Can the Mortensen-Pissarides model match the housing market facts?

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Can the Mortensen-Pissarides Model Match the Housing Market Facts ?

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Abstract

This paper examines whether the baseline Mortensen-Pissarides matching model can account for the housing market facts, namely, the existence of price dispersion, the positive correlation between housing price and trading volume, and between housing price and time-on-the-market. Our main finding is that the model can account for these three basic facts of the housing market, thus showing that the Mortensen-Pissarides framework can be seen as the benchmark macroeconomic model not only for the labour market but for any market with frictions.

Keywords: housing price dispersion, time-on-the-market, trading volume, search and matching process.

JEL Classification: R21, R31, J63

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1. Introduction

Housing markets are characterised by a decentralised exchange framework with important search and matching frictions. It has, in fact, been acknowledged that housing markets clear not only through price but also through the time and money that a buyer and a seller spend on the market. Consequently, the search and matching approach is widely used even in this type of market (see section 2).

Furthermore, three basic facts have been repeatedly reported: (a) the positive correlation between housing price and trading volume (see Leung, Lau and Leong, 2002; Fisher *et al.*, 2003, among others); (b) the positive correlation between housing price and the time-on-the-market (see Leung, Leong and Chan, 2002; Anglin *et al.* 2003; Merlo and Ortalo-Magne, 2004, among others);[1] (c) the existence of price dispersion.

Price dispersion (or price volatility) is probably the most important distinctive feature of housing markets. It refers to the phenomenon of selling two houses with very similar attributes and in near locations at the same time but at very different prices. Although price dispersion research is more commonly found in studies of non-durable consumption goods,[2] price dispersion studies on durable and re-saleable goods such as real estate are also growing rapidly (for an overview see Leung, Leong and Wong, 2006). Real estate is in fact the most important durable consumption good and one of the most important assets for most household portfolios (Leung, Leong and Wong, 2006). Since most real estate transactions come from re-sales between buyers and sellers (transactions in the housing markets are in fact dominated by a second-hand market), it should not be surprising that price dispersion exists even in the housing market (Leung, Leong and Wong, 2006).

In a nutshell, the variance in house prices cannot be attributed completely to the heterogeneous nature of real estate. Remaining price differentials are in fact empirically non negligible. A significant part of housing price dispersion is basically due to the heterogeneity of buyers and sellers, in particular their sustained search costs (see Leung and Zhang, 2011). Vukina and Zheng (2010) find very strong empirical

[1] The time it takes to sell a property, the so-called time-on-the-market (TOM), measures the degree of illiquidity of the real estate asset and is a fundamental characteristic differentiating real estate from financial assets.

[2] A detailed literature review on price dispersion can be found in Baye *et al.* (2006).

support for the theoretical prediction that bargaining with search costs explains price dispersion in the agricultural market.

Nevertheless, the search and matching process is by itself able to explain the price dispersion. The main aim of this paper is to develop a search and matching model *à la* Mortensen-Pissarides (see, e.g. the textbook by Pissarides, 2000) that explains the basic facts of housing markets, only relying on the specific nature of the search and matching process. In particular, we develop a decentralised long-run equilibrium model in which agents (homeless-buyers, homeowner-buyers and sellers) can change their condition in the search process. The proposed work takes the distinctive feature of the considered market into account, where the formal distinction between buyer and seller becomes very subtle. In the model, in fact, a seller can become a buyer and *vice versa*. Indeed, most houses are bought by those who already own one, and most houses are sold by those wanting to buy another house (Janssen *et al.*, 1994); buyers today are in fact potential sellers tomorrow (Leung, Leong and Wong, 2006).

