JSPS Grant-in-Aid for Scientific Research (S)

Central Bank Communication Design

working paper series

No.015 (February 2020)

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Search and Matching in Rental Housing Market*

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November 2019

Abstract

This paper builds up a model for a rental housing market. With a search and matching friction in a rental housing market, a new house entry is endogenized according to a business cycle. A price negotiation happens only when owner and tenant newly match and make a contract for a rental price. After making a contract, a rental price is fixed until the contract ends. Simulations show that variations of a price and a market tightness change according to a search friction in a housing market, a speed of a housing cycle, a bargaining power between owner and tenant for a price setting. An extensive margin effect brought by a housing entry well contributes to a price variation and this effect significantly changes by parameters.

Keywords: rental housing market; search and matching

*First draft is July 2018. We thank Tsutomu Watanabe for valuable comments and discussions. Teranishi gratefully acknowledges financial support from a JSPS Grant-in-Aid for Scientific Research No. 16KK0062 and 18H05217 and Nomura Foundation.

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1 Introduction

Former studies, such as Wheaton (1990), focus on a search behavior in a housing market and show advantage of a search model to explain a housing market.[1]

Non-homeownership rates are at nontrivial level for a business cycle analysis across countries. In Japan, Statistics Bureau of Japan (2018) shows that a non-homeownership rate keep about 40 percent for many years. Australian Bureau of Statistics reports that the proportion of Australian households renting their home is 32 percent in 2017–18. In the U.S., the Census Bureau releases national non-homeownership rates and it is about 35 percent in the last few years. As well as buying and selling houses, a leasing house behavior can contribute to a business cycle.

In this paper, we build up a model for a rental housing market. In particular, we focus on several facts in a rental housing market. First, there exists a search and matching friction in a rental housing market. House owners and tenants search for each other in a housing market through real estate agents. We can precisely observe a vacancy rate in a rental housing market. For example, a vacancy rate of a rental house is recently higher than 10 percent in Tokyo region in Japan as shown in Bank of Japan (2017). This rate is much higher in other rural regions. In Australia, SQM research provides a residency vacancy rate and it is about over 2 percent during the last ten years. In the U.S., the U.S. Census Bureau shows that a rental vacancy rate fluctuates between 7 and 11 percents in the last decade.

Second, we can observe an average tenancy length. There is a rental housing cycle, i.e., entry and exit of a rental house. In Japan, for example, Japan Property Management Association (2018) reports that an average contract period of a general household is 4.7 years in 2018 fiscal year.[2] In Australia, Residential Tenancies Bond Authority (2016) reports that a mean duration of the tenancy is 806 days (about 2 years and 2.5 months) in the Victoria State for bonds repaid in 2015-16. In the State of New South Wales,

[1]Mortensen and Pissarides (1994) develop a search model for a labor market.

[2]Shimizu, Nishimura, and Watanabe (2010) show that monthly probability of contract renewal is 0.038 using unique micro dataset for Japanese rental market for the period from 1986 to 2006.

Rental Bond Board (2016) reports that 65 percent of residents stay in the same rental houses more than 12 months and 35 percent of residents stay greater than two years during 2015-16. We explicitly introduce a length of a leasing contract into a model.

Third, a new rental price can be flexibly set at a desired level and this price is held while a contract continues.[3] Here, a new rental price is negotiated between an owner and a tenant through real estate agents when they make a new leasing contract.[4] We embed this flexible first price setting and no price adjustment after the first price into a model.

Forth, a new rental price is negotiated between an owner and a tenant and this price negotiation depends on a bargaining power of each agent following a rental housing law. For example, we do not have a clear penalty for leasing break during a leasing contract in Japan. On the other hand, tenants need to pay rents for owners when tenants break a lease until owners find new tenants in Australia. Such a difference justifies an existence of a bargaining power between two agents and a bargaining power should be related to a price setting for a rental house.

