Grant-in-Aid for Scientific Research（S）

Real Estate Markets, Financial Crisis, and Economic Growth

: An Integrated Economic Approach

Working Paper Series No.35

Alternative Approaches to Housing Services and Japanese CPI: -Bias from Nominal Rigidity of Rents-

Chihiro Shimizu

Satoshi Imai

Erwin Diewer

First draft : May, 2015

This version : January, 2016

HIT-REFINED PROJECT

Institute of Economic Research, Hitotsubashi University

Naka 2-1, Kunitachi-city, Tokyo 186-8603, JAPAN

Tel: +81-42-580-9145

E-mail: hit-refined-sec@ier.hit-u.ac.jp

http://www.ier.hit-u.ac.jp/hit-refined/

Alternative Approaches to Housing Services and Japanese CPI:*

-Bias from Nominal Rigidity of Rents-

Chihiro Shimizu†· Satoshi Imai‡· Erwin Diewert§

First draft: May 5, 2015
This version: February 12, 2016

Abstract

Despite the significant decrease in housing prices during the collapse of the Japanese bubble in the first half of the 1990s, housing rents hardly changed at all. Why is it that housing rents do not change? Why are housing prices and housing rents not linked? In this paper, in order to address these questions, we conducted an alternative indicators for housing services in CPI. First, we found that the annual proportion of residential units whose rent changed was no more than about 5%. This is extremely low, representing 1/20 of the figure for the U.S. and 1/6 of the figure for Germany. The underlying reason for this high degree of rigidity is the specific circumstances of the Japanese housing market, where opportunities to change rents are inherently limited due to the fact that tenant turnover is low while the duration of rental contracts is two years. Even more important, however, is the fact that rents are not changed even when opportunities to change them arise such as tenant turnover or contract renewals, thereby significantly lowering the probability of rents changing. Based on analysis using the adjustment hazard function technique proposed by Caballero and Engel (2007)[3], we found that whether or not a given unit's rent was adjusted mostly did not depend on how much its current rent diverged from the market conditions. In addition, it has been pointed out that the high depreciation rate characteristic of the Japanese market is a problem. Addressing this problem is extremely important when it comes to estimating housing rent indexes.

JEL Classification Number: E30; R20

Keywords: housing rent; price rigidity; time-dependent model; state-dependent model; adjustment hazard function; user cost; opptunuty cost.

* This research was conducted by the authors while participating in the Hitotsubashi Project on Real Estate, Financial Crisis, and Economic Dynamics, (HIT-REFINED) supported by a JSPS Grant-in-Aid for Scientific Research (S). The authors thank David Fenwick, Kevin Fox, Tsutomu Watanabe, Kiyohiko Nishimura and Derek Bird for helpful comments.

† Correspondence: Professor, Institute of Real Estate Studies, National University of Singapore, 21 Heng Mui Keng Terrace, #04-02, Singapore 119613, e-mail: cshimizu@nus.edu.sg.

‡ Statistics Bureau of Japan

§ University of British Columbia and New South Wales University

1 Introduction

Throughout their histories most advanced nations have experienced the following abrupt increases and subsequent decreases in asset prices, especially housing prices, have a substantial impact on the financial system, leading to a stagnation of economic activity. The most representative examples are Japan and Sweden in the 1990s and, more recently, the global financial crisis triggered by the sub-prime problem in the United States. Reinhart and Rogoff (2008)[17] conducted an exhaustive, long-term, comparative time series analysis of economic data from numerous countries which made it clear that the incidence of various economic phenomena is a common factor underlying banking crises. It has been noted that one of these phenomena is a significant increase in asset prices, and property prices in particular, compared to rents.[*1]

This raises the following question: why do goods and services prices not fluctuate significantly even if asset prices fluctuate? If we consider housing asset prices as being determined based on the net present value of future revenue (rent) that will be produced, housing prices and housing rents should be covariant even if there is a certain lag between them. Moreover, if we assume that consumers choose housing by weighing the cost of investing in housing[*2] versus rental costs, it is difficult to believe that the two would diverge significantly. However in reality the two do diverge significantly and the fluctuation of property prices in particular is a factor that has induced many economic problems.

Rent, meanwhile, occupies an important position in the goods and services market and in many countries accounts for around 25% of the contents of consumer price index baskets.[*3] In this sense the housing market plays an essential role in both the asset market and the goods and services market, and rent in particular is an important connection point linking asset prices to goods and services prices.[*4]

In this case, the estimation of housing rent in CPI is very important for macroeconomic policy.

In estimating rental costs for durable goods, statistical agencies usually use the acquisition approach; i.e., they simply allocate the cost of the durable good to the period when it was purchased. It will be useful to many users if, in addition to the acquisitions approach, the statistical agency would implement a variant of either the rental equivalence approach or the user cost approach for long lived consumer durables. Users can then decide which approach best suits their purposes. Any one of the three main approaches could be chosen as the approach that would be used in the "headline" CPI. (Diewert (2015)[8], Shimizu, Diewert, Nishimura and Watanabe(2012)[21])

The Statistics Bureau of Japan uses the rental equivalence approach to estimate housing rents for Owner Occupied Housing (OOH). However, Diewert (2015)[8] indicated the following

[*1] Others that have been pointed out include a) a relative rise in debt compared to income and net assets and an increase in leveraging, b) a sustained influx of capital and c) a lag in productivity increases compared to increases in asset values and debt.

[*2] This is the so-called user cost and is calculated based on payments (including mortgage interest) and ownership-based taxes (fixed asset tax, etc.).

[*3] Housing services represent 26.4% of the CPI for Tokyo's wards. Of this, 4.3% is private rent paid by tenants to owners while the remaining 19.4% is the imputed rent that the owner's of dwelling units pay for the services of their units. These imputed rents are the rents that owners would pay if they rented a dwelling unit of similar quality; i.e., the rental equivalence approach is used to compute imputed rents in the Japanese CPI.

[*4] With regard to this point, refer to Goodhart (2001)[14].

disadvantages of the rental equivalence approach;

- Homeowners may not be able to provide very accurate estimates for the rental value of their dwelling unit.
- On the other hand, if the statistical agency tries to match the characteristics of an owned dwelling unit with a comparable unit that is rented in order to obtain the imputed rent for the owned unit, there may be difficulties in finding such comparable units. Furthermore, even if a comparable unit is found, the rent for that unit may not be an appropriate opportunity cost for not renting the owned unit. [*5]
- The statistical agency should make an adjustment to these estimated rents over time in order to take into account the effects of depreciation, which causes the quality of the unit to slowly decline over time (unless this effect is completely offset by renovation and repair expenditures).
- Care must be taken to determine exactly what extra services are included in the homeowner's estimated rent; i.e., does the rent include insurance, electricity and fuel or the use of various consumer durables in addition to the structure? If so, these extra services should be stripped out of the rent, since they are covered elsewhere in the consumer price index.[*6]

Recently, the Statistics Bureau of Japan started to collect housing rent data from property management companies or owners to respond to first problem listed above. However, the characteristics of the owner occupied population of dwelling units could be quite different from the characteristics of the rental population.[*7] Thus in valuing the services of OOH in Japan, the current approach has some downward bias in that it does not adjust for quality declines due to depreciation (depreciation bias) and some possible bias due to the fact that the quality of rental units may be different from owned units that are thought to be comparable (quality adjustment bias).

In addition to the above possible biases in using the rental equivalence approach to the valuation of the services of OOH, there are differences between "contract rent" and "market rent". "Contract rent" refers to the rent paid by a renter who has a long term rental contract with the owner of the dwelling unit and "market rent" is the rent paid by the renter in the first period after a rental contract has been negotiated. In a "normal" economy which is experiencing moderate or low general inflation, typically market rent will be higher than contract rent. However, if there are rent controls or a temporary glut of rental units, then

---

*5 Diewert (2007)[7] argued that the correct opportunity cost for valuing the services of an owned dwelling unit is the maximum of the amount the unit could rent for in the current rental market and the user cost of the dwelling unit since this represents the financial opportunity cost of tying up ones capital in the dwelling. In most countries, the user cost of a high end home is often approximately twice as high as its rental equivalence price. For less expensive owned homes, the user cost is usually much closer to the amount it could rent for. However, the situation in Japan could be quite different since Japan has experienced widespread asset deflation which did not occur in other developed countries.

*6 However, it could be argued that these extra services that might be included in the rent are mainly a weighting issue; i.e., it could be argued that the *trend* in the homeowner's estimated rent would be a reasonably accurate estimate of the trend in the rents after adjusting for the extra services included in the rent.

*7 For example, according to the 2013 Housing and Land Survey, the average floor space (size) of owner-occupied housing in Tokyo was 110.64 square meters for single-family house owner-occupied housing and 82.71 square meters for rental housing – a discrepancy of over 30 square meters. For condominiums, an even greater discrepancy exists: the floor space is 65.73 square meters for owner-occupied housing and 37.64 square meters for rental housing. Moreover, in addition to the difference in floor space between rented and owned units, the quality of the owned units tends to be higher than the rented units and these quality differences need to be taken into account.

market rent could be lower than contract rent. In any case, it can be seen that if we value the services of an owner occupied dwelling at its current opportunity cost on the rental market, we should be using market rent rather than contract rent

It can be seen that there are many problems when we attempt to value the services of both owner occupied housing and of rented dwelling units. There have been many attempts in the literature that try to measure these possible biases. For example, Crone, Nakamura and Voith (2004)[5] and Gordon and Goethem (2005)[15] have pointed out the importance of addressing qualitative changes in rents and they estimated CPI bias by calculating hedonic-type quality-adjusted indexes. Crone, Nakamura and Voith (2006)[6], focusing on changes in the estimation method of housing rents for CPIs, have analyzed the structure of these biases based on micro-data used to estimate CPI rents.

The rents used to estimate the cost of rented dwellings in the Japanese CPI is the aggregate of rents paid for rental accommodation. These rents include a combination of newly signed rental contracts and rollover contracts for existing tenants. It is appropriate to use both types of contract to measure the actual cost of rental housing (but of course, these rents should be quality adjusted for depreciation and other changes in quality). But it is not appropriate to use both types of contract to impute rents for owner occupied housing only market rents should be used. It is known that price adjustments are basically not made for rollover contracts (i.e. renewed leases). As a result, it is to be expected that new contract rents determined freely by the market will diverge considerably from rollover contract rents.

In this regard, Genesove (2003)[13], based on a tracking study using individual data from the American Housing Survey and survey research, has analyzed the stickiness of rents by dividing them into new contracts and rollover contracts. In Japan, Shimizu, Nishimura and Watanabe (2010a)[19] and Shimizu and Watanabe (2011)[18] constructed a unique dataset using data from a housing listing magazine and a property management company to measure the extent of housing rent stickiness in the country and analyzed the micro-structure of rental adjustments.

本研究では，第 2 節で持ち家の帰属家賃の測定法として提案されている各種推計方法を，Diewert and Nakamura(2007) をもとに整理する。続いて，第 3 節では，日本の物価指数が採用している Equiavalence Approach の歪みがどの程度存在しているのかを測定する。具体的には，Shimizu, Nishimura and Watanabe (2010a)[19] and Shimizu and Watanabe (2011)[18] を改善するように，新しいデータセットを構築し，家賃が持つ硬直性を測定する。続いて，第 4 節では，User Cost をはじめとする代替的な指標を推計し，第 6 節ではそれぞれの推計された指標が物価指数に対してどの程度のインパクトが与えるのかをシミュレーションする。最後に，第 6 節で結論としてまとめる。

2 Alternative Indicators for OOH

2.1 Housing Rent and User Cost

Katz (2009) reviews the theoretical framework that can be used to derive both user cost and rental equivalence measures from the fundamental equation of capital theory:

"The user cost of capital' measure is based on the fundamental equation of capital theory. This equation, which applies equally to both financial and non-financial assets... states that in equilibrium, the price of an asset will equal the present discounted value of the future net income that is expected to be derived from owning it."