In this model, price dispersion arises from the two kinds of matching: homeless-buyer/seller and homeowner-buyer/seller. Also, this simple theoretical model is able to explain two other well-known empirical regularities, namely the positive correlation between housing price and trading volume, and between housing price and the time-on-the-market. Therefore, this paper clearly shows that the behaviour of the housing market, reflected in the above empirical findings, can be addressed adequately by the standard matching framework *à la* Mortensen-Pissarides.[3]

The rest of the paper is organised as follows: section 2 briefly reviews the literature which makes use of the search and matching models to study the housing market; section 3 presents the housing market matching model; while section 4 concludes.

2. Literature review

This paper belongs to the recent and growing literature that uses search and matching models to explain the behaviour of housing markets. The first search model of the housing market is Wheaton's (1990). Since then, several papers have developed

[3] In addition to the labour market matching models, Wasmer and Weil (2004) show that this framework can also be used to describe matching difficulties between financial backers (banks) and firms.

models to analyse the formation process of prices in housing markets with search/matching/trading frictions (see table 1 for a summary).

========== Table 1 about here now at the end ==========

Recent search and matching models of the housing market (Diaz and Jerez, 2009; Novy-Marx, 2009; Piazzesi and Schneider, 2009; Genesove and Han, 2010; Leung and Zhang, 2011; Peterson, 2012) adopt an aggregate matching function and focus on the role of market tightness in determining the probability of matching between the parties. This is in line with the standard matching approach (see Pissarides, 2000). The main difference between our model and those in the quoted studies is that we closely track the standard matching framework *à la* Mortensen-Pissarides, without any significant deviation from the baseline model.[4]

Among this literature, our model is most related to the competitive search framework developed by Leung and Zhang (2011), since it aims to explain the three basic facts of the housing market. In Leung and Zhang (2011), a necessary condition for explaining the housing market facts is the heterogeneity on the seller's and/or the buyer's side, which generates corresponding submarkets. Precisely, Leung and Zhang (2011) focus on one-side heterogeneity and assume that sellers are different in terms of their waiting costs for selling the house, where buyers are free to enter either submarket. However, in their model the reservation value of a buyer is exogenous and sellers commit to "stay" in one of two submarkets.[5] Furthermore, in our model the free-entry or zero-profit condition for sellers *à la* Pissarides – rather than the buyer's free entry assumption used by Leung and Zhang (2011) – allows to obtain a solution which characterises the direct relationship between market tightness and house price.[6] In Leung and Zhang (2011), the equilibrium is in fact determined by a system of three

[4] Diaz and Jerez (2009), Novy-Marx (2009), Genesove and Han (2010), Leung and Zhang (2011), and Peterson (2012) define the market tightness from a buyer perspective, i.e. housing market tightness is the ratio of buyers to sellers. Instead, we prefer to use the standard definition of tightness, thus considering the ratio of vacant houses to home seekers (the buyers). In the labour market, in fact, tightness is the ratio of job vacancies to job seekers. In Piazzesi and Schneider (2009), houses for sale and potential buyers enter the matching function.

[5] Sellers with higher waiting costs (the so-called impatient or "fire-sale" sellers) are willing to accept lower prices, which attract a larger number of potential buyers so that the house can be sold faster. However, patient sellers (sellers with lower waiting costs) may find it profitable to enter that sub-market.

[6] The free-entry condition for sellers is also used by Albrecht *et al.* (2009) to endogenise housing market tightness. Nevertheless, in their model, search is directed, houses are sold by auction and sellers post prices to attract buyers.

equations in three unknowns, where the value of seller, the value of buyer and the house price depend on market tightness. As a result, with a fixed entry value for the buyers and a fixed number of sellers, they first solve the market tightness, and then the seller value and the house price. Indeed, also in Genesove and Han (2010) there are fewer equations than unknowns,[7] and in order to close the model they assume a constant value for the buyer's search and an infinite supply of buyers, thus assuming that buyers can choose among a large number of markets, while sellers are tied to a specific market.