Our paper is related to former papers regarding a search friction in a housing market. Head, Lloyd-Ellis, and Sun (2014) make a dynamic search model of the housing market and match this model with house prices and sales data in the U.S. housing market. They, however, focus on a house sale rather than a rental house. Clear differences between a house sale and a rental house are a matching duration and a price setting. In a case of a house sale, a match between a seller and a buyer is one period and a price for sale is naturally negotiated every period. On the other hand, in our paper for a rental house, a match between an owner and a tenant continues for multi periods and a price negotiation does not happen every period.

The rest of our paper is organized as follows. Section 2 describes our model. In Section 3, we show a linearized model. Section 4 provides a quantitative analysis using a

[3] In Japan, Shimizu, Nishimura, and Watanabe (2010) show that 90 percent of rental units does not change rents per year. Genesove (2003) show that a rent is sticky in the United States between 1974 and 1981. 29 percent of rental houses does not change price from year to year.

[4] In U.S., there is a rent stabilization mechanism in major cities, such as New York and Los Angeles.

model under a variety of parameters. Section 5 discusses policy implications for a rental apart market. Finally, Section 6 concludes.

2 Simple Model with Housing Entry and Exit

Basic part of this model follows Dong, Shoji, and Teranishi (2019) that focus on products and these prices using a search model for a goods market.

2.1 Setting

We begin with a simple partial equilibrium model with search frictions in a rental housing market. There are two types of economic agents: agent A and agent B. Agent As and agent Bs make contract for a rental house A in a decentralized market. In particular, agent As can lease rental house A. Agent Bs have demand to rent house A. Therefore, agent As and agent Bs randomly search for each other in the decentralized rental market. We can view agent A as a real estate manager for a household that wants to rent a house. On the other hand, we can view agent B as a real estate manager for an owner that want to lease a house. Agent B prepare house A and provide it to person to live in the house. Agent A is of measure 1 and agent B can choose to enter the market with a cost κ.

Let the measure of unmatched agent A be u_t at time t and the measure of vacant agent B be v_t. The matching function exhibits constant return to scale property and is given by

$$m\left(u_t, v_t\right) = \chi u_t^{1-\alpha} v_t^{\alpha} \text{ where } \alpha \in (0,1)\,. \tag{1}$$

Define the market tightness in a housing market as $\theta_t = v_t/u_t$. The probability for a vacant agent B to find an unmatched agent A is denoted as $s(\theta_t)$ and the probability for an unmatched agent A to find a vacant agent B is denoted as $q(\theta_t)$, where

$$s(\theta_t) = \frac{m_t}{v_t} = \chi\theta_t^{\alpha-1}, \tag{2}$$

$$q(\theta_t) = \frac{m_t}{u_t} = \chi\theta_t^{\alpha}. \tag{3}$$

We assume that $s(0) = 1$ and $q(\infty) = 1$. Each match is saparated with an exogenous probability $\rho \in (0, 1)$.

Once an agent A and an agent B match, the agent A provide Z^A units of house A for agent B and a new rental price of house A is negotiated by the Nash bargaining solution. There is no renegotiation of the price after the new price is determined. For simplicity, the amount of house A transferred in each match is exogenously given. Moreover, the cost of preparing Z^A units of house A is X_t, where X_t can include any cost of housing. Changes in X_t could be interpreted as potential cost push shocks. The benefit for the agent B to acquire Z^A units of house A is Z_t^B. The benefit can be brought by person to live in the house. This variable works as a demand shock.

The free entry condition for agent B is

$$\kappa = \beta s_t \mathbb{E}_t V_{t+1} \left(\tilde{P}_{t+1}^A \right), \tag{4}$$

This free entry condition decides the number of new rental houses into a market. Thus, a housing entry into a market and so price setting are endogenous. Agents decide to introduce a new good into a market when a profit from providing a new rental house with a new price is larger than a cost of introducing it. Trade will take place in the following period, where $\tilde{P}_{t+1}^A$ denotes the newly negotiated price of house A and $V_{t+1}(\cdot)$ denotes the value function for agent B. Note that there is one period lag for production after a new match.

