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Explaining Asset Bubbles in Japan*

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This paper examines the behavior of stock and land prices during the bubble economy of the second half of the 1980s, paying considerable attention to the linkage of the two markets and the effects of monetary policy. In particular, we first examine whether the boom in asset prices can be justified by changes in fundamental economic variables such as interest rates and growth of the real economy, analyzing a complex chain of events behind the process of asset price inflation and deflation. Our empirical results suggest: (i) that the initial rise in asset prices was caused by a sharp increase in bank lending to the real estate sector; (ii) that a considerable comovement between stock and land prices is consistent with a theory that emphasizes the relationship between the collateral value of land and cash flow of credit-constrained firms; (iii) that a booming economy and low interest rates from mid-1987 to mid-1989 explain only a part of asset price inflation; and (iv) that the stock price increase in the second half of 1989 and the land price increase in 1990 are not explained by any asset pricing model based on fundamentals or rational bubbles.

Key words: Stock price; Land price; Asset bubbles; Bank lending to the real estate sector

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I. Introduction

In the last ten years, the Japanese economy has experienced great fluctuation in the prices of assets, (including stocks, land, real estate, art, country <golf> club memberships, etc). In the second half of the 1980s, stock and land prices doubled and tripled in a matter of a few years, although the timing of sharp increases for the various asset classes was not synchronized.[1] Then, in the first half of the 1990s, many asset prices plummeted. In some cases, the gains in the second half of the 1980s were completely eroded by the losses in the first half of the 1990s. This asset price inflation and subsequent deflation not only affected the fortunes of many corporations and individuals but caused serious problems for the macroeconomy, and which continue to challenge policy makers to this day. The relationship between macroeconomic policy and financial markets has drawn particular attention.

The experience of asset price inflation and deflation in Japan has stimulated voluminous research and we can identify three movements. First, the question whether asset price inflation and deflation were caused by "fundamentals" or a "bubble" price increases solely due to expectations of further increases has been asked by many financial economists: French and Poterba (1991) and Ueda (1990) with respect to stock prices, and Ito (1993), Nishimura (1990), and Noguchi (1989) land prices, to name a few. Those who regard price increases as a bubble argue that the level and changes in asset prices cannot be justified by asset pricing theory: in particular, no changes in "fundamentals" correspond to the magnitude of fluctuation in stock and land prices. The crucial question here is whether asset pricing models where the effects of fundamentals are measured are reliable, since bubbles are typically inferred from the residuals of these models.

Second, the role of macroeconomic policy, especially monetary policy, in determining asset price movements has been examined, most often by looking at the movement of interest rates. Conventional wisdom states that monetary policy can be judged to have been lax from 1987 to 1989 citing the unprecedentedly low official discount rate.

Third, only a few papers, e.g., Asako, et al. (1989) and Hamao and Hoshi (1991), have been written on the relationship between stock and land price movements.

[1] The Nikkei 225 index was 11,542 in December 1984, 38,915 in December 1989, but then plummeted to 15,951 in June 1992. The Commercial Land Price Index for large cities increased from 38.4 in 1986 to 103.0 in 1991, but then decreased to 71.4 in March 1993.

However, there is little rigorous theoretical and empirical investigation as to why and how the two kinds of asset prices influence each other.

The contribution of this paper is three-fold. First, attempts are made to carefully examine both the "fundamentals" story and the "bubble" story. As mentioned, "fundamentals" are usually defined by an asset pricing model, which depends on a particular set of assumptions. In this paper, we examine the robustness of such a model with respect to assumptions. A bubble model is simulated and calibrated, rather than just relying on residuals. Second, in judging monetary policy stance, we introduce a quantitative variable, for example lending to real estate companies is introduced in addition to interest rates. This specification is consistent with a model which emphasizes liquidity constraint and asymmetric information. Third, the connection between stock and land prices is a focus of this paper. There are two ways to look at the relationship, one is to examine whether price dynamics with respect to stocks and land have common fundamentals, including monetary conditions, and the other is to examine the direct mutual impact on each other. It will be obvious, after the analysis, that paying attention to only one of the prices would, to a considerable degree, not reflect the important role of price inflation and deflation in Japan in the last ten years.

The paper is organized as follows. Section II analyzes land and stock price movements using simple time-series analysis. Section III is devoted to an attempt to fit equations that can be implied from "fundamentals." It will be shown that the large fluctuations in asset prices cannot be explained by changes in variables that are commonly considered as fundamentals. Also, rational bubbles are examined as an alternative explanation of the boom in asset markets. In Section IV, the effect of monetary policy on asset price fluctuations is examined within a multivariate VAR framework. In Section V, the effect of monetary policy on land prices through bank lending is emphasized. Section VI summarizes findings.

II. Econometric Analysis

A. Data Description and Unit Root Tests

Land and stock prices in Japan are the primary asset prices we will examine. Although all pieces of land are heterogeneous and individual stock prices behave differently, the land price index and the stock price index described below will be used in this paper in order to keep macroeconomic analysis simple:

LAND PRICE: The aggregate land price index in this paper is the nationwide, average urban land price index (hereafter the land price index) tabulated semiannually (March and September) by the Japan Real Estate Institute.[2] This index is widely used in time series analysis and dates back to September 1955. Other land price indices have shorter observation samples.[3] Since land prices, which form the basis of the index, are assessed by the assessors, instead of based on actual transaction prices, the index may not reflect market conditions.[4]

STOCK PRICE: TOPIX, the value-weighted index of the first section of the Tokyo Stock Exchange, will be used for the stock price. The observations are taken from the last trading days of March and September in order to match the frequency of the land price index.

