Inflation Dynamics over the Last Quarter Century

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Abstract

We take advantage of a panel data of housing rents for the period of 1986 to 2006 which we have compiled from 720,000 listings in the widely-circulated housing advertisement magazine. First, we find that the probability of rent adjustment does not depend on the deviation of actual rent from its target level. We also find a flat hazard function at least for durations less than 400 weeks. These results suggest that the rent adjustment obeys a Poisson process. Second, the Calvo parameter is estimated to be 0.97, indicating that the probability of the rent adjustment occurs is 3 percent per quarter, much lower than the estimate for other goods and services. Third, we find that estimates for the inflation rate during the bubble and the post-bubble periods are sensitive to a change in the treatment of the imputed rent for owner occupied housing.

1 Why were prices so stable?

Let me start by showing one of my favorite charts. Slide 2 shows fluctuations of the Japanese price level, which is measured by the GDP deflator (in logarithm), over the last 120 years. We can see a big jump in the mid 1940s, immediately after the WWII; this is a famous episode of hyper-inflation. However, if we turn to the peace time, we still see a clear tendency: the price level was on a straight line before 1930, implying that the inflation rate was stable and around six percent during that period (Note that the red line represents the six percent inflation per year).

Turning to the post-war period, we can see that the price level was still on the red line up until the mid 1980s, indicating that the same trend
was maintained during this period. However, the price level has started to deviate from the red line since then: we see almost no change in the price level since the mid-1980s, and consequently the deviation from the red line becomes larger and larger over time. This suggests that something has happened to the mechanism governing inflation. In other words, inflation dynamics over the last quarter century seems to be quite different from the one during the preceding periods. Then a natural question one might have is why and how it has changed. The main purpose of this paper is to provide some sort of answer to such a question.

Before proceeding to detailed analysis, let me make two remarks about this change in inflation dynamics. First, the change in inflation dynamics was perceived to be a good thing by policymakers at least until the early 1990s. For example, Yasushi Mieno, Governor of the Bank of Japan at that time, stated in his public speech given in February 1993 that “we have done a very good job in terms of fighting against inflation.” Probably what he meant was that asset prices were very volatile at that time, which created a lot of difficulty to policymakers; in contrast, goods and services prices had been very stable, which is just a great achievement. This kind of appraisal to stable goods and services prices was shared by the government and the private sector including the mass media.

However, if one looks back and investigates the economic environment in this period, one can easily finds that this perception was too simple because the real side variables, such as the output gap and the unemployment rate, fluctuated a lot so as to compensate high stability in goods and services prices. In this sense there was no free lunch. Then the question is whether price stability, which was achieved at the sacrifice of output stability, was something to be appraised without any reservation. This question seems to be particularly relevant, given that the Japanese economy finally fell into deflation at the very end of the 1990s.

Second, stability in goods and services prices itself lead to serious policy mistakes. As pointed out by Jinushi and Miyao (2001) and others, the BOJ’s policy change from monetary easing to tightening in the early 1990s was too late, and at the same time, the policy shift from monetary tightening to easing in the mid-1990s was again too late. Why did these two policy mistakes occur? These policy mistakes are closely related to stability of goods and services prices during this period. The delay in the policy shift
from easing to tightening occurred simply because the inflation rate was close to zero even during the bubble period; the annual inflation rate never exceeded four percent, so that the BOJ was not able to find a persuasive reason to raise its policy rate. Similarly, the BOJ failed to find a good reason to cut its policy rate immediately after the collapse of the bubble, since goods and services prices continued to be stable in spite of a rapid decline of land and stock prices.

2 Stickiness in housing rents

2.1 The importance of housing rents

Let me turn to the key question: why goods and services prices were so stable in spite of huge up and down in asset prices. I, jointly with Chihiro Shimizu and Kiyohiko Nishimura, argue that the stability of goods and services prices, such as the consumer price index, is related in an important way to the stability of housing rents during the bubble and the post-bubble periods. Slide 3 shows this: the housing rents in the consumer price index was stable during the latter half of the 1980s, and started to exhibit a modest increase in the early 1990s, continuing to increase up until the mid 1990s. It is clear that this is not consistent with fluctuations of the house price, which is shown by the red line in the same figure. If the rental and selling prices had fluctuated in a consistent manner, we should have an increase in housing rents during the bubble period, and thus higher CPI inflation, which might have urged the BOJ to raise its policy rate much earlier, for example even in the latter half of the 1980s. Similarly, if we should have a decline in rental prices in accordance with a decline in selling prices, we would have seen lower (or even negative) CPI inflation rates in the early 1990s, which could have led to an earlier shift to monetary easing.