The user cost of capital measure provides an estimate of the market rental price based on costs of owners. It is directly derived from the assumption that, in equilibrium, the purchase price of a durable good will equal the discounted present value of its expected net benefits; i.e., it will equal the discounted present value of its expected future services less the discounted present value of its expected future operating costs. To see this, let V_v^t denote the purchase price of a v year old durable at the beginning of year t; let V_{v+1}^{t+1} denote the expected purchase price of the durable at the beginning of year $t+1$ when the durable is one year older; let u_v^t denote the expected end of period value of the period t services of this durable; let O_v^t denote the expected period t operating expenses to be paid at the end of period t for the v year old durable; and let r^t denote the expected nominal discount rate (i.e., the rate of return on the best alternative investment) in year t.

Expected variables are measured as of the beginning of year t.
Assume the entire value of the durable's services in a year will be received at the year's end, and that the durable is expected to have a service life of m years. From the definition of the discounted present value, we have

$$\begin{aligned} V_v^t = & \frac{u_v^t}{1+r^t} + \frac{u_{v+1}^{t+1}}{(1+r^t)(1+r^{t+1})} + \cdots + \frac{u_{m-1}^{t+m-v-1}}{\Pi_{i=t}^{t+m-v-1}(1+r^i)} \\ & - \frac{O_v^t}{1+r^t} - \frac{O_{v+1}^{t+1}}{(1+r^t)(1+r^{t+1})} - \cdots - \frac{O_{m-1}^{t+m-v-1}}{\Pi_{i=t}^{t+m-v-1}(1+r^i)} \end{aligned} \quad (1)$$

When the durable is one year older, the expected price of the durable at the beginning of year $t+1$ is:

$$\begin{aligned} V_{v+1}^{t+1} = & \frac{u_{v+1}^{t+1}}{1+r^{t+1}} + \frac{u_{v+2}^{t+2}}{(1+r^{t+1})(1+r^{t+2})} + \cdots \\ & + \frac{u_{m-1}^{t+m-v-1}}{\Pi_{i=t+1}^{t+m-v-1}(1+r^i)} - \frac{O_{v+1}^{t+1}}{1+r^{t+1}} - \cdots - \frac{O_{m-1}^{t+m-v-1}}{\Pi_{i=t+1}^{t+m-v-1}(1+r^i)} \end{aligned} \quad (2)$$

Dividing both sides of (2) by $(1+r^t)$ and subtracting the result from equation (1) yields

$$V_v^t \quad - \quad \frac{V_{v+1}^{t+1}}{1+r^{t+1}} \quad = \quad \frac{u_v^t}{1+r^t} \quad - \quad \frac{O_v^t}{1+r^t} \quad (3)$$

Multiplying through equation (3) by $(1+r^t)$ and combining terms, one obtains the end of period $_t$ user cost:

$$u_v^t = r^t V_v^t + O_v^t - (V_{v+1}^{t+1} - V_v^t) \quad (4)$$

The estimated market value of a home a year later (V_{v+1}^{t+1}) is computed in the context that the home has a remaining service life for the homeowner of m years.

2.2 The Verbrugge Variant (VV) of the User Cost Approach

The specification of the user cost implemented in Poole, Ptacek and Verbrugge (2005) is based on derivations presented in Verbrugge (2008), where alternative ways of handling the home value appreciation term are also investigated more fully. Here, we label the formulation of the user cost presented as equation (1) in Verbrugge (2008) as the Verbrugge variant, hereafter referred to for short as the VV user cost.

The VV user cost is derived by treating homeowners as though they costlessly sell and buy back their homes each year.*8 Stated using our notation, where V^t is the beginning of period value of the home ignoring, as Verbrugge does, the age of the home; r^t is a nominal interest rate; V^t is a term which collects the rates of depreciation, maintenance, and property taxes; and $E[\pi]$ is an estimate of the rate of expected house price appreciation, the VV user cost formula is:

$$u^t = r^t V^t + \gamma_H^t V^t - E[\pi] V^t \tag{5}$$
$$= \text{forgone interest} + \text{operating costs-expected } (t) \text{ to } (t{+}1) \text{ change in home value.}$$

Verbrugge experiments with a number of alternative ways of measuring the final term of (5) for the expected change in home value from the beginning to the end of year t, but his preferred forecasting equation includes a forecast of the home price change based on 4 quarters of prior home price information. With this setup, changes in home prices have an immediate within-year impact on the user cost. When home prices are rising, the final term of (5) serves to offset the contribution of the first term, $r^t V^t$.

2.3 Diewert's OOH Opportunity Cost Approach

The time has come, we feel, to accept the evidence of Verbrugge and others that user costs and rents do not reliably move together! This verdict implies we must rethink the approach for accounting for OOH in the price statistics of nations. We argue in the rest of this paper for a shift to the new opportunity cost approach for accounting for the cost of housing.

The term opportunity cost refers to the cost of the best alternative that must be forgone in taking the option chosen. Thus, we seek to compare implications for homeowner wealth of selling at the beginning of period t with the alternatives of planning to own a home for m more years and of either renting out or occupying the home for the coming year. This comparison is assumed to be carried out at the beginning of period t based on the information available then about the market value of the home and interest rates and the forecasted average increase per year in home market value if the home is held for another m years.

Refinancing can be viewed as a way of a homeowner selling or buying back a fraction of an owned home. In contrast to selling and buying titles to properties, financing and refinancing costs for mortgages and other loans secured by liens on property titles are quite low, in the United States at least. We imagine that a homeowner mentally notes at the start of each year the market price and the forecast for the annual average growth in value for a home that the owner expects to hold for m more years. The homeowner is presumed to use this information as input to decisions made at the start of the year on whether to adjust their debt for the coming year, whether to sell at the start of the year or to plan on continuing to own their home for m more years, and whether to rent out or occupy the home for the coming year if they continue to own it.

Owner occupiers in period t continue to own their homes with the chosen levels of debt, and to occupy rather than renting their homes out. Thus in choosing to own and occupy,

*8 This user cost variant follows naturally from application of the statement of the user cost approach given by Diewert (1974) in the opening quotation for section 3 about how a consumer is imagined to be buying their home and then selling it back each period – (possibly to himself). We note that in section 6 of his paper, Verbrugge (2008) relaxes the assumption that there are no costs of buying and selling a house and he uses this fact to try to help explain the divergence between the rental price of a home and its user cost.

they pass up the opportunity of selling at the start of the period, and also the opportunity of renting out their home that year. At the level of an individual homeowner, the opportunity cost approach amounts to treating the cost to the owner occupant of their housing choice as the greater of the foregone benefit they would have received by selling at the start of period t or renting out the owned home and collecting the rent payments.

The owner occupied housing opportunity cost index can now be defined as follows:

For each household living in owner occupied housing (OOH), the owner occupied housing opportunity cost (OOHOC) is the maximum of what it would cost to rent an equivalent dwelling (the rental opportunity cost, ROC) and the financial opportunity costs (FOC).

The OOHOC index for a nation is defined as an expenditure share weighted sum of a rental equivalency index and a financial opportunity cost index, with the expenditure share weights depending on the estimated proportion of owner occupied homes for which FOC exceeds ROC.

■The Rental Opportunity Cost Component The rental opportunity cost component is operationally equivalent to the usual rental equivalency measure, but the justification for this component here does not rest on an appeal to the fundamental equation of capital theory and is not tied to the potential sale value for the home in the current or subsequent periods. In the present context, the ROC component is simply the rent for period t on an owned dwelling that the owner forgoes by living there that period. That is, it is the rent the owner could have collected by renting the place out rather than living there.[*9]

We next turn our attention to the financial opportunity cost of the money tied up in an owned dwelling. A home, once purchased, can yield owner occupied housing services over many years. The user cost framework provides guidance on how to infer the period-by-period financial costs of OOH services using the observable home purchase data.

We can use the user cost framework this way even in situations when the capital theory assumptions under which the user cost equals the expected rent are not satisfied.

■The Financial Opportunity Cost Component The user cost formulation we recommend for the FOC component of the opportunity cost is referred to here as the Diewert variant, or DV, user cost. For this specification, we let r^t denote the rate of return a homeowner could have received by investing funds that are tied up in the owned home. In addition, we take account of the fact that many homeowners have debt that is secured against their homes and must make regular specified payments on that debt to continue to be in a position to occupy or to rent out their homes.

Research has shown that owner occupied homes, on the whole, exhibit little physical depreciation over time given modern standards for home maintenance.[*10] (This is in contrast to the situation for rental housing units that have been shown to lose significant value, on average, with increasing age.) Hence, since we are focusing on owner occupied housing here, we drop the dwelling age subscript v from this point on, as we did in introducing the Verbrugge variant (VV) user cost in equation (5).

[*9] Notice that, in computing the ROC component, we do not subtract the cost the owner would need to incur to live somewhere else if they rented the home out. The opportunity cost of living in an owned home, which is the maximum of the ROC and FOC components, is what the person would presumably compare with the costs of alternative housing arrangements in making their choice about where to live for period t. It does, however, make sense to think of the ROC value for an individual homeowner as a lower bound on the value they place on living in the home in light of the fact that most people, in the United States at least, seem to have a strong preference for living in owned accommodations.

[*10] Here normal maintenance for owned homes is essentially being defined to include the amount of maintenance and renovation expenditures required to just maintain the overall quality of the home at a constant level.

We also take account of the fact that the vast majority of homeowners own their homes for many years. Indeed, if we take account as well of the phenomenon of serial home ownership, with owner occupiers rolling forward the equity accumulated from one owned home to the next, then the time horizon should arguably be the entire number of years a homeowner plans to continue to live in owned housing. Many people move into their own owned homes as soon as they can afford to after reaching adulthood and die still owning their own homes. The expected remaining years, m, until a homeowner expects to withdraw all the equity they have in their home is an important parameter for determining the FOC component. However, if homeowner-specific information about m is lacking, perhaps m could be set at a value no lower than the median years that homeowners report having been in their present homes.

Having stated the above choices and views, we are now ready to specify the FOC component for an individual homeowner. Here we ignore the case of homeowners who have negative home equity: a more complex and obviously important case in the present circumstances which we are considering now in separate research with Leonard Nakamura. We also abstract from transactions costs and taxes: further complications that we are also considering in our new research with Leonard Nakamura.

As of the start of period t, a homeowner with nonnegative equity could sell, paying off any debt (D^t) in the process, and could collect the (non negative) sum of $V^t - D^t$. Or the homeowner could choose to continue owning the dwelling, in which case they must make payments on any debt they have, and must pay the normal home operating costs; they must do this whether they choose to live in their home or rent it out for the coming year. If they continue to own the dwelling - either living in it or renting it out – they will forego the interest they could have earned on the equity tied up in their home and will incur maintenance costs and carrying costs on any debt, but they will also enjoy any capital gains or incur any capital losses that materialize.

The financial user cost for owning the home in period t and living in it, discounted to the start of period t , is:

$$\frac{u^t}{1+r^t} \equiv [V^t - D^t] - \left[\frac{-r_D^t D^t - O^t + (\overline{V^{t+1}} - D^t)}{1+r^t}\right], \tag{6}$$

where $\overline{V^{t+1}}$ is the value of the home at the beginning of period t plus the expected average appreciation of the home value over the number of years before the homeowner plans to sell. Thus, the second term in square brackets is the forecasted expected value of the home as of the end of period t which is the beginning of period t+1 ($\overline{V^{t+1}}$) minus the period t debt service costs ($r_D^t D^t$) and operating costs (O^t) that must be paid in order to either occupy or rent out the dwelling for period t. If we multiply expression (6) through by the discount factor, $1 + r^t$, we now obtain an expression for the ex ante end of period user cost:

$$u^t \equiv r_D^t D^t + r^t(V^t - D^t) + O^t - (\overline{V^{t+1}} - V^t). \tag{7}$$

The importance of the debt related terms in (6) and (7) can be better appreciated by considering some specific types of homeowners. Consider a type A homeowner who owns their home free and clear. For them, the end of period user cost for period t, discounted to the start of the period, is:

$$\frac{u^t}{1+r^t}\Big|_{typeA} \equiv [V^t] - \left[\frac{-O^t + \overline{V^{t+1}}}{1+r^t}\right] = \frac{O^t + r^t V^t - (\overline{V^{t+1}} - V^t)}{1+r^t}. \tag{8}$$

The user cost considered as of the end of the period is found by multiplying (8) through by $1 + r^t$, yielding:

$$u^t\,|_{typeA} \equiv r^t V^t + O^t - (\overline{V^{t+1}} - V^t). \tag{9}$$

Notice that this is essentially the customary user cost expression, as derived by Katz (2009) and others. This is the same basic formulation used as well by Verbrugge; e.g., see (5) above.