The value function for a agent B with a contract of price $\tilde{P}_t^A$ is

$$V_t \left(\tilde{P}_t^A \right) = Z_t^B - Z^A \frac{\tilde{P}_t^A}{P_t^A} + \beta (1 - \rho) \mathbb{E}_t V_{t+1} \left(\tilde{P}_t^A \right). \tag{5}$$

The term $Z_t^B - Z^A \frac{\tilde{P}_t^A}{P_t^A}$ is the flow benefit of being in a match and $\beta (1 - \rho) \mathbb{E}_t V_{t+1} \left(\tilde{P}_t^A \right)$ shows the continuation value of the match. The new rental price $\tilde{P}_t^A$ for house A is set by only newly matched agents. No adjustment of price from time t to time $t + 1$ is inherent in the contract.

Now consider the value functions for an agent A. Let $J_t^1 \left(\tilde{P}_t^A \right)$ denote the value function for a newly matched agent A with a negotiated new rental price $\tilde{P}_t^A$ at time t, where

$$J_t^1\left(\tilde{P}_t^A\right) = Z^A \frac{\tilde{P}_t^A}{P_t^A} - X_t + \beta \mathbb{E}_t\left[(1-\rho)\, J_{t+1}^1\left(\tilde{P}_t^A\right) + \rho J_{t+1}^0\right]. \tag{6}$$

The flow benefit of having the match is given by the term $Z^A \frac{\tilde{P}_t^A}{P_t^A}$. If the match survives at time $t+1$, the continuation value is $J_{t+1}^1\left(\tilde{P}_t^A\right)$. If the match is destroyed at time $t+1$, the agent A becomes an unmatched one with the value function J_{t+1}^0. The value of an unmatched agent A is

$$J_t^0 = \beta \mathbb{E}_t\left[q_t J_{t+1}^1\left(\tilde{P}_{t+1}^A\right) + (1-q_t) J_{t+1}^0\right]. \tag{7}$$

For the unmatched agent A, it can go back to a rental housing market in the same period and find a match with the probability q_t. Trade will take place in the following period and the value for the match is therefore $\mathbb{E}_t J_{t+1}^1\left(\tilde{P}_{t+1}^A\right)$. With the complementary probability $1-q_t$, the unmatched agent A remains unmatched and has the continuation value J_{t+1}^0. Here the benefit from having a match is $J_t^1\left(\tilde{P}_t^A\right) - J_t^0$. We can find the value of a new match for agent A by taking the difference between $J_t^1\left(\tilde{P}_t^A\right)$ and J_t^0.

In a match, agent A and agent B bargain over the rental price $\tilde{P}_t^A$ of house A, taking into consideration that the price is not renegotiated during the duration of the match and the price does not change. The price $\tilde{P}_t^A$ solves

$$\max_{\tilde{P}_t^A} \left[V_t\left(\tilde{P}_t^A\right)\right]^{1-b} \left[J_t^1\left(\tilde{P}_t^A\right) - J_t^0\right]^b, \tag{8}$$

where b is the bargaining power for agent A. The solution $\tilde{P}_t^A$ is determined by

$$bV_t^A\left(\tilde{P}_t^A\right) = (1-b)\left[J_t\left(\tilde{P}_t^A\right) - J_t^0\right], \tag{9}$$

Lastly, we describe the flow conditions and the aggregate rental price index. A newly separated agent A can search again in the same period. The measure of unmatched agent A is

$$u_t = 1 - (1-\rho)\, N_t, \tag{10}$$

where N_t denotes the measure of matches. The flow condition of u_t is therefore

$$u_{t+1} - u_t = \rho\,(1-u_t) - q_t u_t. \tag{11}$$

It follows that

$$N_t = (1-\rho)\, N_{t-1} + q_{t-1} u_{t-1}. \tag{12}$$

Since rental prices in the new matches are set through Nash bargaining and the old prices in survived matches does not change, we use an aggregate price index P_t^A to denote the aggregate price in the economy at time t,

$$N_t P_t^A = (1-\rho)\, g N_{t-1} P_{t-1}^A + \chi \theta_{t-1}^{\alpha} u_{t-1} \tilde{P}_t^A. \tag{13}$$

The aggregate price index completes the description of the model, where (2), (3), (4), (5), (6), (7), (9), (10), (12), and (13) are used to solve the model.[5]

3 Linearization

We log-linearize the system of equations around a constant steady state with zero inflation.[6] We express the log-deviation of a variable (e.g., P_t) from its efficient steady-state value ($\bar{P}$ or P) by placing a hat ($\hat{}$) over the lower case symbol ($\hat{p}_t$).

