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Measuring the Cost of Imperfect Information in the Tokyo Housing Market

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ABSTRACT

The cost of imperfect information is estimated in the real estate market of resale condominiums in central Tokyo by using a new, comprehensive data set of resale condominium transactions. The results suggest a substantial cost. Specifically, if information were perfectly available and marketing time is null, sellers would get benefits of 10.58% based on average interest rate, 31.28% on gross rent and 22.59% on net rent, against imputed rent of their property. Buyers spend 1,042,000 Yen on search activities for one transaction, which would be saved if information were prefect. This cost amounts to be equivalent to 13.2% of buyers' average annual income.

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1. INTRODUCTION

It is often pointed out that imperfect information plagues the real estate market in Japan. The advertisement for sale of houses and condominiums does not necessarily convey essential information, such as detailed information about the residential environment around the house/condominium, its history of maintenance and restorations, its structural conditions that are hardly seen from outside, and so on. Only a careful on-site check reveals these characteristics. Moreover, most real-estate brokers are small-scale ones and they are not necessarily well-trained to meet buyers' increasing demand for detailed and sophisticated information. They are locally-oriented and often attempt to monopolize local information rather than share it with other brokers in wider areas. Large developers have attempted to organize and consolidate these small-scale brokers to improve their trading practices, but progress so far is disappointing.

Buyers are obliged to search by themselves for the best offer, which involves considerable time and effort. Since it is impossible for a buyer to visit all houses/condominiums for sale, sellers may be able to sell their property at a higher price than its intrinsic value. A bullish seller may put a high price and let his property remain vacant expecting that an urgent buyer may show up. In contrast, an urgent seller may have to offer a lower price than the property's intrinsic value and he may still have to wait for some time to get the property sold.

The above description of the Japanese housing market suggests that there may be a considerable social cost of imperfect information. Suppose that there were an information agency to disseminate detailed information for free or at a very low price, and that expectations for future market conditions were homogeneous among market participants. Then, buyers (including potential ones) would get sufficient information to evaluate all properties for sale and they would take the best offer. Sellers could sell their property no higher, nor be obliged to sell it lower, than its intrinsic value. Once sellers put their price at their property's intrinsic value, the property would be sold immediately. Consequently, some of buyers' search costs and sellers' opportunity costs of vacancy may be socially unnecessary, since they would be reduced substantially if there were a well-functioned information agency as described above (see Baryla and Zumpano, 1995; Read, 1993). Moreover, in reality, property prices in the imperfectly informed market may behave differently from their intrinsic value (see Nishimura (1999) for theory and Nishimura et al. (1999) for empirical evidence), and therefore resource allocation induced by market prices may be distorted. Accordingly, we can identify three types of the social cost of imperfect information: (1) buyers' search costs, (2) opportunity costs of vacant properties, and (3) inefficiency in resource allocation caused by imperfect information, as well as (4) possible costs of establishing and maintaining the information agency.

In this paper, we estimate the cost of imperfect information in the resale market of condominiums in

central Tokyo. We concentrate our attention on the first two types of the social cost of imperfect information: search costs and opportunity costs of vacant properties. This by no means implies that the third type of social cost, i.e., resource allocation cost, is negligible. We are obliged to restrict our attention to the first two, since the measurement of the third one requires a full-fledged general equilibrium analysis of asset markets with detailed data, which is far beyond our scope. We do not consider the fourth type, i.e. the cost of running the information agency, for simplicity, although it may not be so difficult to incorporate this cost.

To our knowledge, this is the first attempt to estimate the magnitude of the social cost of imperfect information empirically in the real estate market, although casual observations of searching home buyers and vacant houses/condominiums suggest that there may be a sizeable social cost. The scantiness of research in this field is partly because market-wide vacancy duration data is not easily accessible, and partly because there is no data on buyers' search behavior.

This paper fills this gap by using a new data set of resale condominium transactions. In Section 2, we explain the unique data set we use as well as the methodology to evaluate costs of imperfect information. Procedures and results of the measurement are reported in Section 3. Technical details are rendered to the Appendix.

2. METHODOLOGY AND DATA

We use a "search model" in order to estimate socio-economic loss caused by imperfect information in the real estate market. In this model, we assume that a seller discloses his/her asking price and the buyer undertakes a search activity and responds to the price to make a transaction happen. This search model is a standard analytical tool and is applied to analysis of labor markets where information tends to be imperfect.

First, we identify the costs for the seller and the buyer due to imperfect information under the search model framework.

2.1. Costs of Imperfect Information

(1) The seller's cost

It is generally time-consuming to complete real estate transactions. The seller has not been able to use the residence to productive purpose for this period. If information is perfectly available in the market, the seller can tell all about the subject property and sell it the moment he gets market price for its intrinsic value. Conversely, the time consumed for selling has an opportunity cost and is a social loss due to imperfect information.

We regard, therefore, the opportunity cost as the seller's loss. The cost can be described in the following

way.

$$Rent \times T. \qquad \textbf{(1)}$$

where T is holding time in the market and *Rent* is rental price.

According to capital theory in neoclassic economics, rental cost equates to capital cost where capital can be transferred freely and perfectly in equilibrium in the capital market. Thus we can alternatively use capital cost from rent to express opportunity cost. One possible problem in this approach is that actual transaction price is not observable. However, as we will explain later, we have information about the "last asking price" of the seller in our data set. Assuming that the last asking price is nearly equal to actual transaction price, the opportunity cost can be approximated by following formula.

$$P \times r \times T \qquad (2)$$

where P is the final asking price, r interest rate and T is the holding time.[1)]

(2) The buyer's search cost

We move on to the search cost for the buyer. If information is perfectly available, the intrinsic value of a residential property is equal to its market price since otherwise there is arbitrage opportunity without taking risk. The buyer can purchase the most favored one from the disclosed price list in the market without making any further search. The reality is that information is not perfectly available. There is a lot of information that cannot be available without inspecting each property. The cost of this search is a social cost due to imperfect information, since it is unnecessary if market information is perfectly distributed.

As described above, we use search theory to analyze the market under imperfect information. However, we need to adjust the theory, because it is usually assumed that goods are homogeneous and that their prices are stochastic (Turnbull and Sirmans, 1993). In contrast, in a residential market, we can see price information on the internet and in the residential listing magazine while the quality of the goods (residential property) is heterogeneous. This makes it necessary for us to inspect the properties to get information about the relevant quality in detail.

[1)] We may need to modify this formula by calculating the present value of the accumulated opportunity cost where the holding time in the market is long.

Consequently, we analyze a quality-adjusted price based on the hedonic approach to replace "price" in the search theory. The "price" is surely available in the existing resources such as internet and magazines, but the hedonic price is only available with inspection of the subject property. The hedonic price is therefore used for the application of the search theory to the residential market. We assume that all buyers share the same information on location and building structure as indicators of quality in broader sense. Thus they make bids at the same hedonic price on the same property if information is perfectly available. The quality-adjusted price established in the market is its fundamental value.

In reality, the buyer is also as heterogeneous as residential real estate is. So we should also take into account the differences between the buyers when estimating the cost. However, data on this difference is not available. Thus, we focus on "typical buyers" who are purchasing a "standard residence" as a rule of thumb and estimate the search cost for them.

The hedonic price is derived from a vector, which expresses the quality of the residence. It is assumed that each market participant puts a price for each quality, which, summed up, is its real estate price.[2)] Therefore, the hedonic price for "standard residence" is equivalent to the quality adjusted price in this paper.

We can classify the factors of asking price in the real estate listing magazine, which we use in this paper and explain in the next section, into three categories. The first set of factors include "age of building", "occupied space area", "distance to the nearest station", "accessibility to CBD", and "total number of units". This information is available at a certain quality level without carrying out a further search. The second sets of factors are only obtainable with an additional search. They are information on schools, education and conveniences. These factors comprise the quality-adjusted price if the information is perfect. This is called intrinsic value. The third group of factors consists of "extra value". The extra value is the difference from intrinsic value due to imperfect information. It is defined as "the actual transaction price minus the intrinsic value". The difference is positive when the actual price is more expensive than its intrinsic value and vice versa.