3. A Baseline Matching Model of Housing Market

3.1 The hypotheses of the model

We adopt a standard matching framework *à la* Mortensen-Pissarides (see e.g. Pissarides, 2000) with random search and prices determined by Nash bargaining.[8] The random matching assumption is absolutely compatible with a market where the formal distinction between the demand and supply side is very subtle; whereas, bargaining is a natural outcome of decentralised markets for heterogeneous goods.

Since we are interested in selling price, the market of reference is the homeownership market rather than the rental market. In this way, if a contract is legally binding (as hypothesised) it is no longer possible to return to the circumstances preceding the bill of sale, unless a new and distinct contractual relationship is set up. In matching model jargon this means that the destruction rate of a specific buyer-seller match does not exist. As a result, the value of an occupied home for a seller is simply given by the selling price.

The economy is populated by sellers and buyers. Sellers (s) hold h houses (with $h \geq 2$) of which $h-1$ are on the market,[9] hence, vacancies (v) are simply given by $v = (h-1) \cdot s$; whereas, buyers (b) expend costly search effort to find a house (if

[7] In Leung and Zhang (2011), the system is composed of three equations (the value of the seller, the value of the buyer and the house price) in four unknowns (the value of the seller, the value of the buyer, the market tightness and the house price); whereas, in Genesove and Han (2010), there are two equations (the value of the seller's search and the value of the buyer's search) in three unknowns (the value of the seller's search, the value of the buyer's search and the market tightness).

[8] In a previous version of the model, we assumed different search costs for both sellers and buyers, and a different bargaining power for sellers.

[9] Since there is no rental market, this is a reasonable assumption.

they are homeless) or a new house (if they already hold a house). It is therefore possible that a buyer can become a seller and that a seller can re-enter the market as a buyer. In particular, the following transitions are possible:[10]

From	To
Homeless-buyer	Homeowner
Homeowner	Seller
Seller	Homeowner

also, sellers can remain sellers. Intuitively, the search effort is higher for the homeless-buyers, since their need for buying a house is greater. We distinguish the two different buyer states in the search process by the subscript $i \in \{n, o\}$, where n = homeless-buyer, and o = homeowner-buyer. However, even in the presence of complete and perfect information, sellers cannot distinguish between them. Agents rapidly change their condition in the search process. Alternatively, one can assume that the homeless are ashamed to reveal their status. Hence, buyers always appear identical to sellers.

The expected values of a vacant house (V) and of finding/buying a house (H) are given by:[11]

$$rV = -a + q(\theta) \cdot [P - V] \tag{1}$$

$$rH = -e^i + g(\theta) \cdot [x - H - P] \tag{2}$$

where $\theta \equiv \frac{v}{b}$ is the housing market tightness from the sellers' standpoint; while $q(\theta)$ and $g(\theta)$ are, respectively, the (instantaneous) probability of filling a vacant house and of finding/buying a home. The standard hypothesis of constant returns to scale in the matching function, $m = m\{v, b\}$, is adopted (see Pissarides, 2000; Petrongolo and Pissarides, 2001), since it is also used in the recent search models of the housing market (see Diaz and Jerez, 2009; Novy-Marx, 2009; Piazzesi and Schneider, 2009; Genesove and Han, 2010; Leung and Zhang, 2011; Peterson, 2012). Hence, the

[10] In the housing market is more interesting to study the transition from seller (buyer) to buyer (seller), rather than the dynamic in and out of the homelessness. According to Wheaton (p. 1274, 1990), in fact, although homelessness is equivalent to unemployment, shifts in the housing market are voluntary changes in the labour market and involve periods in which the household owns two (or more) units, whereas voluntary job transitions usually imply spells of unemployment.