In the model with endogenous entry of a rental house, we have the following linearized price equation.

$$\pi_t = \beta \mathbb{E}_t \pi_{t+1} + \beta(1-b) \frac{\bar{q}}{1-\beta(1-\rho-\bar{q})} \frac{\rho\left[1-\beta(1-\rho)\right]}{1-\rho} \hat{\theta}_t$$
$$+ b \frac{\rho\left[1-\beta(1-\rho)\right]}{1-\rho} \frac{Z^B}{Z^A} \hat{Z}_t^B, \tag{14}$$

where the inflation rate is defined as $\pi_t \equiv \hat{p}_t^A - \hat{p}_{t-1}^A$.[7] We can observe an explicit effect of rental housing market frictions through the market tightness $\hat{\theta}_t$. This generates a direct link between housing entry/exit and rental prices. When the demand for houses changes, the entry rate by agent B changes. Therefore, the number of rental housing in the market also changes. One way to interpret our results is that the model makes the Calvo (1983) parameter endogenous through a search and matching housing market. In this sense, an

[5]See Appendix by request.

[6]See Appendix by request.

[7]To simplify expressions, we assume that a cost shock X_t is zero.

extensive margin effect works with a price change. The market tightness is positively related to a price and increases a price volatility. Regarding effect of parameters on price dynamics, an exit rate ρ, a matching probability $\bar{q}$, and the bargaining power of agent A b decide a response of an inflation rate to the market tightness in eq. (14).

In details, the rental housing market friction captured by $\hat{\theta}_t$ accelerates/decelerates price dynamics as shown in the following equation.

$$\hat{\theta}_t = \beta(1-\rho-\frac{b}{1-\alpha}\bar{q})\mathbb{E}_t\hat{\theta}_{t+1} + (1-b)\frac{1-\beta(1-\rho)}{1-\alpha}\frac{Z^B}{Z^B-Z^A}\mathbb{E}_t\hat{Z}^B_{t+1}. \tag{15}$$

The market tightness $\hat{\theta}_t$ depends on the demand shock. Market frictions allow the market tightness to adjust, which further changes the price dynamics. Here, the two equations above can describe price dynamics in this simple model. A market tightness change an inflation rate. There, however, is no feedback from an inflation rate to a market tightness in this partial equilibrium model. When the exit rate ρ increases, the market tightness is relatively more sensitive to a demand rather than the future market tightness due to a quicker housing cycle. The bargaining power of agent A b, a matching elasticity α, and a matching probability $\bar{q}$ also decide dynamics of the market tightness.

For comparison, we also show a special case in which we assume no variation in the number of house entry and exit. Thus, the number of entry and exit are constant. In this case, we have the following linearized price equation.

$$\pi_t = \beta\mathbb{E}_t\pi_{t+1} + b\frac{\rho\left[1-\beta(1-\rho)\right]}{1-\rho}\frac{Z^B}{Z^A}\hat{Z}^B_t. \tag{16}$$

Price dynamics simply depends on the demand shock $\hat{Z}^B_t$. The effect of housing market frictions appears only through ρ in the coefficient on demand shock. The exit rate ρ works as a probability of re-setting price in the spirit of the Calvo (1983) parameter since both the entry rate and the exit rate are constant in this model. We do not have an extensive margin effect in this setting. Naturally, this model shows very similar dynamics to demand shock as New Keynesian Phillips curve by the Calvo (1983) - Yun (1996) with some differences in parameters. Even though a set up for a model is totally different from New Keynesian model, this price equation for a rental housing price includes New Keynesian Phillips curve as a special case of no variation in entry and exit.