2.2 The Recruit data

Why did rental and selling prices behaved so differently during the bubble and post-bubble periods? Shimizu, Nishimura, and Watanabe (2008) look

\footnote{It should be emphasized that the housing services account for more than one-fourth of the total CPI in the Tokyo metropolitan area. Specifically, 5.8 percent for housing rents, 18.6 percent for imputed rents from owner occupied housing, and 1.9 percent for housing maintenance and others.}
for an answer to this question in the micro price data. We use a new dataset containing 718,811 prices posted in a weekly magazine, *Shukan Jutaku Joho* (Residential Information Weekly) published by RECRUIT Co. Ltd., over the last twenty years.

Our dataset has two important features. First, *Shukan Jutaku Joho* provides the time series of a rental price from the week it is first posted until the week it is removed because of a successful sale or some other reasons. We use the price only at the final week because it can be safely regarded as sufficiently close to the contract price. Second, we use information collected only by the major property management companies. Based on special contract with the Recruit Co., Ltd., they automatically report it to the Recruit whenever a turnover occurs in one of the housing units they manage. Thus we are allowed to create a complete panel dataset for those housing units, which contains the exact timing of start and end of a contract in addition to information on the rent and the quality of each housing unit, including its age, its floor and balcony space (in square meters), commuting time to a nearest station, and so on.

Slide 5 shows how the data looks like. Some of the housing units start at the very beginning of our sample period, 1986-2006, while others start at the middle of the sample period because they were built and provided to the market only after 1986. Also, it should be noted that we have precise information about the level of rent for a new contract that is made between a new tenant and a landlord, but do not have any information about any changes of the rent that are made by an existing tenant and a landlord, simply because it is not reported to the Recruit. As far as the Tokyo metropolitan area is concerned, a housing contract is renewed every two years between an existing tenant and a landlord, so it is possible at least in principle that the level of rent is altered at the timing when such a rollover contract is made. However, it is often pointed out by practitioners that such an adjustment in the rent at the timing of renewal of a contract is not so common, and that the adjustment tends to be relatively small even if it takes place. This is at least partially due to heavy protection of tenants by various institutional restrictions, including the Land Lease and House Lease Law. Based on this information, it is assumed in Slide 5 that there is no change in the rent when a contract is renewed between an existing tenant and a landlord. We will come back to this issue later. Summary statistics of the dataset is presented
2.3 Measuring stickiness in rents

Slide 7 shows the distribution function for weekly rent changes. The horizontal axis represents weekly rent changes, which is defined by \( R_{it}/R_{it-1} \) where \( R_{it} \) is the level of rent for the housing unit \( i \) in period \( t \). The vertical axis represents the probability. The fraction of the units with no rent changes is 0.992 per week: there is a substantial degree of stickiness in housing rents.

2.4 Estimating adjustment hazard

The first thing Shimizu et al. (2008) do is to estimate an “adjustment hazard”, which was first proposed by Caballero and Engel (1993). The target rent for unit \( i \) in period \( t \), which is denoted by \( R_{it}^* \), is the level of rent that a landlord would choose if the landlord were allowed to adjust the rent as much as possible in period \( t \). In other words, the target rent is the rental price we would see in an economy without any stickiness in housing rents. We define a zero-one index \( I_{it} \) as

\[
I_{it} = \begin{cases} 
1 & \text{if the unit } i \text{ is turned over in period } t \\
0 & \text{otherwise}
\end{cases}
\]  

The adjustment hazard is defined to be the probability of a turnover \((I_{it} = 1)\) conditional on the deviation of the actual rent from its target level

\[
\Pr(I_{it} = 1 \mid R_{it-1} - R_{it-1}^*)
\]

This conditional probability is useful when one wants to see a feature of state dependence in firms’ pricing behavior. For example, Slide 9, which is taken from Saito and Watanabe (2008), shows an estimated adjustment hazard for goods sold at supermarkets such as milk, shampoo, and so on. The probability of price adjustment is very small when the price imbalance (i.e. the difference between the actual and target prices) is close to zero, but it monotonically increases with the imbalance, approaching to unity as the imbalance becomes very large. This means a state-dependent feature of firms’ pricing behavior: namely, a firm seldom changes its price when it is
close enough to the target level, but the firm is more likely to change the price when it faces a larger deviation.

