the probability of finding a vacant property (from an 'exited' household) and $\frac{1}{4}^M$ is the probability of finding another mismatched household as a buyer, then (for sufficiently short periods)

$$\frac{1}{4}^M = \frac{1}{4}^e + \frac{1}{4}^M: \quad (14)$$

Given the symmetry of the process, the probability of finding a purchaser with a closed chain on their side, $\frac{1}{4}_F^M$, is given by

$$\frac{1}{4}_F^M = \frac{1}{4}^e + \frac{1}{4}^M \frac{1}{4}_F^M \quad (15)$$

so that

$$\frac{1}{4}_F^M = \frac{\frac{1}{4}^e}{1 - \frac{1}{4}^M}: \quad (16)$$

The equivalent expression for a first time buyer is identical. However, the probability of closing a sale $\frac{1}{4}$ depends also on being found by a closed-chain purchaser. Appealing to symmetry again, this is simply given by

$$\frac{1}{4} = (\frac{1}{4}_F^M)^2: \quad (17)$$

First time buyers have closed chains on one side, by definition, so their probability is given simply by (16). Thus the stock of searching first time buyers N is given by

$$N = B = \frac{1}{4}_F^M: \quad (18)$$

To pursue our simple example further, we make an explicit assumption about these probabilities; namely, that they are proportional to the relevant stocks of searchers and 'vacancies'. Thus

$$\frac{1}{4}^M = \frac{\textcircled{R} M = k}{P} \quad (19)$$

and

$$\frac{1}{4}^e = \frac{\textcircled{R} N = k}{P} \quad (20)$$

where \textcircled{R} is a search technology parameter. So using (16) and (17),

$$\frac{1}{4} = \frac{(\textcircled{R} N)^2}{(kP - \textcircled{R} M)^2}: \quad (21)$$

It follows that $\frac{1}{4}_N = \frac{2\theta^2 N}{(kP_i \theta M)^2} > 0$; $\frac{1}{4}_M = \frac{2\theta^3 N^2}{(kP_i \theta M)^3} > 0$ and $\frac{1}{4}_{MM} = \frac{-6\theta^3 N^2}{(kP_i \theta M)^4} < 0$. Moreover, $\frac{1}{4}(N; P) = \frac{h \theta N}{(k_i \theta) P} i_2$ and $\frac{1}{4}(N; 1) = \frac{h \theta N}{(kP_i \theta)} i_2 > 0$.¹¹ These results are used to sketch the figure below.

Moving to the determination of the equilibrium, note that the equilibrium flow condition (11) defines a simple rectangular hyperbola where $\frac{1}{4} = \frac{1}{2}$ when $M = P$.¹² The assumptions that $\frac{1}{4}_M > 0$, $1 > \frac{1}{4}(N; 1) > 0$ and $\frac{1}{4}(N; P) > \frac{1}{2}$ are sufficient to ensure the existence of a unique equilibrium. If $\frac{1}{4}_M < 0$ over some range multiple equilibria are possible although not all will be stable. Moreover, (11) defines the rest point of the equation of motion:

