Can Housing Prices be Justified by Economic Fundamentals? Evidence from Regional Housing Markets of Korea

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Abstract

In this paper, we employ the present-value approach to examine the dynamics of six regional housing markets of Korea. The large upswing in the price-rent ratio accompanied by intermittent ups and downs, a typical feature of the Korean housing market since the mid-80s, is captured by a periodically collapsing bubble incorporated in an otherwise standard present value model. The movements in the actual price-rent ratio are then decomposed into those explained by the expectations of housing market fundamentals (i.e., the rent growth, risk-free interest rate, and excess returns from housing investment) and the speculative bubble. In all of the six regional markets, most of the variations in the fundamental part of the price-rent ratio are explained by the expected risk premium of housing investment and then by the expected risk-free returns, whereas the expected rent growth account for relatively small fractions of the variations. It is also found that the bubble has continuously accumulated since the early 2000s in all of the six regions, reaching as high as 70% of the house price around the end of 2017.

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Since the mid-80s, there have been three major episodes of housing market boom in Korea. The first boom during 1988:Q1-1991:Q3 marked the annual average of the real house price as high as 14.2%. As the economy bounced back from the Asian currency crisis, the second boom came along. Over 2001:Q4-2004:Q2, the real house price increased by 12.3% per annum and recovered most of the losses since the previous peak. The most recent boom prevailed during 2006:Q4-2007:Q4, registering a 7.6% increase in the real house price per annum. While in general there has been a decline in global real house prices, the patterns of price changes among different regions are not so consistent. For example, during the second episode of bull market, the accumulated rate of nominal increase in house price in Seoul was 49.7%, which is almost double of the 28.5% increase in the other 6 large cities. Even within the capital city of Seoul, a pronounced tendency of housing price de-coupling is frequently observed between the relatively recently developed Gangnam area and the traditional old city area of Gangbuk.

In this paper, we examine whether the house price movements in Korea reflect the existence of housing bubble or whether the changes in fundamentals. Compared to nearly perfect markets, such as stock market, housing market is usually regarded as a locally separated market, given the fact that properties are heterogeneous and immobile among locations. We therefore ask the following specific questions: First, are the movements in housing price mostly responses to changes in market fundamentals or reflecting a speculative bubble? Second, what is the driver of housing prices among its fundamental determinants? Third, how consistent are the answers to the above two questions across different regions?

To address these questions, we need a baseline model for describing how prices of housing units are determined. Maintaining the view that housing units have dual features as a durable good providing housing service and as an asset as well, we use the present value model proposed by
Campbell and Shiller (1988a, b). Tying the price of an asset to the expected value of the future payoff stream accruing to the asset, the present-value model predicts that house price and rents should move more or less in tandem. In terms of the low frequency properties of data, it follows that house prices and rents should be of the same order of integration, and that if the two variables are both nonstationary in level but stationary in first differences, they should be cointegrated so that their ratio (i.e., the price-to-rent ratio) is stationary\(^4\).

The actual movements in the price-rent ratio, however, often stand in contrast to the prediction of the present value model. The plots in Figure 1 provide a clear illustration, in terms of housing market data in Seoul since 1979:Q1. In the earlier part of the sample period, real rents in panel (b) tended to move together with real house price, yielding a stable price-rent ratio. Since the end of the crisis, however, real rents has steadily decreased by 2.5% per annum with its own troughs and peaks around the decreasing trend, whereas the real house price has registered unprecedented increases over a decade. In a nutshell, the price-rent ratio in panel (c) exhibits occurrences of boom-bust around the large upswing in the ratio itself, which is in contrast to the prediction of the present-value model.

[Figure 1 about here]

The standard present value model a la Campbell and Shiller decomposes changes in the price to rent ratio into changes in the expected paths of rent price growth rates, risk-free rates and risk premiums for (or equivalently, excess returns from) housing investment. A fourth “model consistent” factor that we suspect affects the price to rent ratio is the rational bubble component. We

\(^4\) Resorting to these features, quite a few papers have applied the present value model to stock market (e.g., Cochrane (1992) and Campbell and Ammer(1993)) or housing market (e.g., Campbell et al. (2009) and Kishor and Morely (2014)).
particularly note that the intermittent buildup and collapse of the price-rent ratio cannot be adequately explained by linear relations between house price and its drivers including bubbles. To account for this feature, we extend the standard present value model to incorporate a special class of rational bubbles, i.e., those which periodically gestate, bust, and then reappear as in Balke and Wohar (2009). Using the present-value model thus modified, we decompose the movements in the price-rent ratios into what is attributable to the housing market fundamentals and the bubble, so that we can address the main questions posited above. Based on the results, we assess the diversity and similarities between the behavior of house prices in the six largest cities of Korea, in terms of the role played by fundamentals and bubble. To the best of our knowledge, no previous studies have examined the possibility of periodically collapsing bubble in the regional housing markets of Korea.

Two main findings emerge from our study. First, when we focus on the fundamental part of the price-rent ratio, the main driver of the regional housing markets of Korea is the expectation of excess returns to housing investment and then that of the risk-free returns, not the intrinsic rent payments. Second, the onset of a continued bubble build-up is detected in the early 2000s in all regions, where the percentage of speculative bubble in actual real house prices are as high as 70% at the end of 2017. These findings are robust to the use of a different interest rate data and the post-1999 subsample.

