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Bubble Contagion:
Evidence from Japan's Asset Price Bubble of the 1980-90s

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Working Paper in Economics 17/20

September 2017

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Abstract

This paper subjects one of the most documented asset price bubbles of the 1980-90s in Japan, to the rigors of recent time series-based econometric tests. We focus on testing for bubbles in the Japanese stock and real estate markets from 1970Q1 to 1999Q4 using the right-tailed unit root test of Phillips, Shi and Yu (2015, PSY). We also utilize the econometric methods of Greenaway-McGrevy and Phillips (2016) to explore the possibility of contagion between these two markets. We find significant econometric based evidence of bubbles in both markets during this period in Japan and importantly, for the first time in the literature, signs of bubble contagion from Japan's stock market to its real estate market.

Keywords

Japanese asset price bubble
contagion
stock market
real estate market

JEL Classifications

C12; G12; R30

Acknowledgements

We would like to thank Ryan Greenaway-McGrevy for kindly sharing his methods, and Jakob Madsen and Thandinkosi Ndhlela for providing the Japanese stock data. We particularly thank Peter Phillips for helpful comments on this paper and his memory on this critical period in Japan before the asset price bubble bursts.

1. Introduction

Japan's asset price bubble of the 1980-90s has attracted considerable attention in the literature.[1] In particular, Japan experienced the most severe episode of speculation in both the stock and real estate markets in the late 1980s, see for example, French & Poterba (1991), Werner (1994) and Chirinko & Schaller (2001). The aim of this paper is to investigate this period in Japan's financial history, using the right-tailed unit root test of Phillips, Shi & Yu (2015, PSY). The PSY test has been popularized in identifying the presence of financial bubbles. A recent study by Hu & Oxley (2017, forthcoming) subjects the South Sea and Mississippi share prices to the rigours of recent bubble detection tests. Furthermore, an additional focus of the paper is to examine potential contagion between the two markets in Japan by utilising the time-varying regression methodology of Greenaway-McGrevy & Phillips (2016).

There are two 'myths' attributed to the inflated Japanese real estate and stock markets where both house (land) and stock prices grew to unprecedented levels. The first was that land prices could never fall, and the second was that stock prices could only rise (Malkiel, 2003). Stone & Ziemba (1993) stated that the stock market had a value of approximately 4 trillion US Dollar at its peak in December 1989, which represented approximately 44% of the world's stock market value. There had been sharp rises in land prices especially during the late 1980s, see Noguchi (1994), leading Stone & Ziemba (1993) to conclude that the total value of all Japanese property was valued at approximately 20 trillion US Dollar at the end of 1991, which equated to over 20% of the world's total wealth and almost double the total value of the world's stock markets. This leads Malkiel (2003) to suggest that if this were the case, the Japanese could have brought all the property in America by only selling the Tokyo area.

The bursting of the Japan's asset price bubble in the early 1990s certainly destroyed those two myths. As discussed in Okina et al. (2001), the Nikkei 225 reached a historical high of 38130 in December 1989 from a start of 12,598 in September 1985, and then dropped sharply to 14,309 in August 1992, which represented a more than 60% decline from the peak. When we consider land prices in September 1990, they were around four times higher than the level in September 1985, only to drop in 1999 by approximately 80% from the peak in 1990. What we could learn from Japan's experience is perhaps that Japan is no different from other countries that experience a bubble as no asset prices could keep rising forever. Alan Greenspan also described the sudden dramatic decline in the Japanese stock market as "a correction of the bubble in asset prices".[2] A decade of economic

[1] Brunnermeier & Schnabel (2016) survey a collection of 23 famous bubble episodes including the South Sea and Mississippi Bubbles in 1719-20, Railway Mania in 1840 and the more recent Japan's asset price bubble.

[2] Washington Post, April 18, 1992.

stagnation in the 1990s after the bursting of the Japanese asset price bubble is commonly referred to as "the Lost Decade", see Hayashi & Prescott (2002) and Horioka (2006).

2. Method

We apply the right-tailed unit root test of Phillips, Shi & Yu (2015) to examine evidence of explosive behaviour in stock and real estate markets. The martingale null with an asymptotic drift is specified as:

$$H_0 : y_t = dT^{-\eta} + y_{t-1} + \varepsilon_t, \qquad \varepsilon_t \sim \mathrm{NID}(0, \sigma^2), \tag{1}$$

where d is a constant and the localizing coefficient η is greater than 1/2. The alternative hypothesis is a mildly explosive process:

$$H_1 : y_t = \delta_T y_{t-1} + \varepsilon_t, \tag{2}$$

where $\delta_T = 1 + cT^{-\theta}$ with $c > 0$ and $\theta \in (0, 1)$.

