Inflation and Bubbles in the Japanese Condominium Market

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Abstract

In this paper, we investigate the dynamics of condominium prices by using recent national and regional data for Japan. First, using left- and right-tailed integration methods to circumvent deficiencies in existing approaches, we propose two definitions of bubbles and show that the condominium market has experienced neither mild nor explosive bubbles since 2008. The perception of bubbles can be influenced by the variables chosen to represent economic fundamentals; however, the standard model specification suggests no bubbles during that period. Second, consistent with this finding, we point to several economic fundamentals including Chinese money that can explain the long-term trend in condominium prices. Third, we find that, among the explanatory variables considered, transaction volume, particularly the volume of purchases by companies, is relevant in explaining condominium price inflation.

Keywords: Real estate market, condominium prices, market bubble, unit root, cointegration, Japan
JEL classification: R1, R3, C5

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1 Introduction

The analysis of residential property prices is important for a number of reasons. First, people need places to live, which are necessary goods like foods.[1] Second, residential property is often the most expensive item that a person purchases in his or her entire life, and forms a significant part of one's wealth. Third, the bursting of real estate market bubbles has catastrophic effects on economies, leading to a deterioration of the quality of life.[2] Therefore, a number of studies have been conducted in order to investigate changes in the prices of residential property, especially houses.

Traditionally, housing prices have been analyzed based on economic fundamentals. Macroeconomists consider such economic fundamentals as mortgage rates, household income, and housing stocks (Ashworth and Parker (1997), Meese and Wallace (2003), Abelson et al. (2005), Stevenson (2008)). More micro-oriented analyses consider population and the location of residence (Cameron et al. (2006)). However, these economic fundamentals are not always sufficient to explain housing price movements. During bubble periods, noneconomic factors (e.g. consumer expectations) are believed to have more influence over housing prices than do economic fundamentals. Because bubbles are unobservable, previous studies often have regarded sizable deviations of market prices from economic fundamentals as evidence of bubbles (Black et al. (2006), Muellbauer and Murphy (2008), McMillan and Speight (2010)).

More recent theoretical research has utilized information about the volume of housing transactions (e.g. Stein (1995), Ortalo-Magne and Rady (2006)). Transaction volume is believed to explain transitory movements, or volatility, in housing prices, and is expected to be positively correlated with housing prices. Following such theoretical developments, recent research has examined the usefulness of transaction volume in explaining housing prices in developed countries such as Finland (Oikarinen (2012)), the United States (US) (Akkoyun et al. (2013)), the United Kingdom (UK) (Andrew and Meen (2003), Tsai (2014)), and the Netherlands (de Wit et al. (2013)).

Against this background, we investigate the recent movements in condominium prices in Japan. Although there are several types of residence, including (detached) houses

[1]Purchasing a house can be also considered, at least in part, an investment.

[2]For this reason, whether monetary policy should take into consideration rapid and dramatic increases (bubbles) in real estate prices is still under debate (Filardo (2001), Gruen et al. (2005)).

and multi-family residences (e.g. condominiums or flats), we focus on condominiums, which are called apartments or mansions in Japan, for the following two reasons. First, with relatively high population density, living in a house often is just a dream for many business people. Therefore, living in a condominium, even after getting married and having children, is a popular choice. Indeed, approximately 41.6% of households live in condominiums, according to the 2011 Population Census (Kokusei-chosa) of Japan. This proportion is higher in urban areas such as Tokyo (67.7%), Kanagawa (54.9%) and Osaka (54.1%),[3] and the trend of living in a condominium has increased in recent years, while other types of residence have become less popular.

Second, in line with the popularity of condominiums, in Japan prices of condominiums have behaved differently than prices of other types of real estate (see Section 2 of this paper) during the past decade. Notably, there was a sharp increase in condominium prices after the Lehman's collapse of 2008, which outpaced other real estate prices. In 2015, condominium prices reached a record high level (46 million yen on average) and are expected to continue increasing until at least the 2020 Summer Olympics in Tokyo. Therefore, compared with other property markets today the condominium market, which seems to be exhibiting early warning signs of a potential bubble, is of most interest to market participants and analysts.

The contribution of this paper is twofold. First, using left- and right-tailed integration methods, we analyze two definitions of bubbles (mild and explosive bubbles) in the Japanese condominium market, which has been described over recent years as very hot (if not bubbling).[4] Second, we introduce transaction volume into the standard pricing model. This extension is motivated by recent research on changes in the value of other financial assets, such as stocks and exchange rates (e.g. Campbell et al. (1993), Lyons (1995), Barron and Karpoff (2004)). In those studies, transaction volume was incorporated in order to link changes in asset prices to traders' information and expectations. We attempt to analyze the relationship between condominium price inflation and transaction volume by trader type and at both the national and regional levels in Japan. To our knowledge,

[3]The proportion of people living in condominiums in urban cities in Japan is higher than European average of 41.1% (as of 2013) and the New York average of 51%.

[4]The studies of the overall Japanese residential property market, which includes real estate types other than condominiums, are rather limited due, in part, to the lack of data. For example, Adams and Fuss (2010) who studied 15 international housing markets did not cover the Japanese market.

this is the first attempt to utilize such disaggregate data.

2 Theoretical determinants of condominium prices

Theoretical explanations of movements in condominium prices can be considered as identical to those of detached houses since they are economic goods with similar characteristics. The simplest form of fundamental determinants of housing prices consists only of a rental cost (Meese and Wallace (1994), Phillips and Yu (2011)), or a mortgage rate (McGibany and Nourzad (2004)), or residential land (Ooi and Lee (2004)), or household income (Gallin (2006)). Renting is another option than purchasing a house, i.e. an opportunity cost. A mortgage rate is considered as closely associated with the user cost of residential capital based on a neoclassical investment model (Kearl and Mishkin (1977)). Thus, for a mortgage rate to have an expected influence in property markets, a country should possess developed capital and financial markets. While a mortgage rate can be considered as influencing the supply-side as it is closely linked with a variety of interest rates, McGibany and Nourzad (2004) argue that its effect is predominantly demand-oriented. Land availability may be increasingly important in areas with limited landmass and/or heavy government regulation. Finally, the house price-income relationship is closely related to the concept of housing affordability, an index of the difficulty of purchasing a house. A sizable price deviation from these fundamentals indicates the presence of a financial bubble.