Constrained by the frequency of land price observations, most of empirical results in this paper are based on semi-annual data (e.g. 1990:II=the second half of 1990). But, monthly data (e.g. 1990:2=February 1990) is also used in Section III to further investigate the behavior of stock price. The basic statistics of land and stock prices measured by average excess returns, defined as asset return minus the call rate, are reported in Table 1 (panels A and B). The frequency of data is every six months, but the reported numbers are annualized. Volatility, measured by unconditional variance, is far higher for stock prices. The time series of land and stock price index levels are shown in Figure 1 and changes in Figure 2. Casual observation of these

[2] The other aggregate index is "six-largest metropolitan areas," and these two aggregate indices also cover different kinds of usage: "residential", "industrial" and "commercial." The Institute also publishes disaggregate indices for three largest metropolitan areas. Although all indices behave similarly in the long run, suggesting that the major driving force in land price is a nationwide aggregate shock, the magnitude of change and timing of sharp upturn or downturn are slightly different indices. For details of these movements, see Ito (1992; pp.416-418). For purposes of macroeconomics investigation, we mainly deal with the nationwide, aggregate index in this paper.

[3] There are other indices frequently used in analyzing of land price movements. In its calculation of the Official Land Price Index (*Koji Chika*), the National Land Agency surveys and publishes land prices at more than 17,000 sites in Japan on January 1 every year. This is the most comprehensive land price survey in Japan. However, it only goes back to the beginning of the 1970s. Prefectural governments also survey and publish land indices as of July 1, every year which are available only for the last decade or so. Hence, the Japan Real Estate Institute index has the longest time series.

[4] All land price indices described in note 3, including the land price index of the Japan Real Estate Institute, share a defect in that they do not reflect market conditions promptly, because land prices at particular sites are "assessed" by the assessor. Although assessment reflects transaction prices near the assessment point, it may not quickly reflect changing prices if transactions are not frequent. The official land price for particular sites, has been known to undervalue market price by 20-30%. (If consistently undervalued it does not present a problem for our purposes.) Since prices for individual survey sites are not published for the Japan Real Estate Institute index, it is difficult to make any inference on deviation from market price.

Table 1
Basic Statistics of Stock and Land Prices

STOCK: The index of the first section of Tokyo Stock Exchange.
LAND: The country-wide average of the average of all kinds of usage.
ESTOCK/ELAND: Excess returns of assets over call rate (annualized).

Semi-annual data from 1956:I to 1993:I
Number of observations: 75

A. Statistics on Series ESTOCK

Sample Mean	7.81938	Variance	769.85579
Standard Error	27.74628	SE of Sample Mean	3.20386
Skewness	−0.39932	Kurtosis	0.17648

B. Statistics on Series ELAND

Sample Mean	3.22742	Variance	79.21916
Standard Error	8.90051	SE of Sample Mean	1.02774
Skewness	0.33442	Kurtosis	1.33992

C. Cross Correlations of Series ESTOCK and ELAND

a. Autocorrelations

Correlations of series ESTOCK

i=1			i=4			i=7	
0.1055	0.0041	−0.0527	0.0450	0.0140	0.0321	−0.0379	0.0980

Correlations of Series ELAND

i=1			i=4			i=7	
0.8377	0.6125	0.4327	0.3375	0.3149	0.3085	0.2924	0.2412

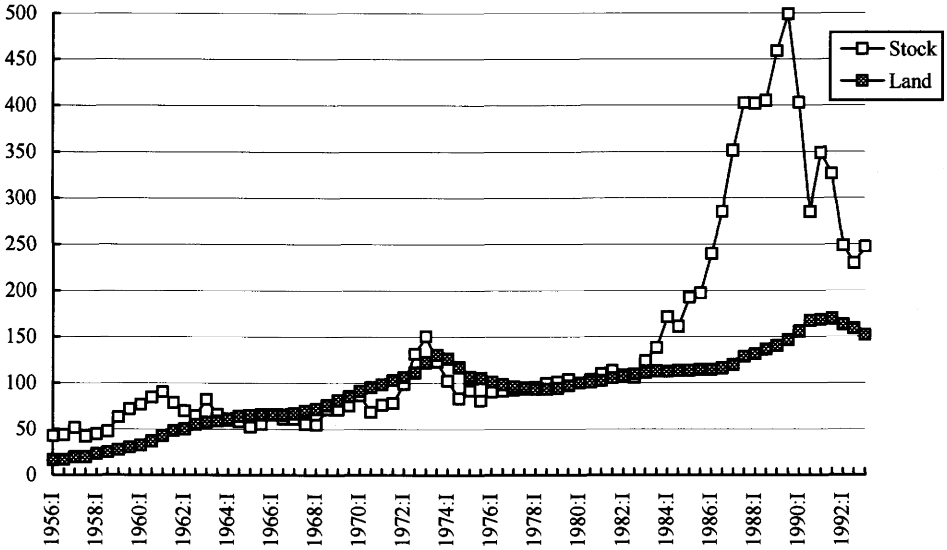
b. Cross correlations: Corr{ESTOCK(t-i), ELAND(t)}

i=8		i=6		i=4		i=2	
0.04349	0.02330	−0.02569	0.08425	0.15729	0.29067	0.35897*	0.29141

i=0		i=−2		i=−4		i=−6	
0.05247	−0.07385	−0.15034	−0.05304	−0.02726	−0.06613	−0.08860	−0.03398

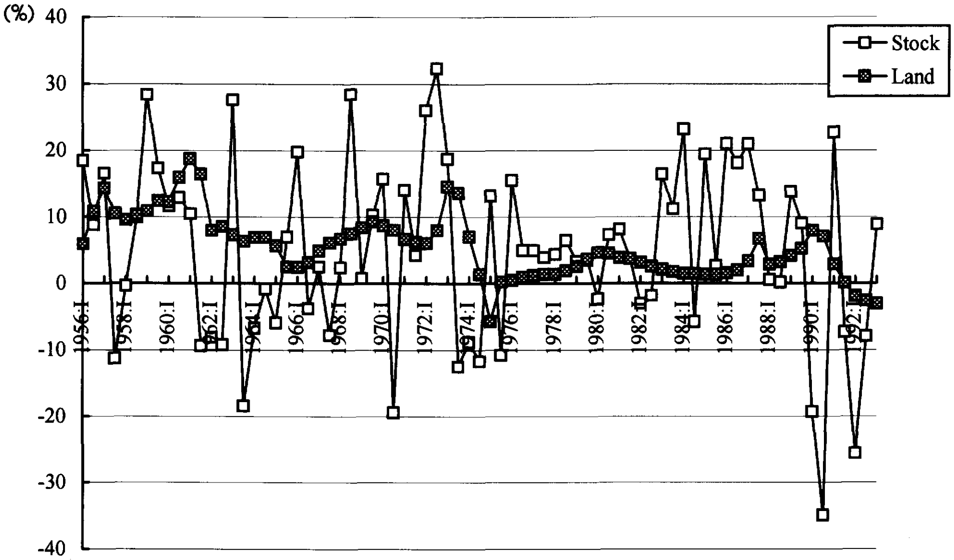
Note: Asterisks (*) denotes maximum cross auto correlation at corr{ESTOCK(t-2), ELAND(t)}.