The following regression model is estimated:

$$\Delta y_t = \alpha + \beta y_{t-1} + \sum_{i=1}^{K} \gamma_i \Delta y_{t-i} + \varepsilon_t, \tag{3}$$

where α is an intercept.

The generalized sup ADF (GSADF) test relies on repeated estimation of the ADF test regression of Equation (3) on subsamples of the data in a recursive fashion. The window size r_w expands from r_0 to 1, where r_0 is the minimum window size. The end point r_2 varies from r_0 to 1 and the starting point r_1 varies from 0 to $r_2 - r_0$. The GSADF statistic is the largest ADF statistic over the range of r_1 and r_2:

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

The backward SADF (BSADF) statistic is defined as the sup value of the ADF statistic sequence:

$$BSADF_{r_2}(r_0) = \sup_{r_1 \in [0, r_2 - r_0]} ADF_{r_1}^{r_2},$$

where the BSADF statistic and its corresponding critical value are used for dating the origination and termination dates of a bubble. The minimum window size r_0 is equal to $0.01 + 1.8/\sqrt{T}$. A fixed lag order of 0 is selected. Critical values are simulated using 2,000 replications.

We then apply the time-varying regression approach of Greenaway-McGrevy & Phillips (2016), to which the reader is referred for details, to examine evidence of bubble contagion. The same notation as Greenaway-McGrevy & Phillips (2016) is adopted here. They fit the following regression

$$\hat{\beta}_{j,s} = \delta_{1i} + \delta_{2j}\left(\frac{S}{T-S+1}\right)\hat{\beta}_{core,s-d} + error_s, s = S, \ldots, T, \tag{4}$$

for some initialization date S for $j \neq core$, where *core* denotes a core market where the asset bubble is hypothesized to originate. The non-negative delay parameter d that captures the lag in market contagion from the core market to other regions and δ_{2j} is the time-varying coefficient.

The time varying coefficient function $\delta_{2j}(r)$ may be estimated by local level kernel regression such that:

$$\hat{\delta}_{2j}(r;h;d) = \frac{\sum_{s=S}^{T} K_{hs}(r)\tilde{\beta}_{j,s}\tilde{\beta}_{core,s-d}}{\sum_{s=S}^{T} K_{hs}(r)\tilde{\beta}_{core,s-d}^{2}}, \tilde{\beta}_{j,s} = \hat{\beta}_{j,s} - \frac{1}{T-S+1}\sum_{s=S}^{T}\hat{\beta}_{j,s}, \tag{5}$$

where $K_{hs}(r) = \frac{1}{h}K\left(\frac{s/T-r}{h}\right)$, $K(.)$ is a Gaussian kernel function and $K(.) = (2\pi)^{-1/2}e^{-\frac{1}{2}^2}$, and h is a bandwidth parameter. The bandwidth h is selected using a simple cross-validation approach and estimated as

$$\breve{h}_{jT}(d) = \arg\min_{h\in\left[H_T^{-1/2}, T_0^{-1/10}\right]} \sum_{s=S}^{T}\left\{\tilde{\beta}_{j,s} - \breve{\delta}_{2j}\left(\frac{S}{T-S+1}; h, d\right)\hat{\beta}_{core,s-d}\right\}^2, \tag{6}$$

where $H_T = \left[(T-S-d+1)^{-1/2}, (T-S-d+1)^{-1/10}\right]$ and

$$\breve{\delta}_{2j}\left(\frac{S}{T-S+1}; h, d\right) = \frac{\sum_{p=S,p\neq s}^{T} K_{hp}\left(\frac{S}{T-S+1}\right)\tilde{\beta}_{j,p}\tilde{\beta}_{core,p-d}}{\sum_{s=S}^{T} K_{hs}\left(\frac{S}{T-S+1}\right)\tilde{\beta}_{core,p-d}^{2}}. \tag{7}$$

The optimal lag order $\breve{d}_j$ minimizes the MSE of the contagion equation.

$$\breve{d}_j = \min_{d\in\{0,1,\ldots,4\}} \sum_{s=S}^{T}\left\{\tilde{\beta}_{j,s} - \breve{\delta}_{2j}\left(\frac{S}{T-S+1}; \breve{h}_{jT}(d), d\right)\hat{\beta}_{core,s-d}\right\}^2 \tag{8}$$

The resulting response function has the form $\breve{\delta}_{2j}\left(r; \breve{h}_{jT}(d), \breve{d}_j\right)$ with optimal bandwidth and lag order choices.