In addition, a pricing model may comprise both demand- and supply-side factors such as real income and the user cost of capital (e.g. Eq. (1) in Oikarinen (2012)). Other possible variables considered are personal sector housing starts (Drake (1993) and Ashworth and Parker (1997)), a real credit to the private sector (Hofmann (2004)), a construction cost (Adams and Fuss (2010)), and employment (Meese and Wallace (2003)). In short, there are many choices of variables that can possibly explain housing price movements in theory, but there is little consensus among researchers regarding the exact definition of fundamental determinants of housing prices, compared with those of stock prices.[5]

From surveying existing studies however, the standard specification generally comprises construction starts as a supply factor and real income and the real mortgage rate

[5] Real dividends are universally used as economic fundamentals for equity prices.

as demand factors. Housing prices are positively correlated with real income; higher income leads to increases in demand for houses. On the other hand, they are negatively associated with the mortgage rate and construction starts; a lower mortgage rate will reduce the financial burden of purchasers and the increased availability of houses will reduce market pressure by increasing the supply schedule.

What is more, there is no clear theoretical distinction regarding whether these explanatory variables determine permanent or transitory movements in housing prices. Probably, transaction volume is a very rare exception that is considered as a determinant of housing price inflation only. The distinction between permanent and transitory factors becomes key in this study since we base our analysis on a concept of integration where a permanent relationship is statistically equivalent to the presence of cointegration, and transitory price movements should be captured by stationary variables. We shall elaborate on this when explaining our statistical pricing model in the next section.

3 Statistical methods

The analyses in this study are based on time-series methods; in particular, the relationship between condominium prices and their determinants is investigated by use of cointegration (Engle and Granger (1987)). The cointegration method has been applied in the analysis of housing markets by a number of researchers (Hendry (1984), Meese and Wallace (2003), McGibany and Nourzad (2004), Gallin (2006), Adams and Fuss (2010), Oikarinen (2012), de Wit et al. (2013)). Given that housing prices have often been characterized as following a nonstationary process, cointegration is attractive because it allows us to test for the presence of bubbles, as well as to model a long-run path and the dynamics of prices to return to this path.

More specifically, in order to derive the long-run relationship between real condominium prices (y) and explanatory variables (x) for the period ($t = 1, \ldots, T$), consider the following dynamic equation:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \beta_0 x_t + \beta_1 x_{t-1} + u_t \tag{1}$$

where the residual u is normally distributed ($u_t \sim N(0, \sigma^2)$). Both x and y are in natural logarithmic form and are assumed to exhibit persistence, in line with many economic and financial variables (e.g. Nelson and Plosser (1982))($x, y \sim I(1)$). Then, following Banerjee et al. (1993), we can rewrite Eq. (1) as follows:

$$\Delta y_t = \alpha_0 + \beta_0 \Delta x_t + (\alpha_1 - 1)\left(y_{t-1} + \frac{\beta_0 + \beta_1}{\alpha_1 - 1} x_{t-1}\right) + u_t \tag{2}$$

or simply

$$\Delta y_t = a + b\Delta x_t + c(y_{t-1} + dx_{t-1}) + u_t \tag{3}$$

The Δ is the difference parameter; thus Δy_t represents condominium price inflation. We need to estimate parameters $a, b, c,$ and d; the short-term sensitivity of y to x is captured by the parameter b. The parameter c measures the speed of adjustment to return to the long-run path $(y_{t-1} + dx_{t-1})$, which is called the error correction mechanism (ECM). The parameter d is the vector of cointegrating parameters that summarize the long-run relationship between x and y. In the presence of a long-run relationship between y and x, d is super-consistent and the ECM is stationary $I(0)$. Then the adjustment parameter c should be $-1 < c < 0$ (Engle and Granger (1987)). A parameter c value that is close to -1 indicates fast adjustment to return to the long-run path, and a parameter c value that is close to 0 indicates slow adjustment to return to the long-run path. In contrast, when there is no long-run relationship between x and y, c will not lie within this theoretical range, which implies that there are significant deviations of prices from economic fundamentals and thus becomes evidence of bubbles.

One can generalize Eq. (3) by introducing a vector of additional explanatory variables (z), which are assumed to be stationary and influence only transitory movements in condominium prices. In this way, we arrive at the following equation on which this study is based.

$$\Delta y_t = a + b\Delta x_t + c(y_{t-1} + dx_{t-1}) + fz_t + u_t \tag{4}$$

In this study, x is a vector of economic fundamentals, such as real disposable income and the real mortgage rate. In addition, we consider Chinese money as part of x since additional demand has been said to be created recently by Chinese funds. The z vector contains stationary explanatory variables such as the transaction volume of condominiums, net migration (or population changes) and the number of construction starts (condominiums).[6] We use Eq. (4) as a basis for analyzing changes in national and regional condominium prices.

The method described thus far with regard to this study are conventional statistical models for analyzing housing markets and bubbles; however, they may be insufficient for detecting periodically collapsing bubbles (Diba and Grossman (1988) and Evans (1991)). To address the shortcoming of these conventional statistical methods, Phillips and Yu (2011) have proposed conceptually different methods for detecting bubbles.

Let us consider e that is an individual time-series or a linear combination of data like the ECM. The standard augmented Dickey-Fuller (ADF) test evaluates the null hypothesis that e_t follows a unit root ($\alpha_1 = 1$, bubbles) against the alternative hypothesis of stationarity ($|\alpha_1| < 1$, no bubble). These hypotheses are analyzed by use of the following specification.

$$\Delta e_t = \alpha + c e_{t-1} + \sum_{i=1}^{p} \theta_i \Delta e_{t-i} + \epsilon_t \tag{5}$$

where $c = \alpha_1 - 1$ and the residual $\epsilon_t \sim N(0, \sigma_\epsilon^2)$. With the null hypothesis being the same as before ($\alpha_1 = 1$ or $c = 0$), Phillips and Yu (2011) suggested the evaluation of the right-tailed alternative of an explosive unit (i.e. $\alpha_1 > 1$ or $c > 0$) as proposed by Bhargava (1986) and Campbell and Perron (1991). Therefore, compared with the standard unit root tests which define bubbles as the $I(1)$ process, this alternative hypothesis has a stronger implication for bubbles, and thus the explosive unit root test is conceptually different from the traditional test of searching for cointegration, i.e. non-bubble periods.