Figure 1
Stock and Land Prices (Nominal)



1980:I=100

Figure 2
Growth Rate of Asset Prices



two figures suggests that stock returns lead land returns: turning points after sharp increases come earlier for stock prices than land prices. The cross correlations of these two variables are shown in Table 1 (panel C.1). The greatest correlation between the two asset returns occurs between stock return at t-2 and land return at t. Another difference in the behavior of the two asset price returns is in their autocorrelation structure: excess land returns have much higher persistence. Unconditional autocorrelations in Table 1 (panel C.2) suggest that if the price of land increases 10% in period t, then it will increase 8% in period t+1 (in six months).

As casually observed in Figure 1, log of stock and land price levels seem to have unit roots. In order to check statistically the existence of unit root, Dickey-Fuller (D-F) and augmented D-F tests are conducted. Table 2 shows the result, where lag lengths

Table 2

Dickey-Fuller Tests for Real Asset Prices

$\Delta Y_t = \beta + (\rho - 1)Y_{t-1} + \sum \theta_i \Delta Y_{t-1} + \varepsilon_t$

$T(\rho - 1)$: 5% critical values

No trend: {−16.3 ~ 0.47}, with trend: {−23.6 ~ −1.37}

The lag length were chosen by AIC and SBIC. If two were different, SBIC is used.

A. STOCK			
a. Log real stock price			
No trend, 0 lags:	−1.942*,	With trend, 0 lags:	−7.423*
b. First differences			
No trend, 0 lags:	−65.341,	With trend, 0 lags:	−65.406
B. LAND			
a. Log real land price			
No trend, 5 lags:	−4.879*,	With trend, 4 lags:	−7.351*
b.1. First differences			
No trend, 4 lags:	−13.650*,	With trend, 4 lags:	−21.490*
b.2. First difference: After 1960:1			
No trend, 4 lags:	−22.384,	With trend, 4 lags:	−29.544
c. Excess return			
No trend, 1 lag:	−26.713,	With trend, 1 lag:	−41.118

Note: Asterisks (*) denote that unit root is not rejected.

on the right-hand side are chosen using information criteria, namely Akaike Information Criterion (AIC) and Schwarz's Bayesian Information Criterion (SBIC) in augmented D-F tests. The existence of unit root is not rejected for stock or land prices.

Further tests reassure us that, taking first differences suffices to attain stationarity for stock price. Real land price appear to allow for the possibility of being I(2), since the correlation of its inflation rate (the log difference) is very high. Testing the unit root hypothesis for various sub-samples suggests that the possibility of I(2) comes from samples in the 1950s. If the first few years of the sample are excluded, we find strong evidence of stationarity in the series of first difference. Or, if excess returns are used instead of simple returns, we also find that the series is I(0). In the rest of this paper, we mainly use excess returns.

Table 3 shows the results of variance ratio tests on nominal asset prices. The z-statistics in the table are the heteroscedasticity-robust statistics derived by Lo and

Table 3
Variance Ratio Tests

VR: $Var(q)/(q \cdot Var(1))$,
$Var(q)$ = Variance of q period log price change
Z: Z-statistics. Asymptotically, $z(q) \sim N(0,1)$.

Sample period: Stock: 1955:II-1993:I, Land: 1960:I-1993:I
Numbers of observations: Stock: 75, Land: 66

	q=2	*q*=3	*q*=5	*q*=8
A. Stock price				
VR	1.132	1.192	1.188	1.150
Z	0.732	0.627	0.430	0.263
B. Land Price				
VR	1.762	2.218	2.422	3.128
Z	3.020*	3.315*	3.045*	3.562*

Note: Z-statistics marked with asterisks (*) indicate that the corresponding variance ratios are statistically different from 1 at the 5% level of significance. See Lo and MacKinlay (1988) for details.

MacKinlay (1988). The test statistics follow an asymptotic, standard normal distribution. Given that we have a relatively small sample, our conclusion based on this test is only tentative. The statistics suggest that the random walk hypothesis is not rejected for the stock price index, but is rejected for the land price index. The latter conclusion is due to high correlations with land price inflation mentioned above.

B. Bivariate Vector-Autoregression System (VAR)[5]

In this subsection, the linkage between land and stock prices will be examined. The purpose of expanding a system to a bivariate system is two-fold. First, examining the two kinds of asset prices improves our chances of separating the bubble component from fundamental values. Second, some theoretical explanation links stock prices to land prices and it is important to understand the mechanism of asset price bubbles in the second half of the 1980s.

In order to judge whether bubbles were present, theoretical, fundamental values have to be calculated. An asset is usually valued as the sum of discounted future profit streams from owning the asset. The discount factor depends on the market interest rate, and profit streams are heavily dependent on expectations of the economy in the future as well as for the specific asset market. Both the interest rate and economy-wide conditions are common to land and stocks. By examining a bivariate system, the power to identify economy-wide shocks may be increased by extracting a common movement in stock and land prices.

Natural linkages between stock and land prices emerge in the calculation of future profit streams. When land prices increase for any reason, a firm that happens to own a large amount of land enjoys (unrealized) capital gains on its balance sheet.[6] The unrealized capital gains signal the increase in future profit streams. Future profits will increase from realizing capital gains by selling the land, utilizing it for a high-yielding business (possibly diversification), or borrowing more funds with the increased value of land as collateral. The last option is particularly relevant for a liquidity-constrained firm with technology to generate income but which has difficulty

[5] Major results obtained in this section have already appeared in Ito and Iwaisako (1992) and Iwaisako (1993).