We assume that typical buyer does not know the individual extra value but knows its probability distribution following standard search theory. The probability distribution function and probability density function are defined as F and f, respectively. We describe how to estimate the search cost for buyer under these assumptions in the following paragraphs.

Suppose that the minimum extra value is y after searching a few residential properties and that the marginal cost for additional search is s. The probability of finding a residence in the next search, the extra value of which is more than y, is given by $1-F(y)$. Otherwise, the probability density function to find the extra value of x ($<y$) is

[2)] See Nishimura and Shimizu (2003) for details.

$f(x)$. Therefore, the expected value of extra value for the next search, X (y), is

$$X(y) = \int_{-\infty}^{y} xf(x)dx + y[1 - F(y)] .$$

The net benefit to undertake this search, B (y,s), is given by

$$B(y,s) = y - X(y) - s = \int_{-\infty}^{y} (y - x) f(x)dx - s .$$

Since this is a monotone increasing function with respect to x, we would be able to calculate y to form B (y,s) = 0 if we have information of f. This threshold y is denoted by y*. Under standard assumptions of search theory, the best search strategy is to continue searching until the extra value becomes less than y*.

Under this strategy, the probability for stopping the search at the first trial is F (y*). The probability of stopping at the second trial is $F(y^*)$ [1-$F(y^*)$], since we multiply the probabilities of not stopping at the first time ([1-$F(y^*)$]) and stopping at the second time ($F(y^*)$). Generally, the probability, Q (n), for stopping the search at n^{th} trial is

$$Q(n) = F(y^*)[1 - F(y^*)]^{n-1} \qquad (3).$$

The expected number of the search is derived as follows.

$$\sum_n nQ(n) = \sum_n nF(y^*)[1 - F(y^*)]^{n-1} = \frac{F(y^*)}{1 - F(y^*)} \sum_n n[1 - F(y^*)]^n$$

Since we know the following formula,

$$\sum_n n[1 - F(y^*)]^n = \frac{1 - F(y^*)}{F(y^*)^2} \qquad (4)$$

We substitute this formula into equation (3) to reach the expected number as $1/F(y^*)$. The search cost for the buyer is, therefore, $s/F(y^*)$. We can estimate s by adding the average time cost (consuming time multiplied by wage) for inspecting a residence to other costs such as transportation cost and information gathering cost (See Appendix 2).[3)]

2-2 Data base

We begin with a brief explanation of our data set since the characteristics of this unique data set determine our methodology in measuring buyers' search costs and the opportunity costs of vacant properties as explained

in the previous section.

Recruit Co., a publisher of information magazines on jobs, entertainment, automobiles and travel, also publishes *Shukan Jutaku Jouhou* (*Weekly Housing Information*). This is a weekly magazine published every Wednesday, and contains house/condominium sellers' advertisements. The advertisements are classified into four categories: new detached houses, resale detached houses, new condominiums, and resale condominiums. They are short, formatted advertisements, which include the location and a brief description of the house/condominium, the asking price, and the name of the seller or the broker representing the seller. *Recruit* publishes the *Shukan Jutaku Jouhou* in seven areas in Japan, including the Tokyo Metropolitan Area.

The coverage of this *Recruit* data set is large, especially with respect to condominiums for resale. In the central Tokyo area (twenty-three Wards), the *Jutaku Tochi Toukei Chousa (Housing and Land Survey)* of the General Administration Agency of the Japanese Government estimates that there were 9,333 transactions of condominium resale in 1998, while the corresponding *Recruit* figure is 10,636. Thus, the *Recruit* figure *exceeds* the official estimate. The difference may be due to differences in definition, sampling errors, and so on.[4] However, it is fair to say that the coverage of the *Recruit* data is close to most of the actual transactions, though there may remain some discrepancies.

Examining each issue of the *Shukan Jutaku Jouhou* for an extended period, we identify when a particular property is listed in advertisement pages and when its advertisement is terminated in a straightforward (though extremely cumbersome[5]) way. We also get a time profile of the property's asking price. We treat the date of termination as the date of transaction, and assume the asking price of one week before termination as the transaction price. The rationale of this convention is found in an unpublished internal follow-up study in *Recruit,* suggesting that the actual transaction price is not very different from the one-week-before-termination asking price. Using this procedure, we identify completed transactions in a particular year and obtain information of the transaction price and vacancy duration of each condominium resold. The total number of resale condominium transactions in 1999 is 10,636 in the central Tokyo area (twenty-three Wards). Table 1 reports summary statistics of the data set and Figure 1 shows the map of the central Tokyo area under our study.

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[3]) We may need to adjust for time if it takes a long time for the search as is the case for the seller.

[4]) On the one hand, the official figure is an estimate based on sampling, while the *Recruit* figure is the real number of transactions. Moreover, the official figure is the number of move-ins, which may be different from the number of transactions since a new owner may choose to leave his property vacant for another resale. In these respects, the Recruit figure is closer to the actual number of transactions. On the other hand, the *Recruit* figure is based on the assumption that the seller drops his advertisement when his property is sold. There may be cases in which sellers simply withdraw their property from the market. In addition, there may be transactions that do not involve any advertisement in the *Recruit* publishing. The former aspect makes the *Recruit* figure overstate and the latter understate the actual number of transactions.

[5] *Shukan Jutaku Jouhou* is published only in a paper form, not in an electronic form. The number of listings in one weekly volume is staggering, and we have to check *all* weekly volumes for more than one year to get necessary

The shaded area in **Figure 1** is the core wards/central business district (CBD) in **Table 1**.

Table 1. Summary Statistics *Jutaku Jouhou Data*

Summary Statistics of *Jutaku Jouhhou* (*Weekly Housing Information*)Data
Total Number of Samples=10,636,unit:thousand yen

	Second-hand condominium price(per property)	
	Core wards*	Periphery wards
The number of samples	2,147	8,489
Average	35,475.00	28,432.30
Median	28,500.00	25,000.00
Standard Deviation	24,478.70	14,869.80
Minimum	5,200.00	1,850.00
Maximum	150,000.00	149,750.00
	Second-hand condominium price (per square meter)	
	Core wards*	Periphery wards
The number of samples	2,147	8,489
Average	584.42	466.29
Median	545.59	449.68
Standard Deviation	162.56	128.58
Minimum	211.44	27.08
Maximum	1,565.03	1,214.65

*Chiyoda, Chuo Minato, Shinjhuku ward

Figure 1. Tokyo 23 wards and CORE WARDS (Chiyoda, Chuo, Minato and Shinjuku)

Recruit also publishes *Shukan Jutaku Jouhou Chintai Ban* (*Weekly Housing Information For-Rent Edition*),

information.

which contains advertisements of properties for rent. The advertisement format of properties for rent is basically the same as that of properties for resale. Using the same technique as used to identify transaction prices, we can identify transaction rents. For the same period and the same area, we get information of the characteristics and the transaction rent of 27,785 condominiums for rent in 1999.

The above description of our data set has revealed that we have fairly good data on condominiums for resale in central Tokyo. Specifically, we have the transaction price and the vacancy duration data for *each* of the condominiums resold in central Tokyo in 1999. In addition, since we have a large data set of transaction rents, we can estimate the transaction rent for *each* of these condominiums using a suitable hedonic rent regression equation. Thus, we are able to estimate the opportunity cost of vacancy for *each* of these condominiums, and then integrate them over central Tokyo to get the total opportunity cost of vacancy.

2-3 Opportunity Costs of Vacancy

The length of vacancy duration is calculated for each property once listed in the *Shukan Jutaku Jouhou.* **Table 2** shows the distribution of vacancy duration over all resale condominiums of our data set, transacted in central Tokyo in 1999.

Table 2. Holding period in the market: Second-hand condominium in Tokyo 23 Wards

Total Number of Samples=10,636

	Holding period in the market(weeks)		
	Tokyo special district(23 Wards)		
		Core wards*	Periphery wards
The number of samples	10,636	2,147	8,489
Average	12.40	13.51	12.19
Median	9.00	10.00	9.00
Standard Deviation	11.94	13.13	11.70
Minimum	1.00	1.00	1.00
Maximum	123.00	111.00	123.00

*Chiyoda, Chuo Minato, Shinjhuku ward

The average of vacancy duration is rather long, equaling 12.40 weeks. In core wards it is 13.51 weeks, while in periphery wards it is 12.19 weeks. This suggests that it takes longer in the core wards to sell and this is possibly due to miss-pricing in the core wards.