$$M = \frac{1}{2}P - \frac{1}{4}M \quad (22)$$

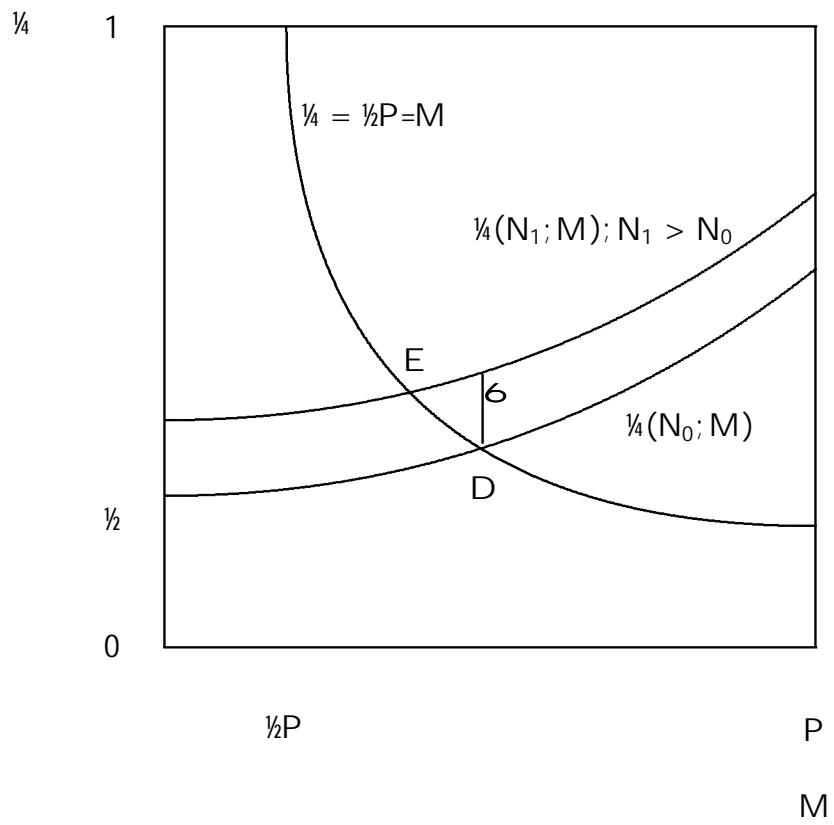
All this is illustrated in the figure, drawn for a unique stable equilibrium, which shows what happens when new entrants rise from N_0 to N_1 . Starting at the equilibrium indicated by D on the diagram, M is fixed initially and the matching probability jumps to the new matching locus, $\frac{1}{4}(N_1; M)$. Then as chain lengths fall, the number of mismatched households M also falls. In equilibrium the matching probability is higher (point E in the diagram) although it is falling along the path. As $\frac{1}{4}$ has risen, equilibrium house prices will also rise.

Vacancies, in the Wheaton sense of empty properties, are clearly important here. Chains begin with a new entrant and end with a vacancy. But they do not have quite the pivotal rôle that Wheaton gives them. For example, if turnover rises then M will rise, and the matching probability for mismatched households will rise at a faster rate than for vacant properties or new entrants. Chains will lengthen, the outflow from the stock of vacant properties and new entrants will increase, and these stocks will fall. The existence of chains and intra-mismatched households makes a significant difference to dynamics.

¹¹ $\frac{1}{4}(N; 0)$ is not defined as there are no mismatched households to search.

¹² (11) will shift out when $\frac{1}{2}$ increases, raising M , ceteris paribus.

Figure 1
Market flow equilibrium



4 Mismatch and house prices

Now we have a framework in place, we can see whether plausible changes in the key parameters can affect house prices to any significant extent. Unfortunately, M is not observed so it is hard to estimate $\frac{1}{2}$ or $\frac{1}{4}$. We do know that T varies widely. For example, residential housing transactions in England and Wales were 1,991,000 in 1988; by 1992 they had nearly halved to 1,031,000. Unless there was a very large fall in $\frac{1}{2}$, it follows that we are sometimes, and possibly often, a long way from the steady state. Moreover, unless M fell over this period, which is against all the anecdotal evidence, from (8), $\frac{1}{4}$ must have at least halved and duration doubled. We can say rather more about average chain lengths. New entrants to the market¹³ numbered 720,000 and 456,000 in 1988 and 1992 respectively. These figures are for the UK, while the transactions figures exclude Scotland, so the calculations underestimate the chain length slightly. But using these figures, estimated chain lengths fell from an average length of 2.8 in 1988 to 2.3 in 1992.¹⁴ This is in contrast to the probable increase in duration.¹⁵ Thus we can be fairly confident that there are large variations in market vacancy durations. It is worth observing that the fall in new entrants explains the large fall in transactions over the period. Moreover, the model predicts a large initial fall in the probability of a sale, followed by a gradual recovery, which seems to accord with the actual experience.¹⁶

Over the same period, real house prices (deflated by the RPI) fell by 12.7%. Can we

¹³By this we mean successful 'first-time purchasers', which includes households who may have owned a house in the past.

¹⁴This fall is despite the fact that we know that in the steady state $L = \frac{\frac{1}{2}P+B}{N}$, implying L must rise for constant $\frac{1}{2}$.

¹⁵A chain has a minimum length of one (a new purchaser buying a vacant house). Some readers may feel these average lengths are surprisingly low. However, it is consistent with the evidence in Forrest and Murie (1994). They survey the purchasers of new dwellings in south east England in 1998-89, tracing chains backwards. Clearly, there is scope for attrition here. But taking the figures for what they are worth, 37% chains were of length one, 38% length two, 17% length three and 8% length four or more.