Type B homeowners do not fully own their homes, but have positive home equity: the most prevalent case for U.S. homeowners. If the homeowner were to sell at the beginning of period t, the realized proceeds of the sale (after repaying the debt) would be $V^t - D^t$. The end of period user cost for period t for these homeowners, discounted to the start of period t, is:

$$\begin{aligned} \frac{u^t}{1+r^t}\,|_{typeB} &\equiv [V^t - Dt] - \left[\frac{-r_D^t D^t - O^t + (\overline{V^{t+1}} - D^t)}{1+r^t}\right] \\ &== \frac{r_D^t D^t + O^t + r^t(V^t - D^t) - (\overline{V^{t+1}} - V^t)}{1+r^t} \end{aligned} \tag{10}$$

The user cost, as of the end of the period, is found by multiplying (10) through by $1 + r^t$:

$$u^t\,|_{typeB} \equiv r_D^t D^t + r^t(V^t - D^t) + O^t - (\overline{V^{t+1}} - V^t). \tag{11}$$

Type C homeowners have zero home equity. In this case, if the homeowner sells at the start of period t, we assume simply that they get nothing from the sale. And if they continue to own and live in the home, they do so without having any equity tied up by this choice and hence are not foregoing any earnings on funds tied up in their home. The end of period user cost for period t, considered as of the start of period t, is:

$$\frac{u^t}{1+r^t}\,|_{typeC} \equiv -\left[\frac{-r_D^t D^t - O^t + (\overline{V^{t+1}} - D^t)}{1+r^t}\right]. \tag{12}$$

The user cost considered as of the end of the period is:[*11]

$$u^t\,|_{typeC} \equiv r_D^t D^r + O^t - (\overline{V^{t+1}} - V^t). \tag{13}$$

We next consider the extreme case in which the interest rate for borrowing equals the returns on investments (i.e., $r_D^t = r^t$). Now, (10) and (11) reduce to (8) and (9). That is, the expressions for the homeowners who have debt but still have positive equity in their homes reduce to the expressions for the user cost for the homeowners who own their dwellings free and clear. We see, therefore, that the traditional user cost expression, as derived by Katz, and the VV user cost implicitly assume that homeowners who have mortgages or other home equity loans are charged an interest rate on this debt that equals the rate of return on their financial investments.

Most well off households have mostly low cost debt whereas many poor households mostly have high cost debt. The importance of this fact can be demonstrated using the end of period

[*11] Note that in this zero equity case, it seems like the payments approach is justified at first glance. However, the payments approach neglects the expected capital gains term and during periods of high or moderate inflation, this term must be taken into account.

user cost for a type B homeowner. For a homeowner who has positive home equity and only low cost debt with $r_D^t < r^t$, expression (11) can be written as:

$$u^t \mid_{typeB} \equiv r_D^t D^t + r^t(V^t - D^t) + O^t - (\overline{V^{t+1}} - V^t) \\ == r_D^t V^t - (r^t - r_D^t)D^t + O^t - (\overline{V^{t+1}} - V^t), \tag{14}$$

where the term $(r^t - r_D^t)$ is positive. Hence, for these homeowners, higher debt reduces the financial cost of OOH services. Indeed, this is a potential motivation for a Type B homeowner to increase their low cost borrowing to the greatest extent possible. The only rational constraint on doing this, from an economic perspective, is that higher debt can also bring a greater risk of home foreclosure or personal bankruptcy in the event of a downturn in the economy or personal problems such as job loss or illness.

The case of a homeowner with only high cost debt (i.e., with $r_D^t > r^t$) is different. Now (11) reduces to:

$$u^t \mid_{typeB} \equiv r_D^t D^t + r^t(V^t - D^t) + O^t - (\overline{V^{t+1}} - V^t) \\ == r^t V^t + (r_D^t - r^t)D^t + O^t - (\overline{V^{t+1}} - V^t), \tag{15}$$

where $(r_D^t - r^t)$ is positive. So now, higher debt means a higher financial cost of OOH services. Most subprime loans are high cost, with interest rates at least three interest rate points above Treasures of comparable maturities.

We come now to the question of how the DV user cost would behave over a housing bubble. In this portion of our analysis, we use the general (8) expression for the end of period user cost. Moreover, we will define $r_{H(m)}^t$ as the expected rate of home price change under the assumption a home will be held for m more years. Now, (7) can be rewritten as

$$u^t \equiv r_D^t D^t + r^t(V^t - D^t) - r_{H(m)}^t V^t + O^t \\ == (r_D^t - r^t)D^t + (r^t - r_{H(m)}^t)V^t + O^t, \tag{16}$$

where

$$r_{H(m)}^t V^t = \overline{V^{t+1}} - V^t$$

Hence the FOC for a household can be negative when, for example, the borrowing rate is less than the expected rate of return on financial assets, and the expected rate of return on financial assets is less than the expected annual rate of return on housing assets.

However, the OOHOC for a household will never be zero or negative because it is defined as the maximum of the ROC and the FOC, with the rental opportunity cost necessarily being positive.

Notice also that the FOC component will rise as home prices rise, and first and foremost, when the expected rate of return on financial investments (r^t) is greater than the expected rate of return on the housing asset ($r_{H(m)}^t$). Going into a bubble, the first term,

$$(r_D^t - r^t)D^t,$$

will be hard to forecast even in terms of sign, but we would expect the changes in this term to be small compared to the changes in the second term,

$$(r^t - r^t_{H(m)})V^t$$

During the expansion phase of a bubble, home values, and hence V^t , will grow rapidly, but the longer run return on housing assets should not change as much and hence the financial user cost of OOH, given by equation (8), should increase. This result underlines the importance of incorporating longer run expectations into the user cost formula. Of course, when the bubble bursts, the financial user cost will rapidly decline, although the decline will be offset somewhat by the possible decline as well in $r^t_{H(m)}$.[*12]

3 Biases in Equivalence Rent Approach

3.1 Equivalence Rent Approach

When attempting to conduct empirical research focusing on the housing market there are various difficulties involved in obtaining research data. This is because the organization and disclosure of information lags behind other markets. Data is even more limited for the housing rental market in particular. In both domestic and international research, analysis is conducted on a strongly hypothetical basis as typified by Shimizu, Nishimura and Watanabe (2010a)[19] and Shimizu and Watanabe (2011)[18].

Housing rent-related data may be broadly divided into two types. First, there are market rents, which are generated when a specific event occurs (i.e. a contract is created). These rents can be further broken down into rents based on new contracts when there is tenant turnover and rents based on new contracts for tenants who continue to reside in the same unit at the moment when the term of the previous contract ends. In general, the former are known as "new contracts" and the latter as "rollover contracts." Rents for the former are basically freely determined by the transaction market, while rents for the latter are determined based on systemic limitations such as the Act on Land and Building Leases. The other type of data is rent that continues to be paid on an ongoing basis. This rent is determined based on the new contract when a tenant arrives or the subsequent rollover contract and remains the same as long as no new event (i.e. contract) occurs. In this study, we have prepared these three types of data.

Data were provided by the company Recruit Insure. This is an insurance company that handles rental guarantees. As a result of handling insurance contracts at the time new rental contracts are drawn up, it has access to initial new rent amounts. In addition, since it provides compensation for rental defaults, it records the rental payment status each month and, by the same token, records the status of rental adjustments for rollover contracts.

The data is summarized in Table 1. It is limited to Tokyo's wards. We obtained data for 52,524 units covering the Tokyo ward area. In terms of the track record for rents recorded during the period covered here, there are 1,529,485 data items of which 36,832 were generated by new contracts and 41,117 were related to rollover contracts.

The average rent was ¥101,721 and the standard deviation was ¥46,210. Single-occupancy rental housing was common with an average floor space of 32 m^2. The average building age was 13.0 years while the average time to the closest station was 5.1 minutes and the shortest

[*12] Locked in aspects of the financing arrangements of home buyers may also matter in this regard. We are exploring this issue now in a follow-up study.

average time by train from the closest station to a terminal station on the Yamanote Line (Tokyo, Shinagawa, Shibuya, Shinjuku, Ikebukuro, Ueno) or Otemachi was 12.4 minutes, meaning that rental housing was concentrated in areas that are relatively convenient in terms of transportation.

If we compare the data by separating new contracts and rollover contracts there are no major differences in average rent, floor space, building age, time to the closest station or average time to a terminal station, which suggests that rental adjustments occur randomly.

Table 1 Housing Rent Dataset

Sample period	January 2010 - July 2014					
Frequency	Monthly					
Area	Tokyo's wards					
Type of data	Paid rent					
Coverage	New and rollover contracts					
Provided by	Recruit					
Number of units	52,524					
Number of samples	All samples		New contracts		Rollover contracts	
	1,529,485		36,832		41,117	
	mean	s.d.	mean	s.d.	mean	s.d.
Monthly rent	101,721.2	46,209.7	100,423.7	45,271.9	102,094.6	46,480.0
Floor space (m^2)	32.4	15.6	32.2	15.6	32.5	15.7
Price per m^2	3,293.3	788.3	3,271.9	756.8	3,292.8	798.1
Age of unit (years)	13.0	9.9	12.3	10.1	13.4	9.8
Time to nearest station (min)	5.1	3.8	5.0	3.7	5.2	3.9
Time to central business district (min)	12.4	6.4	12.1	6.3	12.5	6.4

3.2 Hedonic estimation for housing rent

In this section, we estimate hedonic constant quality index using new housing rent data.

Shimizu, Nishimura and Watanabe (2010b)[20] , Shimizu and Watanabe (2011)[18] indicated that difference between new housing rent and paying rent impacts rent price indexes. They mentioned that paying rent occasionally changes during the contract period. In the opposite direction, new housing rent reflects changes in the market. As a consequence of this difference, significant difference is caused between two price indexes.

Let us begin with a hedonic price index. Suppose that we have the price and property-characteristics data of houses, pooled for all periods $t = 1, 2, ..., T$, and that the number of data samples in period t is n_t. Then, a standard hedonic price index is produced from the following house-price estimation model:

$$\ln R_{it} = \boldsymbol{\beta}_t \boldsymbol{x}_{it} + \varepsilon_{it} \tag{17}$$

where R_{it} is the rent of house i in period t, $\boldsymbol{\beta}_t$ is a vector of parameters associated with residential property characteristics, $\boldsymbol{x}_{it}$ is a vector of property characteristic for house i in period t, and ε_{it} is an error term, which consists of time dummies and iid disturbance ($\varepsilon_{it} \equiv \alpha + \delta_t + \nu_{it}$ and $\nu_{it} \sim N(0, \sigma_\nu^2)$). The standard hedonic price index is then constructed from the time dummies. The coefficient $\boldsymbol{\beta}_t$ is often assumed to be constant over time; in that case.

Shimizu, Takatsuji, Ono and Nishimura (2010)[22] and Shimizu, Nishimura and Watanabe (2010b)[20] modified the standard hedonic model given by equation (17) so that the parameters associated with the attributes of a house are allowed to change over time. Structural changes in the Japanese housing market have two important features. First, they usually occur only gradually, triggered, with a few exceptions, by changes in regulations by the central and local governments. Such gradual changes are quite different from "regime changes" discussed by econometricians such as Bai and Perron (1998)[1] in which structural parameters exhibit a discontinuous shift at multiple times. Second, changes in parameters reflect structural changes at various time frequencies. Specifically, as found by Shimizu, Nishimura and Watanabe (2010b)[20], some changes in parameters are associated with seasonal changes in housing market activity.