The remainder of this paper is organized as follows. In Section 2, we present the workhorse model of the housing market and briefly describe the data used. In Section 3, we present and discuss the estimation results, focusing on the relative results of the tests. Section 4 presents a sensitivity analysis of the results, and Section 5 concludes.
2. The Model, Data, and Key Estimates

2.1 A Present-value model with collapsing bubbles

We follow Campbell et al. (2009) and Balke and Wohar (2009) to construct a theoretical home pricing model for the housing market. We set off with the definition of the realized gross real return from holding a housing unit

\[ H_{t+1} = \frac{(P_{t+1} + R_{t+1})}{P_t} \]  

where \( H_{t+1} \) denotes the real gross return on a home held from time \( t \) to \( t + 1 \), \( P_{t+1} \) is the real house price at the end of period \( t+1 \), and \( R_{t+1} \) is the real rent payment received from time \( t \) to \( t + 1 \).

Applying the Campbell-Shiller approximation, we have

\[ pr_t = \mathcal{K} + \rho pr_{t+1} + \Delta r_{t+1} - h_{t+1} \]  

where \( pr_t = \log(P_t/R_t) \), \( r_{t+1} = \log(R_{t+1}/R_t) \), \( h_{t+1} = \log(H_{t+1}) \), \( \rho = e^{pr}/(1 + e^{pr}) \), \( \overline{pr} \) is the average of the log of price-rent ratio over the sample, and \( \mathcal{K} \) is a linearization constant. Absent any explosive behavior in \( pr_t \), we obtain the standard present-value formula

\[ pr_t = \frac{\mathcal{K}}{1 - \rho} + E_t\{ \sum_{j=0}^{\infty} \rho^j \left( \Delta r_{t+j+1} - h_{t+j+1} \right) \} \]

which implies that the log of the price-rent ratio is a weighted discounted sum of the expected future rent growth \( \Delta r_{t+j+1} \) and gross real return \( h_{t+j+1} \), for \( j \geq 0 \).

We make two modifications to the present value formula above: first, as in Campbell and Ammer (1993) and Campbell et al. (2009), the log of gross real return, \( h_t \), is broken down into the real interest rate, \( i_t \) (corresponding to the risk-free rate of return), and the excess rate of return, \( \pi_t \) (reflecting the risk premium for investing in housing). Second, we allow the price-rent ratio to deviate from what is predicted by (3):

\[ pr_t = \frac{\mathcal{K}}{1 - \rho} + E_t\{ \sum_{j=0}^{\infty} \rho^j \left( \Delta r_{t+j+1} - i_{t+j+1} - \pi_{t+j+1} \right) \} + b_t = pr_t^f + b_t \]  

(4)
where \( pr_t^f \) is the *fundamental* price-rent ratio determined by the expectations of the three housing market fundamentals \((\Delta r, i, \pi)\), and \( b_t \) captures the deviations of the actual ratio from the fundamental level.

Following van Binsbergen and Koijen (2010), we treat the one-period-ahead expectations of rent growth, \( g_t = E_t[\Delta r_{t+1}] \), real interest rate, \( \mu_t = E_t[i_{t+1}] \), and housing risk premium, \( \lambda_t = E_t[\pi_{t+1}] \), as unobserved components following parsimonious AR(2) processes:

\[
\begin{align*}
    g_t - y_0 &= y_1(g_{t-1} - y_0) + y_2(g_{t-2} - y_0) + \epsilon_t^g, \\
    \mu_t - \delta_0 &= \delta_1(\mu_{t-1} - \delta_0) + \delta_2(\mu_{t-2} - \delta_0) + \epsilon_t^\mu, \\
    \lambda_t - \theta_0 &= \theta_1(\lambda_{t-1} - \theta_0) + \theta_2(\lambda_{t-2} - \theta_0) + \epsilon_t^\lambda,
\end{align*}
\]

where the innovations \( \epsilon_t = (\epsilon_t^g, \epsilon_t^\mu, \epsilon_t^\lambda) \) can be interpreted as the effects of news on the expectations. We assume that \( \epsilon_t \) follows an i.i.d. Gaussian process with a general covariance matrix \( \Sigma_\epsilon \). The law of motion in (5a)-(5c) can be recursively used in equation (3) to pin down the fundamental price-rent ratio, so that

\[
pr_t = pr_t^f + b_t
\]

\[
= \frac{\kappa}{1-\rho} + \left[ \frac{y_0}{1-\rho} + B_1 G_t \right] - \left[ \frac{\delta_0}{1-\rho} + B_2 M_t \right] - \left[ \frac{\theta_0}{1-\rho} + B_3 \Lambda_t \right] + b_t
\]

where \( G_t = \begin{bmatrix} g_t - y_0 \\ g_{t-1} - y_0 \end{bmatrix} \), \( M_t = \begin{bmatrix} \mu_t - \delta_0 \\ \mu_{t-1} - \delta_0 \end{bmatrix} \), and \( \Lambda_t = \begin{bmatrix} \lambda_t - \theta_0 \\ \lambda_{t-1} - \theta_0 \end{bmatrix} \). The factor loading coefficients \((B_1, B_2, B_3)\) in the second line of (5) measure how much the three expectation terms contribute to the fundamental ratio.