2-4 Search behavior of "the buyer" in Metropolitan Area

In order to understand the search behavior of "the buyer" in the Metropolitan Area, we analyze a questionnaire survey, "Recruit: *Shukan Jutaku Jouhou*/Weekly Housing Information – The questionnaire

survey for new buyers of newly built condominiums in Metropolitan Areas".[6] This survey consists of responses from those people who have purchased newly built condominiums in Metropolitan Areas (*Tokyo*, *Chiba*, *Kanagawa* and *Saitama* prefectures) after 1st January 2000. We analyze the responses between 20th August 2000 and 31st March 2000. The total number of responses is 10,503, of which 9,498 are analyzed after excluding outliers and fractured information[7].

Firstly, we investigate five factors of purchasers' characteristics: housing price, average income, average age, housing price to annual income ratio and loan amount to annual income ratio (**Table 3**).

The average housing price in the survey is 39.34 million Yen in the Metropolitan area (MA). In the Tokyo wards area (TWA), it is 43.13 million Yen, which is higher than the Metropolitan average by more than 3.5 million Yen. The average annual salary for MA is 7.35 million Yen, while it is 7.88 million Yen for TWA. The latter is larger than the Metropolitan average by 0.5 million Yen. The average ages of purchasers for MA and TWA are almost the same as each other; they are 37.3 years old and 38.0 years old respectively.

[6]) The respondents are required to attach their contract to the answering sheets, which makes the information provided in the survey very accurate.
[7]) We exclude from the data those responses missing some items as well as condominiums for which the transaction price is less than 10million yen.

Table 3. Characteristics of buyer

	Metoropolitan Area		
	Average	Standard Deviation	The number of samples
Average price	3,934.90	1109.96	9,498
Average annual income	735.03	304.72	9,498
Average age	37.37	8.24	9,498
Average ratio of price to annual income*	5.79	1.77	9,498
Average ratio of loan amount to household income**	4.49	1.52	4,203
	Tokyo 23 wards		
	Average	Standard Deviation	The number of samples
Average price	4,313.22	1339.01	3,504
Average annual income	788.34	354.32	3,504
Average age	38.08	8.37	3,504
Average ratio of price to annual income*	6.01	2.01	3,504
Average ratio of loan amount to household income**	4.53	1.66	1,506

*Price/Household income(head of household only)

**Total debt amount/Household income(head of household only)

The ratio of price to annual income is 5.79 in MA and 6.01 in TWA. The ratio of total debt to annual salary[8)] is 4.49 in MA and 4.53 in TWA, which is almost the same. We found that the purchasers in TWA have paid more initial deposit than those in MA because there is a big difference in price to annual income ratios between the two groups but few differences in the debt to annual income ratio.[9)] We also think that the Housing Loan Corporation lend the purchasers up to 4.5 times the purchasers' salary, since the average ratio above is about 4.5.

[8]) Many respondents leave total amount of debt blank. Some did so because they did not want to report it. Others did, for they thought it not necessary to fill in because they had no debt. We include the response in which they put null for debt but exclude when it is left blank. Therefore, the amount of debt is possibly over estimated. Also the debt of family is excluded and hence it may be underestimated.

[9]) We include second time buyers in these statistics. They can sell at higher prices in Tokyo wards area and this may make payback rates smaller.

Table 4. Pattern of moving by buyers

		New house location				
		Tokyo 23 wards	Outside of 23 wards in Tokyo	Saitama	Chiba	Kanagawa
Previous house location	Tokyo wards	70.83%	14.98%	16.60%	13.25%	10.08%
	Outside of 23 wards in Tokyo	5.17%	63.63%	4.67%	1.62%	3.61%
	Saitama	6.42%	4.67%	69.68%	2.39%	1.55%
	Chiba	7.91%	2.71%	3.98%	77.43%	2.89%
	Kanagawa	7.79%	12.49%	3.58%	3.47%	80.28%
	Other area	1.88%	1.52%	1.49%	1.85%	1.59%
	Number of purchasers	3,504	921	1,006	1,298	2,769

Number of Observation=9,498

We compared the previous addresses and new addresses of the purchasers to investigate the pattern of their movement (**Table 4**). First, we focused on those respondents that had moved within the same area. In TWA, the ratio is 70.83%. In Tokyo Outwards Area (outside of 23 wards in Tokyo), it is 63.63%. As for Saitama, Chiba and Kanagawa, it is 69.68%, 77.43% and 80.28% respectively. In comparison to previous surveys[10], the move within TMA increased to 82.00% in 1998 and 70.83% in 2000. In those three years, therefore, people had moved into the core area from periphery areas.

We then looked at the issues of search period and number of searches (**Table 5** and

[10]) The previous survey was undertaken by the Urban Housing Foundation using a different method. We can compare our results with "Survey of new comers in condominium in Tokyo Metropolitan area 1998" (July, 1999). The survey focused on the buyers or their partners who have purchased new condominiums **which are higher than 5 stories** between March 1997and April 1998. Because the response rate is small, 335 respondents and 53%, we must be careful in the comparison.

Table 6). We have three categories of search period. The first one corresponds to the whole period from considering searching for a house to making a contract (Search period 1). The second one is the period from "starting information collection" to making a contract (Search period 2). The third search period is the period from "serious inspection of the properties" to making a contract (Search period 3).

In MA, search periods 1, 2 and 3 on average are 39.19 weeks, 25.98 weeks and 11.30 weeks respectively. We are not sure that we can regard them as typical buyers. However, these figures show that once they decide to buy a house, they start collecting information within 3 months, inspecting houses in 9 months and reach the contract stage within 12 months on average.

Table 5. Search period and search times – first time buyer and second time buyer

(weeks) (times)

			Search period 01 Start thinking of purchase	Search period 02 Start collecting information	Search period03 Start inspection	The number of search acitivities	Total number of samples
Metoropolitan Area		First time buyer	37.12 (61.82)	24.43 (45.47)	10.23 (22.38)	4.98 (5.86)	7,909
		Second time buyer	49.48 (115.72)	33.72 (85.60)	16.63 (65.97)	4.85 (6.07)	1,589
		Total	39.19 (73.78)	25.98 (54.40)	11.30 (33.92)	4.96 (5.89)	9,498
	Tokyo 23 Wards	First time buyer	39.01 (68.12)	26.67 (52.56)	11.10 (25.57)	5.74 (6.70)	2,809
		Second time buyer	51.00 (128.97)	34.75 (90.87)	16.97 (63.14)	5.61 (7.02)	695
		Total	41.39 (83.89)	28.28 (62.13)	12.27 (36.32)	5.71 (6.76)	3,504

Figures in blaket is standard deviation

If we compare the result in MA with that in TWA, search period 1 for TWA is 41.39 weeks (as opposed to 39.19 weeks in MA), search period 2 is 28.28 weeks for TWA (25.98 weeks for MA) and search period 3 is 5.71 weeks for TWA (4.96 weeks for MA). The purchasers in TWA spend a longer time searching than those in MA and inspect properties more frequently (4.96 times in MA as opposed to 5.71 times in TWA). This suggests that people can easily go for inspection in TWA since there are more housing supplies.

We then compare the first time buyers and the second time buyers in TWA.

- Search period 1 is 39.01 weeks for the first time buyers as opposed to 51.00 weeks for the second time buyers.
- Search period 2 is 26.67 weeks for the first time buyers as opposed to 34.75 weeks for the second time buyers.
- Search period 3 is 11.10 weeks for the first time buyers as opposed to 16.97 weeks for the second

time buyers.

The differences in Search period 1 and 2 are approximately three months, while there is less difference for Search period 3.

Table 7 shows search period 2 and 3 for different age cohorts of the head of household. Generally, more than half of them make a contract within 3 months from when they start collecting information and within one month of starting inspection seriously. By age groups, 57.12 % are between 30 – 40 years old, 21.15% between 40-50 years old, 12.56% from under 30 years old and 9.17% from older than 50 years.

