



Prepayment behaviors of Japanese residential mortgages



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ABSTRACT

We investigate full prepayments of Japanese residential mortgages during a ten-year period from 1996 to 2005. This investigation is important because the amount of mortgages outstanding in Japan is huge, yet the study on their prepayments is very limited. This period from 1996 to 2005 was characterized by two distinct features of the evolution of interest rates that might have significant effects on mortgage refinancing. First, interest rate fluctuations were limited to a narrow range of a little over 1%. Surprisingly, full prepayments of Japanese mortgages were sensitive to small changes in interest rates. Second, long-term refinance rates did not fall well below the contract rates of most mortgages in our sample during the ten-year period, while short-term refinance rates did. With this interest rate relationship, if mortgagors ever refinanced, it was likely that they rolled over short-term mortgage rates several times until they repaid mortgages completely. Hence, we examine the sensitivity of full prepayments to short-term vs. long-term interest rates, mortgagors' expectation of future course of interest rates (by the slope of yield curve), and that of interest rate volatility. Our analysis shows that short-term interest rates have a slightly greater explanatory power for full prepayments than long-term interest rates. In addition, our analysis confirms that full prepayments are sensitive to both the slope of yield curve and interest rate volatility. Other issues we look into are the patterns of full prepayments in relation to loan age and seasonality. We find that the pattern of full prepayments relative to loan age is comparable to that of mortgages in the U.S., and that the seasonal pattern of full prepayments is attributable to relevant institutional arrangements in Japan.

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1. Introduction

Prepayments of residential mortgages considerably alter the pattern of cash flows the holders of the mortgages receive. As a result, they pose major risk to the holders of mortgages, such as financial institutions (FIs) holding mortgages directly, and investors in mortgage-backed securities (MBSs). Hence, the questions such as how common prepayments are and how prepayments are related to interest rate movements are of critical importance to these mortgage investors with regard to their risk management as well as the pricing of mortgages and MBSs. It should be noted that the economic significance of this risk is substantial because massive amounts of residential mortgages are outstanding. For example, at the end of 2011, the amount of U.S.

home mortgages of the household sector was 9840 billion dollars, which was well above the corporate debt of 7800 billion dollars and a little below the Federal government debt of 10,453 billion dollars. Similarly, at the end of 2011, the total balance of Japanese residential mortgages was 207 trillion yen, which was approximately a half of the entire debt (402 trillion yen) of the private nonfinancial corporate sector and one fifth of national government debt (887 trillion yen).²

These facts warrant serious investigation into prepayments of residential mortgages. Indeed, many researchers have looked into prepayments of U.S. residential mortgages. A partial list of them includes Green and Shoven (1986), Schwartz and Torous (1989, 1993), Deng et al. (2000), and Dunskey and Ho (2007). By sharp contrast, such studies on Japanese residential mortgages are

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² These numbers are based on *Flow of Funds Accounts of the United States Fourth Quarter 2011*, downloadable at <http://www.federalreserve.gov/releases/z1/20120308/> and *Japan's Flow of Funds Accounts*, downloadable at <http://www.boj.or.jp/en/statistics/sj/index.htm>.

minimal. Specifically, to our best knowledge, publicly available studies on prepayments of Japanese residential mortgages are limited to only three academic papers: Sugimura (2002), Ichijo and Moridaira (2006), and Kutsuzawa (2007).³

Before we describe these studies on prepayments of Japanese residential mortgages, we point out a few distinct features of mortgage interest rates that are observed during the sample period from May 1996 to December 2005. Fig. 1 plots four interest rates in each month of the sample period. In this figure, WAC represents the weighted average coupon (WAC) of mortgages in our sample that started repayments in the same month. ARM rate stands for the average of interest rates on adjustable rate mortgages (ARMs) that are offered in the same month. 3-, 5- and 10-year rates are the averages of interest rates on mortgages which have fixed interest rates for the first 3, 5, and 10 years of mortgage terms, respectively, and which are offered in the same month. Incidentally, the ARM rates are compiled by the Bank of Japan, and the 3-, 5- and 10-year rates are compiled by Japan Financial News Co. Ltd. Also, in this paper, we refer to mortgages that have fixed interest rates for the first few years of mortgage terms as renegotiable mortgages.

Fig. 1 reveals that interest rate movements during the sample period exhibited three features we ought to pay close attention to. First, all of the five time series showed little variation during this 10-year period. Specifically, the differences between the maximum and minimum values during this period of WAC, ARM, 3-year, 5-year, and 10-year rates were 1.19%, 0.25%, 1.1%, 1.3%, and 1.32%, respectively. These changes are small compared to changes in mortgage interest rates in other developed countries. For example, according to Freddie Mac's "Primary Mortgage Market Survey Archives," the differences between the maximum and minimum values during our sample period of U.S. 1-year adjustable, 15-year fixed, and 30-year fixed rates were 3.875%, 3.55%, and 3.29%, respectively.⁴ Similarly, according to a Deutsche Bundesbank's publication, the differences between the maximum and minimum values during our sample period of German variable, 5-year fixed, and 10-year fixed rates were 2.71%, 2.65%, and 3.53%, respectively.⁵ Second, the 10-year rate was above the concurrent WAC in every month of the sample period.⁶ Furthermore, the 10-year rate offered

in any month was never lower than the WAC of any mortgage pool that had been formed prior to that month by more than 35 basis points. Third, all of the 5-year, 3-year, and ARM rates were below the concurrent WAC of mortgage pools for most of the 10-year period, although none of the 5-year, 3-year, and ARM rates in any month of the sample period were lower than the WACs of mortgage pools that had been formed prior to that month by more than 135 basis points.