To estimate the conditional probability given in (2), we make the following assumptions about \( R_{it}^* \). First, we assume that \( R_{it}^* \) equals to \( R_{it} \) if a turnover occurs at unit \( i \) in period \( t \) (i.e., \( I_{it} = 1 \)). In this period, a landlord makes a new contract with a new tenant, and therefore is allowed to choose freely any level of the rent as far as it is acceptable to the new tenant. There is no reason for the landlord to pay attention to the level of the rent with the previous tenant. In this sense there is no stickiness in housing rents, so that the new rent \( R_{it} \) coincides with the target rent. Note that the new rent \( R_{it} \) can be regarded as “market” rent in period \( t \) because it fully reflects the market condition in period \( t \). In this sense “marking to market” occurs only when one tenant leaves and another one arrives.

The target rent \( R_{it}^* \) is not directly observable unless a turnover takes place at unit \( i \) in period \( t \). However, it is still possible to estimate \( R_{it}^* \) as long as turnovers take place in other units, say the units \( j, k, \) and so on, and thus we are able to observe the target prices for those turnover units, \( R_{jt}^* \), \( R_{kt}^* \), and so on. Specifically, we first run a hedonic regression for period \( t \) using the rents for all of the turnover units, and then extrapolate it to obtain an estimate for the rent of the unit \( i \) in that period.

In sum, \( R_{it}^* \) is estimated as follows:

\[
R_{it}^* = \begin{cases} 
R_{it} & \text{if } I_{it} = 1 \\
\hat{R}_{it} & \text{if } I_{it} = 0 
\end{cases}
\]  

(3)

and \( \hat{R}_{it} \) is defined by

\[
\hat{R}_{it} \equiv \hat{\beta}_t x_i + \hat{\gamma}_t T D_t
\]  

(4)

where \( x_i \) is the vector representing attributes for the unit \( i \), \( T D_t \) is the time dummy, and \( \hat{\beta}_t \) and \( \hat{\gamma}_t \) are hedonic estimates.

Given the estimate of \( R_{it}^* \) at hand, we are now ready to estimate an adjustment hazard function. Slide 11 presents the result. We clearly see that the probability of adjustment, \( Pr(I_{it}) \), does not depend on the deviation of the actual rent from its target (or market) level. This is in sharp contrast with the case of goods prices reported in Saito and Watanabe (2008). Non-state-dependent pricing, which is sometimes referred to as time-dependent pricing, is an important feature of housing rents.
2.5 Estimating hazard function

The next thing Shimizu et al. (2008) do is to conduct duration analysis. Specifically, they estimate “hazard function”, which is defined by

$$
\Pr(I_{it} = 1 \mid I_{it-1} = \cdots = I_{it-m} = 0 \quad \text{and} \quad I_{it-m-1} = 1)
$$

Slide 12 shows the histogram of the completed price spells. We have 157,815 completed price spells. The length of these price spells ranges from 53 weeks (i.e., a tenant lives in a unit only for 53 weeks) to 1144 weeks (someone lives in a unit for more than 23 years!), and its median is 177 weeks.

Slide 13 shows the cumulative distribution function (CDF) for price duration. The vertical axis represents the cumulative probability in logarithm; for example, the value corresponding 400 weeks represents the fraction of price spells exceeding 400 weeks. The CDF seems to be on a straight line at least for the price spells whose length is less than 400 weeks. This indicates that price duration obeys an exponential distribution, implying that the rent adjustment is well approximated by a Poisson process.

Slide 15 conducts the same exercise as in Slide 13, but we now use censored spells in addition to the completed ones. The Kaplan-Meier hazard estimates indicates that the hazard function is almost flat at least for the duration less than 400 weeks, implying again that the rent adjustment is approximated by a Poisson process. These results could be interpreted as reflecting the fact that a turnover occurs due to purely random events such as marriage, childbirth, and job transfer.