[6] It was ironic that some declining industries attracted investor attention this way such as steel company with obsolete steel mills at Tokyo Bay and a brewery with excess capacity in Tokyo. For example, Sapporo beer developed its old brewery at Ebisu, Tokyo into a hotel/office complex to take advantage of higher market rents.

convincing a bank. Hence an increase in land values logically results in an increase in stock prices. Conversely, when stock prices suddenly increase, land prices may be influenced by stock prices. An increase in stock prices may prompt firms (especially ones that are liquidity constrained) to use equity financing to raise funds for investment. Then these firms may purchase or lease land in order to carry out fixed investment (such as build factories or offices). The increased demand for land will push up land prices. Thus, there are good reasons to believe stock and land price movements are correlated, but the direction of causality cannot be determined in theory.

In order to gain insights into the nature of the land-stock relationship, a vector-autoregression system (VAR), including stock and land prices, will be examined below. First, a bivariate system is examined. Since both stock and land prices are I(1) variables, the cointegration of stock and land prices is suspected. The t-test type unit root test of the residuals from spurious regressions (Phillips and Ouliaris, 1990) is employed. First, cointegration between concurrent asset prices is tested. Then, tests are conducted for cointegration between current land prices and lagged stock prices up to three lags. For all cases, no cointegration was found between two asset prices at the significance level of 5%. We proceed on the understanding that cointegration between stock and land prices does not exist.

Table 4 presents results of a bivariate VAR with excess stock returns (ESTOCK) and excess land returns (ELAND) from the first half of 1960 to the first half of 1993, with sub sample results for the period after the first oil shock. Excess returns here are the returns from capital gains only above the short-term interest rate (call-tegata rate). Using nominal returns or real returns gives basically the same results. ELAND is statistically explained by past (one period lagged) ESTOCK and ELAND. On the other hand, current ESTOCK is statistically independent of lagged ELAND as well as its own lagged variables. The sub sample presents essentially the same results.

Figures 3 and 4 plot impulse responses to the shock in one variable in the bivariate VAR system. The orthognalization ordering for the plotted series is {ESTOCK, ELAND}. The qualitative result is robust for the change of ordering. Original impulse responses were calculated in return, assuming unit innovations in stock and land returns. Then they are transformed into multiplier processes in price level which correspond to a 1% initial increase from the baseline price level.

A 1% unexpected increase in stock prices causes a further stock price increase for two years but results in a permanent increase of 0.8% above the baseline. The

Table 4
Bivariate VAR(3): ESTOCK and ELAND

A. Full Sample; 1960:I-1993:I

Dependent variable ESTOCK
$\overline{R}^2$: 0.0050, D.W.: 2.00

	1 lag	2 lags	3 lags	Constant	F-statistic	
ESTOCK	0.0965	−0.0220	0.0967	1.9499	ESTOCK:	0.3260
	(0.7475)	(−0.1548)	(0.6547)	(0.1594)		(0.8065)
ELAND	0.9681	−2.2435	0.8512		ELAND:	1.7704
	(1.1616)	(−2.0230)	(1.0815)			(0.1625)

Dependent variable ELAND
$\overline{R}^2$: 0.7633, D.W.: 2.01

	1 lag	2 lags	3 lags	Constant	F-Statistic	
ESTOCK	0.0854	0.0252	0.0204	−0.1153	ESTOCK:	6.7285
	(4.2963)	(1.1501)	(0.8946)	(−0.3981)		(0.0005)
ELAND	0.9518	−0.4042	0.1855		ELAND:	36.3326
	(7.4149)	(−2.3665)	(1.5301)			(0.0000)

B. After the First Oil Shock; 1974:I-1993:I

Dependent variable ESTOCK
$\overline{R}^2$: -0.0141, D.W.: 2.14

	1 lag	2 lags	3 lags	Constant	F-Statistic	
ESTOCK	0.1005	−0.0590	0.1336	0.4463	ESTOCK:	0.2738
	(0.5798)	(−0.3182)	(0.6696)	(0.1849)		(0.8438)
ELAND	0.6891	−1.6719	0.0212		ELAND:	1.4518
	(0.5609)	(−1.1837)	(0.0209)			(0.2462)

Dependent variable ELAND
$\overline{R}^2$: 0.6028, D.W.: 1.87

	1 lag	2 lags	3 lags	Constant	F-Statistic	
ESTOCK	0.0612	0.0279	0.0221	−0.7837	ESTOCK:	2.8873
	(2.4926)	(1.0621)	(0.7827)	(−2.2921)		(0.0507)
LAND	0.7037	−0.1998	−0.0936		ELAND:	7.8529
	(4.0430)	(−0.9987)	(−0.6505)			(0.0005)

C. Before Plaza Agreement; 1960:I-1985:I

Dependent variable ESTOCK

$\bar{R}^2$: 0.03367, D.W.: 1.94

	1 lag	2 lags	3 lags	Constant	F-Statistic	
ESTOCK	0.0165	0.0591	−0.0017	2.5843	ESTOCK:	0.0434
	(0.1092)	(0.3512)	(−0.0099)	(1.2988)		(0.9878)
ELAND	1.1130	−2.5206	1.1228		ELAND:	1.8855
	(1.3302)	(−2.2793)	(1.4573)			(0.1460)

Dependent variable ELAND

$\bar{R}^2$: 0.7684, D.W.: 2.01

	1 lag	2 lags	3 lags	Constant	F-Statistic	
ESTOCK	0.1133	0.0253	0.0170	−0.1300	ESTOCK:	5.7704
	(4.1306)	(0.8313)	(0.5424)	(−0.3601)		(0.0020)
ELAND	0.9471	−0.4349	0.2237		ELAND:	25.9947
	(6.2465)	(−2.1701)	(1.6024)			(0.0000)

Notes: 1. Coefficients: t-statistics in parentheses
2. F-statistic: Significance level in parentheses