To apply this method, estimate the model defined by equations (17) for periods $t = 1, ..., \tau$, where $\tau < T$ represents the *window width*. As usual, set $d_1 = d_1^* \equiv 1$ and denote the remaining estimated time parameters for this first regression by $d_2^*, ..., d_\tau^*$. These parameters are exponentiated to define the sequence of house price indexes P_t for the first τ periods; i.e., $P_t \equiv \exp[d_t^*]$ for $t = 1, 2, ..., \tau$. Then this τ period regression model using the data for the periods $2, 3, ..., \tau + 1$ can be repeated and a new set of estimated time parameters, $d_2^{2*} \equiv 1, d_3^{2*}, ..., d_{\tau+1}^{2*}$ can be obtained. The new *price levels* P_t^2 for periods 2 to $\tau + 1$ can be defined as $P_t^2 \equiv \exp[d_t^{2*}]$ for $t = 2, 3, ..., \tau+1$. Obviously, this process of adding the data of the next period to the rolling window regression while dropping the data pertaining to the oldest period in the previous regression can be continued. The focus in the Shimizu, Takatsuji, Ono and Nishimura (2010)[22] paper was on determining how the structural parameters changed as the window of observations changed.*13

In this paper, we run rolling regression using new housing rent with $T = 12$. Table 2 indicates the estimation results of rolling hedonic models.

3.3 Micro-Analysis of Rent

3.3.1 Frequency of Rent Adjustments

In this section we will conduct further analysis at the micro level. We will begin by measuring the stickiness of rent. What we will measure here is the probability that rent will not change during a given year (i.e. the percentage of all units for which the rent does not change), which may be expressed as $\Pr(\Delta R_{it} = 0)$.

Rents are changed at the times when rental contracts are revised, which means either 1) there is tenant turnover or 2) the rental contract is renewed even though there is no tenant turnover. I_{it}^N is a variable that takes a value of 1 if unit turnover occurs and a new contract is agreed between the landlord and the new tenant with regard to unit i in period t, and 0 otherwise. Meanwhile, I_{it}^R takes a value of 1 if a rollover contract is agreed between the existing tenant and the landlord with regard to unit i in period t, and 0 otherwise. In addition, the rent level for unit i in period t is denoted by R_{it}, while $\Delta R_{it} \equiv R_{it} - R_{it-1}$ shows the rental adjustment amount at the time the contract is agreed. Therefore, the probability that there will be a change in rent ($\Pr(\Delta R_{it} = 0)$) can be expressed as follows:

$$\begin{aligned}\Pr(\Delta R_{it} = 0) = &\left[1 - \Pr(I_{it}^N = 1) - \Pr(I_{it}^R = 1)\right] + \Pr(\Delta R_{it} = 0 \,|\, I_{it}^N = 1) \Pr(I_{it}^N = 1) \\ &+ \Pr(\Delta R_{it} = 0 \,|\, I_{it}^R = 1) \Pr(I_{it}^R = 1) \qquad (18)\end{aligned}$$

Let us look at the terms on the right side of Eq. (18) one at a time. First, as seen in Table

*13 They called their method the *Overlapping Period Hedonic Housing Model* (OPHM).

Table 2 Estimation Result of Hedonic Model of New Housing Rent

Estimation Window	Floor space	Age of building	Time to nearest station	Commuting time to CBD	Adjusted R^2	Number of observations
201001 - 201012	0.0188	−0.0109	−0.0087	−0.0058	0.917	17,697
201002 - 201101	0.0188	−0.0109	−0.0088	−0.0058	0.916	16,707
201003 - 201102	0.0188	−0.0109	−0.0089	−0.0059	0.917	15,670
201004 - 201103	0.0188	−0.0110	−0.0090	−0.0059	0.917	14,504
201005 - 201104	0.0188	−0.0110	−0.0092	−0.0058	0.916	13,303
201006 - 201105	0.0189	−0.0111	−0.0094	−0.0058	0.915	11,684
201007 - 201106	0.0189	−0.0112	−0.0096	−0.0060	0.914	10,667
201008 - 201107	0.0190	−0.0114	−0.0097	−0.0062	0.916	9,942
201009 - 201108	0.0189	−0.0115	−0.0095	−0.0065	0.918	9,099
201010 - 201109	0.0190	−0.0114	−0.0099	−0.0065	0.919	8,346
201011 - 201110	0.0191	−0.0113	−0.0104	−0.0067	0.922	7,571
201012 - 201111	0.0191	−0.0113	−0.0105	−0.0066	0.924	6,698
201101 - 201112	0.0191	−0.0114	−0.0104	−0.0067	0.924	6,490
201102 - 201201	0.0192	−0.0114	−0.0104	−0.0067	0.927	6,446
201103 - 201202	0.0192	−0.0113	−0.0101	−0.0065	0.927	6,485
201104 - 201203	0.0192	−0.0113	−0.0102	−0.0067	0.927	6,564
201105 - 201204	0.0194	−0.0113	−0.0099	−0.0071	0.928	6,664
201106 - 201205	0.0194	−0.0112	−0.0096	−0.0075	0.929	6,782
201107 - 201206	0.0194	−0.0110	−0.0095	−0.0074	0.927	6,788
201108 - 201207	0.0193	−0.0110	−0.0096	−0.0071	0.925	6,880
201109 - 201208	0.0193	−0.0109	−0.0098	−0.0068	0.923	6,887
201110 - 201209	0.0191	−0.0109	−0.0096	−0.0071	0.922	6,913
201111 - 201210	0.0191	−0.0110	−0.0096	−0.0072	0.922	6,920
201112 - 201211	0.0192	−0.0110	−0.0094	−0.0074	0.922	6,988
201201 - 201212	0.0191	−0.0109	−0.0091	−0.0075	0.922	6,963
201202 - 201301	0.0189	−0.0109	−0.0091	−0.0072	0.918	6,968
201203 - 201302	0.0188	−0.0109	−0.0091	−0.0076	0.918	7,000
201204 - 201303	0.0188	−0.0108	−0.0093	−0.0076	0.918	7,012
201205 - 201304	0.0187	−0.0109	−0.0097	−0.0073	0.917	6,939
201206 - 201305	0.0186	−0.0109	−0.0098	−0.0071	0.916	6,785
201207 - 201306	0.0186	−0.0110	−0.0098	−0.0071	0.917	6,725
201208 - 201307	0.0186	−0.0110	−0.0098	−0.0073	0.918	6,526
201209 - 201308	0.0186	−0.0110	−0.0097	−0.0075	0.918	6,409
201210 - 201309	0.0187	−0.0110	−0.0097	−0.0074	0.918	6,260
201211 - 201310	0.0186	−0.0110	−0.0098	−0.0073	0.916	6,179
201212 - 201311	0.0186	−0.0110	−0.0099	−0.0073	0.916	6,028
201301 - 201312	0.0187	−0.0110	−0.0105	−0.0075	0.915	5,869
201302 - 201401	0.0189	−0.0109	−0.0107	−0.0078	0.918	5,718
201303 - 201402	0.0191	−0.0108	−0.0110	−0.0077	0.918	5,530
201304 - 201403	0.0190	−0.0108	−0.0109	−0.0075	0.919	5,389
201305 - 201404	0.0191	−0.0107	−0.0109	−0.0075	0.918	5,288
201306 - 201405	0.0192	−0.0106	−0.0112	−0.0077	0.918	5,273
201307 - 201406	0.0191	−0.0105	−0.0114	−0.0077	0.916	5,206
201308 - 201407	0.0192	−0.0104	−0.0113	−0.0079	0.915	5,225
Average	0.0190	−0.0110	−0.0099	−0.0070	0.9196	7,863

1, among the total of 52,524 units, 36,832 new contracts occurred during the entire sample period. However, this does not mean that the rent was changed for all units for which new contracts were signed. This is examined in Table 3. The upper part of this table shows the proportion of rents that decreased, remained stable and increased among those units for which a new contract occurred within the sample period. Looking at the sample period as a whole, the rent was kept stable for 86.2% of the 36,832 new contracts. Meanwhile, the lower part of the table shows the same figures for rollover rents. Rollover contracts were renewed for 41,117 of the units during the sample period but the rent remained stable for 98.0% of these.

Table 3 Nominal Rigidity of Rent

	Rent decreased	Rent unchanged	Rent increased	Total	(Rent change)
Changes accompanying new contracts	4,181 (0.114)	31,737 (0.862)	914 (0.025)	36,832 (0.224)	5,095 (0.138)
Changes accompanying rollover contracts	641 (0.016)	40,284 (0.980)	192 (0.005)	41,117 (0.250)	833 (0.020)
Total contract changes	4,822 (0.029)	72,021 (0.438)	1,106 (0.007)	164,356 (1.000)	5,928 (0.036)

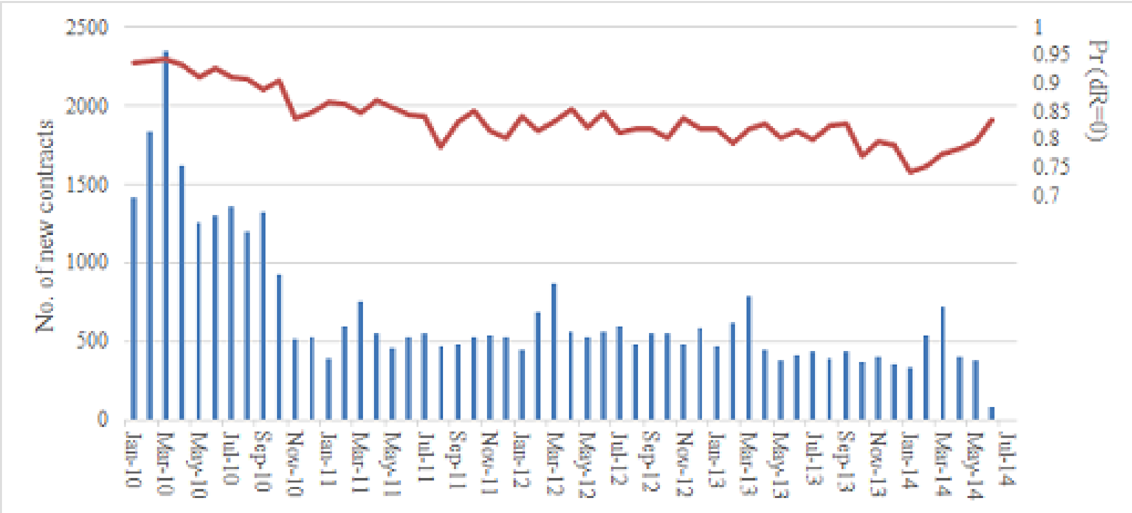
Taking these numbers as given, the first term on the right side of Eq. (18), $\left[1 - \Pr(I_{it}^N = 1) - \Pr(I_{it}^R = 1)\right]$, is 0.526, which shows that there was neither a new contract or contract renewal for 52.6% of the units. Moreover, even if a new contract did occur, there was a 0.862 probability that the rent would be kept at the same amount, which means that the second term on the right side of Eq. (18), $\Pr(\Delta R_{it} = 0 \mid I_{it}^N = 1)\Pr(I_{it}^N = 1)$, is 0.193. Similarly, even if a rollover contract occurred, the rent did not change for 95.8% of units, so the third term on the right side of Eq. (18), $\Pr(\Delta R_{it} = 0 \mid I_{it}^R = 1)\Pr(I_{it}^R = 1)$, is 0.245. Based on the above, the sum of the three terms on the right side of Eq. (18) is 0.964, so the proportion of units for which rent did not change in one year, ($\Pr(\Delta R_{it} = 0)$), is 96.4%.

How should we interpret these results showing that the rent did not change in a given year for 96.4% of units and, conversely, did change for 3.6% of units? According to Genovese (2003)[13], who performed similar calculations for the U.S., the proportion of units for which rent did not change in a given year in the U.S. was 29%, with the rent being changed for the remaining 71%. Hoffmann and Kurz-Kim (2006)[16], meanwhile, performed similar calculations for Germany, finding that the proportion of units for which rent did not change in a given year was 78% while it was changed for the remaining 22%. Compared to these figures, the 3.6% probability that rent will be changed in Japan is extremely low, representing a mere 1/20th of the U.S. figure and 1/6th of the German figure. It can therefore be said that rents in Japan have an extremely high degree of rigidity compared to the U.S. and Germany.