¹⁶This raises the question of why the number of new entrants fell so rapidly. The reason is probably connected with the collapse of the housing bubble. After 1988, with higher real interest rates and falling prices, the user cost of housing rose dramatically. Many prospective householders feared, correctly, that they would make a capital loss if they purchased. In addition, it seems likely that there was a rise in uncertainty, about interest rates, house prices and household income, following the onset of the 1990 recession. There are strong reasons for believing that even small increases in uncertainty cause agents to defer investment; see Dixit and Pindyck (1994) for an introduction to the issues.

explain this fall with the increase in the difficulty of selling a property? The answer is probably that we cannot.

To get some feel for the orders of magnitude, Table 1 shows what happens to the value of a house when key parameters change, based on the results from (4). The baseline has $\frac{1}{4} = 0.5$ so that the expected duration is two periods, which we treat as quarters. Thus on average it takes six months to move. The results are qualitatively exactly what we expect. Row 1 is the baseline, with annual interest rates of 4%, the flow utility y at 1, a 5 % mismatch cost, and a 10% probability of becoming mismatched in any period. In row 2, duration doubles; but this reduces the value of a house by only 0.57%. Similarly, if $\frac{1}{4}$ doubles to 0.2, the value of a house falls by only 0.59%. In fact, even if there is a 100% chance of being mismatched, the value only falls by 2.51% (row 4). A doubling in the mismatch cost (row 5) lowers the value by 0.83%. So all the search parameters have fairly small impacts on values. Indeed, if there is no mismatch at all ($\frac{1}{4} = 0$; row 6) prices rise by a mere 0.83%. By contrast, changes in interest rates (row 7) and the flow utility (row 8) have large effects.

Finally, Table 2 compares our results with Wheaton's. Comparison is not entirely straightforward, as Wheaton endogenises effort and (as we argue above) the role of vacancies is problematic. Fixing parameters at levels consistent with Wheaton (1990) Table 1 (p 1287), we find the comparative statics differ markedly. The characterisation of the matching process and the treatment of vacancies does matter, therefore.

5 Conclusions

This short paper has a simple message. Houses are valuable assets with idiosyncratic characteristics, which make matching buyers and sellers a difficult task. Consequently, the value of a house should reflect the difficulty of making a match, and the cost of being mismatched. However, compared to the costs associated with changing interest rates and valuations of the benefits flowing from occupation of a property, these effects are small. Quite large changes in the probability of finding a match, or the costs or

Table 1
House prices and parameter values.

case	y	m	r	$\frac{1}{4}$	duration	$\frac{1}{2}$	value	% deviation from base
1	1	0.05	0.04	0.50	2	0.1	101.65	0.00
2	1	0.05	0.04	0.25	4	0.1	101.06	-0.57
3	1	0.05	0.04	0.50	2	0.2	101.04	-0.59
4	1	0.05	0.04	0.50	2	1.0	99.09	-2.51
5	1	0.10	0.04	0.50	2	0.1	100.81	-0.83
6	1	0.05	0.04	-	-	0.0	102.49	0.83
7	1	0.05	0.05	0.50	2	0.1	81.81	-19.51
8	0.9	0.05	0.04	0.50	2	0.1	91.40	-10.08

Notes:

- i y is flow utility from occupation.
- ii m is the cost of being mismatched.
- iii $\frac{1}{2}$ is the probability of becoming mismatched per quarter.
- iv $\frac{1}{4}$ is the probability of making a successful match in any quarter.
- v r is the annual discount rate.
- vi 'value' is the value of a property.
- vii Row 1 is the base for comparisons.
- viii In row 6 duration and $\frac{1}{4}$ are inapplicable as mismatch never occurs.

Table 2
House prices and parameter values: comparison with Wheaton (1990).

case	y	m	r	$\frac{1}{4}$	duration	$\frac{1}{2}$	% deviation from base	Wheaton's deviation
base	1	0.5	0.05	0.694	1.44	0.1	0.00	0.00
	1	0.5	0.05	0.943	1.06	0.2	-7.51	11.44
	1	0.5	0.05	0.585	1.71	0.05	-2.66	-31.84
	1	0.5	0.05	0.559	1.79	0.05	-6.29	5.47

chances of being mismatched, should have very little impact on house prices. This helps to explain why estate agents' pleas for more 'realistic' pricing - that is, lower - in the face of greatly reduced turnover in the post-1989 UK housing market tended to fall on deaf ears. We are also able to explain the pivotal rôle that new entrants play in this market. As they determine the number (and length) of chains, a fall in new entrants has profound implications for the ease with which houses may be sold. However, there is no reason to suppose this will translate into large changes in house prices.

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