In principle, the non-fundamental deviation \( b_t \) may reflect irrational behavior such as fads (e.g., Summers (1986) and Shiller and Perron (1985)) as well as rational speculation. Resorting to previous studies of the Korean housing market, however, we interpret \( b_t \) as representing a rational speculative bubble\(^6\). We further follow Balke and Wohar (2009) and specify \( b_t \) as a periodically

\(^5\) At an earlier stage of this study, we also tried the AR(1) specification but the AR(2) specification turned out to far better fit the data.

\(^6\) Using the regime switching model of van Norden (1996), Kim and Min (2011) find evidence supporting
collapsing bubble switching between the non-exploding regime and the exploding regime. The realizations of the bubble regime are governed by a hidden state variable $S_t$, which follows a Markov regime-switching process with the transition probabilities

$$\text{Prob}[S_t = 1|S_{t-1} = 1] = p, \quad \text{Prob}[S_t = 0|S_{t-1} = 0] = q.$$  \hspace{1cm} (7)

which is time-invariant and independent of any other disturbances. In the regime with $S_t=0$, $b_t$ follows a stationary AR process:

$$b_t = \bar{b} + \psi b_{t-1} + \epsilon^b_t, \quad 0 < \psi < 1$$ \hspace{1cm} (8a)

so that $b_t$ dies out slowly in the absence of the innovation $\epsilon^b_t$ in the bubble. This regime is dubbed the non-exploding regime. If the regime switches from the non-exploding one to the exploding one (i.e., $S_{t-1} = 0$ precedes by $S_t = 1$), $b_t$ evolves as

$$b_t = -\frac{q}{(1-q)}\bar{b} + \frac{1}{1-q} \left[ 1 - q\psi \right] b_{t-1} + \epsilon^b_t.$$ \hspace{1cm} (8b)

Finally, if the exploding regime continues (i.e., $S_{t-1} = 1$ is followed by $S_t = 1$), we have

$$b_t = -\frac{(1-p)}{p}\bar{b} + \frac{1}{p} \left[ 1 - (1-p)\psi \right] b_{t-1} + \epsilon^b_t.$$ \hspace{1cm} (8c)

Note that we are not imposing the non-negativity constraint on the bubble term $b_t$, because the bubble is formed in the price-rent ratio not in the price. Also, as Weil (1990) argues on theoretical grounds, it is possible for an asset to be undervalued when the economy is in a bubble equilibrium.

The model is closed with the measurement equations relating the observed data with their model counterparts. The actual price-rent ratio is related to the model components $(G_t, M_t, \Lambda_t, b_t)$ via equation (5), and the observations of the rent growth and real interest rate are put equal to the sum of respective one-step-ahead expectations and their idiosyncratic innovations:

the presence of sporadic speculative bubbles in the Korean housing market during 1997-2003. It is also generally accepted that the availability of easy credits has been the main cause of speculation since the early 2000s, encouraging ‘buying by borrowing’.

7 We specify $\epsilon^b_t$ as a Gaussian $i.i.d.$ process, independent of any other disturbances or innovations.

8 By using data series on the rent growth and real interest rate, we are in effect treating the contribution of housing
\[ \Delta r_t = \gamma_0 + g_{t-1} + u_t^r, \quad i_t = \delta_0 + \mu_{t-1} + u_t^i \]  

where the unexpected innovations, \( u_t = (u_t^r, u_t^i) \), follow Gaussian i.i.d. distribution with a diagonal covariance matrix, \( \Sigma_u = \text{diag}(\sigma_r^2, \sigma_i^2) \). We further assume that \( \varepsilon_t \) and \( u_t \) are mutually uncorrelated at any leads and lags.

The present-value model constructed above is cast into a state-space form with Markov-Switching, and estimated via the approximate maximum likelihood method of Kim and Nelson (1999)\(^9\).

2.2 Data

The raw data used in the present paper are the nominal interest rates, core CPI, and nominal purchase and chonsei prices in six largest cities, all spanning 1987:Q1 to 2017:Q4. The purchase and chonsei prices are taken from the Kookmin Bank database\(^10\), from which the price-rent ratio is constructed. The nominal interest rate is the AA-rate corporate bonds yields with 3-year maturity, considered a representative market rates in Korea. Nominal interest rates and CPI series are obtained from the Bank of Korea database. Real interest rate is then constructed as the difference between nominal rates and the actually realized rate of year-on-year inflation for the core CPI. Real interest rate thus constructed is used as the data for risk-free rates of return\(^11\).

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9 Due to the possible explosiveness of \( b_t \), the Kalman filter is seeded with an arbitrarily large variance for the initial bubble term. We put, again arbitrarily, the initial value of the bubble as \( \bar{b} \). Using 0 for the initial value of bubble did not change the estimation results in any significant way.

10 A monthly survey is sent out by the Kookmin Bank to real estate brokers inquiring the prices of sample properties. As such, the purchase and chonsei price indexes in a particular month may include the ‘asking’ prices for the sample properties not sold or rent in that month. Since price information on similar units are readily available even on a daily basis to the public, however, those indexes are considered very accurate.