[11] Time is continuous; individuals are risk neutral, live infinitely and discount future payoffs at rate $r > 0$. The interest rate r is exogenous, and assuming risk-neutral agents, it is equal to the discount rate of agents.

properties of these functions are straightforward: $q'(\theta)<0$ and $g'(\theta)>0$.[12] The term a represents the cost sustained by sellers for the advertisement of vacancies; whereas e^i represents the effort in monetary terms made by buyers to find and visit the largest possible number of houses, with $i \in \{n,o\}$ and under the assumption that $e^n > e^o$, since the homeless are more pressed to buy a house. If a contract is stipulated, the buyer gets a benefit x from the property (abandoning the home searching value) and pays the sale price P to the seller (who abandons the value of finding another buyer). As usual, the buyer's benefit x depends on the value of the house; hence, x does not depend on the buyer's state.[13]

3.2 Equilibrium and the trade-off between prices and time-on-the-market

In a housing market with frictions, the endogenous variables that are determined simultaneously at equilibrium are market tightness (θ) and sale price (P).

The customary long-term equilibrium condition, namely the "zero-profit" or "free-entry" condition, normally used in the matching models (see Pissarides, 2000) yields the first key relationship of the model, in which market tensions are a positive function of price. In fact, using the condition $V=0$ in [1], we obtain:

$$\frac{a}{P}=q(\theta)\Rightarrow q(\theta)^{-1}=\frac{P}{a} \qquad [3]$$

with $\frac{\partial\theta}{\partial P}>0$, since $q(\theta)^{-1}\equiv\frac{1}{q(\theta)}$ is increasing in θ. This positive relationship is very intuitive: in fact, if the price increases, more vacancies will be on the market.

The free-entry condition also implies a trade-off between the housing price and the speed of sales for the sellers. In fact, with an arrival rate of $q(\theta)$, the expected time-on-the-market is $q(\theta)^{-1}$. As a result, from [3] there is a positive correlation between housing price and the time on the market, since a higher price requires a

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[12] Standard technical assumptions are assumed: $lim_{\theta\to 0}q(\theta)=lim_{\theta\to\infty}g(\theta)=\infty$, and $lim_{\theta\to 0}g(\theta)=lim_{\theta\to\infty}q(\theta)=0$. By definition, markets with frictions require positive and finite tightness, i.e. $0<\theta<\infty$, since for $\theta=0$ the vacancies are always filled, whereas for $\theta=\infty$ the home-seekers immediately find a vacant house.

[13] In Albrecht *et al.* (2007) and Leung and Zhang (2011), the value of the house is independent of agent types.

longer time to sell a house (as pointed out by Leung, Leong and Chan, 2002; Anglin *et al.* 2003; Merlo and Ortalo-Magne, 2004; Leung and Zhang, 2011).

The (generalised) Nash bargaining solution, usually used for decentralised markets, allows the sale price P to be obtained through the optimal subdivision of surplus deriving from a successful match. The surplus is defined as the sum of the seller's and buyer's value when the trade takes place, net of the respective external options, i.e. the value of continuing to search:[14]

$$surplus = \underbrace{(P-V)}_{capital\ gain\ of\ seller} + \underbrace{(x-H-P)}_{capital\ gain\ of\ buyer} = x-H$$

The price is then obtained by solving the following optimisation condition:

$$P = argmax\left\{(P-V)^{\gamma} \cdot (x-H-P)^{1-\gamma}\right\}$$

$$\Rightarrow P = \frac{\gamma}{(1-\gamma)} \cdot (x-H-P)$$

$$\Rightarrow P = \gamma \cdot (x-H)$$

where γ is the bargaining power of sellers. Simple manipulations thus yield:

$$P = \frac{\gamma \cdot (rx + e^{i})}{r + g(\theta) \cdot (1-\gamma)} \qquad [4]$$

being $H = -\frac{e^{i}}{r} + g(\theta) \cdot P \cdot \frac{(1-\gamma)}{r \cdot \gamma}$, and $(x-H-P) = P \cdot \frac{(1-\gamma)}{\gamma}$. As market tensions increase, the probability of finding/buying a home increases, and the sale price decreases; hence, we obtain the second key relationship of the model: $\frac{\partial P}{\partial \theta} < 0$. In short, if the market tightness increases, the effect of the well-known congestion externalities on the demand side (see Pissarides, 2000) will lower the price.