According to Fabozzi and Modigliani (1992, p. 198), "historically, it has been observed that when mortgage rates fall to more than 200 bp below the contract rate, prepayment rates increase." Given this historical fact, the observations made in Fig. 1 lead to a question: how sensitive mortgage refinancing was to interest rate movements during the sample period?

Note that the prepayment data that are available to us do not distinguish prepayments due to refinancing from full prepayments due to other reasons, such as moving. Hence, we analyze full prepayments instead of refinancing. Note also that because full prepayments due to moving and default are less frequent than and not as closely related to interest rate movements as those due to refinancing, the effects of interest rates on full prepayments are likely to be found weaker than the effects of interest rates on refinancing. In this sense, it is not so bad to analyze full prepayments in order to obtain insights on the effects of interest rates on refinancing.

In addition, our prepayment data are grouped data. Hence, we follow Schwartz and Torous (1993) in running Poisson regression, where the dependent variable is the number of occurrences of full prepayments in a month and the independent variables are a variety of interest-rate-related variables and other variables.⁷ We find that the coefficients of the interest rate variables are statistically significant and their values are fairly stable across various specifications of Poisson regression.

The second and third observations in Fig. 1 imply that if a mortgage loan was prepaid due to refinancing, it is most likely that it was refinanced by an ARM or a renegotiable mortgage. This conjecture, in turn, implies that mortgagors who were considering refinancing were more concerned about short- and medium-term mortgage rates than long-term mortgage rates. To examine this hypothesis, we run various specifications of Poisson regression where a long-term mortgage rate is replaced by a short- or medium-term mortgage rate as an independent variable. The estimation results turn out to be in favor of this hypothesis.

In addition, as we will see in detail in the next section, if a mortgagor refinances a mortgage loan by an ARM or a renegotiable mortgage, she is most likely to roll over a series of short- and/or medium-term rates in the future until she repays the mortgage completely. Hence, it is plausible that mortgagors' expectation of both future course and volatility of interest rates has direct effects on mortgagors' decision on refinancing. Therefore, we include the slope of Japanese government bond yield curve and the standard deviation of Japanese Treasury bill as additional independent variables of Poisson regression. It is confirmed that the estimation results are consistent with this hypothesis.

Furthermore, it is well known that the age of a mortgage pool and dummy variables for months of the year exert strong influence on full prepayments. Hence, we include them as additional independent variables of Poisson regression to control the effects of them on prepayments. The estimation results indicate that the pattern of full prepayments relative to mortgage pool age is comparable to that for U.S. mortgages. In particular, the prepayment intensity increases consistently for the first seventy two months and declines gradually afterward. Furthermore, we have

³ Publicly available studies on prepayments of Japanese residential mortgages are rare mainly because Japanese FIs have been reluctant to give prepayment data to outsiders, including academicians. Sugimura (2002) and Ichijo and Moridaira (2006) could avoid this problem by obtaining in-house data from different FIs Sugimura and Ichijo worked for, while Kutsuzawa (2007) could do so by conducting an Internet survey of mortgage prepayments. We are fortunate that we could obtain Government Housing Loan Corporation (GHLC) prepayment data as recipients of a scholarship from GHLC's affiliate, Housing Loan Progress Association, while GHLC had the policy to give the scholarship recipients access to its prepayment data. Note, however, that GHLC ended compiling prepayment data in the format that is amenable to our study shortly after we obtained the prepayment data. Currently, GHLC's successor, Japan Housing Finance Agency, compiles aggregate prepayment data on its MBSs, each of which consist of mortgage loans with various contract rates and diverse stated maturities.

⁴ Freddie Mac's Primary Mortgage Market Survey Archives are found at http://www.freddiemac.com/pmms/pmms_archives.html.

⁵ This publication is published as a pdf file titled "Housing loans to households/ Mortgage loans secured by residential real estate," which is downloadable at http://www.bundesbank.de/Navigation/EN/Statistics/Money_and_capital_markets/Interest_rates_and_yields/Interest_rates_on_deposits_and_loans_interest_rates_on_deposits_and_loans.html.

⁶ Newly originated GHLC mortgages typically had 20 years or longer until maturity and the yield curve based on Japanese government bonds was upward sloping throughout the sample period. Hence, the fact that the WAC was below the concurrent 10-year mortgage rate implies that GHLC mortgages were offered below the interest rates that would prevail in a competitive mortgage market. In fact, the financial statements of GHLC show that the GHLC could offer low rates due to the Japanese Government's subsidy. For example, in the fiscal year ending in March 2005, GHLC received over 404 billion yen from the Japanese government, which helped fill the gap between GHLC's interest expenses of 2073 billion yen and interest revenues of 1816 billion yen.

⁷ In addition, we ran logit regression for grouped data and obtained results similar to the ones from Poisson regression, which are shown in Tables 2 and 3.

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