11 The use of the AA- corporate bonds rate is dictated by the availability of interest rate data with sufficient length. Including risk premiums already, corporate bonds rates are likely to overstate the risk-free returns. We will deal with
Since chonsei contracts do not involve explicit rent payments, we need to construct the implicit quarterly rent payments. A problem is that both the purchase and chonsei price series are available as indexes only. Fortunately, their ratios for apartments are also available from 1999 on. We therefore rescale the chonsei price index to match the average purchase-to-chonsei price ratio in 2013, and then multiply the rescaled chonsei index with the nominal interest rate (divided by 4). The resulting implicit nominal rent index is then deflated into real terms by the core CPI, from which the real rent growth series are constructed.

The six regional log price to rent ratios are plotted (solid lines) in Figure 2, along with the nationwide average ratio (dotted lines). As we can see from the graphs, the price to rent ratio in all six cities is currently high compared to historical levels, where the upward trend for most regions started in the late 1990s. Despite the similar trend in the ratio throughout the sample period, dynamics of the regional price to rent ratios heterogeneous, especially since the early 2000s. Seoul exhibits almost the same pattern seen at the national level, while the other regions display a rather subdued rise in the ratio during the same period. The presence of heterogeneous dynamic patterns highlights the importance of regional-level analysis since it potentially enables us to detect regional housing bubbles that otherwise would have been missed within a national level analysis because of the averaging nature of the aggregate ratio.

[Figure 2 about here]
In Table 1 we list the sample mean ("Avg."), standard deviation ("SD"), and autocorrelation coefficient (p) for the annualized real growth rate of rents (columns 1–3), annualized real housing returns (4–6), and annualized excess returns (7–9) for our six housing markets over the entire sample. Shown in columns 4 and 7, real housing returns in the aggregate averaged 4.01% per year and excess returns averaged about -1.02% over our full sample. Across our six cities, average real housing returns range from 3.2% (Gwangju) to 5.1% (Ulsan). Shown in columns 5 and 8, the standard deviations of real and excess housing returns vary from about 7% to 10% per year, depending on the market and whether the total or excess return is considered. Excess returns tend to be more variable than total returns everywhere, and the returns of the first three larger cities tend to be more volatile than in the other smaller cities. In general, the first-order autocorrelations of housing returns (columns 6 and 9) range 0.6 to 0.8, about two times larger than that of rent growth (column 3).

2.3 Key Estimated parameters

Table 2 reports the key estimates of the model parameters. The top panel shows that the expectations of future real interest rate and excess returns change only very slowly as implied by the estimated long-run AR coefficients, i.e., \( \delta_1 + \delta_2 \) and \( \theta_1 + \theta_2 \) are around 0.97 and 0.92, respectively. In contrast, the expectation of future rent growth exhibits only a modest degree of persistence with the long-run AR coefficient around 0.45.
In the bottom panel, the estimated properties of the bubble components are reported. The transition probabilities for the two bubble regimes are sharply estimated. On average, the non-exploding regime is expected to last for $1/(1-0.934)=15.2$ quarters, but the exploding regime is very persistent with the average duration of $1/(1-0.992)=125$ quarters. The estimated AR coefficient and transition probabilities of the bubble term show the qualitatively different behavior of the bubble across the two regimes. In the non-exploding regime, the bubble process is stationary with $\psi$ around 0.9 on average, although it exhibits a considerable degree of inertia. In contrast, the bubble in the exploding regime is clearly self-reinforcing: for Seoul as an example, when the current bubble regime is explosive following the non-exploding one in the previous period, the AR coefficient $\frac{1}{1-q} \left[ \frac{1}{p} - q\psi \right]$ is as large as 2.78, exhibiting a sudden expansion of bubble in its gestation stage. If the bubble continues in the exploding regime, the AR coefficient $\frac{1}{p} \left[ \frac{1}{p} - (1-p)\psi \right]=1.01$ implies that the bubble is less explosive and close to a random walk.

3. What drives Regional Housing Markets in Korea?

We are ready to address the main questions of the paper. We first explain what determines the movements in the fundamental part of the price-rent ratio, and then examine the relative importance of the bubble and fundamental part. To save space, we only report here the results for Seoul and Ulsan, two cities most isolated in terms of geographic and socio-economic aspects. The results for the other cities are provided in the appendix.

3.1 Movements in the fundamental Price-Rent Ratio

Figures 3A and 3B shows the loadings of the expected market fundamentals (in solid lines) onto the fundamental price-rent ratio (in dotted lines) for the two cities. For the ease of comparison,
each series is plotted in mean-deviations. For both cities, even a casual inspection tells us that the expected excess returns in the bottom panel have made by far the largest contribution to the fundamental ratio, moving closely with the latter throughout the sample period. In contrast, the contributions of the other two expectations of housing market fundamentals are relatively small, if not negligible. Simple correlation coefficients with the fundamental ratio convey a similar picture: For Seoul as an example, the correlation between the expected rent growth and the fundamental ratio is as low as 0.201, but those for the expected risk-free returns and excess returns are 0.654 and 0.640, respectively. We also note that the expected risk-free returns capture the gentle rise in the fundamental ratio over the whole sample period. This finding supports that the continued fall in the interest rate has played some role in fueling the bullish runs in the 2000s.