2.6 Estimating the Calvo parameter

The fact that the rent adjustment is approximated by a Poisson process suggests that one can apply the idea of Calvo pricing (Calvo 1983) to housing rents. As a first step, let me compare the rent estimated by hedonic regression in Shimizu et al. (2008) with the CPI rent. Slide 16 shows the coefficients on the time dummies, $\hat{\gamma}_t$ in equation (4), together with the CPI rent. The estimated rent index rose significantly until the second quarter of 1992, and it started to decline after that, which is more or less consistent with fluctuations in selling prices. In contrast, the CPI rent did not exhibit such a large up and down during the bubble and the post-bubble periods.
Where does such a big difference come from? It is important to note that the hedonic rent index reflects changes only in the rents adopted in a new contract between a new tenant and a landlord, while the CPI rent contains the rents both for turnover and non-turnover units. Given the anecdotal evidence that the rent is seldom altered for non-turnover units, it would not be so surprising even if one finds slower adjustments (or more stickiness) in the CPI rent as compared with the hedonic rent.

To know whether this actually accounts for the difference between the hedonic and CPI rents, let us conduct a simple regression. We apply the Calvo model to housing rents by assuming that a turnover obeys a Poisson process with the probability $\alpha$; namely, a tenant continues to stay at a unit with the probability of $\alpha$ and leaves a unit with the probability of $1 - \alpha$. Furthermore we assume that a rent adjustment occurs with the probability of $1 - \theta$ even in a period in which an existing tenant continues to stay at a unit. Put differently, a rent adjustment occurs because of the two independent reasons: it takes place when one tenant leaves and a new one arrives; it also takes place at the timing of a renewal of a contract between an existing tenant and a landlord. The anecdotal evidence indicates that the rent adjustment of the latter type seldom occurs; if so, the value of $\theta$ would be very close to unity.

Given these assumptions, the transition equation for the average rent of all housing units, including both turnover and non-turnover units, is given by

$$ R_t = \alpha [\theta R_{t-1} + (1 - \theta)R_t^*] + (1 - \alpha)R_t^* $$

where $R_t$ is the average of $R_{it}$ over $i$, including turnover and non-turnover units, and $R_t^*$ is the average of $R_{it}^*$ over $i$ for the turnover units in period $t$. $R_t$ and $R_t^*$ correspond to the CPI rent and the hedonic rent ($\hat{\gamma}_t$ in equation (4)), respectively. Rearranging (6) gives us an estimating equation

$$ R_t = \alpha \theta R_{t-1} + (1 - \alpha \theta)R_t^* + \epsilon_t $$

Note that we are only allowed to get an estimate for the product of $\alpha$ and $\theta$ but not for each of these two parameters. However, we have already learned something about the value of $\alpha$ in the previous subsection; the estimated hazard in Slide 15 implies that $\alpha = 0.970$ at the frequency of quarter.\footnote{The estimated hazard function in Slide 15 is almost flat at least for the durations less}
means that the fraction of turnover units is 3 percent per week, much smaller than the numbers reported in the related studies. On the other hand, we get $\alpha \theta = 0.968$ by estimating (7) for the period of 1986:1Q to 2006:4Q. These two estimates imply $\theta = 0.997$, indicating that a rent adjustment for non-turnover units occurs only with a very low probability.

Slide 17 summarizes the regression results. The figure on the left hand side shows an impulse response of $R_t$ to a shock to $R^*$. It takes 20 quarters to complete even half of its entire adjustment, which indicates a very strong price stickiness. The figure on the right hand side shows the values of the hedonic rent $R^*_t$, as well as the values of $R_t$ which are calculated using the relationship

$$R_t = \frac{1 - \hat{\alpha} \hat{\theta}}{1 - \hat{\alpha} \hat{\theta} L} R^*_t$$

(8)

which is implied by equation (7). We see that fluctuations in $R^*_t$ are considerably smoothed out, and that $R_t$ is very close to the actual CPI rent.

### 2.7 Implications for the conduct of monetary policy

The empirical result of very sticky housing rents has some important implications for the conduct of monetary policy.

**Optimal CPI weights** The fact that housing rents are much stickier than the other goods and services implies the possibility that the price index to be used as a guideline for monetary policy could differ from the cost of living index. Specifically, consider an economy with two sectors, each of which is characterized by Calvo pricing with price stickiness $\alpha_1$ in one sector and $\alpha_2$ in the other sector. Benigno (2004) shows that the economic welfare is maximized in this economy if the central bank seeks to stabilize the following price index.

$$\gamma \pi_{1t} + (1 - \gamma) \pi_{2t},$$

(9)

time than 400 weeks, and it is about 0.0025. Then $\alpha$ is equal to 0.9975 at the frequency of week, and $\alpha = (1 - 0.0025)^{12} = 0.970$ at the frequency of quarter.