In order to evaluate such null and alternative hypotheses, four types of explosive unit root tests are used; the right-tailed version of the conventional ADF (ADF), the rolling ADF (RADF), the supremum ADF (SADF), and the generalized SADF (GSADF) tests (Phillips et al. (2011), Phillips et al. (2014)). The first test is the right-tailed version of the conventional ADF, with its statistic following a nonstandard distribution. Unlike the ADF which utilizes all observations, the RADF is conducted by shifting forward the starting and ending sample data points. The SADF is based on the recursive method, and thus the statistic is obtained by fixing the initial point (r_0) equal to the first observation

[6] Demographic changes are found to influence only housing price inflation in Japan (Ohtake and Shintani (1996)). The construction starts are considered as affecting housing price inflation as they are found to be stationary. See also footnote 8.

in the data set but extending the ending point (r_2) one by one for each successive run. The largest statistic obtained from the recursive method is used in evaluating the null hypothesis. Thus, for the time period from 0 to r_2 in which r is a fraction of the total time period, the SADF statistic can be expressed as follows:

$$SADF(r_0) = \underset{r_2 \in [r_0, 1]}{sup} \, ADF_0^{r_2}$$

The SADF statistic is consistent if there exists only one bubble, but is problematic if multiple bubbles exist. For this reason, Phillips et al. (2011) proposed the GSADF. It relaxes the SADF such that the initial observation (r_1) in the analysis does not need to be identical to the first observation in the data set. Phillips et al. (2014) proposed a statistical method for identifying a period of multiple bubbles, which has been shown to have reasonable power (Homm and Breitung (2012)). In short, the GSADF statistic can be expressed as:

$$GSADF(r_0) = \underset{\substack{r_2 \in [r_0, 1] \\ r_1 \in [0, r_2 - r_1]}}{sup} \, ADF_{r_1}^{r_2}$$

These unit root tests have been used in recent studies. Phillips et al. (2011) applied them to the US markets for housing, crude oil and bonds, and Phillips and Yu (2011) and Phillips et al. (2014) applied them to US stock markets (the NASDAQ stock exchange and the S&P500 Index). Kraussl et al. (2016) used these tests to examine bubbles in art markets.

In this study, we use these methods to test for the presence of bubbles in Japan's condominium market; we name here a case of $\alpha_1 > 1$ an explosive bubble and the case in which $\alpha_1 = 1$ (unit root) a mild bubble (or hereafter simply a bubble). In this way, we can evaluate both conventional and occasionally collapsing explosive bubbles. Thus these tests can be also regarded as equivalent to analysis of the stability of a cointegrating relationship.

Proposition 1 *Based on Eqs. (3) and (5), there is evidence of explosive bubble periods if $c > 1$, mild bubble periods if $c = 1$, and tranquil periods if $c < 1$.*

4 Data summary and preliminary analyses

We use a unique data set that allows us to investigate Japanese real estate markets. Indeed, until recently, a data set for Japan's real estate markets has not been well developed, which is one of the reasons that Japanese markets were not been fully analyzed in the past. Only recently, as part of an initiative with the IMF, did Japan's Ministry of Land, Infrastructure, Transport and Tourism (MLIT) start compiling Japanese real estate data and disseminating them on the MLIT website. These data are available at the national and regional levels; however, due to limited data availability from that website and the need for consistency with other statistical data used in this study, our regional analysis focuses on four prefectures that are generally large, in terms of landmass and population: Hokkaido, Tokyo, Nagoya, and Osaka. Of these four prefectures, Hokkaido is the only one that is not included in the three major metropolitan areas.

The data are monthly, available beginning in April 2008 (see Table 1 for additional details about data), and tailored for time-series analyses.[7] Specifically, condominium price indexes (2010=100, Figure 1) cover mainly existing condominiums and are constructed from Hedonic regression because prices are influenced by multiple factors. The factors considered in the construction of these condominium price indexes include the size, location, and age of the condominium. Also considered are whether the condominium is renovated and whether it is south-facing.

Figure 2 shows the peculiarity of condominium prices as compared with prices of other types of real estate such as residential land, detached houses and overall residential property (Overall). In particular, inflation in the condominium market is noticeably higher than inflation in other real estate markets, while prices of other types of real estate appear to be more highly correlated among themselves. Increases in condominium prices are notable since those of residential land have been in a declining trend. This phenomenon is also demonstrated in the correlation matrix (Table 2).

Table 3 reports the results of the conventional unit root test (i.e. the left-tailed version of the ADF) applied to statistical data related to condominium prices (nominal and real condominium prices, and the ratio of condominium prices to residential land prices).[8]

[7] While empirical results may be sensitive to data frequency (e.g. Berkovec and Goodman (1996), Akkoyun et al. (2013)), we do not focus on the low frequency due to the limited number of observations.

[8] When creating the ratio, we use residential land prices because monthly condominium rents are not

A bivariate relationship between housing and land prices is analyzed in the context of cointegration, for example, by Ooi and Lee (2004). In order to express condominium prices in real terms, monthly price data at the national level were obtained from Datastream, and monthly price data at the regional level were obtained from Japan's Ministry of International Affairs and Communication (MIAC). They are all part of Japan's consumer price index (CPI) and, therefore their 2010 values are equal to 100. Monthly residential land prices are obtained from the MLIT. The ADF tests are conducted for both the level and the first difference of the price indexes, in order to evaluate the null hypothesis of the unit root against the alternative hypothesis of stationarity. The appropriate lag length (p in Eq. (5)) is determined by the Akaike information criterion.

There are two important findings from these tests. First, consistent with the statistics presented in Figure 2 and Table 2, there is no evidence of convergence between condominium prices and land prices. This lack of convergence is confirmed by a failure to reject the null hypothesis for the condominium-land price ratio. If there is convergence, this ratio would be stationary. This result is in sharp contrast to the conventional belief that condominium prices and land prices are cointegrated (Ooi and Lee (2004)). In addition, as shown in Table 4, there is evidence of unidirectional causality from condominium prices to land prices. This is determined by a Granger non-causality test, which rejects at the 10% significance level the null hypothesis that condominium prices do not affect land prices but fails to reject the null hypothesis that land prices do not influence condominium prices. The unidirectional causality from housing prices to land prices is consistent with findings from Singapore (Ooi and Lee (2004)) and Finland (Oikarinen (2013)). Oikarinen discussed that this is due to the fact that housing prices capture shocks in economic fundamentals more swiftly than land prices.

The second important implication of the unit root tests is that only real condominium prices seem to follow a unit root process $I(1)$. We cannot reject the null hypothesis for real condominium price level but do reject the null hypothesis for the difference in real condominium prices (Table 3). In contrast, for nominal prices, often the null hypothesis cannot be rejected; therefore, nominal prices are integrated of order of two or higher.[9]

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available during our sample period. While not reported here due to limited space, real compensation, interest rates and Chinese money are also found to be $I(1)$, while explanatory variables used in the paper are $I(0)$.