[Figures 3A and 3B about here]

Having estimated the model parameters, we can decompose the unconditional variance of \( pr_t^f \) can be decomposed as follows:

\[
\begin{align*}
\text{var}(pr_t^f) &= B_1 \text{var}(G_t)B'_1 + B_2 \text{var}(M_t)B'_2 + B_3 \text{var}(\lambda_t)B'_3 \\
&\quad -2B_1 \text{cov}(G_t, M_t)B'_2 - 2B_1 \text{cov}(G_t, \lambda_t)B'_3 - 2B_2 \text{cov}(M_t, \lambda_t)B'_3
\end{align*}
\]

(10)

which shows that, the uncertainty of the estimated coefficients abstracted away, the variance of \( pr_t^f \) depends on the variance-covariance structure among the three fundamental market expectations. The above variance decomposition constitute another way to assess the relative importance of the individual expectation terms for driving the fundamental price-rent ratio.

The results of variance decomposition are reported in Table 3. Since the innovations \( \varepsilon_t = (\varepsilon_t^G, \varepsilon_t^M, \varepsilon_t^\lambda) \) in the expectations are correlated, it may not appear straightforward to single out the portions of variance attributable to individual expectation terms. Fortunately, the variations due to the piecewise correlation structure in the bottom panel are considerably cancelled out, so that we concentrate on the individual variance terms in the top panel. Once again, the expected risk premium is the dominant factor driving the housing market, explaining about 65% of the total
variance in the fundamental ratio for both cities. In contrast, the shares of the variations in the expected rent growth and real interest rate are merely around 20% across the two cities.

The message conveyed by Figure 3A, Figure 3B, and Table 3 is clear: in the absence of bubble, the fundamental price-rent ratio in the Korean housing market is mainly driven by the expected future excess returns, whereas the expectations of the intrinsic cash flow and real interest rate are of secondary importance. This result is reminiscent of Campbell et al. (2009), although their results are for the US and obtained from a standard present-value model without a bubble component. Similar results are also found in stock market studies: Campbell and Ammer (1993) estimate that 70% of the variations in the US stock returns is attributable to news about future excess returns, whereas only 15% of the return variance is explained by news about future dividends. Bernanke and Kuttner (2005) also find that an important channel in which stock prices increase occurs is the expected equity premium or perceived riskiness of stocks, roughly three times as volatile as the expected future dividend increase.

### 3.2 Relative Importance: Bubble vs. Fundamentals

We now turn to the relative importance of the fundamental and bubble parts in the whole price-rent ratio. The first panels of Figure 4A and Figure 4B plot the estimated fundamental ratio along with the actual ratio for Seoul and Ulsan, respectively. Until before the 2000s, the two ratio series tend to move around a common average, although the difference between the two series imply a modest degree of over-valuation (during 1987-1991). Since 2001, however, the actual ratio has continued to increase whereas the fundamental ratio has remained more or less stable around its post-2000 average. Accordingly, the estimated bubble in panel (b) has also built up since then. We have previously seen that, among the expectations of housing market fundamentals, the expected risk premium is the most dominant driver of the price-rent ratio. Compared with this,
the bubble part has claimed a far larger share of the movement in the price-rent ratio since the early 2000s. As a result, the percentage of speculative bubble in the actual real house price is as large as 70% in both cities, as shown in the bottom panels of Figures 4A and 4B.

The movements of the estimated bubble are consistent with many previous studies on the Korean housing market. Using the composite indexes of house price and rents for apartments and other types of dwellings in Korea, Kim and Min (2011) detect a speculative bubble in house prices, which reaches a local peak around 1991 and starts to build up again from the end of the currency crisis till 2003. The study of the apartment price in Seoul by Xiao and Park (2010) is also comparable to ours, in that the fit of the present value model for apartment prices in Seoul is significantly improved if augmented with a rational bubble. Finally, using the standard present-value model without a bubble, Hwang et al. (2006) find no evidence of bubble in the Seoul apartment price over 1986-2006. Notwithstanding, we believe our results are not so much contradictory to theirs, however, since our estimates of bubble are on average quite small over the sample period of Hwang et al.

4. Sensitivity Analysis

4.1 Nominal Interest Rate

As mentioned above, the use of AA-corporate bonds rate is dictated by the data availability. As the first robustness check, we use another nominal interest rate series with comparable length: the rates on the National Housing Bonds of 5-year maturity, which is also available from 1987:Q1
on and less subject to the risk of default than the corporate bonds.\textsuperscript{13}

Figures 5 and 6 show the robustness of the two main results presented in Section 3. As we can see in Figure 5, the expected excess returns move almost in tandem with the fundamental price-rent ratio in all of the six regions. The evidence shown in Figure 6 confirms that the movements in all the regional housing prices since the early 2000s have been mainly driven by bubble buildup, most prominently in Seoul and Ulsan.

\[\text{[Figures 5 and 6 about here]}\]

\textbf{4.2 Sample Period}

It has been argued by many economist, e.g., Kim and Cho (2010), that the Korean housing market went through structural changes around 2000, especially in mortgage lending and its consequences for the housing price dynamics. As the second robustness check, we examine if our main findings are still preserved in the subsample period since 2000. The results are summarized in Figures 7 and 8.