When an exit rate ρ increases, an inflation rate is more responsive to demand shocks. This is because a chance to set a price increases when the turnover of rental housing increases. This model has another parameter related to a price setting, i.e., the bargaining power of b. When b decreases, the inflation rate becomes less sensitive to demand shocks since agent B can take a larger share of the surplus and is likely to keep the price of input good A unchanged against a demand shock.

4 Quantitative Analysis

In this section, we calibrate a model in a quarterly base and implement various simulations. Baseline parameters are given in Table 1.[8] The discount rate is 0.99 as in conventional models. For comparison, we assume a matching elasticity $\alpha = 0.5$ and an agent A's bargaining power $b = 0.5$ in baseline parameters. We set an exit rate as $\rho = 0.25$ since we assume a rental contract continues for one year. In simulations, we assume a demand shock with 1 percent standard deviation and a persistence of 0.9. We change key parameters in simulations to show roles of these parameters on rental price dynamics and market tightness.

4.1 Role of Matching Friction

To evaluate effects of matching frictions on rental price dynamics, we change matching elasticity α for a vacancy posting by a demand side. Table 2 shows simulation results. When α increases and an elasticity for vacancy by a demand side increases, standard deviations of an inflation rate and a market tightness increase. This is because agents B enter into a market to a positive demand shock and the number of matches increases more when α becomes higher. Then, a market becomes tighter and price increases more.

[8] Under baseline parameters, we calculate steady state values of $\bar{q} = 0.31$ and $Z^B = 2.48$. We need these values for simulations and do not change these values even when we change parameters to show a pure effect of changing parameters.

4.2 Role of Exit Rate

To evaluate effects of a housing cycle on rental price dynamics, we change an exit rate ρ. Table 3 shows simulation results. When ρ increases and a housing cycle becomes quicker, a standard deviation of an inflation rate becomes larger. This is because agents have more chance to change rental prices when a housing cycle becomes quicker. This is a situation of more flexible price setting. A standard deviation of a market tightness also becomes larger since more frequency of exit and entry and a market tightness becomes more elastic to a business cycle.

4.3 Role of Bargaining Power

To evaluate effects of a bargaining power for a price setting on rental price dynamics, we change agent A's bargaining power b. Table 4 shows simulation results. When b deviates from 0.5 and a bargaining power has bias for two agents, a standard deviations of an inflation rate increases. One reason for it is that a larger bargaining power for a demand side induces more entry for agents B to a positive demand shock and makes a market tighter. This increases a standard deviation of an inflation rate. Another reason for it is that a larger bargaining power for a supply side induces a larger price change to a demand shock by a sharing condition since agent A demands more benefit by changing a rental price. On the other hand, when b becomes smaller and a bargaining power of a supply side for rental house becomes smaller, a standard deviation of a market tightness monotonically becomes larger. This is because a larger bargaining power for a demand side induces more entry for agents B to a positive demand shock and makes a market tighter.

4.4 Role of Extensive Margin Effect

When we compare price models of eqs. (14) and (16), we can evaluate an extensive margin effect in a search model. In a model of eq. (14), the number of rental house entries change according to a business cycle and so the number of houses that newly set rental house prices changes. This is an extensive margin effect when we define an aggregate price by an weighted average of new prices and survival prices. On the other hand, in a model of eq. (16), we do not have an extensive margin effect since the number of rental house entries is constant. So, a price change is given by only an intensive margin effect.

Table 5 shows simulation results. Under baseline parameters, 32 percent of a standard deviation of an inflation rate is given by an extensive margin effect. Here, this ratio is given by one minus a ratio of a standard deviation of an inflation rate in a model of eq. (16) over that in a model of eq. (14).

An extensive margin effect changes by parameters. When α becomes larger, an extensive margin effect becomes larger since an elasticity for vacancy by a demand side and so a variation of the number of matches become larger to a demand shock. When ρ becomes larger, an extensive margin effect becomes larger since a variation of entry becomes larger due to a shorter housing cycle. When b becomes larger, an extensive margin effect becomes smaller since a smaller bargaining power for a demand side induces less entry for agents B to a positive demand shock and makes a variation of entry less volatile.