[9]The unit root test for the condominium-land price ratio in the first difference was not conducted

Data on transaction volumes were obtained from the MLIT, for the nation and for the four prefectures. Furthermore, unlike the data used by previous studies that analyzed real estate markets of other countries, these data are also available by the type of trader. Specifically, four types of transaction volumes are recorded for condominiums: from individuals (Ind) to individuals, from Ind to companies (Com), from Com to Ind, and from Com to Com. In this study, we use this information to identify who has contributed most to condominium price inflation.

In addition to real estate data, data on economic determinants of condominium prices, based on previous literature, were gathered. Monthly Japanese net migration data for each prefecture are available from the MIAC.[10] We would expect an increased inflow of people to increase the demand for condominiums and to result in a rise in condominium prices, all else being constant. For the national level analysis, we use monthly Japanese population data, which are also obtained from the MIAC. For consistency with the time-series property of net migration data, we use annual changes in national population.

Data on other variables, such as employee compensation, mortgage rates, and new housing (condominium) construction starts are not available at a regional level; in those cases, we use national data. For the mortgage rate, we use the floating rates for city housing loans. The real mortgage rate is then calculated by subtracting expected inflation from the nominal rate (i_t); expected inflation is assumed to be equal to observed inflation (Δp_t, in which p is the CPI in logarithmic form).[11] The number of new condominium construction starts is introduced in order to capture supply-side changes in the real estate market. Japan's secondary real estate market is shallow compared with those of other developed countries: existing houses accounted for 37% of total home sales in Japan in 2012, which is substantially lower than in the US (78%) and France (66%). This situation resulted from Japanese housing policy after World War II, which was designed to increase the number of accommodations regardless of their quality. These data are available on a monthly basis except employee compensation; monthly employee compensation is proxied by quarterly data (see Table 1).

Finally, in the absence of detailed housing loan data, we consider the number of

since it does not have interesting economic implications.

[10]The MIAC's migration data are based on information from local registers (Jumin-hyo).

[11]A change in inflation formation (i.e. Δp_{t+1}) would not alter the overall conclusion.

Chinese residents as a proxy for extra housing demand. With economic growth in China over recent decades, Chinese money is said to have had significant impacts on global property markets (e.g. Australia, the UK and the USA). The Japanese market is no exception. This can also be seen by Chinese residents now accounting for over 30% of the total number of non-Japanese residents in 2015, followed by Koreans (over 20%) and Filipinos (about 10%). The Chinese community has recently shown a rapid increase in size exceeding that of Koreans in 2007. We gather information on the number of Chinese residents registered with local councils in order to exclude the short-term residents (e.g. tourists) who have no a credit history and so are not eligible for bank loans.

5 The long-run trend and explosive bubbles in condominium prices

Based on the cointegration model discussed in Section 3, we use a parsimonious model, because of data availability and the time-series properties, in order to analyze long-run movements in condominium prices. While other explanatory variables will be considered in the short-run analysis later, our models specification of potential cointegrated relationships consists of real condominium prices, real employee compensation, and the real mortgage rate, similar to the model of Adam and Fuss (2010). In addition, Chinese money will also be considered. Other variables such as credit available to households (e.g. Agnello and Schuknecht (2011)) also may influence the long-run trend in condominium prices. However, credit data are not available, and further, as is shown later in this paper, this minimal model specification is cointegrated. Therefore at least from a statistical point of view, our specification is appropriate for analyzing the long-run trend of condominium prices in Japan.

The results from the ordinary least squares (OLS) estimation of the model are reported in Table 5. Theoretically speaking, real condominium prices are positively correlated with real employee compensation and Chinese money, and negatively correlated with the real mortgage rate. The OLS results show that the coefficients on real mortgage rates and Chinese money have the expected sign in all cases. In contrast, the sign of the coefficient on real employee compensation varies by prefecture. It is positively associated with real condominium prices in relatively large prefectures, such as Tokyo, Osaka, and Aichi, but is negatively associated with real condominium prices in Hokkaido and the nation overall. However, a positive relationship between condominium prices and compensation is reported for the nation once Chinese money is included.[12]

Next, a stricter definition of bubbles in the Japanese condominium market is tested with the alternative hypothesis of the explosive case. The residual (e_t) in Eq. (5) is the ECM given in Table 5. Table 6 shows weak evidence of explosive bubbles when nominal condominium prices alone are examined. Figure 3 shows possible explosive bubbles in the nominal price data of the nation and Tokyo in early 2014, implying the effectiveness of Prime Minister Abe's economic policy in property markets. However, such evidence becomes much weaker when economic fundamentals are analyzed together, suggesting that possible explosive moments occur at the same time in both condominium prices and economic fundamentals including the CPI. Furthermore, more robust explosive tests (i.e. SADF and GSADF) suggest virtually no evidence of bubbles. In order to conduct the GSADF test, which allows the starting point to change, we set $r_0 = 0.01 + 1.8\sqrt{T}$, as recommended by Phillips et al. (2014). The critical values (95 and 99%) for the finite sample are obtained from a Monte Carlo simulation of 1,000 iterations. The corresponding p-values are greater than 5%, which implies that no explosive bubbles exist in the Japanese condominium market. However, as discussed before, this result does not mean that there is no bubble, but rather that there appears to be no explosive bubble. (Mild bubbles are analyzed by use of cointegration in Section 6.)

The perception of bubbles is sensitive to the researcher's choice of variables to represent economic fundamentals. Thus, we check the robustness of our finding by substituting land prices for real employee compensation, real mortgage rates and Chinese money, and conduct the explosive unit root tests to the ratio of condominium prices to land prices. The results reported in Table 6 alongside the results of the previous version of the model, show no evidence of explosive bubbles in the Japanese condominium market. This result reinforces our finding from the conventional unit root tests (Table 3) that there may be mild bubbles when residential land prices alone are used to measure economic

[12]No improvement occurred in the performance of regional models even when Chinese money was included in the ECM. For this reason, we carry out regional cointegration analyses without Chinese money.

fundamentals. Since the explosive unit root test does not give us much information about cointegration (non-bubble periods), in Section 6 we use the ECM to analyze the relationship between condominium prices and the standard economic fundamentals (i.e. real employee compensation, real mortgage rates and Chinese money).

6 Analyses of mild bubbles and condominium price inflation

We analyze the short-term dynamics of condominium prices by calculating the ECM for the long-run analysis, and during the process we also study mild bubbles in the condominium market. We measure dynamic price behaviors as annual changes, a popular measure since policymakers are often interested in general market trends.