Figure 7 plots the expected excess returns along with the fundamental price-rent ratio, where the close movements of the two series are even more pronounced than in the whole sample estimates. Figure YY plots the actual real house price and the estimated percentage of speculative bubble in each region.

Compared with the whole sample estimates from the previous section, the results in Figure 8 for the post-1999 subsample are not so unequivocal about the time of bubble onset. For example, the real house prices in Seoul, Daejon, and Ulsan come to gestate speculative bubbles starting as early as in 2002, whereas the onset of serious bubble in the other cities is identified about 10

\textsuperscript{13} Over the period of 2000:Q4-2017:Q4, where the rates of the 10-year government bonds are available, the housing bonds rates and government bonds rates are almost indistinguishable and exhibit less pronounced variations than the AA- rates, especially during the period of global financial crisis in 2007-2008.
years later. Notwithstanding, the results in Figure 8 confirm again that the nationwide housing price increases in the past decade are mainly driven by speculative bubble, not any of the housing market fundamentals.

5. Conclusion

In this paper, we employ the Campbell-Shiller present-value model to examine the sources of variation in the Korean housing market over 1987-2014. In contrast to the prediction of the standard present-value formula, the price-rent ratio in Korea since the early 2000s exhibits a sustained increase along with a large swing around the rising trend. We therefore modify the Campbell-Shiller model and allow the price-rent ratio to be driven by a periodically collapsing rational bubble, in addition to the expectations of future housing market fundamentals such as the rent growth, real interest rate, and risk premium for (or excess returns from) housing investment. The model is then estimated using a unique body of data consistent with the postulates of the present-value approach. Using the estimated model, we then decompose the price-rent ratio into the fundamental part explained by those expectations and the bubble part.

Our first finding suggests that, in the absence of bubbles, the price-rent ratio is mainly driven by the expected excess returns from housing investment and the role of the expected rent growth and real interest rate is of secondary importance. This finding is corroborated by the results of the variance decomposition: on average across the six regional housing markets, the variation in the expected excess returns to housing investment accounts for around 65% of that in the fundamental price-rent ratio, whereas the expected rent growth and real interest rate individually explain about 25% of the variation in the fundamental ratio. The second finding suggest that the speculative bubble term representing the deviation of the price-rent ratio from its present-value model is important in all of the six regional housing markets. In particular, the Korean housing market over 2001-2014 is significantly affected by the accumulation of the bubble, so that the bubble takes up around 70% of the house price toward the end of 2017. These findings are robust
to the use of a different interest rate series and the post-1999 subsample characterized with a bulli
gh run in the housing market.

References


Tables and Figures

Table 1: Summary data on the real growth of rents, real return to housing, and excess return.

<table>
<thead>
<tr>
<th>City</th>
<th>$\Delta r_t$ Avg</th>
<th>$\Delta r_t$ SD</th>
<th>$\Delta r_t$ p</th>
<th>$h_t$ Avg</th>
<th>$h_t$ SD</th>
<th>$h_t$ p</th>
<th>$\pi_t$ Avg</th>
<th>$\pi_t$ SD</th>
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</tr>
</thead>
<tbody>
<tr>
<td>SEOUL</td>
<td>-3.157</td>
<td>41.937</td>
<td>0.329</td>
<td>4.326</td>
<td>9.184</td>
<td>0.585</td>
<td>-0.700</td>
<td>9.890</td>
<td>0.646</td>
</tr>
<tr>
<td>BUSAN</td>
<td>-4.002</td>
<td>41.368</td>
<td>0.345</td>
<td>4.207</td>
<td>8.562</td>
<td>0.736</td>
<td>-0.819</td>
<td>9.224</td>
<td>0.776</td>
</tr>
<tr>
<td>DAEGU</td>
<td>-3.816</td>
<td>41.618</td>
<td>0.318</td>
<td>3.982</td>
<td>9.721</td>
<td>0.592</td>
<td>-1.044</td>
<td>10.520</td>
<td>0.661</td>
</tr>
<tr>
<td>GWANGJU</td>
<td>-4.715</td>
<td>41.095</td>
<td>0.357</td>
<td>3.191</td>
<td>7.372</td>
<td>0.698</td>
<td>-1.835</td>
<td>8.489</td>
<td>0.775</td>
</tr>
<tr>
<td>DAEJON</td>
<td>-3.707</td>
<td>40.311</td>
<td>0.307</td>
<td>3.252</td>
<td>7.139</td>
<td>0.517</td>
<td>-1.775</td>
<td>8.284</td>
<td>0.643</td>
</tr>
<tr>
<td>ULSAN</td>
<td>-3.736</td>
<td>42.323</td>
<td>0.377</td>
<td>5.107</td>
<td>8.144</td>
<td>0.812</td>
<td>0.081</td>
<td>8.709</td>
<td>0.836</td>
</tr>
<tr>
<td>Nationwide</td>
<td>-3.236</td>
<td>41.138</td>
<td>0.334</td>
<td>3.991</td>
<td>7.488</td>
<td>0.615</td>
<td>-1.035</td>
<td>8.316</td>
<td>0.691</td>
</tr>
</tbody>
</table>

Note: All data series are annualized rates.