Figure 3a
Responses in Returns

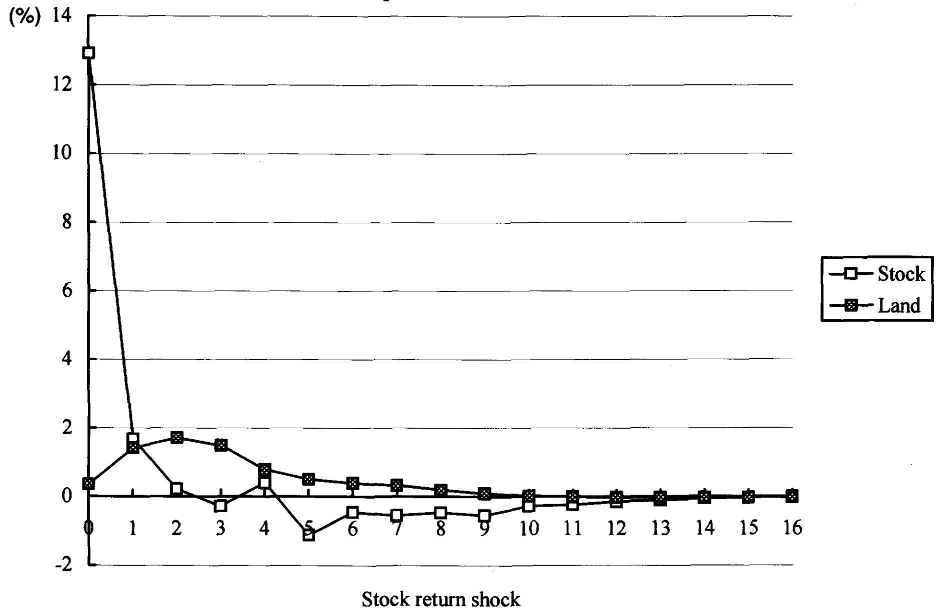


Figure 3b
Responses in Returns

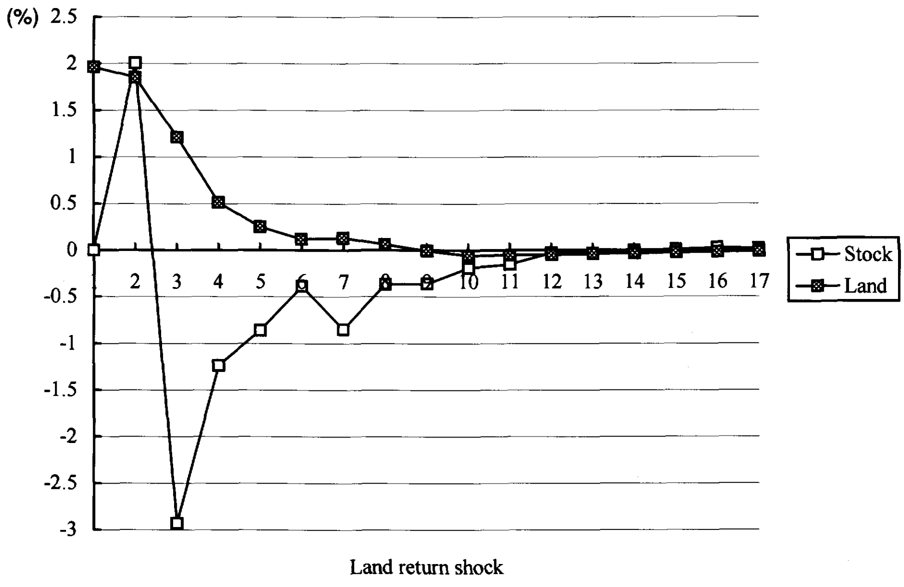


Figure 4a
Responses in Level

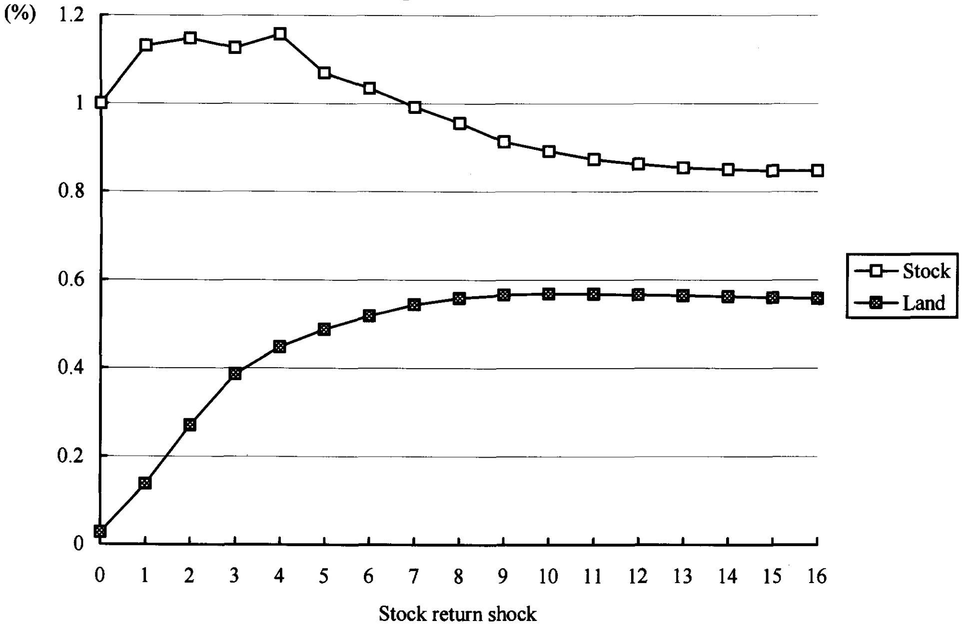
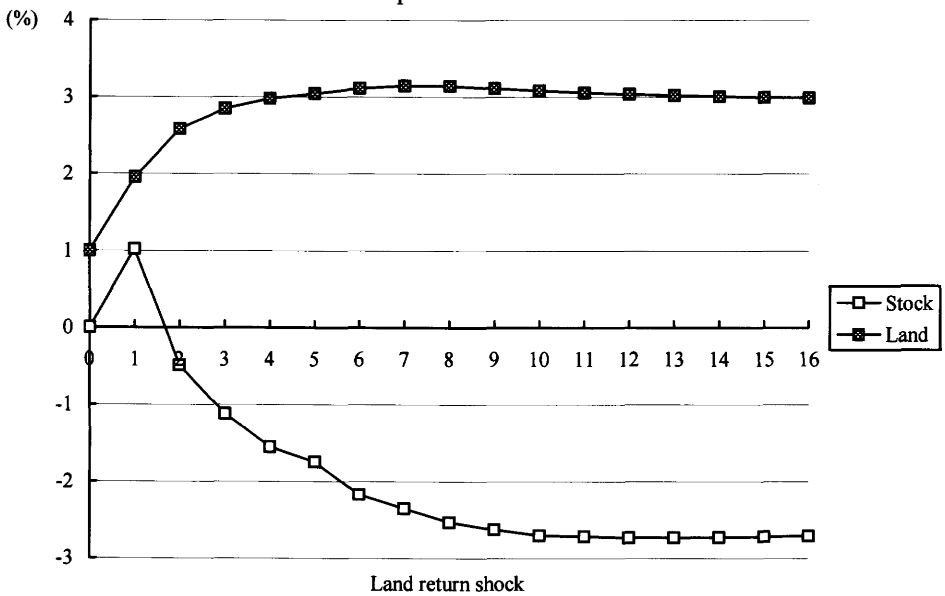