3. Data

We obtain the house price-rent ratio for Japan between 1970Q1 and 1999Q4 from the OECD Main Economic Indicators. The 10-year cyclically adjusted price-earnings (CAPE) ratio (also known as *Shiller PE Ratio*) for Japan between 1970M1 and 1999M12 is obtained from the Global Financial Data. Due to the data frequency, we create a quarterly CAPE ratio by averaging. Both the price-rent

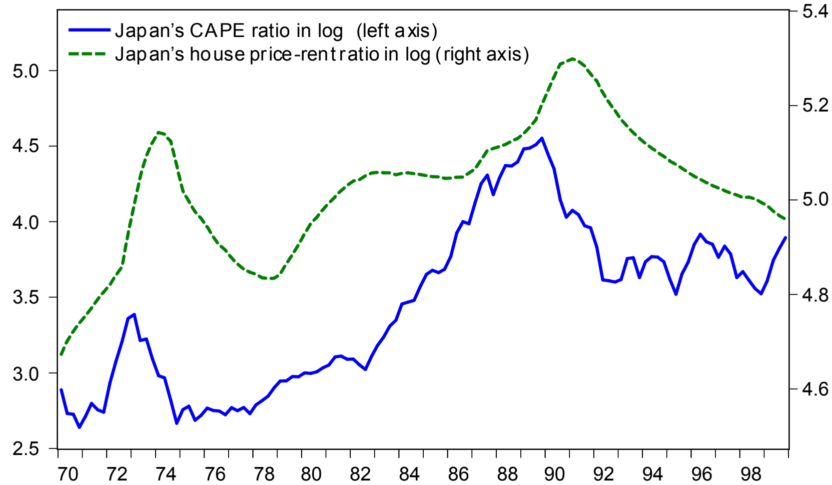


Figure 1: The time series plot of Japan's house price-rent ratio and CAPE ratio in log scale between 1970Q1 and 1999Q4.

ratio and CAPE ratio data are transformed to natural logarithms. A time series plot for both ratios is provided as Figure 1. It can be seen from Figure 1 that both ratios rise dramatically after the mid-1970s, where the CAPE ratio and house price-rent ratio climb to peaks in 1989 and 1991, and then decline sharply.

4. Results

We provide date-stamping outcomes for both Japan's stock and real estate markets in Figure 2. The null of no explosive behaviour in Japan's price-earnings ratio is strongly rejected at the 1% level (3.7536>2.6738), which suggests strong evidence of bubbles. As shown in Figure 2a, we identify a bubble between 1983Q2 and 1990Q3 in the stock market, which is clearly related to Japan's asset price bubble. On the other hand, Japan's real estate market also exhibits bubble-like behaviour as shown by Figure 2b. The null of no explosive behaviour in Japan's house price-rent ratio is also rejected at the 1% level (8.2139>2.6738), indicating very strong evidence of bubbles. As presented as Figure 2b, we find two bubbles in the 1980s (e.g., 1981Q2-1984Q2 and 1987Q2-1992Q2).[3] Of particular interest is that the bubble, which originated in 1987Q2 and collapsed in 1992Q2, is linked with Japan's asset price bubble. Overall, we provide overwhelming evidence of bubbles for both markets during this

[3] Phillips & Shi (2017, forthcoming) recommend users identifying false positive identification episodes ex-post using the PSY procedure, we therefore only report the presence of a bubble in this paper.

period of time in Japan.[4]

We believe that the bubble migrates from the stock market to the real estate market for three reasons.[5] First, the stock price-earnings ratio reached its peak in 1989 while the price-rent ratio climbed to its maximum in 1991. Second, the stock market exhibits bubble-like behaviour earlier than housing market during the late 1980s. Third, transaction costs are much lower in the stock market as people can simply and quickly sell off their shares and then invest in the housing market.

Using the appraoch of Greenaway-McGrevy & Phillips (2016), we let the fixed window size S be 50 and delay parameter d be 4.[6] The time-varying coefficient estimates are plotted as Figure 3, which clearly shows an inverted U shape. As discussed in Greenaway-McGrevy & Phillips (2016), the contagion coefficient may take an inverted U shape as it grows over the time before climbing to a peak and then declining. Figure 3 demonstrates signs of migration from the core market (stock market) to the real estate market as the sensitivity rises to a peak in 1993 and then declines, which is the major finding in this paper.