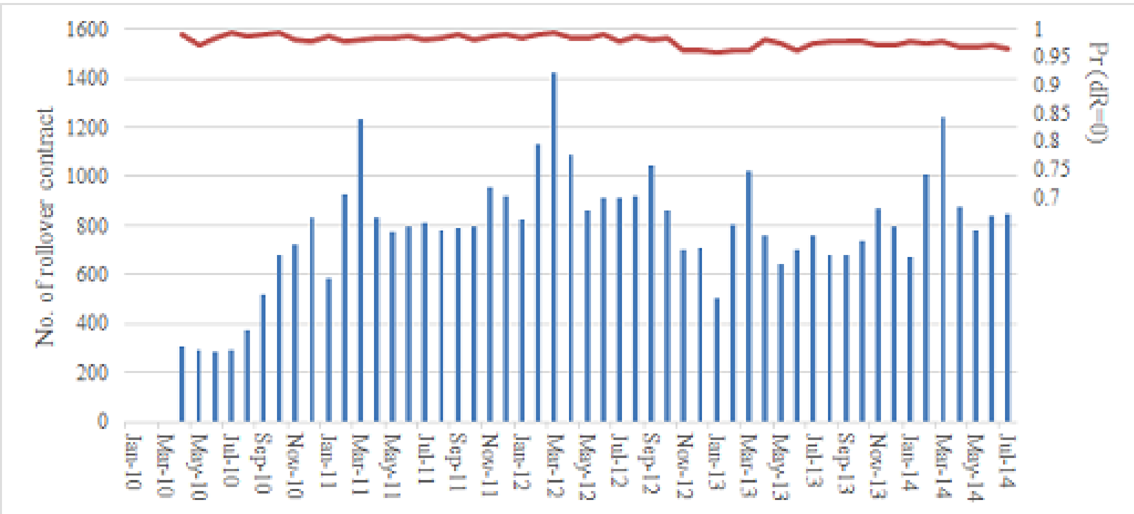
Figures 1a and 1b look at changes over time in nominal rent rigidity. Given that rollover contracts occur once every two years as a rule, they reduce the frequency of new contracts. Additionally, if we look at changes in the probability that rents will not change, gradual changes can be seen over time, but when aggregated by month, they remain stable at roughly 85%.

On the other hand, the stickiness of rollover rents (i.e. the probability that the rent will not change) hovers at around 95%. In other words, this shows that while the probability of a change in rent accompanying a new contract changes based on seasonality, there is no change in the probability of rent changing for rollover contracts, which remains uniform. To put it another way, we may consider that neither new contract rent nor rollover contract rent change depend on the contract renewal time and instead occur randomly in conjunction with contract changes.

Next, we looked at the magnitude of rental changes when a rent renewal event occurs (Figure 2). Specifically, we observed the probability density for the rental comparison before and after rent revision ($\Delta R_{it} = R_t/R_{t-1} \mid I_{it}^N = 1$, $\Delta R_{it} = R_t/R_{t-1} \mid I_{it}^R = 1$) excluding events in which the rent was kept at the same level. First, looking at the rent renewal range for new contracts, the scope of rent renewal was from -30% to $+10\%$. For rollover contracts, on the other hand, upward revisions were relatively few in comparison to new contracts. Even if there was a rental revision, the amount was more or less the same as before and it was most likely to be a downward adjustment. In other words, it is rare for rent to be increased for a rollover contract. If we look at the extent of decreases in rent, there was a certain likelihood of new contract rents decreasing by as much as 30%, whereas for rollover contracts, it was kept at around 20%. Thus, for rollover contracts, not only is the probability that the rent changes extremely low, but if a change does occur, the scope of the change will be small.



a) New Contracts

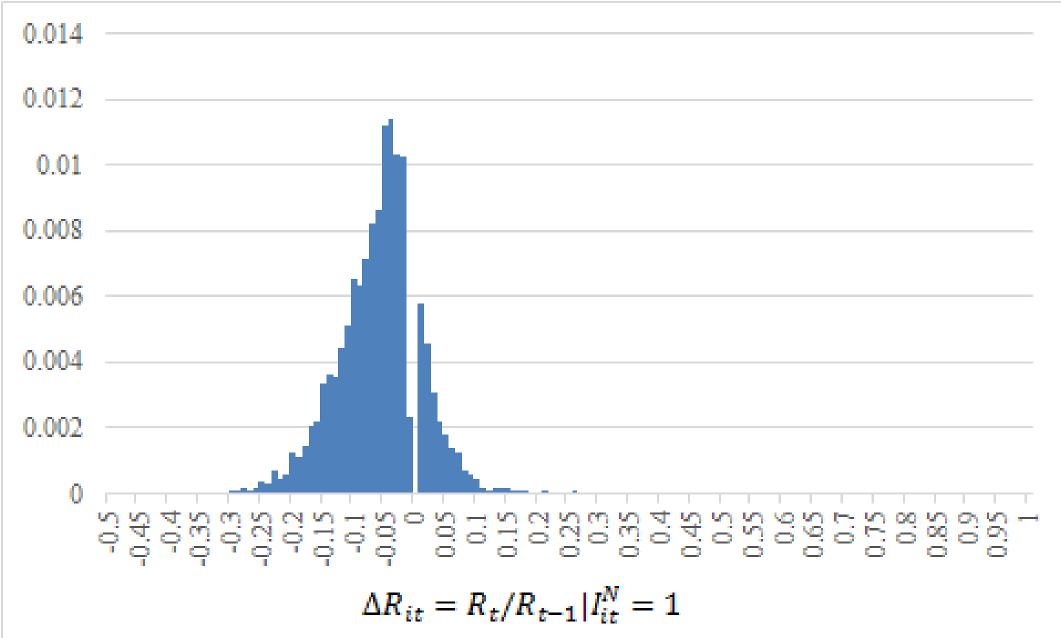


b) Rollover Contracts

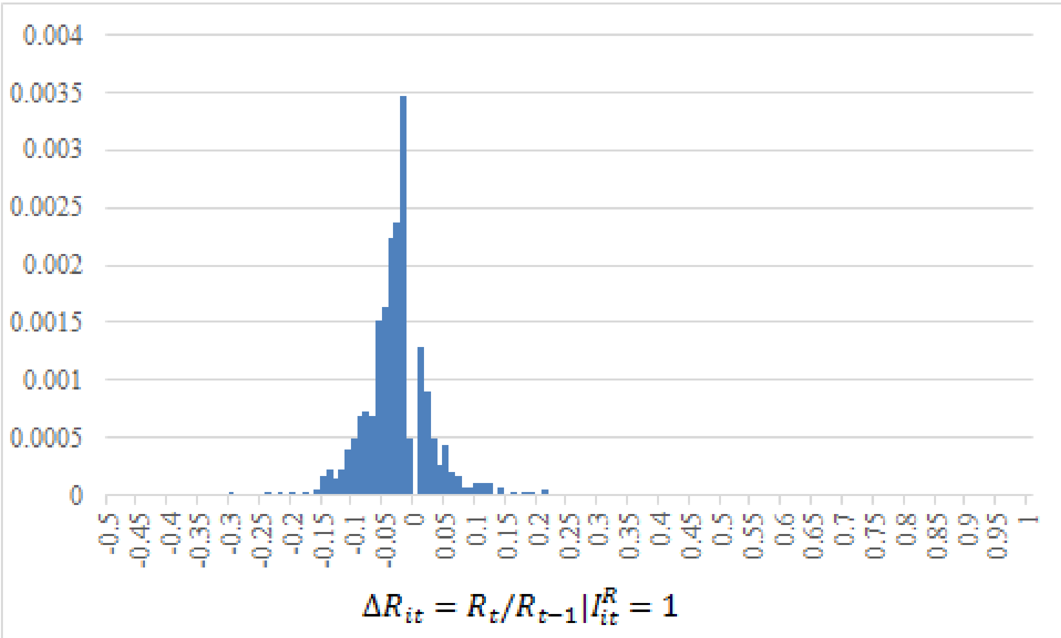
Figure 1 Monthly Changes in Nominal Rigidity of Rent

In addition, for both new contract rent revisions and rollover contract rent revisions, the revision probability decreases in the vicinity of 0. In other words, this shows that rent revisions are made within a certain range and it is rare for minor changes to occur. This suggests the presence of a so-called "menu cost."

Since the probability of a rent revision event occurring is extremely low, we may also consider that once such an event does occur, the range of the change will be relatively large compared to other goods and services. For example, new contract revisions occur as a result of finding new tenants via listing magazines, the Internet, etc., and if a new tenant cannot be found within a certain period of time, the search will be continued by lowering the amount of rent. In such cases, we may consider it unlikely that the price revision will be a minor one since the change must be enough to justify the time and cost involved in running advertisements and implementing the price change.



a) New Contracts



b) Rollover Contracts

Figure 2   Rent Revision Range Density Distribution

3.3.2 Time-Dependent versus State-Dependent Adjustments

In a given month, the rent for a given unit will be revised while the rent for another unit will not be revised. What is the reason for this difference? There are two theories. The first is that there is a target rent level for different units, and when they diverge significantly from that level, the rent will be revised. According to this theory, the more the rent for a given unit diverges from the target level, the higher the probability that it will be revised. The extent to which the current rent diverges from the target rent is called the "price gap," and using this term, we can say that the probability of rent revision depends on the price gap. This theory is referred to as "state-dependent" pricing. In contrast, there is another theory which says that the probability of rent revision does not depend on the price gap at all. In other words, the probability of rent revision does not change based on how close or how far the current rent is from the target level. This is known as "non-state dependent" or "time-dependent" pricing. Below, we will investigate whether rent revision is state-dependent or time-dependent using the method of Caballero and Engel (2007)[3].

We will define the target rent level as R^*_{it} which we will assume is determined based on the following formula:

$$\Delta \log R^*_{it} = \Delta\xi_t + \nu_{it} \tag{19}$$

Here, $\Delta\xi_t$ represents aggregate shocks (shocks common to all units) and ν_{it} idiosyncratic shocks. The price gap is defined as the difference between the current rent and target rent level—i.e. $X_{it} \equiv \log R_{it} - \log R^*_{it}$. The probability that the rent will be revised based on this condition alone is expressed by the following equation:

$$\Lambda(x) \equiv \Pr(\Delta R_{it} \neq 0 \,|\, X_{it} = x) \tag{20}$$

This $\Lambda(x)$ function is called the adjustment hazard function. It was first proposed by Caballero and Engel (1993)[2]. If the probability $\Pr(\Delta R_{it} \neq 0)$ changes depending on the state variable x, it is state-dependent, and if it does not depend on x, it is time-dependent.

Having established the above, it is possible to calculate how the average rent level of all units responds to aggregate shocks.

$$\Delta \log R_{it}(\Delta\xi_t) \equiv \int \Delta \log R_{it}(\Delta\xi_t, x)h(x)dx = -\int (x - \Delta\xi_t)\Lambda(x - \Delta\xi_t)h(x)dx \tag{21}$$

Here, $h(x)$ is the cross-section distribution of the state variable x. Differentiating Eq. (21) based on aggregate shock after integrating i yields the following equation:

$$\lim_{\Delta\xi_t \to 0} \frac{\Delta \log R_t}{\Delta\xi_t} = \int \Lambda(x)h(x)dx + \int x\Lambda'(x)h(x)dx \tag{22}$$

The left side of this equation indicates how much the average rent for all units responds to aggregate shocks and is similar to an impulse response function. If the average rent for all units is adjusted rapidly in response to aggregate shocks, this value will be high. In this sense, the left side of Eq. (22) represents the elasticity of rent. According to Eq. (22), the elasticity of rent defined in this way is decided by two factors. The first term on the right side is the average rent adjustment probability for all units. Naturally, if the rent revision probability for all units is high, the average value will be high as well and rent will therefore be elastic. However, according to Eq. (22), the elasticity of rent is not just defined by this because a second term exists on the right side. In order to explain the significance of the second right-hand term, let us consider a case where $\Lambda(x)$ does not depend on x—i.e. a time-dependent case. In this case, since $\Lambda'(x)$ is 0, the second right-hand term is also 0. However, in a state-dependent case, $\Lambda'(x)$ is not 0, so the second right-hand term will not be 0 either. As shown by Caballero and Engel (2007)[3], the second right-hand term is positive in many state-dependent models. The value of the second right-hand term is determined by how large $\Lambda'(x)$ is (how much it differs from 0). Caballero and Engel (2007)[3] refer to the first right-hand term as the intensive margin and the second right-hand term as the extensive margin.