Transaction volume is often used to explain movements in stock prices and exchange rates; however, as briefly mentioned in Section 1, using transaction volume to explain movements in property markets is relatively new compared with other research fields in finance. Among those of property markets, after underscoring the importance of down-payments, Stein (1995) demonstrated numerically that the positive relationship between prices and volume is more robust to volatility implications. Furthermore, this relationship is shown to be stronger for repeat buyers who put existing homes on sales prior to purchasing new ones than for first-time buyers. Follain and Velz (1995) documented the negative relationship between home prices and housing sales when down-payments are significant. The life-cycle model of Ortalo-Magne and Rady (2006) further focuses on the overreaction of property prices to the income of young households. Indeed, to our knowledge, this study is the first to use transaction volume in an analysis of the Japanese condominium market. In the field of finance, the motivation for considering transaction volume is to capture investors' information that is relevant to short-term movements in asset prices. Considering transaction volume is also consistent with technical analysts' view that trading volume influences asset prices (Kapoff (1987)).

Most previous studies reported a positive correlation between trading volume and contemporaneous asset returns. For example, a positive relationship between stock returns and trading volume was reported by Karpoff (1987) and Gervais et al. (2001). Karpoff stated two stylized facts from previous literature: a positive relationship between volume and the absolute value of changes in stock prices, and a positive relationship between trading volume and changes in stock prices. Gervais et al. argued that this high volume premium was created by stocks' visibility, which results in increased demand.[13] Further, trading volume is often discussed in finance literature as being highly positively correlated with public information; in other words, more information is conveyed to equity investors at times of high trading volume. In exchange rate studies, order flows which are transaction volume with signs (plus or minus) are used to differentiate between informed traders and uninformed traders. They are used to explain intraday changes in exchange rates during very short time periods (Lyons (1995), Evans and Lyons (2002)).[14] The data used in this study generally confirm this positive relationship. Generally, Table 7 shows positive contemporaneous correlation between transaction volume and condominium price inflation, but less correlation between lagged transaction volume and condominium price inflation in all cases, even turning negative in two cases.

Table 8 summarizes the results from OLS estimation of cointegration equation (Eq. (4)). As discussed, the presence of the cointegration (i.e. a long-run relationship between prices and their economic fundamentals) and mild bubbles can be tested by estimating the adjustment coefficient (c) in Eq. (4). This estimated parameter is negative and remains within the theoretical range. Therefore, the ECM is stationary, which confirms that condominium prices can be explained by the standard economic fundamentals in the long-run and suggests that no mild bubbles exist in the market despite the recent hike in prices. While our research focuses only on the condominium market, our conclusion of no bubbles in this market implies the absence of bubbles in the Japanese property market in general. This is in line with Figure 2 where prices of other property markets have shown a rather slow recovery after the Lehman shock, and this trend has not changed much in the more recent period. Further, this is the statistical hypothesis for which the explosive

[13] Although not directly related to this study, a negative relationship between lagged trading volume and stock returns has been reported. For example, Campbell et al. (1993) showed that the autocorrelation of daily stock returns is low when trading volume is high. They argued that this is due to a shift in the demand for stocks of uninformed traders: a low stock return can be caused by either an increase in aggregate risk aversion or realization about the probability of lower future cash flow.

[14] In finance research, high frequency (intraday) data are used to capture short-term movements. In contrast, in this study monthly data are used because that is the frequency of data available. However, monthly data are reasonable for analyzing the real estate market, in which trades occur much less frequently than they do in equity markets and foreign exchange markets.

unit root tests could not test due to the formulation of a different alternative hypothesis; therefore this result is not inconsistent with our previous finding. Moreover, we observe that the adjustment speed for condominium prices seems slightly faster in urban areas: a positive relationship is observed between price adjustment speed and transaction volume.

Many additional explanatory variables, in the first difference form, are found to have parameter signs consistent with economic theory. The coefficient on real employee compensation is positive, the coefficient on the mortgage rate is negative, and both are statistically significant. The increase in population would be expected to impose inflationary pressure on the condominium market, but we find few statistically significant links between population and condominium price inflation. Similarly, in most cases analyzed, the coefficient on the number of condominiums construction starts during the period has a negative sign, which is consistent with economic theory, but it is not statistically significant. In short, real employee compensation and the real mortgage rate are highly influential over condominium prices even in the short-term.

Finally, evidence that transaction volume has accelerated condominium price inflation is mixed, although in four of the five cases the coefficient is positive. A positive relationship exists for Osaka and for the nation overall, and results for the other three prefectures analyzed are statistically insignificant. Furthermore, a negative relationship (although statistically insignificant) is found for Tokyo. A somewhat weaker relationship compared with other countries analyses may be related to market imperfection. Mortgage loans are expected to be returned by the age of 70 to 75 years, and most private transactions in Japan are carried out by first-time buyers at an average age of 35 who are more likely to face liquidity constraints (due to down-payments). Hayashi et al. (1988) demonstrated that lack of developments in these markets led consumers to save for down-payments and to acquire residential properties late in life. Given these unclear results with regard to transaction volume, we analyze disaggregate transaction volume data in order to investigate who affects condominium price inflation.

7 Who has the most influence over condominium prices?

In this section of the paper, rather than aggregate transaction volume, volumes for the following four types of condominium transactions are used in the equation for condominium price inflation: from individuals to individuals, from individuals to companies, from companies to individuals, and from companies to companies. As shown in Table 1, approximately 50% of condominium transactions were conducted between individuals. The second most common transaction type (approximately 30%) was for companies selling condominiums to individuals.

Table 9 summarizes the results of the OLS estimation. These results reveal why the results based on aggregate transaction volume (see Table 8) are unclear. Table 9 shows that the results are somewhat dependent on the types of trader involved in the transaction and the prefecture in which the condominium is located; in fact, both negative and positive relationships can be observed in all prefectures. However, only a positive relationship is statistically significant. This positive relationship is found for sales from individuals to companies in Hokkaido and Aichi and for sales between companies in Hokkaido and Osaka. In addition, two cases in Tokyo, in which individuals act as the seller, show a positive relationship, but the relationship is statistically insignificant in both cases.

It is interesting to note that a statistically significant positive relationship between transaction volume and condominium price changes can be observed in transactions in which companies are the buyer. This relationship is consistent with the fact that companies, rather than individual consumers, benefit from the initial (weak) economic recovery and are thus considered to be in better financial condition (i.e. with less liquidity constraints). Furthermore, compared to individuals, companies often invest in more expensive condominiums and have access to (public) information that enables them to more accurately assess market conditions. Therefore despite the relatively lower frequency of transactions involving companies, companies (not individual consumers) have been the driving force behind the condominium price inflation since April 2008. Finally, consistent with the findings from Section 5, the ECM remains negative and within the theoretical range, which is indifferent whether or not the ECM contains Chinese money.