Table 6. Distribution of search period by age cohort

		Under 30's	30-40 years old	40-50 years old	Over 50 years old	The number of buyers	Ratio
Search period 2	Within one month	26.91%	22.88%	21.45%	21.70%	2,182	22.97%
	2-3 months	30.18%	27.80%	24.64%	23.65%	2,569	27.05%
	4-6 months	25.23%	22.97%	23.54%	22.96%	2,220	23.37%
	7-12 months	11.90%	13.64%	14.63%	13.89%	1,297	13.66%
	More than 12 months	5.78%	12.72%	15.73%	17.80%	1,230	12.95%
Search period 3	Within one month	57.67%	48.61%	46.09%	48.56%	4,674	49.21%
	2-3 months	26.99%	28.46%	28.77%	23.77%	2,651	27.91%
	4-6 months	10.48%	13.03%	13.54%	14.70%	1,232	12.97%
	7-12 months	3.10%	5.82%	6.52%	5.97%	536	5.64%
	More than 12 months	1.76%	4.07%	5.08%	7.00%	405	4.26%
The number of buyers		1,193	5,425	2,009	871		
Ratio		12.56%	57.12%	21.15%	9.17%		

Number of Observation=9,498

We can see that the younger the buyers are, the shorter the search period. For example, the age group of under 30 years has the highest proportion (26.91%) in “less than one month” for search period 2. If we then extend that to “less than three months”, the proportion rises to be 57.08%. In the other age groups, the share of “less than three months” in search period 2 are 50.67% for 30-40 years, 46.09% for 40-50 years old and 45.35% for over 50 years old.

With regard to search period 3, the period of the younger generation is short. The share of “less than one month” is 57.67%, which is much bigger than that of the other age cohorts. Two possible reasons can be pointed out in this regard. One is that older people tend to spend a longer search time, since they would live at that property for a long time, while younger people tend to spend a shorter time since they think that they would move after a certain period, or they may buy their house on the spur of the moment. Another reason is that the younger generation can collect information more efficiently and quickly to make their decision.

The questionnaire also asks what are the most frequently used information resources (**Table 7**). Broadly, information magazines and advertisement leaflets are mostly used (40%) in search period 2, as they are a starting point for collecting information. This is followed by information from brokers (6%) and internet web-sites (5%). In search period 3, the rates for information magazines and advertisement leaflets falls to 31.81% and 36.81%, respectively. The rates for direct mail advertisements and information from brokers increase by 3.64% to 7.41% and by 4.1 % to 9.67% from the previous period. These results suggest that the buyers wanted to have more detailed information in search period 3 than in search period 2 when information on plan, space, facilities, the nearest station and distance to the station was mostly sufficient. Therefore, they have to visit the property to get more information. This is shown by the fact that the rate for the other information resources increases from 5.80% to 9.41%.

Table 7. Information resources of purchasers by age cohort

		Under 30's	30-40 years old	40-50 years old	Over 50 years old	The number of buyers	Ratio
Search period 2	Information magazine	38.39%	41.57%	37.48%	31.11%	3,737	39.35%
	Leaflet	40.91%	39.43%	42.96%	42.48%	3,860	40.64%
	Direct mail	2.51%	3.65%	3.78%	6.54%	361	3.80%
	Internet website	6.54%	5.11%	4.03%	2.30%	456	4.80%
	Television	0.08%	0.04%	0.05%	0.00%	4	0.04%
	Brokers	6.29%	5.29%	5.67%	6.08%	529	5.57%
	Other resources	5.28%	4.92%	6.02%	11.48%	551	5.80%
Search period 3	Information magazine	32.86%	33.77%	29.47%	23.54%	3,021	31.81%
	Leaflet	36.38%	36.46%	37.93%	36.97%	3,496	36.81%
	Direct mail	5.62%	7.15%	7.67%	10.91%	704	7.41%
	Internet website	6.29%	5.33%	3.98%	2.30%	464	4.89%
	Television	0.00%	0.02%	0.00%	0.00%	1	0.01%
	Brokers	9.56%	9.24%	10.65%	10.22%	918	9.67%
	Other resources	9.30%	8.04%	10.30%	16.07%	894	9.41%
The number of buyers		1,193	5,425	2,009	871		

Number of Observation=9,498

By age cohort, the older they are, the less they use information magazines in search period 2. The elder people do not use the magazine so often because they tend to move within their home area rather than to move out from that area. Also, it is the case that the ratio of use of internet search is lower for the older people. This is not only because fewer people use internet search in the elder generation, but because the younger people are likely to look for their accommodation in a wider area. The information they try to collect is not available from magazines and hence they use the other media more often. In other words, the quality of information people want to have is different in their age groups.

3. RESULTS

3.1. "typical second-hand condominium" transaction

The residential property type on the market varies from a studio for single user to a luxurious mansion. The buyers' behavior depends on which type of the properties they want to buy. We therefore set up a "typical residential property for typical buyer".

From the second-hand residential property database, we estimate a hedonic model for a standard condominium. Careful consideration is necessary in utilizing the database. Firstly, the database includes a studio for the young generation. Secondly, the luxurious top-end mansions are also included. We can see that this database consists of several subsets of data with different structures. A structural change test is applied to

this whole database to divide it into groups of data, each of which has a similar structure. Then we choose a sub-data set for the "typical" condominium and estimate a hedonic model.

As shown in Appendix 1, the database was divided into several groups by AIC (Akaike's Information Criterion). The reason for our focus on size is that we expect that the price structure of a typical condominium to be different from a studio which generally has small space, and from a luxurious condominium with large space. Our analysis shows that the data can be divided into three groups by space. The first group is residential property, the area of which is from 25 to 85 square meters. The second group consists mostly of studios of size smaller than 25 square meters. The third one is mostly luxurious properties of size larger than 85 square meters. We also checked the difference of the regression coefficient on "age of building", "occupied space", "the distance to the nearest station" and "accessibility to CBD" by F-test. The null hypothesis that the regression coefficients are equal among the three sets of data is rejected with significance level being less than 0.0001. Consequently, the typical residential property is set to be a second-hand condominium of which size is from 25 to 85 square meters.

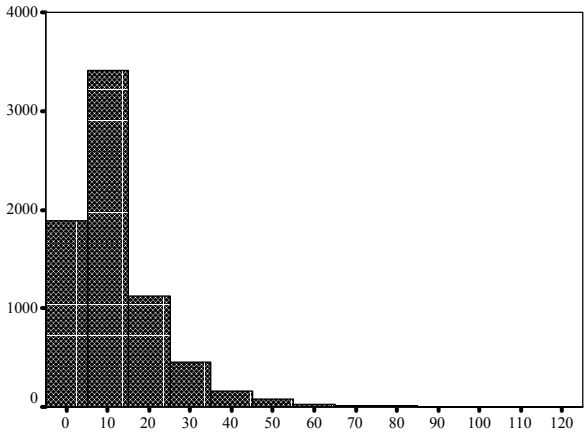
3.2 The seller's loss - opportunity costs of vacancy

The opportunity cost of a vacant condominium is its vacancy duration times its market rent (net of depreciation, maintenance and other expenses). The total opportunity cost of vacant condominiums in the central Tokyo area is obtained by summing up individual opportunity costs over the entire of central Tokyo.

(1) Vacancy-Duration Distribution in the Central Tokyo Area

We have two ways to estimate opportunity costs from equation (1) and equation (2).

Let us first consider vacancy duration (T). As explained in the previous section, we can calculate the length of vacancy duration for each property once listed in the *Shukan Jutaku Jouhou.* **Figure 2** shows the distribution of the vacancy duration of "typical condominium" in our data set in central Tokyo in 1999. As is evident in this figure, the distribution is skewed toward zero, and its median is 8 weeks. The average of vacancy duration is 11.77 weeks, which is shorter than the average of all data (12.4 weeks, see **Table 3**). This suggests that non-typical condominiums are less liquid.



Histogram of Vacancy Duration/Week

	Vacancy Duration(Week)
	Tokyo 23 wards
Number of Samples	7,183
Average	11.58
Median	8.00
Standard Deviation	11.07
Minimum	1.00
Maximum	123.00

Figure 2. Vacancy Duration of second hand condominium market in Tokyo

(2) Opportunity cost

To estimate the opportunity cost by equation (2), we need to know the interest rate for each month in 1999 (Table 8).