In order to apply the above analysis framework to rent, we will first define $\Lambda(x)$ for housing rent as follows:

$$\Lambda(x) = \Pr(\Delta R_{it} \neq 0 \mid I_{it}^N = 1, x_{it} = x) \Pr(I_{it}^N = 1, x_{it} = x) + \Pr(\Delta R_{it} \neq 0 \mid I_{it}^R = 1, x_{it} = x) \Pr(I_{it}^R = 1, x_{it} = x) \quad (23)$$

As can be understood from the right side, the rent revision probability function $\Lambda(x)$ is composed of four conditional probabilities. It is the sum of the product of the probability of a state-dependent new contract occurring ($\Pr(I_{it}^N = 1, x_{it} = x)$) and the probability of the rent revision based on that contract ($\Pr(\Delta R_{it} \neq 0 \mid I_{it}^N = 1, x_{it} = x)$) and the product of the probability of a rollover contract occurring ($\Pr(I_{it}^R = 1, x_{it} = x)$) and the probability of the rent changing based on that ($\Pr(\Delta R_{it} \neq 0 \mid I_{it}^R = 1, x_{it} = x)$).

Figure 3 looks at the distribution of the price gap x.*14 For both new contracts and rollover contracts, it falls within the range of roughly -0.3 to $+0.4$. In other words, at its highest, the rate of divergence from the appropriate rent level is around 30%. Given this distribution for x, Figure 4 shows the calculated four conditional probabilities in Eq. (23).

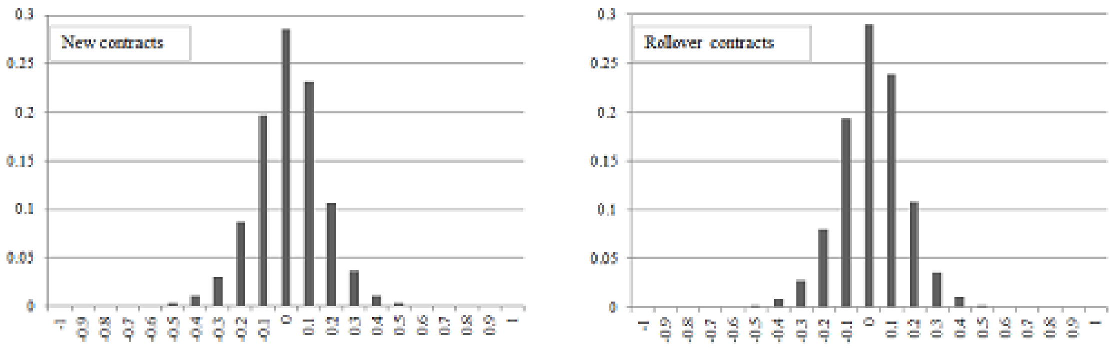


Figure 3 Price Gap Distribution

First, the probability of a new contract occurring ($\Pr(I_{it}^N = 1, x_{it} = x)$) in the upper left of Figure 4 is more or less level at around 0.025 per month (approx. 30% per year). In other words, this is not dependent on the price gap. We may consider tenant turnover as occurring when moving becomes necessary due to circumstances such as changing job, getting married, giving birth, etc., and this shows that these circumstances occur independently of the price gap. No tendency for people to move due to their current rent being higher than the appropriate level can be observed. The probability of a rollover contract occurring ($\Pr(I_{it}^R = 1, x_{it} = x)$) shown in the lower left of Figure 4 is also more or less level and not dependent on the price gap. We can see that contract renewals occur once every two years or so regardless of the price gap.

Next, if we look at the probability that rent will change based on a new contract ($\Pr(\Delta R_{it} \neq 0 \mid I_{it}^N = 1, x_{it} = x)$) in the upper right of Figure 4, it is more or less flat, but when one examines it in detail, there is a slight upward slope and there is dip at 0.3. What this means is that if tenant turnover occurs in units where the current paid rent is higher than the appropriate level (market rate), the probability of the rent being changed is higher than it is in cases of tenant

*14 The target rent R^* was estimated based on the hedonic method in the same manner as Shimizu, Nishimura and Watanabe (2010a)[19]. With regard to the choice of hedonic model, we chose the Rolling Hedonic Model proposed by Shimizu, Ono, Takatsuji and Nishimura (2010)[22].

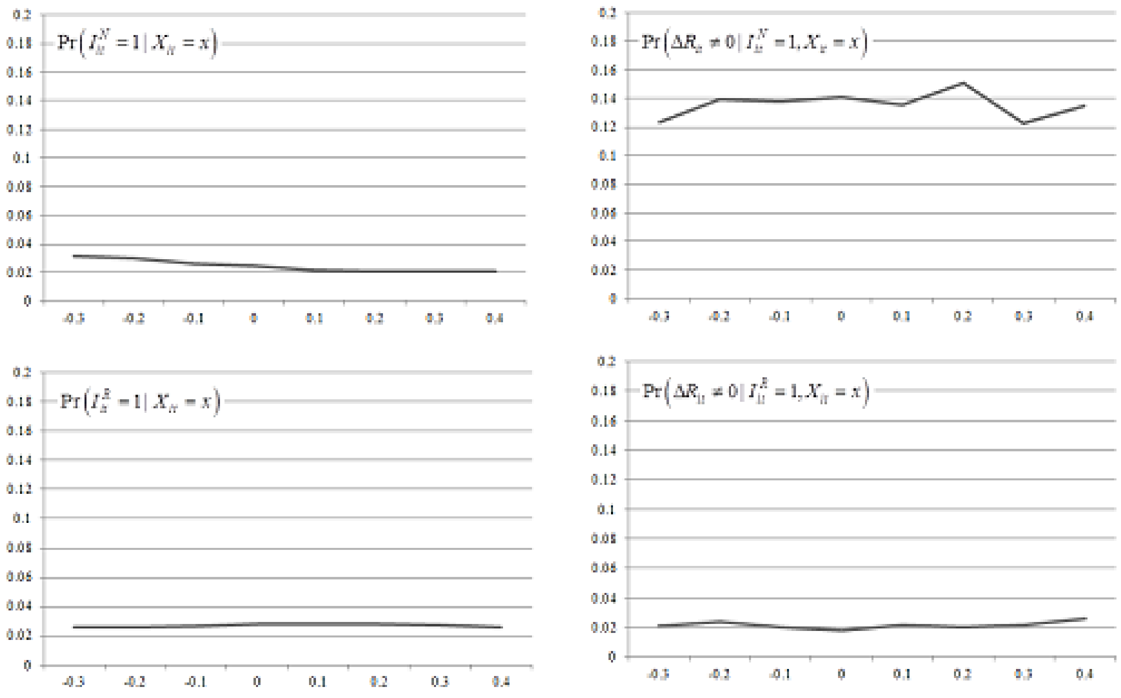


Figure 4 State-Dependency

turnover in units where the current rent is not higher. This suggests that when searching for new tenants for units where the paid rent is higher than the market rent, it will not be possible to find one unless a lower rent is set. Finally, looking at the probability that the rent will change based on rollover contracts ($\Pr(\Delta R_{it} \neq 0 \,|\, I_{it}^R = 1, x_{it} = x)$) in the lower right, one can see that it is similar to new contracts: it slopes upward when the price gap exceeds the level of 0.3.

Compared to Shimizu, Nishimura and Watanabe (2010a)[19]'s estimation results, a number of differences can be observed in these results. The reason for this may be that the distribution of price gap x varies. In Shimizu, Nishimura and Watanabe (2010a)[19], the bubble period that occurred from the 1980s through the 1990s is included in the sample, so x changed significantly due to abrupt fluctuations in R^*. As a result, despite the strong inherent stickiness of the rental market, a tendency for paid rents to approach market rents was observed. However, Shimizu and Watanabe (2011)[18] obtained more or less the same results in analysis using large management company data. In this sense, a certain robustness can be seen in terms of Japanese rents' rigidity and price gap dependency.

Table 4 summarizes the above estimation results. It shows at a glance how the four probabilities indicated on the left side are dependent on the price gap x. On the one hand, we can see that the probability $\Pr(I_{it}^N = 1, x_{it} = x)$ tends to slightly decrease somewhat as the price gap x grows bigger, whereas the probability $\Pr(I_{it}^R = 1, x_{it} = x)$ does not depend on the price gap and remains more or less fixed. Meanwhile, the probability $\Pr(\Delta R_{it} \neq 0 \,|\, I_{it}^N = 1, x_{it} = x)$ that the rent will be changed when there is tenant turnover becomes larger when the price gap x is positive compared to when it is negative. This suggests that when the current rent exceeds the market rate, rent will be adjusted at the time of tenant turnover. Finally, the probability $\Pr(\Delta R_{it} \neq 0 \,|\, I_{it}^R = 1, x_{it} = x)$ also becomes larger when the price gap x is positive compared to when it is negative.

As shown in Eq. (23), it is possible to calculate $\Lambda(x)$ using the four probabilities in Table 4. The results of the actual calculations are shown in the row for $\Lambda(x)$ in Table 4. $\Lambda(x)$ is more or less flat, with no relation to x. We can consider this as showing that $\Lambda(x)$ mostly does not depend on x. The level of $\Lambda(x)$ stays between 0.003 and 0.005, and this, as shown by the definition of $\Lambda(x)$ in Eq. (22), is an indicator representing the elasticity of rent. It signifies that in a given year, the rent will be changed for 4.1% to 5.5% of all units.

Here, a key point is how much the intensive margin and extensive margin contribute to the rent revision probability. If we actually calculate how much each contributes in line with Eq. (22), the formula is as follows*15:

$$\int \Lambda(x)h(x)dx = 0.0500, \int x\Lambda'(x)h(x)dx = 0.0081, \lim_{\Delta\xi_t \to 0} \frac{\Delta \log R_t}{\Delta \xi_t} = 0.0581 \qquad (24)$$

In other words, Caballero and Engel (2007)[3]'s price elasticity indicator on the left side of Eq. (22) is 0.0621. If we separate this into two, following the example of Eq. (22), the intensive margin is 0.0081 and the extensive margin is 0.0082. From this we can see that the extensive margin is extremely small, accounting for only 14% of Caballero and Engel (2007)[3]'s price elasticity indicator. We may consider it as being practically 0. The fact that the extensive margin is 0 means that rent revision is not state-dependent but time-dependent.

Table 4 Summary of Estimation Results

	$x \in [-0.4, -0.2)$	$x \in [-0.2, -0.0)$	$x \in [0.0, 0.2)$	$x \in [0.2, 0.4)$
$\Pr(I_{it}^N = 1 \mid X_{it} = x)$	0.035	0.029	0.023	0.021
$\Pr(I_{it}^R = 1 \mid X_{it} = x)$	0.006	0.026	0.028	0.027
$\Pr(\Delta R_{it} \neq 0 \mid I_{it}^N = 1, X_{it} = x)$	0.131	0.134	0.138	0.137
$\Pr(\Delta R_{it} \neq 0 \mid I_{it}^R = 1, X_{it} = x)$	0.015	0.022	0.020	0.021
$\Lambda(x)$	0.005	0.004	0.004	0.003
$h(x)$	0.039	0.569	0.337	0.047

4 Estimation of Oppotunity Costs for Owner-Occupied Housing

Next, we will estimate the imputed rent for owner-occupied housing using the User Cost Approach. When attempting to estimate the imputed rent of owner-occupied housing using the User Cost Approach, whether the Basic User Cost Approach, Verbrugge Variant (VV) User

*15 Comparing the analysis results in Table 4 to Table 3 in Shimizu, Nishimura and Watanabe (2010a)[19], the value of $\Lambda(x)$ differs considerably. According to Table 3 in Shimizu, Nishimura and Watanabe (2010a)[19], the value of $\Lambda(x)$ is around 10%, which is double the result in this paper. When we look at the source of this difference, we find that it can largely be explained by the difference in probability $\Pr(\Delta R_{it} \neq 0 \mid I_{it}^N = 1, x_{it} = x)$. In this paper, the probability that rent will be changed when there is tenant turnover is approximately 20%, but in Shimizu, Nishimura and Watanabe (2010a)[19] it is around 70%. This may reflect a fundamental difference in the nature of the buildings covered by the analysis. It may also reflect the difference in the analysis periods. Specifically, Shimizu, Nishimura and Watanabe (2010a)[19]'s sample period includes the bubble period. That was a time when major fluctuations in the market occurred rapidly, so we may consider that landlords and tenants both behaved in a way that led to rent being changed when a new contract was agreed.