3For example, Gali and Gertler (1999) reports that $\alpha$ is about 0.8 for the whole industries in the United States: Gali, Gertler, and Lopez Salido (2001) finds that $\alpha$ is in the rage of 0.5 to 0.9 for the European countries.
where the weight $\gamma$ is defined by

$$\gamma \equiv \frac{n \alpha_1 (1 - \alpha_1)^{-1} (1 - \alpha_1 \beta)^{-1}}{n \alpha_1 (1 - \alpha_1)^{-1} (1 - \alpha_1 \beta)^{-1} + (1 - n) \alpha_2 (1 - \alpha_2)^{-1} (1 - \alpha_2 \beta)^{-1}}. \tag{10}$$

Here $\pi_{it}$ represents the inflation rate in the sector $i$, and $n$ is the consumption basket share of the goods produced in the sector 1. Note that $\gamma$ is equal to $n$ if the two sectors have the same degree of price stickiness (namely, $\alpha_1 = \alpha_2$). This is the definition of the standard cost of living index. However, $\gamma$ differs from $n$ unless $\alpha_1$ and $\alpha_2$ are the same. According to equation (10), if $\alpha_1$ is greater than $\alpha_2$, which means that prices are stickier in the sector 1, then more weight should be put on $\pi_{1t}$. Intuitively speaking, the welfare loss due to price instability (inflation or deflation) is higher in the sector with higher price stickiness, therefore it is desirable not to allow the price of that sector to fluctuate a lot.

We assume that the economy consists of two sectors: the housing service sector and the other sector. We use the empirical results in the previous section for the price stickiness in the housing service sector, while we borrow the estimate of the stickiness in the other sector of the economy ($\alpha = 0.8$) from the previous studies. Then equation (10) tells us that the weight for the housing service sector, $\gamma$, should be equal to 0.9, which is much larger than the weight assigned to that sector in the consumption basket ($n = 0.25$).

The figure on the left hand side of Slide 18 compares the guideline index, which is denoted by $\pi^\gamma$, with the CPI. Looking at the second half of the 1980s and the first half of the 1990s, during which housing rents fluctuated a lot, we see no significant difference between the two indices, implying that the central bank had no reason to pay special attention to the housing rent during this period because of its high price stickiness.

**Treatment of owner occupied housing** It is appropriate to use $R$ (instead of $R^*$) when one is interested in calculating the cost of living for renter occupied housing. This is simply because what a renter pays in period $t$ is based on the contract made in the past, and therefore the relevant rental price is not necessarily identical to the current market price $R_t^*$. However, as far as owner occupied housing is concerned, there is some reason to use the market price in evaluating its value. In particular, the so-called rental equivalence approach requires us to use the market price in evaluating
the services provided by owner occupied housing. The United States and Germany adopt this approach, while Japan adopts the so-called user costs approach. Specifically, the Japan’s Statistics Bureau uses $R$ even when evaluating the owner occupied housing services, based on the assumption that an owner pays the same amount as a renter does in period $t$. The fact that the deviation between $R$ and $R^*$ was substantial during the bubble and the post-bubble periods suggests that the movement of CPI could be altered significantly by replacing $R$ by $R^*$ in evaluating the owner occupied housing services.

The figure on the right hand side of Slide 18 compares the price index using $R^*$ instead of $R$ with the CPI. One can see that the inflation rate in the new index is higher by about one percent in the latter half of the 1980s, and that it is lower by about two percent in 1993 to 1995. In particular, it fell to a negative value in the second quarter of 1993, while the CPI became negative only two years later. This reflects a noticeable difference between $R$ and $R^*$ in that $R^*$ recorded a substantial decline in 1993 and 1994, while there was no such a decline in $R$. Deflation in 1993, rather than in 1995, could have urged the central bank and the government to make an earlier shift from monetary tightening to easing.

3 Some Evidence from Scanner Data
[to be completed]

References


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The rental equivalence approach values the services yielded by the use of a dwelling by the corresponding market rental value for the same sort of dwelling for the same period of time (if such a rental value exists)” (Diewert and Nakamura (2008))