Table 8. Loan contract interest rate in 1999

Month/Year	Interest Rate
Jan-99	2.252%
Feb-99	2.246%
Mar-99	2.223%
Apr-99	2.190%
May-99	2.172%
Jun-99	2.146%
Jul-99	2.134%
Aug-99	2.127%
Sep-99	2.117%
Oct-99	2.114%
Nov-99	2.109%
Dec-99	2.100%

source) *Bank of Japan*

Another way of measuring vacancy cost is to estimate the market rent for each of the condominiums in our data set. To do this, we first estimate a hedonic rent equation based on rent data for a typical property.

We can get information on transaction rents in central Tokyo in another *Recruit* publication, *Shukan Jutaku*

Jouhou Chintai-Ban (*Weekly Housing Information For-Rent Edition*). **Table 9** shows summary statistics of transaction rents in central Tokyo based on this information source.

Using this data set, we estimate a hedonic rent model. The explanatory variables are fairly standard: years after construction, floor space, distance to the nearest railway/subway station, and accessibility to the central business district. We also include a first floor dummy, railway/subway line dummies, and location (ward) dummies, since some of them are known to be significant in this type of regression. Both the dependent variable (the transaction rent) and the explanatory variables, except for the dummies, are log-transformed and the estimation method is OLS (Ordinary Least Squares).

Table 9. Rent of typical condominium

Summary Statistics of *Jutaku Jouhhou Chintai-Ban* (*WHI For rent Edition*)Data
Total Number of Samples=27,072 (1,000 yen)

	Condominium rent (by unit)	
	Core wards*	Periphery wards
Samples	2,476	21,596
Average	198.83	142.71
Median	179.93	131.97
Standard Deviaition	72.01	48.44
Max.	71.71	52.59
Min.	498.99	451.50
	condominium rent (per square meter)	
	Core wards*	Periphery wards
Samples	2,476	21,596
Average	3.45	2.75
Median	3.36	2.70
Standard Deviaition	0.62	0.55
Max.	2.12	1.35
Min.	6.07	6.00

*Chiyoda, Chuo, Minato, Shinjhuku

Table 10 reports the results.[11] The adjusted R square is 0.884, suggesting a good fit. Using the rent equation in Table 10, we can estimate the market rent of a particular condominium in our data set of transacted resale condominiums. The opportunity cost of vacancy, however, may be lower than the market rent, because of maintenance and other expenses necessary for renting, about which information is hard to obtain. Thus, we use three measures of the opportunity cost of vacancy: (1) the average loan-contract rate of interest (representing the minimum), (2) the net rent (the market rent net of maintenance and other expenses, calculated using the formula in the *Manual of the Japanese Association of Real Estate Appraisal*), and (3) the gross rent (which equals the market rent, representing the maximum). Summary statistics of typical second hand

[11]) We tried other specifications but the specification reported in Table 10 is found the best in view of Mallow's CP criterion.

condominiums are presented in **Table 11**.

By adding individual opportunity costs over all samples in our data set, we have the total opportunity cost of vacancy in central Tokyo in 1999 (**Table 12**). Using this information, we can calculate the magnitude of the imperfect information cost on the side of sellers. We consider three situations. Case 1 compares the present state with the perfect information case in which all properties are sold immediately after being listed. The magnitude of the difference is shown in this table as a percentage of the total imputed rents of condominiums resold in 1999. Case 2 compares the present state with the case in which all properties are sold within four weeks (the mode of the present vacancy duration distribution). Case 3 compares the present state with the case in which all properties are sold within twelve weeks.

Table 10. Hedonic rent equation of Tokyo 23 wards in 1999

(1) Dependent Variable: Log Rent of "Typical" Condominiums (2) Method of Estimation: OLS (3) Year = 1999

Variables	Coefficient	t-value	Variables	Coefficient	t-value
Property Characteristics			DCBD x Meguro	0.153	3.009
Constant	0.218	7.440	DCBD x Ota	0.028	3.939
YEAR:Building age	-0.004	-5.924	DCBD x Setagaya	0.033	5.977
SQMTR:Floor space	0.875	212.954	DCBD x Nakano	0.014	1.733
ST:Dsitance to the nearest station	-0.038	-29.148	DCBD x Toshima	-0.027	-1.952
DCBD:Distance to CBD*	-0.350	-45.944	DCBD x Kita	-0.023	-2.599
D1F:Ground floor dummy	-0.038	-16.919	DCBD x Arakawa	-0.136	-11.559
Railway/Subway Line Dummy			DCBD x Itabashi	-0.018	-1.660
Yamanote Line	-0.062	-13.934	DCBD x Nerima	0.054	7.142
Ginza Line	0.103	12.675	ST x Minato	-0.045	-6.950
Marunouchi Line	0.053	12.495	ST x Shinjhuku	0.015	2.604
Hibiya Line	0.143	22.952	ST x Sumida	-0.023	-2.948
Tozai Line	0.060	10.645	ST x Shinagawa	0.011	2.106
Chiyoda Line	0.068	11.607	ST x Shibuya	-0.011	-1.673
Asakusa Line	0.036	5.586	ST x Arakawa	-0.014	-1.645
Shinjhuku Line	0.029	4.693	ST x Nerima	-0.007	-1.728
Keikyu Line	0.027	3.663	YEAR x Chiyoda	0.033	1.558
Keihinn Tohoku Line (Yokohama)	0.020	2.864	YEAR x Minato	-0.010	-2.681
Ikegami Line	0.071	10.246	YEAR x Shinijhuku	-0.085	-18.121
Mekama Line	0.087	12.932	YEAR x Bunkyo	-0.051	-12.513
Oimachi Line	0.075	10.351	YEAR x Taito	-0.054	-7.419
Toyoko Libe	0.124	19.688	YEAR x Sumida	-0.073	-12.793
Denen Toshi Line	0.035	5.443	YEAR x Koto	-0.061	-13.042
Odakyu Line	0.019	3.089	YEAR x Shingawa	-0.048	-11.181
Inogashira Line	0.031	4.831	YEAR x Meguro	-0.061	-13.766
Keio Line	-0.030	-5.336	YEAR x Ota	-0.046	-13.036
Seibu Shinjhuku Line	0.015	3.086	YEAR x Shibuya	-0.077	-18.272
Tobu Tojyo Line	0.030	5.628	YEAR x Nakano	-0.049	-11.103
Saikyo Line	-0.082	-9.283	YEAR x Suginami	-0.042	-10.555
Isezaki Line	0.024	2.676	YEAR x Toshima	-0.053	-9.970
Sobu Line	0.059	9.586	YEAR x Kita	-0.045	-7.565
Setagaya Line	0.026	1.749	YEAR x Arakawa	-0.029	-4.144
Location (Ward) Dummy			YEAR x Itabashi	-0.051	-12.997
Chuo	-0.658	-12.878	YEAR x Nerima	-0.056	-15.026
Minato	-0.989	-8.298	YEAR x Adachi	-0.062	-10.839
Shinjhuku	-0.112	-2.596	YEAR x Katsushika	-0.044	-6.527
Taito	0.446	13.391	YEAR x Edogawa	-0.037	-7.888
Koto	0.218	7.759	SQMTR x Chiyoda	-0.062	-2.647
Shinagawa	0.224	6.125	SQMTR x Chuo	0.253	17.864
Meguro	-0.354	-3.297	SQMTR x Minato	0.289	19.117
Ota	0.082	3.551	SQMTR x Shinijhuku	0.062	8.431
Setagaya	-0.086	-3.700	SQMTR x Bunkyo	0.070	22.801
Nakano	0.148	6.282	SQMTR x Koto	-0.034	-4.749
Suginami	0.191	15.616	SQMTR x Shinagawa	0.010	1.447
Toshima	0.141	3.295	SQMTR x Meguro	0.086	12.271
Kia	0.332	7.975	SQMTR x Setagaya	0.055	12.393
Arakawa	0.518	10.289	SQMTR x Shibuya	0.110	26.175
Itabashi	0.258	6.898	SQMTR x Toshima	0.021	2.579
Cross-Term Effect			SQMTR x Kita	-0.053	-5.140
DCBD x Chiyoda	0.225	4.965	SQMTR x Arakawa	-0.038	-3.255
DCBD x Minao	0.073	2.092	SQMTR x Itabashi	-0.040	-6.736
DCBD x Shinjhuku	0.072	4.744	SQMTR x Nerima	-0.013	-2.444
DCBD x Taito	-0.135	-11.866	SQMTR x Katsushika	0.006	1.539
DCBD x Sumida	0.043	7.460	SQMTR x Edogawa	0.010	2.891
DCBD x Shinagawa	-0.053	-4.481			