By combining equations [3] and [4], this model is able to reproduce the observed joint behaviour of prices and time-on-the-market: in fact, the house with a higher selling price has a longer time on the market (see equation (3)), but, *ceteris paribus*, the longer the time-on-the-market the lower the sale price, since the expected time-on-the-market $q(\theta)^{-1}$ is increasing in θ (see Krainer, 2001; Merlo and Ortalo-Magne, 2004; Leung and Zhang, 2011; Diaz and Jerez, 2009).

[14] Entering into a contractual agreement obviously implies that the surplus is always positive, i.e. $x > H$, $\forall\theta$. This realistic condition on the buyers' side also ensures that the price is positive.

Proposition 1: *In the standard matching model extended to the housing market there is a trade-off between selling price and time-on-the-market.*

Finally, given the properties of the matching probabilities, it is straightforward to obtain from equation [3] that when P tends to zero (infinity), θ tends to zero (infinity), as $q(\theta)$ tends to infinity (zero). Consequently, given the negative slope of equation [4], with positive intercept, and the fact that price is always positive, the following remark can be stated:

Remark: *Only one long term equilibrium deriving from the intersection of the two curves exists in the model (see point A in Figure 1).*

========== *Figure 1 about here (now at the end)* ==========

3.3 Comparative statics, price dispersion and trading volume

From equation [4], the selling price depends on the bargaining power of the seller. In fact, $\lim_{\gamma \to 0} P = 0$, and $\lim_{\gamma \to 1} P = x + \frac{e^i}{r}$. In the latter case, the selling price is higher than the value of the house. Since the price can never be negative or null, we assume that $0 < \gamma \leq 1$.

Furthermore, the selling price also depends on the search costs of buyers and sellers. In particular, from [4] it is straightforward to obtain that an increase in the search effort of buyers increases the selling price, since a higher e^i implies a more eager buyer. As regards the effect of advertising vacancies on the selling price, an increase in a decreases market tightness, which in turn increases the selling price. In short, an increase in the seller's search cost also leads to an increase in the selling price (see point A' in *Figure 2*).

========== *Figure 2 about here (now at the end)* ==========

Intuitively, the trading volume for a given period is given by the matching rate (see Leung and Zhang, 2011). Following Pissarides (2000), it is straightforward to include the search cost/effort of buyers and sellers in the matching function, i.e. $m = m\{a \cdot v, e \cdot B\}$, with $\theta \equiv \frac{a \cdot v}{e \cdot b}$, where e is the aggregate (or average) search intensity.[15] Indeed, on the one hand the search process involves costs; on the other, those costs allow the matching probability to increase. Hence, in the "extended" matching function, an increase in the search effort or in advertising vacancies will increase the matching rate m. As a result, the model could also explain the positive relationship between housing price and trading volume, since an increase in the search costs of buyers and sellers increases both the selling price and the matching rate. This is in line with the empirical works of Fisher *et al.* (2003) and Leung, Lau and Leong (2002).

Proposition 2: *In the baseline Mortensen-Pissarides model of the housing market we find a positive correlation between house prices and trading volume.*

Finally, we consider two similar houses, which give the same benefit. In this case, price dispersion comes from the two different buyer states in the search process. Indeed, the search effort is higher for homeless-buyers. Hence, housing prices would be different even for identical houses. Specifically, homeless-buyers will pay a higher price for the same house: $P^n(x) > P^o(x)$, since $e^n > e^o$.

Proposition 3: *Price dispersion exists in the basic model à la Mortensen-Pissarides only relying on the specific nature of the search and matching process.*

In a nutshell, the house price depends on the kind of matching (homeless-buyer/seller or homeowner-buyer/seller).