Figure 4b
Responses in Level



1% stock price increase results in a permanent increase in land prices by 0.6%. A 1% unexpected increase in land prices strongly affects land prices, resulting in a 3% land price increase. These findings are consistent with a popular observation that stock prices and land prices move in concert. Since both asset prices respond to the same fundamentals, such as the interest rate and economic growth rate (as a proxy for future cash flow), the comovement is not surprising. There are also other explanations which are consistent with the observed impulse response patterns.

The impulse responses of stock prices to the shock in land prices, however, appear to be counter-intuitive because they suggest negative long-term effects on stock prices. This apparent anomaly should be understood as a statistical relationship rather than a description of an economic causal relation. In the typical asset price boom, stock prices always statistically leads land prices. Thus, when land prices reached their peak, stock prices were already on a decline. The impulse response function captures the relationship as the negative effect of land return shock on stock return. There are two sources of leads and lags between two asset prices. The first source is, as mentioned in the description of the land price index, that land price data do not reflect actual market prices accurately, so that responses to the shock are delayed. The second source is market imperfections in the real estate market, which will be discussed in Section V.

III. Neoclassical Model and Bubbles

A. Neoclassical Asset Pricing Model

In this section, a neoclassical model of asset price determination is introduced. In subsection III.B, we extend this basic model to consider rational stochastic bubbles as an alternative explanation of the asset price boom in the second half of the 1980s. In subsection III.C, some numerical examples are presented to understand how monetary policy could affect asset prices through changes in real interest rates. We further explore to what extent price changes in the 1980s can be explained by changes in "fundamentals", including a very low real interest rate.

In a standard asset pricing model, arbitrage implies that we can always write a price as the expected discounted value of the payoff. It implies that there is a stochastic discount factor ρ such that

$$P_t = E_t[\rho_{t+1} Z_{t+1}] = E_t[\rho_{t+1}(P_{t+1} + D_{t+1})] \quad (1)$$

where Z = payoff, P = price, and D = cash flow (dividend or rent). Within the framework of the consumption-based asset pricing model, ρ is also interpreted as the intertemporal marginal rate of substitution. In simple versions of this model, the price P of any payoff z is given by

$$P_t = E_t\left[\delta \frac{U'(C_{t+1})}{U'(C_t)} Z_{t+1}\right]$$

where U = utility function, C = consumption, and δ = subjective discount factor. The Capital Asset Pricing Model and related models are special cases.

Now, solving equation (1) forward for period K we have,

$$P_t = E_t \sum_{i=1}^{K} \left(\prod_{j=1}^{i} \rho_{t+j}\right) D_{t+i} + E_t\left(\prod_{j=1}^{K} \rho_{t+j}\right) P_{t+K}. \quad (2)$$

By repeating the procedure, the following formula for asset price determination is derived:

$$P_t = E_t \sum_{i=1}^{\infty} \left(\prod_{j=1}^{i} \rho_{t+j}\right) D_{t+i} \quad (3)$$

For now, we also assume the transversality condition (or "no Ponzi game" condition) so that "rational bubbles" are ruled out. (Rational bubbles will be discussed in subsection III.B.):

$$\lim_{K \to \infty} E_t \sum_{i=1}^{K} \left(\prod_{j=1}^{i} \rho_{t+j}\right) D_{t+i} = 0. \quad (4)$$

Expression (3) is a very general formula of asset price determination. In addition, we adopt the following common assumptions in the literature.

(A.1) Constant discount factor: $\rho = \rho_{t+1} = \rho_{t+2} = \cdots\cdots = \rho_{t+I}$

Further, we assume ρ^{-1} is equal to the constant risk-free interest rate, i.e.,

$$\rho^{-1} = 1 + r_t = 1 + r \qquad \text{for all } t.$$

(A.2) Constant dividend (or rent) growth rate: $D_{t+1} = (1+g)D_t$ for all t, and $g < r$.

Assumption (A.1) implies the risk neutrality of investors. In reality, the expected returns to risky assets should include risk premium. By assuming (A.1), (A.2), and perfect foresight, expression (3) is reduced to the following heuristic expression, which is often called the Gordon valuation model in financial literature:

$$P_t = D_t / (r - g) \tag{5}$$

This relationship is easy to verify.[7]

As clearly seen from the right-hand side of the above expression, asset price is quite sensitive to a small change in "r" and "g". Rearranging (5) we have the following expression for the dividend (or rent) /price ratio:

$$D_t / P_t = r - g. \tag{6}$$

The casual evidence cited in the preceding section suggests that equation (5) likely holds in U.S. stock markets. But it hardly holds for the Japanese stock or land markets, since the dividend/price ratio fluctuated wildly, or drifted up so much. However, "g" could be understood as earnings growth in the sense that it reflects future returns from both dividends and capital gains.