Adjusted R squre = 0.884 Number of Observations = 24,072

(*) Distance measured by time (minutes) required from nearest railway/subway station to Yamanote Line

Main stations: Tokyo, Shinjhuku, Shibuya, Ikebukuro, Ueno, Kasumigaseki, Otemachi

Table 11. Statistics summary –Typical second hand condominium

Summary Statistics of *Jutaku Jouhhou Chintai-Ban* (*WHI For rent Edition*)Data

Total Number of Samples=27,072 (1,000 yen)

	Condominium rent (by unit)			
	A: Condo. Unit Price	B: Imputed Rent	B/A	Holding period in the market
Unit	1,000 Yen	1,000 Yen/month	%	Week
Average	26,969	149.40	7.14	11.77
Median	25,000	148.99	7.05	8.00
Standard Deviaition	10,197	39.59	1.99	11.32
Maximum	5,300	40.98	2.26	1.00
Minimum	89,950	302.62	17.12	167.00

The result shows that the magnitude of the cost of imperfect information is substantial. According to the net rent case (1), the cost of imperfect information is 22.59% of the total imputed rents of condominiums resold in 1999.

Table 12. Opportunity cost of vacancy against imputed rent

Case	Measure of Opportunity Cost of Vacancy		
	Interest Rate	Net Rent	Gross Rent
Case 1: All properties are sold immediately.	10.58%	31.28%	22.59%
Case 2: All properties are sold by no more than 4	7.34%	21.54%	15.52%
Case 3: All properties are sold by no more than 12	3.50%	10.10%	7.28%

3.3 Search cost of typical buyer

We work out the distribution of extra value in order to derive the search cost. This distribution is approximated by the distribution of residual errors from the hedonic price model. The following is the estimated model of second-hand condominium of "typical residential property".

$$\log Pcod = a_0 + \sum_h a_{1h} \log X_h + \sum_i a_{2i} \log Z_i + \sum_j a_{3j} ERD_j + \sum_k a_{4k} ELD_k + \sum_l a_{5l} ESD_l$$

$$+ \sum_{h,k} a_{6hk} (\log X_h)(LD_k) + \varepsilon \qquad (3)$$

$Pcod$: Price of second hand Condominium

X_h : Property Characteristics

YEAR : Building age(year)

SQMTR : Occupied space(㎡)

ST : Distance to the nearest station(minute)

DCBD : Distance to CBD(minute)

TU : Total units : (unit)

BS : Balcony space(㎡)

D1F : Ground floor dummy

Z_i : Environmental Information Obtained only by Visiting

RB : BD : Building density - number of buildings

RP : Population density

AS : Average stories in the block

AF : Average floor space in the block

BF : Building floor area/Area of block

RD_j : Railway/Subway Line Dummy ($j = 0.....J$)

LD_k : Location (Ward) Dummy ($k = 0 \ldots\ldots K$)

SD_l : Seasonal Dummy ($l = 0 \ldots\ldots L$)

The function above has such variables as age of building, exclusive occupied space, the distance to the nearest station, accessibility to CBD, total number of units, balcony space and the number of stories, which are available from the listing magazine. Additionally, it includes other environmental variables which we can get through a further search. They are building density per block, average story of buildings, building area ratio to block area and population density per administrative block number.[12)] Also, we use regional variables such as the railway line dummy variable and the area dummy variable, since the model should reflect the fact that the model covers all of Tokyo. We put a seasonal dummy variable in the model so that we could adjust monthly price movement. As in the case for our Rent model, we use cross factor to main variables since we cannot assume that they are the same through all regions.

Below is the price distribution of "typical second-hand condominium".

[12]) We estimate this from the following references: "Survey on land and building in Tokyo", "National Census" and "Zenrin Residential Map". The Survey makes it available to analyze each building with GIS. Area of each block and street number can be calculated by Zenrin's map.

Table 13. Typical second hand condominium price (25 ••85 •)

Total Number of Samples = 8,344 (1,000 yen)

	Condominium price (by unit)	
	Core Wards*	Surrounding Wards
Samples	1,114	7,230
Average	29,335	26,605
Median	26,950	24,800
Standard Deviaition	12,169	9,809
Max.	9,500	5,300
Min.	72,700	89,950
	Condominium price (per •)	
	Core Wards*	Surrounding Wards
Samples	1,114	7,230
Average	544.77	463.60
Median	522.82	448.91
Standard Deviaition	110.14	120.11
Max.	302.43	181.21
Min.	1,005.67	1,067.91

*Chiyoda, Chuo, Minato, Shinjhuku

The total number of the database is 10,636, of which 8,344 condominiums are chosen. There are 1,114 samples for CORE wards *(Chiyoda, Chuo, Minato* and *Shinjhuku*) and 7,230 in the other wards. The average price in the CORE wards is 29.335 million yen while it is 26.605 million yen in the other wards. The highest price in CORE wards is 72.7 million yen. Those properties over 100 million yen are excluded here.

Table 14 shows the results of estimation of the second-hand condominium price function. The adjusted R square is 0.918, which has high explanatory power.

Table 14. Hedonic price of second hand condominium in Tokyo 23 wards in 1999

(1) Dependent Variable: Log Resale Price of "Typical" Condominiums (2) Method of Estimation: OLS (3) Year = 1999

Variables	Coefficient	t-value
Property Characteristics		
Constant	5.318	50.506
YEAR:Building age	-0.016	-36.572
SQMTR: Occupied space	0.004	7.497
ST: Distance to the nearest station*	-0.009	-21.510
DCBD:Distance to CBD	-0.006	-8.556
TU: Total units	0.025	16.502
D1F: Ground floor dummy	-0.029	-7.079
SD: South-facing dummy factor	0.016	6.333
RT:Holding period in the market**	0.007	4.999
Environmental Information Obtained only by Visiting		
BD: Building density-number of buildings***	-0.013	-2.950
RP:Population density ****	0.011	2.958
AS:Average stories in the block***	-0.014	-3.715
AF:Average floor space in the block***	-0.018	-1.586
BF:Building floor area/Area of block***	0.022	1.912
Railway/Subway Line Dummy		
Yamanote Line	-0.038	-4.225
Ginza Line	0.133	10.079
Marunouchi Line	0.048	5.443
Hibiya Line	0.110	11.146
Tozai Line	0.091	9.187
Chiyoda Line	0.046	5.826
Yurakucho Line	0.038	5.066
Asakusa Line	0.038	4.078
Keihin Tohoku Line (Kanagawa)	0.069	6.721
Ikegami Line	0.103	8.846
Mekama Lime	0.059	5.426
Oimachi Line	0.116	10.952
Tokyu Toyoko Libe	0.142	11.657
Denen Toshi Line	0.111	12.949
Odakyu Line	0.085	9.301
Inogashira Line	0.080	6.177
Chuo Like	0.060	5.648
Seibu Shinjhuku Line	0.091	8.643
Seibu Ikebukuro Line	0.074	6.872
Tobu Tojo Line	0.030	3.150
Saikyo Line	-0.079	-4.488
Sobu Line	0.058	4.794
Location (Ward) Dummy		
Taito	1.145	3.732
Koto	0.275	2.424
Ota	-0.780	-6.652
Toshima	0.333	2.676
Kita	1.431	4.438
Arakawa	0.766	3.925
Nerima	-0.277	-2.699