8 Conclusion

In this paper, we have studied the movement of condominium prices in Japan since April 2008. This research topic is important because, for many people, a residence is the most expensive product they will purchase in their lifetime, and its price increases significantly affect their quality of life. Furthermore, in Japan condominiums are a very popular type of housing, one whose price increases have outpaced those of other types of residential property and are expected to continue, due in part to the 2020 Summer Olympic Games in Tokyo and the concomitant expected increases in the number of foreign residents (notably Chinese people).

By using the concept of integration, we have examined the unique data set that has only been made available recently. Initially, in order to identify tranquil periods and deal with deficiencies in existing approaches, we proposed a combination of traditional and explosive tests. Then we have shown, based on the standard model specification for economic fundamentals and two definitions of a bubble, that there is no evidence of mild or explosive bubbles in the Japanese condominium market during the period analyzed; long-run prices can be explained by economic fundamentals, such as employee compensation and the mortgage rate. We also report a positive long-run relationship between condominium prices and Chinese money, suggesting that the increased number of foreign residents does indeed push property prices higher. Furthermore, consistent with theoretical predictions, transaction volume contains information that is useful for explaining transitory movements in condominium prices. That is, increases in volume, especially increases in companies' transaction volume, are often associated with higher condominium price inflation. Thus, in line with market microstructure models in finance, we can see that transaction volume contains private information that induces volatility and uncertainty in the markets.

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Table 1: Basic summary and sources of the data

		Mean	Std Dev	Unit	Source
Condominium nominal prices					
	Nation	103.690	6.561	Index, 2010=100	MLIT
	Hokkaido	111.930	14.100		MLIT
	Tokyo	102.356	6.498		MLIT
	Aichi	102.842	6.612		MLIT
	Osaka	103.785	5.774		MLIT
CPI					
	Nation	100.894	1.465	Index, 2010=100	Datastream (JPCONPRCE)
	Hokkaido	101.567	1.905	Index, 2010=100	e-Stat
	Tokyo	100.390	1.332		e-Stat
	Aichi	100.959	1.525		e-Stat
	Osaka	100.970	1.563		e-Stat
Transaction volumes (Aggregate)					
	Nation	12787.740	230.873	Unit	MLIT
	Hokkaido	403.000	73.282		MLIT
	Tokyo	3796.753	628.371		MLIT
	Aichi	578.494	108.427		MLIT
	Osaka	1511.741	260.745		MLIT
Transaction volumes (Individuals to Individuals)					
	Nation	6343.976	132.836	Unit	MLIT
	Hokkaido	234.459	47.570		MLIT
	Tokyo	1523.141	339.595		MLIT
	Aichi	332.918	75.980		MLIT
	Osaka	762.365	146.764		MLIT
Transaction volumes (Individuals to Companies)					
	Nation	2297.282	52.034	Unit	MLIT
	Hokkaido	70.753	16.958		MLIT
	Tokyo	740.588	163.263		MLIT
	Aichi	104.835	19.221		MLIT
	Osaka	286.588	87.552		MLIT
Transaction volumes (Companies to Individuals)					
	Nation	3740.694	88.437	Unit	MLIT
	Hokkaido	88.28235	25.41073		MLIT
	Tokyo	1355.718	312.6904		MLIT
	Aichi	128.4118	31.91779		MLIT
	Osaka	416.3294	91.36483		MLIT
Transaction volumes (Companies to Companies)					
	Nation	395.188	9.320	Unit	MLIT
	Hokkaido	9.471	5.277		MLIT
	Tokyo	174.741	51.179		MLIT
	Aichi	12.318	5.701		MLIT
	Osaka	46.082	19.703		MLIT
Migration (net)					
	Hokkaido	-744.356	1458.6	People	e-Stat
	Tokyo	5257.598	8699.782		e-Stat
	Aichi	583.6092	1123.271		e-Stat
	Osaka	53.86207	1039.758		e-Stat
National population		1.28E+08	246185.6	People	e-Stat
Employee compensation		247901.1	4316.898	Billion yen	Datastream (JPCOMEMPB)
Construction starts (apartments)		9706.667	2933.417	Unit	Datastream(JPHOUSAPP)
Mortgage rates		2.516379	0.118667	%	Datastream (JPFHOUSE)

Notes: The Ministry of Land, Infrastructure, Transport and Tourism (MLIT). The e-Stat is a data set organized by the Ministry of Internal Affairs and Communication. The code numbers are stated in the bracket for variables from Datastream. All data were downloaded on a monthly basis except employee compensation which is converted from quarterly to monthly using the function (cubic-match last) in Eviews 8. The sample period is from 2008M4 to 2015M4.

Table 2: Correlation between real estate prices

	Overall	Condominium prices	Housing prices	Residential land prices
Overall	1.000	0.509	0.788	0.528
Condominium prices	0.509	1.000	-0.083	-0.424
Housing prices	0.788	-0.083	1.000	0.803
Residential land prices	0.528	-0.424	0.803	1.000

Notes: Statistics are based on national and raw (non-log) values. The sample period is from 2008M4 to 2015M4.

Table 3: The conventional unit root tests

Variables tested	Level		First difference	
	Statistics	*p*-value	Statistics	*p*-value
National level				
Nominal condominium prices	2.025	1.000	-2.781	0.066
Real condominium prices	1.128	0.998	-3.036	0.037
Condominium prices/residential land prices	0.458	0.984	–	–
Hokkaido				
Nominal condominium prices	1.869	1.000	-2.435	0.137
Real condominium prices	1.313	0.999	-5.609	0.000
Condominium prices/residential land prices	-0.024	0.953	–	–
Tokyo				
Nominal condominium prices	1.736	1.000	-0.970	0.761
Real condominium prices	1.171	0.998	-2.898	0.050
Condominium prices/residential land prices	-1.610	0.473	–	–
Aichi				
Nominal condominium prices	0.909	0.995	-2.811	0.062
Real condominium prices	-1.529	0.515	-3.515	0.010
Condominium prices/residential land prices	-1.098	0.714	–	–
Osaka				
Nominal condominium prices	0.422	0.983	-3.070	0.033
Real condominium prices	-0.190	0.935	-4.733	0.000
Condominium prices/residential land prices	-1.176	0.682	–	–

Notes: The results are based on the Augmented Dicky-Fuller (ADF) unit root tests where the appropriate lag length is determined by the Akaike information criterion and the constant term is included. The sample period is from 2008M4 to 2015M4.