B. Simulation with Interest Rate Changes

Next, let us turn to changes in fundamentals as the cause of the asset price boom and the subsequent bust at the beginning of the 1990s. The changes in fundamentals are represented by the reduction in the discount rate "r" and higher growth of dividends (or earnings more generally) "g." Many economists (e.g. Japan Security Analysis Institute, 1988) argue that the asset price increase was quite natural since interest rates fell dramatically during 1985-87. From 1987 to 1989, the official

[7] Ito (1993a) tried to exploit this relationship in his investigation of land price determination in Japan.

Table 5
Permanent Change in Interest Rate and Stock Price

$P_t = D_t / (r - g)$

D_t = dividend payment at time t

r = interest rate

g = the growth rate of dividend

r (%)	g (%)	$1/(r-g)$
4	3	100
5	3	50
6	3	33.3

discount rate remained at a then record low level of 2.5%. For example, if the required rate of return is 6% while dividend growth is 3%, then the *P/D* ratio in equation (6) is 33; while a decrease in the required rate of return (interest rate) to 5% makes the *P/D* ratio increase to 50 (Table 5). Thus a small increase in "*r*" causes a large change in "*P*." The 2 percentage point decrease in the interest rate triples the price. Hence, many argued that all the wild fluctuation in stock and land prices in the second half of the 1980s could be explained by changes in "*r*."

However, this argument is not correct unless all participants thought that the interest rate change was a "once-and-for-all" type change, i.e., a permanent change to a new lower level from a higher level. Since interest rates go up and down depending on the stage of business cycle, (A.1) does not hold true in its purest form. Suppose, instead, a more realistic situation that the change in the interest rate or dividend growth is perceived as "temporary." This case is shown in Table 6. Now, let us consider the temporary decrease of r from 6% to 5% or to 4%. It is assumed to be the case that g = 3%, and the interest rate will return to 6% after K periods. Admittedly, the length of time (K) where the new interest rate level is in place, or the level itself in the future, is difficult to quantify since they are in the minds of market participants.

However, some simple observations are still possible. First, with rational expectations, it is justified to use *ex post* real interest rates in calculating the effect of the low interest rate on fundamentals. Figure 5 shows the difference in *ex post* "g"

Table 6

Temporally Change in Interest Rate and Stock Price

Simulation scenario: Initial interest rate was 6%. It goes down to 4% or 5%, and comes back to 6% after K periods.

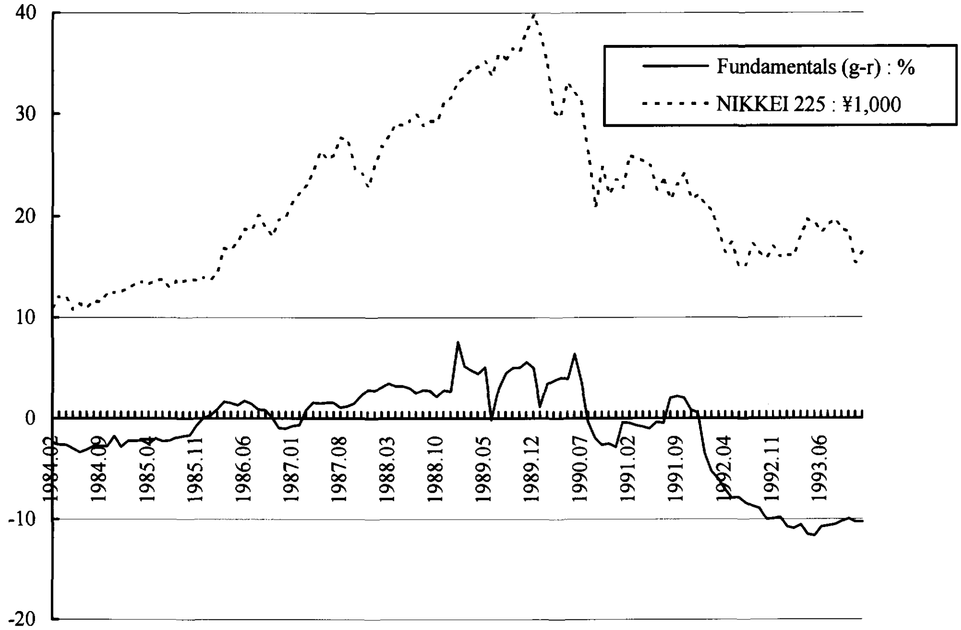
	r = 5		r = 4	
K	Price		Price	
$K = 0$	33.33		33.33	(Benchmark case)
Three months	33.51	(0.54%)	33.59	(0.78%)
Six months	33.59	(0.78%)	33.75	(1.26%)
One year	33.74	(1.23%)	34.06	(2.19%)
Two years	34.06	(2.19%)	34.70	(4.11%)
Three years	34.37	(3.12%)	35.33	(6.0%)
Five years	34.97	(4.92%)	36.56	(9.69%)
Ten years	36.38	(9.15%)	39.55	(18.7%)
$K = \infty$	50.00	(50.0%)	100.00	(200%) (Permanent decrease)

and "r" and the Nikkei 225 Index.[8] Stock prices today reflect the expectation of future changes in fundamentals as well as fundamentals today, so the entire future paths of "r" and "g" from tomorrow affect asset prices today. It seems impossible to offer a rational explanation for asset price inflation in the second half of the 1980s by changes in fundamentals, namely "r" and "g," unless lower interest rates were expected to continue forever.

To see this point, let us do some calculations. From the first oil shock of 1973 to 1993, real stock price growth averaged 6-6.5% annually. So assume $g = 6.5\%$ in 1985, though this is obviously much higher than the average growth rate of actual

[8] Our r is the new CD issue rate (90-179 days). For g, the three-month moving average of the one year growth rate of the sales of large-scale retail stores is used. We used consumption data for g rather than output data such as GDP or industrial output. That is because consumption is supposed to reflect the expectation of future permanent income, so that it better approximates the expectation of future output or earnings than actual output or earnings.