Cost Approach, or Diewert's OOH Opportunity Cost Approach, it is necessary to calculate the expense of keeping a home. The expense of keeping a home is comprised of the opportunity cost when viewing the home as a financial asset, property tax arising from keeping a home, damage insurance costs, and maintenance/administration costs. Here, we take into account property tax and maintenance/administration costs.*16

In many cases, purchasing a home involves obtaining a mortgage. In this kind of typical case, the Financial Opportunity Cost (FOC) of home ownership is calculated as $r_D^t D^t + r^t(V^t - D^t)$, as shown in Equation7. The FOC in this case is the mortgage payment interest combined with the investment gains that could have been obtained if that money had been invested. Since the mortgage amount is not considered in Equation4 and Equation5, Equation7 is the case where the mortgage is 0. For r_D^t *17, this study used loan interest rates from the former Government Housing Loan Corporation (now the Japan Housing Finance Agency) and the yield on 10-year Japanese government bonds for the asset investment yield.*18

■Property Tax It is now supposed that the owner of the housing unit must pay the property taxes T_S^0 and T_L^0 for the use of the structure and land respectively during period 0.*19 Define the period 0 structures tax rate $\tau_S^0$and land tax rate τ_L^0 as follows:

$$\tau_S^0 \equiv T_S^0 / P_S^0 Q_S^0 \tag{25}$$

$$\tau_L^0 \equiv T_L^0 / P_L^0 Q_L^0 \tag{26}$$

The new imputed rent for using the property during period 0, R^0, including the property tax costs, is defined as follows:

$$\begin{aligned} R^0 &\equiv V^0(1+r^0) + T_S^0 + T_L^0 - V^{1a} \qquad (27) \\ &= [P_S^0 Q_S^0 + P_L^0 Q_L^0](1+r^0) + \tau_S^0 P_S^0 Q_S^0 + \tau_L^0 P_L^0 Q_L^0 - [P_S^0(1+i_S^0)(1-\delta_0)Q_S^0 + P_L^0(1+i_L^0)Q_L^0] \\ &= p_S^0 Q_S^0 + p_L^0 Q_L^0 \end{aligned}$$

where separate period 0 tax adjusted user costs of structures and land, p_S^0 and p_L^0 , are defined as follows:

$$p_S^0 \equiv [(1+r^0) - (1+i_S^0)(1-\delta_0) + \tau_S^0] P_S^0 = [r^0 - i_S^0 + \delta_0(1+i_S^0) + \tau_S^0] P_S^0 \tag{28}$$

$$p_L^0 \equiv [(1+r^0) - (1+i_L^0) + \tau_L^0] P_L^0 = [r^0 - i_L^0 + \tau_S^0] P_L^0 \tag{29}$$

*16 Since damage insurance costs are extremely low, we decided not to consider them in this study.

*17 In recent years, mortgages from private financial institutions have come to be used, but prior to 2000, it was normal to use mortgages from the former Government Housing Loan Corporation. As well, even now, the interest rate set by the Japan Housing Finance Agency is the benchmark for mortgage interest. Given this, we believed that its rates were representative. The average loan interest from the Government Housing Loan Corporation was 0.0527 in 1990, which fluctuated over time to 0.0363 in 1995, 0.0278 in 2000, 0.0308 in 2005, and 0.0343 in 2010.

*18 The yield on 10-year government bonds from 1990 to 2010 peaked at 0.052 in 1990, dropping to 0.0346 in 1995, 0.0183 in 2000, 0.0140 in 2005, and 0.0117 in 2010. However, throughout the period in question, it may be considered one of the assets that offered the highest return on investment.

*19 If there is no breakdown of the property taxes into structures and land components, then just impute the overall tax into structures and land components based on the beginning of the period values of both components.

Here, the question of how P_S^0 or P_L^0 was calculated is important. We estimated P_L^0 with the hedonic function using published land prices that are the benchmark for property tax land evaluation. The estimation results are as shown in Table**??**.

Using these hedonic function estimation results, we estimated the land evaluation amount by building unit. In addition, we obtained the building price by deducting the land evaluation amount based on the published land price from the estimated total housing price amount.

The nominal property tax rate was 1.4% of the asset amount for both buildings and land. However, the actual effective tax rate is known to be lower than that level. Accordingly, we estimated the effective tax rate for Tokyo.[*20]

■Maintenance and Renovation Expenditure Another problem associated with home ownership is the treatment of maintenance expenditures, major repair expenditures and expenditures associated with renovations or additions.

Empirical evidence suggests that the normal decline in a structure due to the effects of aging and use can be offset by maintenance and renovation expenditures. How exactly should these expenditures be treated in the context of modeling the costs and benefits of home ownership?

A common approach in the national accounts literature is to treat major renovation and repair expenditures as capital formation and smaller routine maintenance and repair expenditures as current expenditures.

Accordingly, we calculated annual maintenance/administration costs in this study as well.

Housing maintenance/administration costs may be expected to change in accordance with home size. We therefore calculated maintenance/administration costs per square meter based on a Recruit survey of home buyers, and multiplied this cost by the size (S) of the home. [*21]

The values based on this survey are for fiscal 2005 only. We therefore estimated the values for other fiscal years based on the 2005 estimate values and the rate of change for "Repairs & maintenance" in the Tokyo CPI.

■Capital Gain The most important element in the User Cost Approach is capital gain.

In the Basic User Cost Approach (Equation4), it is defined as $(V_{v+1}^{t+1} - V_v^t)$, which is the price change for each dwelling unit.

However, in the VV User Cost Approach and Diewert's User Cost Approach, it is defined as the expected value for a future period. The reason for this is that it is difficult to assume that in household accounting, the choice of home is made by looking at the price change for a single year and then making an investment, and because the volatility in the actual value of single-year capital gains becomes excessive.

For the present estimate, in the basic model we made the calculation with the actual value of $(V_{v+1}^{t+1} - V_v^t)$ for each dwelling unit.

[*20] In property tax land evaluation, various adjustments are performed, such as relief measures for small-scale residential land. As a result, tax amounts are not necessarily determined based on the land evaluation amount. Accordingly, we obtained the tax base amount for Tokyo as a whole (the total price determined as the land price for actual taxation purposes) as a proportion of the land asset amount calculated with SNA statistics. The land asset amount calculated with SNA uses published land prices for land price data and uses data adjusted for property taxes for floor space. As a result, both proportions are similar in that they are proportions of the published land price and property tax land evaluation amount.

[*21] In Recruit's survey, housing floor space and the actual maintenance/administration costs corresponding to it were surveyed. In the 2005 survey, data was collected for 48,532 condominiums and 23,200 single family houses in Tokyo. Maintenance/administration costs for the 2005 year were ¥3,130 per square meter (annually) for condominiums and ¥920 per square meter (annually) for single family houses. Multiplying these amounts by the average floor space of 60 square meters for condominiums and 100 square meters for single family houses, the annual cost was ¥187,000 for condominiums and ¥92,000 for single family houses.

On the other hand, for the calculation of VV User Cost and Diewert's User Cost, capital gain was obtained as $(\overline{V^{t+1}} - V^t)$. The anticipated growth rate ($E[\pi]$) was obtained as the geometric average of the rate of change over the past 5 years by municipality unit (k). [*22]

We estimated the price for a future period by multiplying the anticipated growth rate obtained in the above manner by the asset price for each property unit, and obtained the capital gain with $(\overline{V^{t+1}} - V^t)$.

Comparison of Estimated User Costs

Using the various parameters established as shown above, we obtained the Basic User Cost based on Equation (4), the VV User Cost based on Equation 5, and Diewert's User Cost based on Equation 7. As well, we calculated Diewert's OOH Index taking the maximum value of the results obtained with Diewert's User Cost and Equivalent Rent.

Diewert's OOH Index takes the maximum value when Diewert's User Cost and Equivalent Rent are compared.

5 Re-estimation of CPI

We have seen in the previous sections that the probability of individual rent adjustments is very low and that it depends little on price imbalances. These two facts imply that price flexibility in terms of the impulse response function is low, thus causing the CPI for rent to respond only slowly to aggregate shocks. Shimizu, Nishimura and Watanabe (2010a)[19] simulate estimation of CPI depending on the change of stickiness and examine the impact. In this paper, we simplify the model, we assume that the (imputed) prices for owner-occupied housing services are very flexible and thus never deviate from the corresponding market prices. Based on this assumption, we replace the imputed rent for owner-occupied housing in the CPI by our estimate of the market rent R^*. And for second assumption, we replace the imputed rent for OOH by our estimate of the depreciation adjusted rent R-age. A certain amount of depreciation occurs over rent properties year by year. We estimate R-age by multiplying the imputed rent of OOH by this depreciation rate as a rise of prices. The depreciation rate is estimated as -0.011[*23] from Table 2.

Figure 6 shows R^*, R-age and actual CPI in 2000:1Q-2014:4Q. This treatment is perfectly consistent with the rental equivalent approach which "values the services yielded by the use of a dwelling by the corresponding market value for the same sort of dwelling for the same period of time" (Diewert and Nakamura, 2009[9]).

Figure 5 shows clearly that actual CPI rent continues to decrease but contrary to Hedonic estimate R_t^* increased 6% from 2006 to 2008. After that it drop sharply due to the Financial Crisis but it turns up again after starting the great ease by "Abenomics". In the other hand, depreciation adjusted R-age runs intermediate between R^* and actual CPI. And it is clear that if we adjust the depreciation, the reduction of index has practically disappeared and it stays almost flat.

Figure 6 shows the simulation result how these change of rent impacts to CPI. First we look at R^*. During IT bubble in early 2000's, it impacts about 0.4% to difference of inflation. From 2006 to 2008 just before the Financial Crisis, largest difference of inflation is 0.5% and

[*22] The city of Tokyo was divided into a total of 53 areas: 23 special wards and 30 municipalities. It has become evident that moving to a new location outside of one's administrative district happens very rarely. As well, it is known that housing price changes vary considerably by region. As a result, we deemed it appropriate to calculate anticipated growth rate by administrative district.

[*23] The average of coefficient β for "Age of Building" in Table **??** is -0.011. It means that the depreciation rate is minus 1.1 percent per year.

average difference is about 0.3 %.

Focusing from Jan. 2013 onward that Bank of Japan announced the price stability target and started the great ease, there is a difference from 2013:4Q. 0.2% difference constantly appeared from this period. This difference is important signal because Hedonic estimate R_t^* turns up meanwhile CPI rent continues to decrease. It implies that the difference from actual CPI seems to increase because Hedonic estimate R_t^* seems to be increasingly apt to increase.

Next we turn into R-age. In 2001, its inflation does not quite reduced and stay about half of actual CPI. Also it is significant that it does not reflect the hike during the Financial Crisis, it almost follows the actual CPI. In addition, it also is not sensitive to the change from 2013:4Q.

This result shows clearly that the depreciation adjusted rent mortifies the downward bias of actual rent. But it is also based on the sticky rent prices so it hardly reflects the effect of economic policy.

Shimizu, Nishimura and Watanabe (2010a)[19] examined same analysis for the period after bubble burst. They found that estimated CPI replaced by R_t^* indicates deflation from 1993 to 1994. However the time that actual CPI starts to indicate minus inflation is after 1995. They designated that there is a possibility that this gap led to behind the timing of monetary easing.

From such experience, it is bound to be quite important that how the CPI treats the owner-occupied housing rent on these background to evaluate the effect of "Abenomics" or policy change in these days.