3.4 Closing the model with the natural vacancy rate

In order to find the "natural" vacancy rate, i.e. the optimal share of houses for sale on the market that prevails in long term equilibrium at which sellers make no economic profits (see Arnott and Igarashi, 2000; McDonald, 2000), we normalise the population in the housing market to the unit, i.e. $1 = s + b$.

[15] The search intensity and the cost of advertising vacancies may be seen as parameters of technological change in the matching function (see Pissarides, p. 124, 2000). The search intensity decision may be endogenised (see e.g. Yashiv, 2007). In the housing market, this implies that a buyer will choose the search effort which maximises the value of buying a home. In this case, a convex search cost function is usually assumed and the probability of buying a home would be $e^i \cdot g(\vartheta)$. It is straightforward to find that the optimal search intensity depends on: i) market tightness (positively); ii) the house value (positively); and iii) the house price (negatively).

As a result, using the definitions of equilibrium tightness, $\theta = \theta^* \equiv \frac{v}{b}$, and vacancies, $v = (h-1) \cdot s$, it straightforward to obtain the stock of sellers, buyers and the "natural" vacancy rate:

$$s = \frac{\theta^*}{h-1+\theta^*} \quad [5]$$

$$b = \frac{h-1}{h-1+\theta^*} \quad [6]$$

$$v = \frac{(h-1) \cdot \theta^*}{h-1+\theta^*} \quad [7]$$

these equations have very intuitive properties: $\frac{\partial s}{\partial \theta^*} > 0$, $\frac{\partial b}{\partial \theta^*} < 0$, and $\frac{\partial v}{\partial \theta^*} > 0$.

4. Conclusions

Housing markets are characterised by a decentralised framework of exchange with important search and matching frictions. Furthermore, three basic facts have been repeatedly reported by empirical studies: 1) the variance in house prices cannot be completely attributed to the heterogeneous nature of real estate and the residual price volatility is empirically non negligible; 2) the positive relationship between housing price and the number of contracts traded during a given period; 3) the trade-off between the housing price and the speed of sales for the sellers. This theoretical paper clearly shows that the behaviour of housing markets, reflected in the above empirical findings, can be addressed adequately by the standard matching framework *à la* Mortensen-Pissarides.