Variables	Coefficient	t-value
Seasonal Dummy		
March	0.011	2.370
July	-0.011	-2.623
September	-0.013	-3.125
December	-0.022	-4.701
Cross-Term Effect		
DCBD x Shinjhuku	0.016	3.260
DCBD x Taito	-0.492	-4.938
DCBD x Ota	0.252	6.863
DCBD x Setagaya	0.071	8.127
DCBD x Shibuya	0.102	5.835
DCBD x Nakano	0.064	2.124
DCBD x Toshima	-0.139	-3.363
DCBD x Kita	-0.283	-3.457
DCBD x Arakawa	-0.299	-4.916
DCBD x Edogawa	-0.050	-10.926
ST x Chuo	-0.009	-1.162
ST x Minato	0.021	2.146
ST x Bunkyo	0.065	9.328
ST x Koto	-0.023	-2.615
ST x Shinagawa	0.015	2.270
ST x Ota	0.012	1.430
ST x Setagaya	-0.012	-1.655
ST x Arakawa	-0.046	-2.701
ST x Adachi	-0.051	-5.642
ST x Katsushika	-0.039	-4.535
YEAR x Chiyoda	0.056	7.864
YEAR x Minato	0.053	4.254
YEAR x Taito	0.044	2.632
YEAR x Setagaya	-0.014	-1.969
YEAR x Shibuya	-0.030	-2.153
YEAR x Suginami	-0.028	-3.245
YEAR x Toshima	0.022	1.499
YEAR x Itabashi	-0.047	-9.778
YEAR x Adachi	-0.087	-10.505
YEAR x Katsushika	-0.074	-9.524
SQMTR x Minato	-0.017	-1.542
SQMTR x Koto	-0.108	-3.796
SQMTR x Meguro	0.031	8.185
SQMTR x Nakano	-0.035	-1.542
SQMTR x Suginami	0.046	6.898
SQMTR x Kita	-0.179	-2.988
SQMTR x Nerima	0.064	2.480
Adjusted R squre = 0.918		
Number of Observations = 8,808		

(*) Distance measured by time (minutes) required from nearest railway/subway station to Yamanote Line
Main stations: Tokyo, Shinjhuku, Shibuya, Ikebukuro, Ueno, Kasumigaseki, Otemachi

(**) Date firstly listed - Date of list deleted

(***) In the same "Banch" area

(****) In the samae "Chome" area

The histogram of the residuals of the hedonic price regression is shown in **Figure 3**. As explained before, we assume that this distribution of residuals is the distribution of the "extra value" over the theoretical mean price of the typical condominium. A typical buyer searches for the lowest extra value sequentially, with a search cost *c* of 207,900 yen. (See Appendix 2 for the measurement of the search cost.)

Let us sort in the order of extra values (that is, residuals of the hedonic price regression) from the minimum to the maximum. Let x_i be the *i*th excess price and *n* is the total number of samples. Then, the reservation extra value x_R is determined by

$$c = \frac{1}{n}\sum_{i=1}^{R}\left(x_R - x_i\right)$$

From this relation, we get R =1,389 and x_R = - 2,774,400 Yen. With the relation that

$$F\left(y^*\right) = \frac{R}{n}.$$

Thus, the expected total search cost of the typical buyer is given by

$$Expected\ Total\ Cost = \frac{c}{F\left(y^*\right)} = c \times \frac{n}{R} \approx \text{ 1,042,000 Yen}$$

This result suggests a substantial search cost on average. The expected search cost of 1,042,000 yen is 13.2% of the typical buyer's annual income (7.88 million yen).

The expected number of times of search is sought as $\frac{1}{F(y^*)}$, which is 7.11 in this case. This result is bigger than the results shown in Table 5, based on the questionnaire survey, by a ratio of 1.5 (The average for Tokyo Wards is 5.71). The response for the questionnaire survey comes from those who bought new condominiums, which generally have a certain quality. On the other hand, we can see that the number of searches is bigger since the subject of this study is second-hand condominiums, which have some uncertainty in terms of quality.

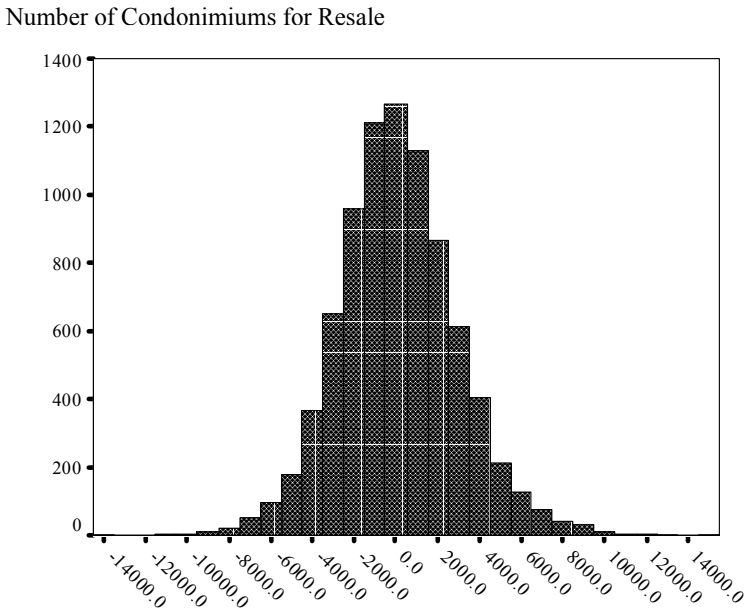


Figure 3. Distribution of extra price (1,000 Yen)

4. CONCLUDING REMARKS

In this study, we estimated economic loss caused by imperfect information in the second-hand condominium market in Tokyo wards. It is extremely important to identify the cost both for the seller and the buyer, and from imperfect information in the market, in order to improve the efficiency of the real estate market transaction system.

We carried out our questionnaire survey on the buyer to ascertain how the buyers undertake their search activities. We found that the residential information magazine and distributed leaflets are the most frequently used. Approximately 40% of people use them when they collect their information. However, when making their final decision, these are not so effective. This suggests that buyers have further costs in their search activity because the information provided, including from the real estate brokers, is neither sufficient nor accurate.

Based on the above results, we estimated economic loss due to the lack of information for the seller and the buyer.

- For the seller side, if information is perfectly available and marketing time is null, they will get benefits of 10.58% based on average interest rate, 31.28% on gross rent and 22.59% on net rent against imputed rent of the property in the market.
- For the buyer, they spend 1,042,000 Yen on search activities for one transaction. This is equivalent to 13.2% of the buyers' average annual income of head of household.

The results of this paper suggest an urgent need for improving informational efficiency of second-hand residential real estate markets. For example, information is indispensable, such as on child care and education available in the area and convenience for shopping. Also buyers may need information on the incidence rate of flooding, strength of ground and air pollution, since all of these may affect their choice of location. These aspects do not appear in the magazines and hence can only be known when they undertake search activity or even only after we actually start living. The strength of structure needs to be inspected by professional people. This information is hard to find out from historical record and inspection from outside. If all of these information-items were provided inexpensively, it would improve social welfare greatly.

Appendix 1. Identification of "Typical transactions" – structural change test

In general, a structural change test is an equality test of partial regression coefficients where a point of structural change is known and where the data is split into two parts thereof.

However, we need to extract a sub-set of data for typical condominiums where we have no knowledge about the place(s) and number of structural changes. Garcia and Perron (1996) showed how to identify the changing points for two structural changes. Jushan and Perron (1998) discussed a way of structural change testing where there are unknown changing points of unknown frequencies. In our study, we used a simplified way in terms of tractability, following Nishimura and Shimizu (2003).

It is very likely that neither the sub-set of data for studios nor that of luxurious mansions is similar to the data for a typical condominium. Thus we identify a sub-set of data for typical condominium based on occupied space. We carry out an equality test for three sub-sets of data, namely, for studios, typical condominiums and luxurious mansions and select the most fitted model.