Table 4: The causality between condominium and land price inflation

Null hypothesis	F-statistic	p-value
Condominium price inflation do not cause land price inflation	1.912	0.066
Land price inflation do not cause condominium price inflation	0.937	0.523

Notes: Full sample. F tests are based on VAR(12) for annual inflation in condominiums and residential lands. The sample period is from 2008M4 to 2015M4.

Table 5: The long-run relationship between real condominium prices and economic fundamentals

Variable	Coef	Std. Err	p-value	Coef	Std. Err	p-value
	Nation^a			Nation^b		
Constant	3.698	16.544	0.824	-20.344	24.22	0.403
Real compensation	-0.463	2.120	0.828	0.753	1.707	0.660
Real mortgage rate	-0.025	0.008	0.002	-0.032	0.007	0.000
Chinese money				1.087	1.055	0.306
	Hokkaido			Aichi		
Constant	22.038	13.542	0.108	-6.572	10.436	0.531
Real compensation	-2.806	1.738	0.110	0.848	1.336	0.527
Real mortgage rate	-0.029	0.013	0.036	-0.014	0.009	0.103
	Tokyo			Osaka		
Constant	-2.611	6.878	0.705	-6.887	4.580	0.137
Real compensation	0.345	0.882	0.697	0.891	0.585	0.132
Real mortgage rate	-0.027	0.013	0.038	-0.019	0.008	0.024

Notes: Heteroscedasticity and autocorrelation consistent (HAC) standard errors are calculated using Bartlett kernel and Newely-West bandwidth equal to 4. The sample period is from 2008M4 to 2015M4. Nation^a comprises of the real compensation and real mortgage rate in the ECM while Nation^b comprises of the real compensation, real mortgage rate and Chinese money in the ECM.

Table 6: Tests for explosive bubbles for real condominium price equation

	Nation	Hokkaido	Tokyo	Aichi	Osaka	Critical value	
	Stat	Stat	Stat	Stat	Stat	99%	95%
Nominal prices with the constant							
ADF	0.519	-1.052	-0.490	-1.980	-1.080	0.475	0.017
RADF	0.301	-0.713	0.662	-0.741	-1.080	0.777	0.068
SADF	0.219	-0.853	-0.490	-1.715	-1.499	1.851	1.211
GSADF	0.790	-0.509	0.789	-0.760	-1.098	2.648	2.062
Real prices with the real compensation, real mortgage rate, Chinese money[a]							
ADF	-0.721	-4.562	-1.335	-2.471	-2.388	0.475	0.017
RADF	0.022	-1.533	0.881	-1.163	-1.086	0.777	0.068
SADF	-0.788	-1.534	0.757	-1.263	-1.105	1.851	1.211
GSADF	0.022	-1.305	0.888	-0.911	-1.057	2.648	2.062
Condominium-land price ratio with the constant							
ADF	-0.792	-2.803	-3.303	-2.765	-3.468	0.475	0.017
RADF	0.153	-0.908	-1.158	-1.134	-1.202	0.777	0.068
SADF	-0.936	-0.908	-1.533	-1.938	-2.166	1.851	1.211
GSADF	0.166	-0.908	-1.158	-0.931	-1.202	2.648	2.062

Notes: Critical values are obtained from a Monte Carlo simulation of 1,000 iterations. Here, the ADF is the right-tailed unit root test. [a]Chinese money is included in the ECM only for Nation.

Table 7: Correlation between real condominium price inflation and transaction volume

	Contemporaneous correlation	Lagged correlation
	Transaction volume (t)	Transaction volume ($t-1$)
National level		
Condominium price inflation (t)	0.167	0.125
Hokkaido		
Condominium price inflation (t)	-0.022	-0.027
Tokyo		
Condominium price inflation (t)	0.259	0.169
Aichi		
Condominium price inflation (t)	0.094	-0.006
Osaka		
Condominium price inflation (t)	0.161	0.089

Notes: Inflation is measured by annual rates. The sample period is from 2008M4 to 2015M4.

Table 8: Results from the real condominium price equation at the national and regional levels

Variable	Coef	Std Err	p-value	Coef	Std Err	p-value
	Nation^a			Nation^b		
Constant	-0.280	0.160	0.085	-0.033	0.172	0.849
Real compensation	5.294	2.549	0.042	4.772	2.341	0.046
Real mortgage	-0.018	0.003	0.000	-0.016	0.004	0.000
Volume	0.038	0.015	0.015	0.035	0.016	0.029
Construction starts	0.002	0.010	0.866	-0.023	0.010	0.021
Population changes	-1.911	1.575	0.230	0.004	1.691	0.998
ECM	-0.613	0.145	0.000	-0.478	0.201	0.020
	Hokkaido			Aichi		
Constant	-0.036	0.152	0.811	0.414	0.514	0.423
Real compensation	8.498	3.332	0.013	17.307	3.833	0.000
Real mortgage	-0.005	0.002	0.044	-0.010	0.005	0.064
Volume	0.013	0.025	0.605	0.015	0.026	0.571
Construction starts	-0.013	0.016	0.445	-0.005	0.005	0.354
Net migration	0.000	0.000	0.900	0.000	0.000	0.275
ECM	-0.626	0.196	0.002	-0.720	0.213	0.001
	Tokyo			Osaka		
Constant	0.639	0.250	0.013	-0.374	0.277	0.182
Real compensation	14.929	2.837	0.000	8.641	2.122	0.000
Real mortgage	-0.017	0.004	0.000	-0.015	0.005	0.002
Volume	-0.005	0.016	0.734	0.064	0.026	0.016
Construction starts	-0.007	0.002	0.001	-0.001	0.001	0.599
Net migration	0.000	0.000	0.000	0.000	0.000	0.070
ECM	-0.882	0.172	0.000	-0.812	0.273	0.004

Notes: Heteroscedasticity and autocorrelation consistent (HAC) standard errors are calculated using Bartlett kernel and Newely-West bandwidth equal to 4. The sample period is from 2008M4 to 2015M4. Nation^a comprises of the real compensation and real mortgage rate in the ECM while Nation^b comprises of the real compensation, real mortgage and Chinese money.