5 Policy Implication for Rental Housing Market

From numerical simulations in Section 5, we have several policy implication for a rental apartment market.

First, a longer rental contract decreases a volatility of a rental apartment price. This implies that a policy inducing a longer rental contract is beneficial for macro economy. A rent stabilizer can be an incentive for owner and tenant to make a longer term contract since the stabilizer makes owner and tenant share the future risk of a price variation.

Second, to design regulations for owner and tenant, we need an optimal allocation for the right in a contract between owner and tenant. A volatility of rental price increases when we give a larger right for owner or tenant. For example, we need to carefully think of a penalty for a leasing break in a contract to keep an equal bargaining power for owner and tenant.

Third, a price volatility can increase through an entry of an owner and a tenant. This is an extensive margin effect on prices. This implies that a housing rent can be volatile when the number of new apartments and the number of persons moving to a country/region/city increase. In this aspect, we need some restrictions for a new housing construction and an investment for real estate to stabilize a housing price.

6 Concluding Remark

We make a model for a rental housing market with a search and matching friction. By various simulations, we show that a search friction in a housing market, a speed of housing cycle, a bargaining power between owner and tenant for price setting hold significant effects on an inflation rate and a market tightness.

As the future extensions, we would like to calibrate our model to micro rental housing data. Also, it would be of interest to introduce a price indexation by an inflation rate to subsequent prices after a first price. Making a general equilibrium model including a frictional rental housing market is also the future topic.

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Table 1: Model Calibration

Parameters	Explanations	Values
β	Discount factor	0.99
ρ	Exit rate	0.25
ρ_{Z^B}	Shock persistence	0.9
σ_{Z^B}	Standard deviation of demand shock	1
α	Matching elasticity	0.5
b	Agent A's bargaining power	0.5
χ	Matching efficiency	0.5
k	Entry cost by agent B	1
Z^B	Agent B's benefit	2.48
Z^A	Agent A's production	1

Table 2: Simulation Results for Market Friction

	Std(π)	Std(θ)
Baseline Parameters	0.391531	0.578846
$\alpha = 0.9$	0.487545	1.027310
$\alpha = 0.7$	0.426133	0.740469
$\alpha = 0.3$	0.369327	0.475137
$\alpha = 0.1$	0.353871	0.402944

Note: Quarterly base. Std denotes a standard deviation.

Table 3: Simulation Results for Exit Rate

	Std(π)	Std(θ)
Baseline Parameters	0.391531	0.578846
$\rho = 0.05$	0.014644	0.189213
$\rho = 0.5$	1.777121	0.830812
$\rho = 0.7$	4.223119	0.952278
$\rho = 0.9$	13.174124	1.037277

Note: Quarterly base. Std denotes a standard deviation.

Table 4: Simulation Results for Bargaining Power

	Std(π)	Std(θ)
Baseline Parameters	0.391531	0.578846
$b = 0.1$	0.684318	1.636849
$b = 0.3$	0.457407	0.990362
$b = 0.7$	0.412396	0.293898
$b = 0.9$	0.485319	0.084908

Note: Quarterly base. Std denotes a standard deviation.

Table 5: Simulation Results for An Extensive Margin Effect

Std(π)	Frictional Model	No Friction Model	Share of EM
Baseline Parameters	0.391531	0.267602	0.32
$\alpha = 0.1$	0.353871	0.267602	0.24
$\alpha = 0.9$	0.487545	0.267602	0.45
$\rho = 0.05$	0.014644	0.012367	0.16
$\rho = 0.9$	13.174124	3.370847	0.74
$b = 0.1$	0.684318	0.053520	0.92
$b = 0.9$	0.485319	0.481683	0.01

Note: Quarterly base. Std denotes a standard deviation. Frictional Model denotes a model with variable entry and exit. No Friction Model denotes a model with constant entry and exit. Share of EM denotes a share of extensive margin effect in Frictional Model. This ratio is given by one minus a ratio of a standard deviation of an inflation rate in No Friction Model over that in Frictional Model.