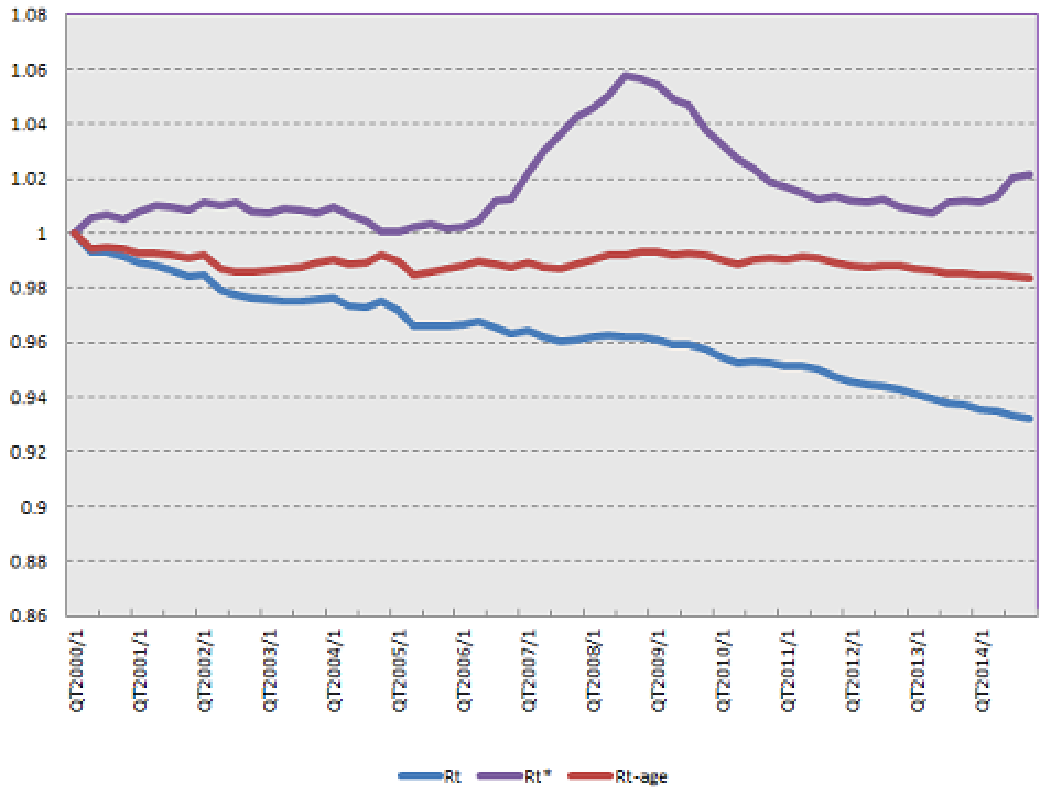


Figure 5 Hedonic estimate R_t^*, R-age and Actual CPI

6 Conclusion

Goods and services prices, as represented by consumer price indexes and the like, have not changed all that much in response to fluctuations in asset prices. In particular, there was no major change in goods and services prices even during the significant rise in asset prices that was one of the factors leading to the global financial crisis and subsequent decline in such prices. This lack of correlation means that business cycle management via financial policy is difficult.

Accordingly, focusing on rents, which are an important connecting point between asset market and goods and services market, we attempted to measure housing rent for Japan. Our research has two major implications for the construction of a price index for rented properties in Japan.

Our first major point is that the Japanese rent index has a downward bias due to the neglect of depreciation. In other words, the actual CPI holds a strong downward bias due to the neglect of this "aging depreciation". We calculated depreciation rate for housing rent in Japan using hedonic regression techniques and it is approximately 1.1 percent per year.[*24] In

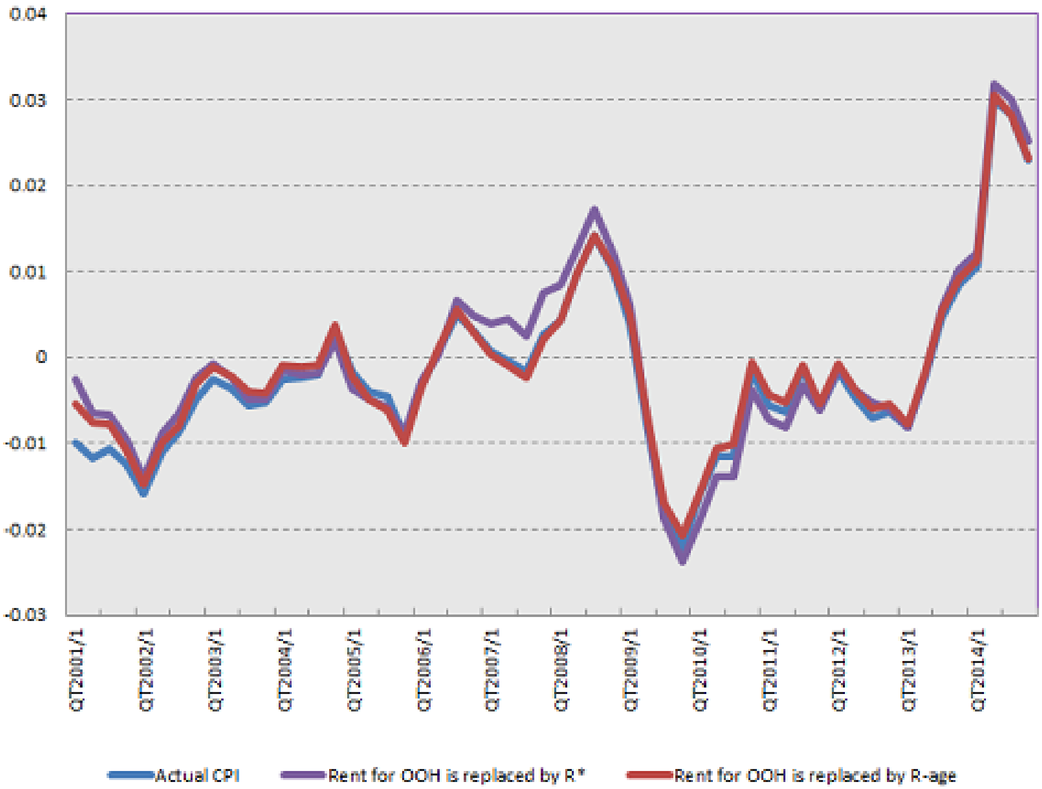


Figure 6 Reestimates of CPI inflation under Rent for OOH replaced by R_t^* and R-age

[*24] The depreciation rate is expressed as a fraction of property value, which includes the value of land. Thus the structure (net) depreciation rate is actually higher than 1.1% per year.

addition to this depreciation bias problem, housing rent has another problem in CPI: namely strong rigidity of price changes.

Thus our second major result in this paper showed that, while rents based on new contracts change in an elastic manner, actual paid rents change only gradually, even when market shocks occur. In other words, average market rents, which are representative of consumer prices, have a strong tendency to change in a random manner, independently of changes in rents determined freely by the market. This rent stickiness means that consumer prices as a whole fluctuate gradually. As a result, when it comes to financial policy and the like, agile policy management targeting only goods and services price indicators is not possible.

Under this situation, the importance of developing economic statistics (residential price indexes) that are able to accurately capture fluctuations in residential property prices as an asset price has been pointed out (Diewert, 2007)[7] and the United Nations, IMF, OECD, BIS, and ILO have jointly put together international handbook on residential property price indexes.[*25] Many countries in Europe are constructing these types of indexes and from March 2015, a Residential Property Price Index has been published on an experimental basis for the past 3 years in Japan.

By developing a Residential Property Price, it becomes possible to construct user cost price indexes and acquisition cost price indexes for OOH and these alternative OOH indexes can be compared with their rental equivalence counterparts. On the other hand, the fact that such an index has been developed does not mean that it is possible to respond immediately to asset bubbles or subsequent recessions. However, considering past experiences in which policy implementation delays caused significant economic confusion, it is strongly hoped that the development of asset price-related statistics will make it possible to achieve more flexible policy management.

Going forward, it will likely be necessary to clarify the relationship between asset price fluctuations and rent fluctuations. There are also still many significant questions to be addressed in future regarding this issue.

References

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

[2] Caballero, R. J., and E. Engel (1993), "Microeconomic Rigidities and Aggregate Price Dynamics", *European Economic Review*, Vol. 37, pp. 697-717.

[3] Caballero, R. J., and E. Engel (2007), "Price Stickiness in Ss models: New interpretations of old results", *Journal of Monetary Economics*, Vol. 54, pp. 100-121.

[4] Calvo, G (1983), "Staggered Prices in a Utility-Maximizing Framework", *Journal of Monetary Economics*, Vol. 12, pp. 383-398.

[5] Crone, T. M., L. Nakamura and R. Voith (2004), "Hedonic Estimates of the cost of housing services: Rental and owner-occupied units", *Price Federal Reserve of Bank of Philadelphia Working Papers*, No. 04-22.

[6] Crone, T. M., Leonard Nakamura and Richard Voith (2006), "The CPI for Rents: A Case of Understated Inflation", *Price Federal Reserve of Bank of Philadelphia Working Papers*, No. 06-7.

[7] Diewert, W. E (2007), "The Paris OECD-IMF Workshop on Real Estate Price Indexes: Conclusions and Future Directions", University of British Columbia Discussion Paper

[*25] http://epp.eurostat.ec.europa.eu/portal/page/portal/hicp/methodology/residential_property_price_indices

07-1.

[8] Diewert, W. E (2015),*INDEX NUMBER THEORY AND MEASUREMENT* , ECONOMICS 580: LECTURE NOTES at University of British Columbia.

[9] Diewert, W.E. and A. O. Nakamura (2009), Accounting for Housing in a CPI, chapter 2, pp. 7-32 in W.E. Diewert, B.M. Balk, D. Fixler, K.J. Fox and A.O. Nakamura (2009),PRICE AND PRODUCTIVITY MEASUREMENT: Volume 1 – Housing. Trafford Press.

[10] Diewert, W. E. and C. Shimizu (2013), "Residential Property Price Indexes for Tokyo," Discussion Paper 13-07, Vancouver School of Economics, University of British Columbia. *Macroeconomic Dynamics*, forthcoming.

[11] Diewert, W. E. and C. Shimizu (2014), "Alternative Approaches to Commercial Property Price Indexes for Tokyo," Discussion Paper 14-08, Vancouver School of Economics, University of British Columbia.

[12] Diewert, W. E., K. Fox and C. Shimizu (2014), "Commercial Property Price Indexes and the System of National Accounts," Discussion Paper 14-09, Vancouver School of Economics, University of British Columbia./Paper

[13] Genesove, D (2003), "The Nominal Rigidity of Apartment Rents", *The Review of Economics and Statistics*, Vol. 85 (4), pp. 844-853.

[14] Goodhart, C (2001), "What Weight Should be Given to Asset Prices in Measurement of Inflation?" *The Economic Journal*, Vol. 111, (No. 472), pp. 335-356.

[15] Gordon, R. J and Todd van Goethem (2005), "A Century of Housing Shelter Prices: Is there a downward bias in the CPI", *NBER Working Paper*, No. 11776.

[16] Hoffmann, J, and Jeong-Ryeol Kurz-Kim (2006), "Consumer price adjustment under the microscope: Germany in a period of low inflation", Deutsche Bundesbank Discussion Paper Series 1: Economic Studies, No. 16.

[17] Reinhart C. M and K. S. Rogoff (2008), "This Time Is Different: A Panoramic View of Eight Centuries of Financial Crises," NBER Working Paper No. W13882.

[18] Shimizu, C and Tsutomu Watanabe (2011), "Nominal Rigidity of Rents," *Financial Review*, Vol.106, pp. 52-68.

[19] Shimizu, C, K.G. Nishimura and T. Watanabe (2010a), "Residential Rents and Price Rigidity: Micro Structure and Macro Consequences", *Journal of the Japanese and International Economics*, Vol. 24, No. 1, pp 282-299.

[20] Shimizu, C, K.G. Nishimura and T. Watanabe (2010b), "House Prices in Tokyo - A Comparison of Repeat-sales and Hedonic measures-," *Journal of Economics and Statistics* ,Vol.230, pp.792-813.

[21] Shimizu,C, W.E.Diewert, K.G.Nishimura and T.Watanabe(2012), "The Estimation of Owner Occupied Housing Indexes using the RPPI: The Case of Tokyo,"RIPESS (Reitaku Institute of Political Economics and Social Studies) Working Paper,No.50.(presented at: Meeting of the Group of Experts on Consumer Price indexes Geneva, 30 May - 1 June 2012(UNITED NATIONS)).

[22] Shimizu, C, H. Takatsuji, H. Ono and K. G. Nishimura (2010), "Structural and Temporal Changes in the Housing Market and Hedonic Housing Price indexes," *International Journal of Housing Markets and Analysis*, Vol. 3, No. 4, pp. 351-368.