5. Conclusion

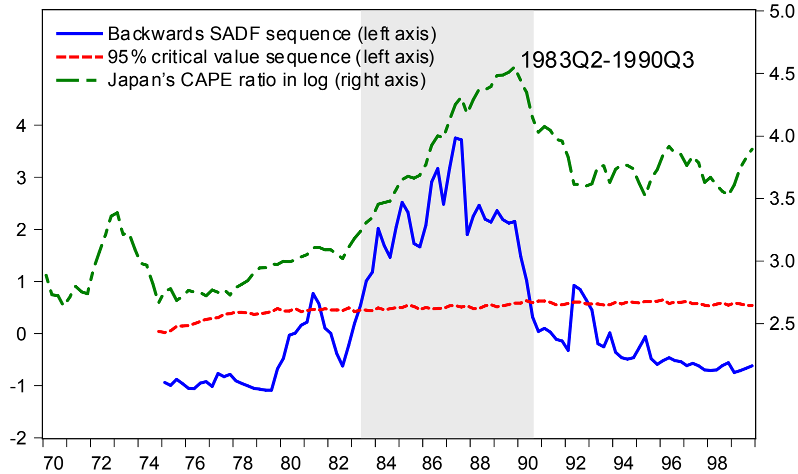
This paper has two key contributions. First, it presents empirical evidence to support the existence of an asset price bubble in Japan in the late 20th century using the right tailed unit root test of Phillips, Shi & Yu (2015, PSY) as we find overwhelming evidence in both the stock and real estate markets between the 1980s and the early 1990s. Second and more importantly, we then apply the Greenaway-McGrevy & Phillips's (2016) methodology to detect possible contagion between the two markets. Our results show signs of bubble migration from the Japan's stock market to its housing market for the first time in the literature.

[4] We also apply the PSY procedure to the Japan's CAPE and house price-rent ratios to take into account the presence of possible heteroscedasticity using wild bootstrapping. We identify a bubble in the stock market (1980Q4-1995Q2) and two bubbles in the real estate market (1981Q1-1986Q4 and 1987Q3-1993Q1). The conclusion of bubbles in both markets still holds. Results are not shown here to conserve the space, but are available upon request.

[5] Deng et al. (2017) also find signs of bubble migration from the stock market to the housing market in China using weekly data between 2005 and 2010.

[6] A fixed window subsample method is utilized for selecting the subsample sequence of estimated autoregressive coefficients as suggested by Greenaway-McGrevy & Phillips (2016). We also try different choices of the fixed window size S and delay parameter d, and the results remain unchanged.

(a) Stock price-earnings ratio



(b) House price-rent ratio

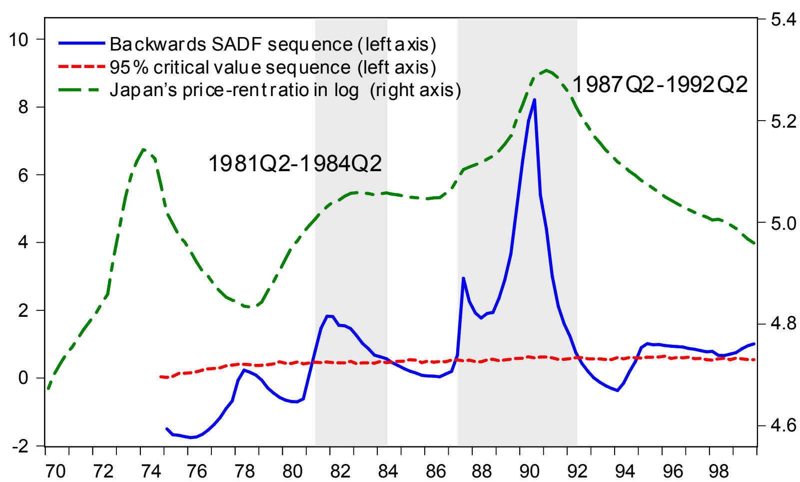


Figure 2: Date-stamping strategy of CAPE ratio and house price-rent ratio in Japan between 1970Q1 and 1999Q4.

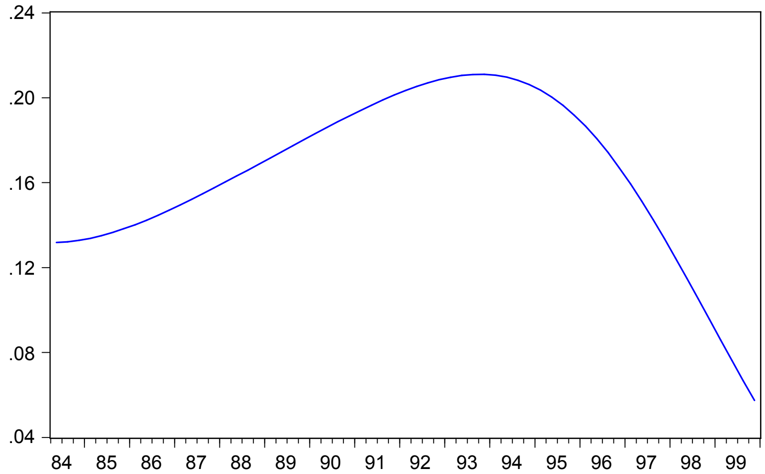


Figure 3: Time-varying contagion coefficient from the Japanese stock market to the real estate market.

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