Table 9: Disaggregate transaction volume in the real condominium price equation

Variable	Coef	Std Err	p-value	Coef	Std Err	p-value
	Nation[a]			Nation[b]		
Constant	-0.256	0.139	0.072	0.006	0.167	0.972
Real compensation	5.221	2.347	0.030	4.660	2.374	0.054
Real mortgage rate	-0.017	0.003	0.000	-0.016	0.004	0.001
Vol(Ind $\rightarrow$ Ind)	-0.008	0.024	0.741	-0.011	0.028	0.694
Vol(Ind $\rightarrow$ Com)	0.035	0.020	0.090	0.027	0.018	0.133
Vol(Com $\rightarrow$ Ind)	0.020	0.023	0.374	0.027	0.024	0.259
Vol(Com $\rightarrow$ Com)	-0.002	0.008	0.781	-0.004	0.008	0.639
Construction starts	-1.780	1.541	0.253	0.068	1.808	0.970
Population changes	0.002	0.010	0.863	-0.024	0.011	0.042
ECM	-0.709	0.167	0.000	-0.533	0.205	0.012
	Hokkaido			Aichi		
Constant	-0.346	0.466	0.461	0.114	0.465	0.807
Real compensation	4.615	4.237	0.280	16.993	3.616	0.000
Real mortgage rate	-0.004	0.005	0.473	-0.008	0.005	0.118
Vol(Ind $\rightarrow$ Ind)	-0.012	0.043	0.773	-0.007	0.027	0.791
Vol(Ind $\rightarrow$ Com)	0.071	0.030	0.022	0.084	0.028	0.004
Vol(Com $\rightarrow$ Ind)	-0.042	0.032	0.195	-0.037	0.025	0.134
Vol(Com $\rightarrow$ Com)	0.024	0.008	0.005	0.003	0.011	0.776
Construction stars	0.003	0.004	0.465	-0.003	0.005	0.558
Net migration	0.000	0.000	0.565	0.000	0.000	0.273
ECM	-0.202	0.155	0.196	-0.845	0.158	0.000
	Tokyo			Osaka		
Constant	0.487	0.262	0.068	-0.399	0.321	0.219
Real compensation	11.734	2.681	0.000	11.443	1.752	0.000
Real mortgage rate	-0.015	0.005	0.002	-0.017	0.004	0.000
Vol(Ind $\rightarrow$ Ind)	0.005	0.039	0.891	0.012	0.022	0.574
Vol(Ind $\rightarrow$ Com)	0.053	0.032	0.102	0.027	0.025	0.279
Vol(Com $\rightarrow$ Ind)	-0.015	0.025	0.551	-0.014	0.019	0.471
Vol(Com $\rightarrow$ Com)	-0.018	0.017	0.300	0.024	0.010	0.015
Construction starts	-0.007	0.002	0.002	0.002	0.003	0.557
Net migration	0.000	0.000	0.001	0.000	0.000	0.010
ECM	-0.910	0.194	0.000	-0.998	0.201	0.000

Notes: Heteroscedasticity and autocorrelation consistent (HAC) standard errors are calculated using Bartlett kernel and Newely-West bandwidth equal to 4. The sample period is from 2008M4 to 2015M4. Nation[a] comprises of the real compensation and real mortgage rate in the ECM while Nation[b] comprises of the real compensation, real mortgage and Chinese money.

Figure 1: Regional condominium price indexes (nominal values, 2008M4-2015M4)

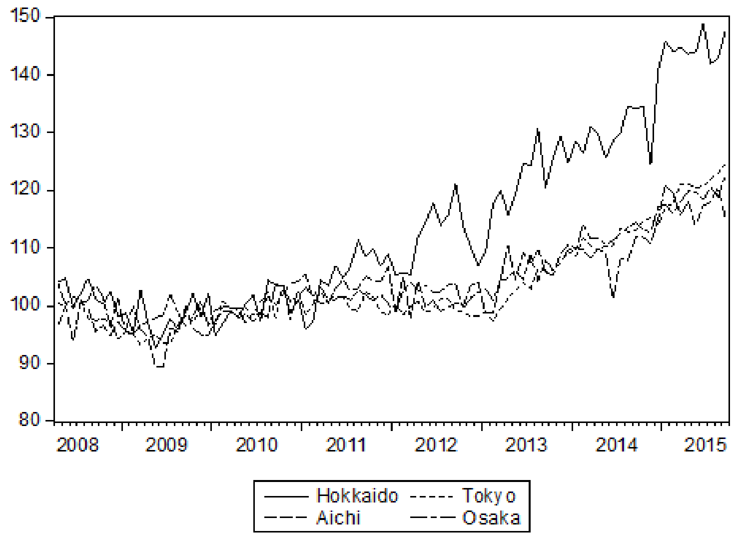
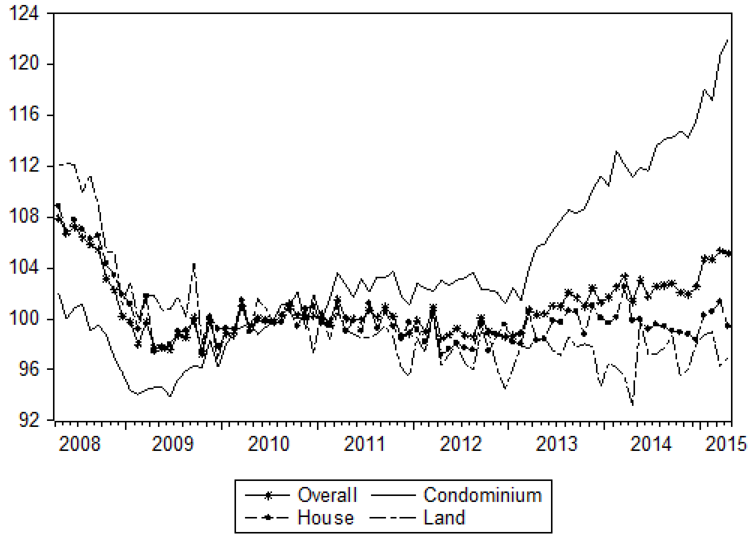


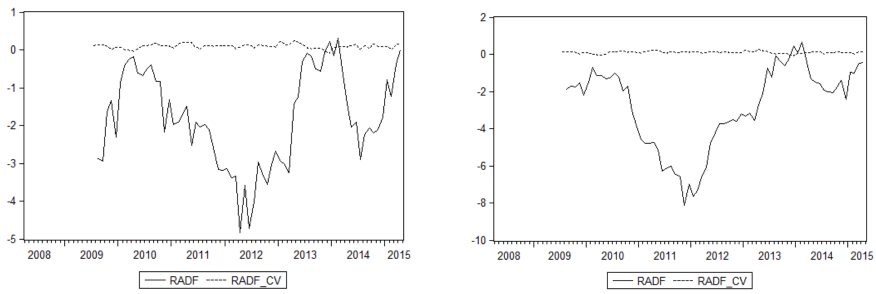
Figure 2: Real estate prices (national average)



Note: Statistics are at the national level. 2008M4-2015M4.

Figure 3: Explosive unit root test results applied to nominal condominium prices

Nation Tokyo



Note: Statistics based on the rolling ADF. The rolling window size is 17.