Table 2: Maximum Likelihood Estimates of Parameters

<table>
<thead>
<tr>
<th></th>
<th>SEOUL</th>
<th>BUSAN</th>
<th>DAEGU</th>
<th>GWANGJU</th>
<th>DAEJON</th>
<th>ULSAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\gamma_1$</td>
<td>0.495(0.056)</td>
<td>0.503(0.056)</td>
<td>0.508(0.041)</td>
<td>0.451(0.062)</td>
<td>0.511(0.047)</td>
<td>0.492(0.054)</td>
</tr>
<tr>
<td>$\gamma_2$</td>
<td>-0.044(0.037)</td>
<td>-0.051(0.027)</td>
<td>-0.055(0.017)</td>
<td>-0.038(0.025)</td>
<td>-0.055(0.020)</td>
<td>-0.044(0.026)</td>
</tr>
<tr>
<td>$\delta_1$</td>
<td>1.371(0.066)</td>
<td>1.408(0.066)</td>
<td>1.430(0.041)</td>
<td>1.364(0.067)</td>
<td>1.394(0.065)</td>
<td>1.388(0.067)</td>
</tr>
<tr>
<td>$\delta_2$</td>
<td>-0.400(0.062)</td>
<td>-0.436(0.062)</td>
<td>-0.457(0.038)</td>
<td>-0.398(0.061)</td>
<td>-0.423(0.061)</td>
<td>-0.417(0.063)</td>
</tr>
<tr>
<td>$\theta_1$</td>
<td>0.496(0.045)</td>
<td>0.527(0.045)</td>
<td>0.557(0.048)</td>
<td>0.747(0.087)</td>
<td>0.588(0.060)</td>
<td>0.521(0.051)</td>
</tr>
<tr>
<td>$\theta_2$</td>
<td>0.424(0.042)</td>
<td>0.395(0.041)</td>
<td>0.366(0.045)</td>
<td>0.176(0.081)</td>
<td>0.335(0.056)</td>
<td>0.399(0.047)</td>
</tr>
<tr>
<td>$q$</td>
<td>0.942(0.007)</td>
<td>0.940(0.007)</td>
<td>0.938(0.008)</td>
<td>0.914(0.010)</td>
<td>0.933(0.008)</td>
<td>0.939(0.008)</td>
</tr>
<tr>
<td>$p$</td>
<td>0.994(0.004)</td>
<td>0.995(0.004)</td>
<td>0.995(0.003)</td>
<td>0.987(0.008)</td>
<td>0.994(0.003)</td>
<td>0.993(0.004)</td>
</tr>
<tr>
<td></td>
<td>Measured by</td>
<td>Estimate</td>
<td>% of $\text{var}(p_r^f)$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\text{var}(p_r^f)$</td>
<td>-</td>
<td>0.1460</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\text{var}(G_t)$</td>
<td>$B_1\text{var}(G_t)B_1$</td>
<td>0.0264</td>
<td>18.1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\text{var}(M_t)$</td>
<td>$B_2\text{var}(M_t)B_2$</td>
<td>0.0292</td>
<td>20.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\text{var}(\Lambda_t)$</td>
<td>$B_3\text{var}(\Lambda_t)B_3$</td>
<td>0.0963</td>
<td>66.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\text{cov}(G_t, M_t)$</td>
<td>$-2B_1\text{cov}(G_t, M_t)B_2$</td>
<td>-0.0212</td>
<td>-14.5%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\text{cov}(G_t, \Lambda_t)$</td>
<td>$-2B_1\text{cov}(G_t, \Lambda_t)B_3$</td>
<td>-0.0437</td>
<td>-30.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\text{cov}(M_t, \Lambda_t)$</td>
<td>$2B_2\text{cov}(M_t, \Lambda_t)B_3$</td>
<td>0.0590</td>
<td>40.4%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Standard errors in parentheses.

**Table 3A:** Variance Decomposition for the fundamental price-rent ratio (Seoul)

<table>
<thead>
<tr>
<th></th>
<th>Measured by</th>
<th>Estimate</th>
<th>% of $\text{var}(p_r^f)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{var}(p_r^f)$</td>
<td>-</td>
<td>0.172</td>
<td>100%</td>
</tr>
<tr>
<td>$\text{var}(G_t)$</td>
<td>$B_1\text{var}(G_t)B_1$</td>
<td>0.035</td>
<td>20.3%</td>
</tr>
<tr>
<td>$\text{var}(M_t)$</td>
<td>$B_2\text{var}(M_t)B_2$</td>
<td>0.041</td>
<td>24.0%</td>
</tr>
<tr>
<td>$\text{var}(\Lambda_t)$</td>
<td>$B_3\text{var}(\Lambda_t)B_3$</td>
<td>0.112</td>
<td>65.1%</td>
</tr>
<tr>
<td>$\text{cov}(G_t, M_t)$</td>
<td>$-2B_1\text{cov}(G_t, M_t)B_2$</td>
<td>-0.030</td>
<td>-17.4%</td>
</tr>
<tr>
<td>$\text{cov}(G_t, \Lambda_t)$</td>
<td>$-2B_1\text{cov}(G_t, \Lambda_t)B_3$</td>
<td>-0.058</td>
<td>-33.7%</td>
</tr>
<tr>
<td>$\text{cov}(M_t, \Lambda_t)$</td>
<td>$2B_2\text{cov}(M_t, \Lambda_t)B_3$</td>
<td>0.072</td>
<td>41.7%</td>
</tr>
</tbody>
</table>