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Figures

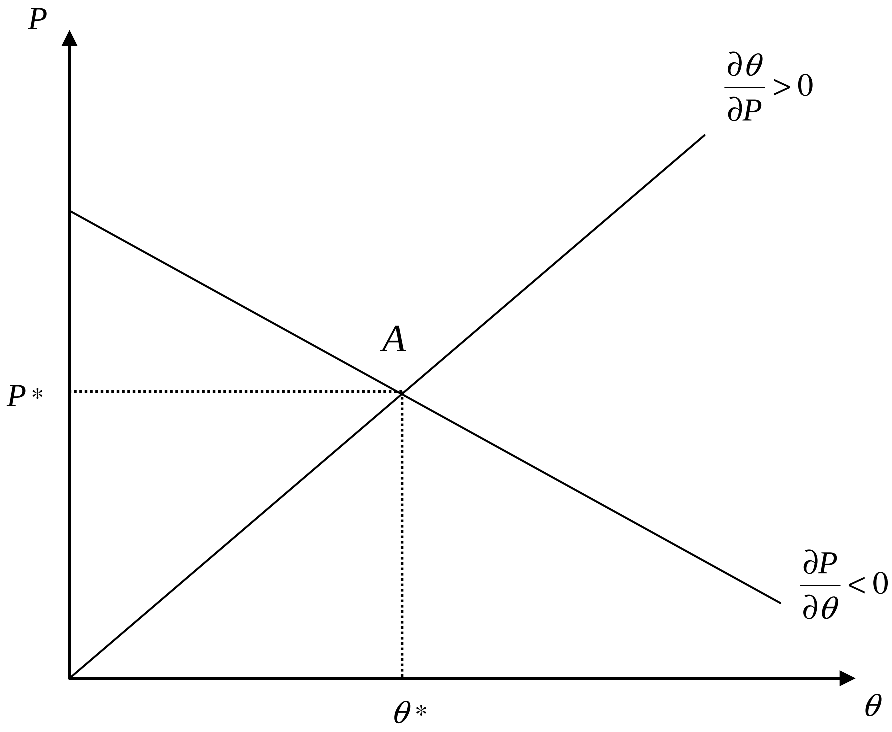

Figure 1. Equilibrium

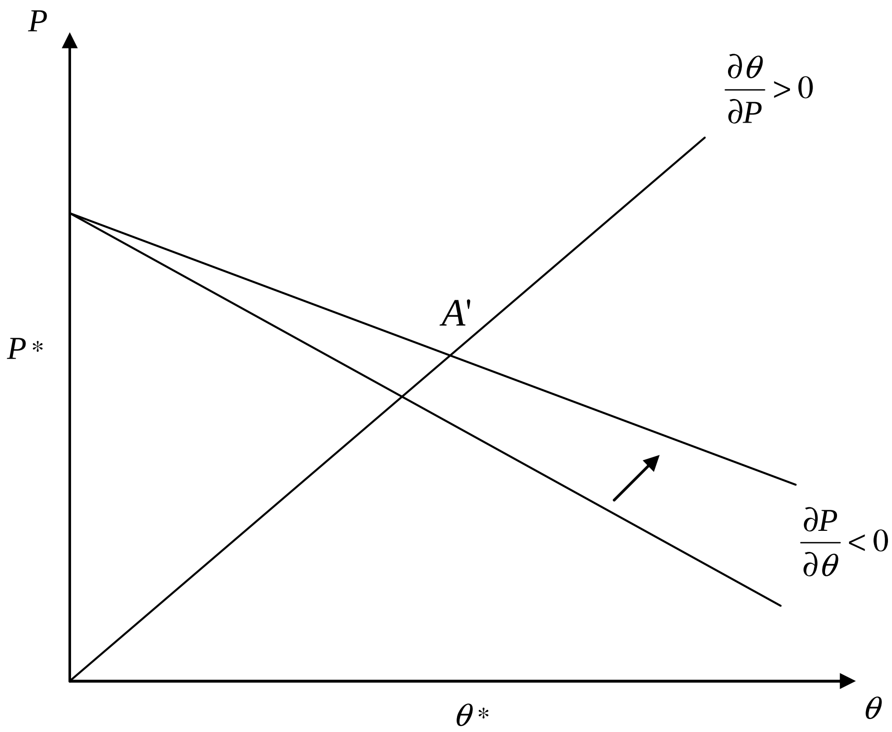

Figure 2. Increase in the search costs of sellers (advertising vacancies)