We transform equation (3) into the form shown below. Explanatory variables are divided into two groups (X_{hm}, X_{hn}), where X_{hm} is explanatory variables whose effects are different among sub-sets and X_{hn} is those whose effects are the same. We tentatively assume that (a) *f* square meters is the threshold determining whether a particular condominium is a studio (or its equivalent) or a typical condominium, and that (b) *g* square meters is the threshold determining whether a particular condominium is a typical condominium or a luxurious one. We use two dummy variables (D_{fg}, D_g) representing these segmentation. The choice of *f* and *g* is discussed later. By putting these dummy variables into the regression equation, we assume that the model has two structural changes and variance of error terms is the same among sub-sets

$$\log Pcod = a_0 + \sum_{hm} a_{1hm} \log X_{hm} + \sum_{hm} a_{2hm} (\log X_{hm})(D_{fg}) + \sum_{hm} a_{3hm} (\log X_{hm})(D_g) + \sum_{hn} a_{4hn} \log X_{hn}$$

$$+ \sum_j a_{5j} RD_j + \sum_i a_{6i} \log Z_i + \sum_k a_{7k} LD_k + \sum_l a_{8l} SD_l + \sum_{h,k} a_{9hk} (\log X_h)(LD_k) + \varepsilon \quad (5)$$

where

X_{hm} : Property characteristics whose effects are different among sub-sets

YEAR: Building age

SQMTR: Occupied space (square meter)

ST: Distance to the nearest station (minute)

DCBD:Distance to CBD (minuite)

X_{hn} : Property characteristics whose effects are common among sub-sets

TU: Total units : (unit)

BS:Balcony space (square meter)

D1F: Ground floor dummy

$D_{fg} : if \quad f < SQMTR \le g \quad then \to 1, otherwise \to 0; f \ge 0, g > f$

$D_g : if \quad g < SQMTR \quad then \to 1, otherwise \to 0$

We undertake structural change tests on building age (*Year*), occupied space (*SQMTR*), distance to the nearest station (*ST*) and accessibility to CBD (*DCBD*). In terms of occupied space, we change *f* and *g* by 5 square meters between 0 and 150 and choose the model that produces the highest AIC (Akaike's Information Criterion). The number of combinations tested is 378.

As a result, we know that the best fitted model is constructed where *f* = 25 square meters and *g* = 85 square meters. In this way, we identify that condominium of size between 25 and 85 square meters as a "typical condominium".

To check appropriateness of our choice, we carry out structural change tests for the three groups of data, on this assumption. Table A-1 reports the results.

Table A-1. The results of structural change test

variables	α=Prob(F>F_0)
YEAR:Building age	0.0017
SQMTR:Floor space	0.0049
ST:Dsitance to the nearest station	0.0021
DCBD:Distance to CBD*	0.1401
All	0.0001

The regression coefficients among three categories are significantly different with level of significance being 0.0001, as expected.

Appendix 2. Derivation of a typical buyer's search costs

Transportation Costs.

We have assumed that a typical buyer lives in one of the twenty-three wards of Tokyo and searches for a condominium located in one of these wards. In this area, *Ikebukuro* is the main terminal station for *Tobu Tojo* and *Seibu Ikebukuro* lines, *Shibuya* for *Tokyu Toyoko* and *Denentoshi* lines, *Shinjuku* for *Odakyu*, *Keio*, and *Chuo*, *Tokyo* and *Shinagawa* for *Tokaido* line, Tokyo for *Sobu* line. The average distance from the center to railway stations on the edge of the twenty-three wards is about 30 km and its traffic cost is approximately 300 yen (one way) for one adult and 150 yen for a child. The transportation time is approximately 30 minutes. Thus, the per-search transportation cost of a typical household of two adults and one child is 2*(300*2 + 150) yen, which is equal to 1,500 yen.

Time Costs

The per-search time cost of the buyer is the value of time spent for one round of searching, which is the opportunity cost per hour times the time interval required for one search. We assume the per-hour opportunity cost of the household is the wage rate.[13)] Specifically, we use the hourly income (the annual income divided by hours worked).

According to the Urban Housing Foundation's survey discussed in the text and Appendix A.1, the average annual income of condominium buyers is 7.88 million yen. Dividing the annual income by the average annual work hours (1,839.4hours) in 1998 gets the hourly income of approximately 4,300 yen per hour.

Next, based on our interviews of sales managers of large developers, we postulate the following composition of search time:

Pre-search consideration period (10 days, 3 hours per day)

Transport time (1 hour)

Inspection time (2 hours)

Post-search consideration period (5 days, 3 hours per day)

Total (48 hours)

Thus, the time cost of one search is 4,300 yen times 48 hours, that is, 206,400 yen. Consequently, total search cost is

1,500 Yen + 206,400 Yen = 207,900 Yen.

[13] This is a standard practice, although there is a strong opposition to this practice (see Shaw 1992). Here we implicitly assume that the buyer chooses between work and search.

REFERENCES

Amemiya, T. (1985) *Advanced Econometrics*, Harvard University Press.

Arno, J., Van der Vlist, P. Rietveld, and P. Nijkamp. (2002) "Residential Search and Mobility in a Housing Market Equilibrium Model" *Journal of Real Estate Finance and Economics*, Vol.24, No.3, pp.277-299.

Arnott, R. (1989) "Housing Vacancies, Thin Markets, and Idiosyncratic Tastes" *Journal of Real Estate Finance and Economics*, Vol.17, No.2, pp.223-249.

Asami, Y., and X. Gao. (2001) "External Effects of Local Attributes on Living Environment in Detached Residential Blocks" Seminar Paper, Bartlett School of Graduate Studies, January 31, 2001, University College London, London.

Edward, A.B., and L.V. Zumpano (1995) "Buyer Search Duration in the Residential Real Estate Market: The Role of the Real Estate Agent" *Journal of Real Estate Research*, Vol.10, No.1, pp.1-13.

Garcia, A. R., and P. Perron. (1996) "An Analysis of the Real Interest Rate under Regime Shifts" *Review of Economic and Statistics*, Vol.78, pp.111-125.

Haurin, D. (1988) "The Duration of Marketing Time of Residential Housing" *AREUEA Journal*, Vol.16, No.4, pp.396-410.

Jushan, B., and P. Perron (1998) "Estimating and Testing Linear Models with Multiple Structural Changes" *Econometrica*, Vol.66, No.1, pp.47-78.

Krainer, J. (1999) "Real Estate Liquidity" *FRBSF Economic Review*, 1999.No.3, pp14-26.

Maddala,G.S. (2001) *Introduction to Econometrics: Third Edition*, Prentice – Hall, Inc.

Nishimura, K.G. (1999) "Expectation Heterogeneity and Excessive Price Sensitivity in the Land Market" *Japanese Economic Review*, Vol.50, pp.27-44.

Nishimura, K.G., and C. Shimizu (2003) "Distortion in Land Price Information-Mechanism in Sales Comparables and Appraisal Value Relation-" *Center for International Research on the Japanese Economy, Faculty of Economics, The University of Tokyo ,Discussion Paper*, CF-195.

Nishimura, K.G., F. Yamazaki, T. Ide, and T. Watanabe. (1999) "Distortionary Taxation, Excessive Price Sensitivity, and Japanese Land Markets" Boston: *National Bureau of Economic Research, Working Paper* 7254, July 1999.

Ono, H., H. Takatsuji, and C. Shimizu (2003) "Conjunct method of hedonic price index in a second hand housing market under structural changes" *Reitaku Institute of Political Economics and Social Studies, Working Paper*, No.15.

Reed, C. (1993) "Tenants' Search and Vacancies in Rental Housing Markets," *Regional Science and Urban Economics*, Vol.23, pp.171-183.

Shaw, W.D. (1992) "Searching for the Opportunity Cost of and Individual Time," *Land Economics,* Vol.68, pp.107-115.

Shukan Jutaku Jouhou (*Weekly Housing Information*), Tokyo: Recruit Corporation, various issues, January 1999 – December 1999.

Stein, J. (1995) "Prices and Trading Volume in the Housing Market: A Model with Down Payment Effect," *Quarterly Journal of Economics*, Vol.110, pp.379-406.

Turnbull, G.K., and C.F. Sirmans. (1993), "Information, Search, and House Prices" *Regional Science and Urban Economics,*Vol.23, pp.545-557.

The Urban Housing Foundation, Tokyo-Ken Manshion Nyuukyo-Sha Doukou Chousa 1998 (The Survey on Condominium Purchasers in the Tokyo Metropolitan Area 1998), July 1999.

Wheaton, W. (1990) "Vacancy, Search, and Prices in Housing Market Matching Model," *Journal of Political Economy*, Vol.61, pp.1270-1292.