Table 3B: Variance Decomposition for the fundamental price-rent ratio (Ulsan)
Figure 1: Housing market trend in Korea (Seoul, 1987:Q1-2017:Q4)

(a) Real House price (1987:Q1=100)

(b) Nominal Rent (1987:Q1=100)

(c) Price-Rent Ratio (1987:Q1=100)
Figure 2: Log Price-Rent Ratios at the Regional Level (1987:Q2-2017:Q4)

Note: dotted lines denote the price-rent ratio calculated at the national level.
Figure 3A: Contributions of Expected Market Fundamentals (Seoul)

Note: dotted lines denote the fundamental part of the price-rent ratio.
Figure 3B: Contributions of Expected Market Fundamentals (Ulsan)
Note: dotted lines denote the fundamental part of the price-rent ratio.

Figure 4A: Fundamental and Bubble Components (Seoul)

(a) Actual vs. Fundamental Ratio

(b) Actual Ratio vs. Bubble (Right Axis)

(c) Actual Real House Price vs. % of Bubble (Right Axis)
Note: Real house price is indexed with 87:Q3=100.

Figure 4B: Fundamental and Bubble Components (Ulsan)

(a) Actual vs. Fundamental Ratio

(b) Actual Ratio vs. Bubble (Right Axis)

(c) Actual Real House Price vs. % of Bubble (Right Axis)
Note: Real house price is indexed with 87:Q3=100.

Figure 5: Contributions of Expected Excess Returns (using National Housing Bonds Rates)

Note: dotted lines denote the fundamental part of the price-rent ratio.
Figure 6: Percentage of Bubble in the Real House Price (using National Housing Bonds Rates)

(a) Seoul

(b) Busan

(c) Daegu

(d) Gwangju
Note: Solid lines denote actual real house price, and the percentages of bubble are denoted by the shades against the right axes.

Figure 7: Contributions of Expected Excess Returns (2000:Q2-2017:Q4 Subsample)
Figure 8: Percentage of Bubble in the Real House Price (2000:Q2-2017:Q4 Subsample)

Note: dotted lines denote the fundamental part of the price-rent ratio.
Note: Solid lines denote actual real house price, and the percentages of bubble are denoted by the shades against the right axes.

Appendix: Results for the other cities
Table A1. Variance Decomposition for the Fundamental Price-Rent Ratio

<table>
<thead>
<tr>
<th></th>
<th>Busan</th>
<th>Daegu</th>
<th>Gwangju</th>
<th>Daejon</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{var}(G_t) )</td>
<td>19.1%</td>
<td>19.4%</td>
<td>22.0%</td>
<td>20.1%</td>
</tr>
<tr>
<td>( \text{var}(M_t)  )</td>
<td>24.7%</td>
<td>23.3%</td>
<td>23.5%</td>
<td>24.0%</td>
</tr>
<tr>
<td>( \text{var}(\Lambda_t) )</td>
<td>63.6%</td>
<td>66.6%</td>
<td>69.6%</td>
<td>66.9%</td>
</tr>
<tr>
<td>( \text{cov}(G_t, M_t) )</td>
<td>-17.0%</td>
<td>-16.6%</td>
<td>-18.0%</td>
<td>-17.4%</td>
</tr>
<tr>
<td>( \text{cov}(G_t, \Lambda_t) )</td>
<td>-31.9%</td>
<td>-33.0%</td>
<td>-36.7%</td>
<td>-34.3%</td>
</tr>
<tr>
<td>( \text{cov}(M_t, \Lambda_t) )</td>
<td>41.5%</td>
<td>40.3%</td>
<td>39.6%</td>
<td>40.8%</td>
</tr>
</tbody>
</table>

Figure A1: Contributions of Expected Market Fundamentals
Note: Dotted line denotes the estimated fundamental part of the ratio
Note: Dotted line denotes the estimated fundamental part of the ratio
Note: Dotted line denotes the estimated fundamental part of the ratio

Figure A1: Contributions of Expected Market Fundamentals (cont.)
Note: Dotted line denotes the estimated fundamental part of the ratio

Figure A2.1: Fundamental and Bubble Components (Busan)
Figure A2.2: Fundamental and Bubble Components (Daegu)

Note: Real house price is indexed with 87:Q3=100.
Figure A2.3: Fundamental and Bubble Components (Gwangju)

Note: Real house price is indexed with 87:Q3=100.
(a) Actual (shade) vs. Fundamental Ratio (solid)

(b) Actual Ratio vs. Bubble (Right Axis)

(c) Actual Real House Price vs. % of Bubble (Right Axis)

Note: Real house price is indexed with 87:Q3=100.

Figure A2.4: Fundamental and Bubble Components (Daejon)
Note: Real house price is indexed with 87:Q3=100.