Table 1. Search and matching models of housing market: a summary

Author/s	Key mechanism or insight behind the model	Price determination	Characteristics of search and matching process	Main result
Wheaton (1990)	*households move when a stochastic process leaves them dissatisfied with their current unit (moving or changing houses involves transaction costs)*	*Nash bargaining*	*matching function + random search*	*the model yields a strong theoretical relationship (inverse) between vacancy and prices, which with competitive supply explains the existence of longer-run "structural" vacancy*
Krainer (2001)	*as in Wheaton (1990), trade in housing market takes place because individuals are vulnerable to idiosyncratic shocks that break the match with their house*	*sellers makes a take-it-or-leave-it offer*	*random search*	*liquidity can be good while prices are high ("hot" markets) because the opportunity cost of failing to complete a trade is high for both buyers and sellers*
Albrecht et al. (2007)	*buyers and sellers move from one state (relaxed) into another (desperate), at the exogenous constant rate, if they remain unmatched*	*Nash bargaining*	*traders meet each other (randomly) at the exogenous constant rate*	*the expected price conditional on time to sale falls with time spent on the market, whereas the conditional variance of price first rises and then falls with time on the market*
Caplin and Leahy (2008)	*mismatch between sellers and buyers; whenever there is excess demand, sellers extract the maximal price; whenever there is excess supply, sellers must be indifferent between sales today and sales tomorrow*	*Bertrand competition among sellers*	*Search is a "black box" (however it is not directed)*	*the model generates the positive correlation between price changes and the volume of transactions displayed by the data*
Novy-Marx (2009)	*market participants optimally respond to shocks in a manner that amplifies a shock's initial impact, which in turn further elicits a reinforcing response*	*Nash bargaining*	*matching function + random search + market tightness*	*the model generates a positive correlation between prices and tightness, but not necessarily a positive correlation between prices and the volume of transactions*
Ngai and Tenreyro (2009)	*Amplification mechanism due to the "thick-market effect" on "match-specific quality": in a market with more houses for sale, a buyer is more likely to find a better match; this makes it appealing to all agents to transact in that season ("hot" market); also, better matches imply higher surpluses and thus higher house prices*	*Nash bargaining*	*random match-quality (while the contact probability is always one)*	*the calibrated model can quantitatively account for the seasonal fluctuations in prices and transactions observed in U.S. and U.K.*

Diaz and Jerez (2009)	*when hit by idiosyncratic shocks, agents become mismatched and seek to move, but they take time to locate an appropriate unit*	*sellers post prices to attract buyers (as in Albrecht et al. (2009))*	*competitive search process + matching function + market tightness*	*the model is able to generate a positive co-movement in prices, sales and liquidity*
Albrecht et al. (2009)	*houses are sold by auction and are sometimes sold above, sometimes below and sometimes at the asking price. Hence, the final selling price need not be the same as the posted price*	*"asking price": the price posted by a seller is used to attract buyers (i.e. sellers post asking prices, and buyers direct their search based on these prices)*	*directed search + market tightness*	*it captures the main features of the house-selling process in the U.S. and explains the role of asking price and its relationship to the sales price*
Piazzesi and Schneider (2009)	*a household is initially a "happy owner" who obtains housing services; however, s/he may be hit by a shock that makes him an "unhappy" owner who no longer obtains any services from the house. S/he can then sell the house and purchase a new one to again begin obtaining housing services*	*seller makes a take-it-or-leave-it offer, and the buyer accepts or rejects the offer*	*matching function + random search*	*optimists (investors) can drive up the average transaction price without a large increase in trading volume or in their market share*
Genesove and Han (2010)	*demand shocks (average income and population are used as demand proxies, given the difficulties of measuring yearly consumption and production amenities)*	*Nash bargaining (with an extension to the case in which seller makes a take-it-or-leave-it offer)*	*matching function + random search + market tightness*	*a positive demand shock leads to shorter seller time on the market and fewer home visits, while buyer time on the market is much less sensitive*
Lisi (2011)	*direct relationship between market tightness and house price*	*Nash bargaining*	*matching function + random search + market tightness*	*the standard matching framework à la Mortensen-Pissarides is integrated with the hedonic price theory*
Leung and Zhang (2011)	*one-side heterogeneity which generates corresponding submarkets; sellers are different in terms of their waiting costs for selling the house, where buyers are free to enter either submarket*	*Nash bargaining*	*matching function + random search + market tightness*	*the model is able to reproduce the three basic facts of housing market (price dispersion, positive correlation between house prices and time-on-the-market, and between house prices and trading volume*
Peterson (2012)	*the model combines search frictions with a behavioural assumption where market participants incorrectly believe that the efficient market theory holds (the so-called "Fooled by search")*	*Nash bargaining*	*matching function + random search + market tightness*	*the model can replicate the observation that real price growth and turnover are highly correlated, explaining over 70% of the housing bubble in the United States*