Figure 5
NIKKEI and Fundamentals



dividends in this period.[9] Although the Japanese economy was suffering from the deflationary impact of the sharp appreciation of the yen against the dollar from the first quarter of 1986 to the first half of 1987, it was temporary. So we further assume that g was unchanged (not increasing). TOPIX was approximately 1000, 1265, and 1870, respectively in March 1985, 1986, and 1987. So, from March 1985 to March 1986, the stock price increased 26.5%. If "r" had been constant, the appreciation of stock prices must have been 6.5% plus some error, so that TOPIX would be 1065. Thus the remaining 3/4 (= 1 - 6.5%/26.5% = 0.755) of the price increase has to be explained by the reduction in interest rates. In order to make the story simple, let us assume that all further stock price increases occurred at the end of this period. Then we have to consider the change in the future interest rate path which would cause a

[9] From the Gordon valuation formula,

$$R_{t+1} = \frac{P_{t+1}}{P_t} - 1 = \frac{D_{t+1} / (r-g)}{D_t / (r-g)} - 1$$

and $D_{t+1} = (1+g)D_t$. Therefore R_{t+1} is equal to "g," if the r is fixed.

15-20% (1265/1065 - 1 = 18.8%) increase in stock prices in March 1986.[10] This means that the real interest rate has to go down 2% for 11 years, or 3% for seven years. Considering the two-year period from March 1985 to March 1987, more than 4/5 of the 87% price increase must be explained by the reduction in real interest rate, which means a 3% reduction in the interest rate for more than 20 years. Even if we change the starting point to March 1986, a perception of a 3% reduction for 13 years is required in order to explain the additional 40% stock price appreciation from March 1986 to March 1987. On the other hand, the fall in interest rates from the first quarter of 1985 to the first quarter of 1987 was around 3%, and nominal interest rates recorded their lowest levels in May or June of 1987 during this monetary expansion period, while inflation was no more than 0.5% per year.

Those who still believe that the asset pricing model should be able to explain price movements may argue that "g" as well as "r" have changed. As noted above, the perception of growth was not particularly great after the yen's sharp (60%) appreciation from September 1985 to August 1986. Although strong growth resumed in 1987, it is highly debatable that the long-term trend of "g" changed around 1986-87 and that investors acknowledged that change.

One support for a fundamentals story comes from the pattern of land price increases from 1986 to 1988. (See Ito, 1992, regarding the discussion below.) The initial price increase was seen on commercial property in central Tokyo. Then it spilled over to residential, inner suburbs of Tokyo, before spreading to neighboring prefectures and cities of Tokyo and other large cities such as Osaka and Nagoya in one year. The initial increase in land prices in central Tokyo coincided with increased demand for commercial property due to Tokyo's increased role as a financial center.

Next, we consider the increase in stock prices after Black Monday. In March 1988, when the Tokyo market had fully recovered the level just prior to Black Monday, TOPIX was 2145. By the end of 1989, TOPIX had risen to 2880, an approximate 40% increase in two years. First, the real interest rate was already at a record low level in 1987, and became even lower in 1988 and 1989. However, this is mainly because inflation, as measured by CPI, began to rise as the real economy experienced a big boom. Thus, it is natural to assume that future monetary tightening by the Bank of Japan had been expected, so that at least no further

[10] This calculation holds, approximately, either if we assume that all the change in "r" happened at the beginning, or if we assume that there were small changes spread over the period.

prolonged interest rate decline should have been expected. So let us assume "*r*" was expected to be unchanged in this period. Then, $(1.065)^2$ = a 13.5% increase in two years would be expected, so that TOPIX was supposed to be around 2350. This time, the remaining 65-70% of the stock price increase in this period has to be explained by the change in "*g*" alone. In the context of our thought experiment, this implies that we have to consider the change in the future path of "*g*" that would cause a 20-25% asset price increase today (e.g., stock price increase due to change in "*g*" at the end of this period, 2880/2350 - 1 =22.55%.) This corresponds to the 2% increase in "*g*" for more than ten years. It is true that the real economy experienced a big boom from 1988 to 1990, so that this story might be rationalized if there was an unforeseen change in "*g*." But, it is too hard to assume that this boom was totally unexpected at the beginning of 1988. And, the recovery from Black Monday cannot be justified if it were not expected. Also, dividend growth was stagnant in 1988 and 1989 compared with the period from 1985 to Black Monday in October 1987. Overall, it is safe to say that the further increase in stock prices in this period cannot be fully justified by the change in fundamentals. Furthermore, it is even harder to justify the stock price increase in 1988-89 compared with the period of 1985 to just before Black Monday. Stock prices might have been too low in 1985, but prices were apparently already very high at the beginning of 1988.

C. Rational Stochastic Bubbles

Some researchers (for example, Asako et. al., 1990, Asako, 1992) have tried to explain the boom and bust of Japanese asset prices using a model of rational stochastic bubbles.[11] This model can explain why asset prices exceeded the price level determined by fundamentals. Rational bubbles are modeled by adding the "bubble" term to (3), and assuming a constant discount factor (A.1) (i.e., constant expected returns).

[11] This type of model has its origin in the multiple solution problem of linear rational expectations models. Thus it is called "rational" bubbles. However, this model is not consistent with the assumption of fully rational agents or common knowledge, since it violates (4). The full rationality assumption can be very restrictive. See chapter 7 of Campbell, Lo, and MacKinlay (1996), for other various economic arguments that the "rational" bubble model is unlikely to be a good description of speculative behavior in asset markets.

$$P_t = E_t \sum_{i=1}^{\infty} (\frac{1}{1+r})^i D_{t+i} + b_t \tag{7}$$

As long as $(1+r)b_t = E_t b_{t+1}$, this equation satisfies the arbitrage condition (1). The simplest case is the deterministic bubble which implies $(1+r)b_t = b_{t+1}$[12] In order to make the model more realistic and to incorporate inflation and the deflation of asset prices, b_t can be modified to be stochastic, which was first developed by Blanchard (1979) and Blanchard and Watson (1982). For example, Blanchard and Watson suggested the following specification of the stochastic bubble, where e_{t+1} is white noise:

$$\begin{aligned} b_{t+1} &= (\frac{1+r}{p})b_t + e_{t+1} \quad \textit{with prob. } p \\ &= e_{t+1} \quad\quad\quad\quad\quad \textit{with prob. } 1-p \end{aligned} \tag{8}$$

Empirical testing of the "bubble" in asset prices is closely related with the volatility tests which LeRoy and Porter (1981) and Shiller (1981) embarked on more than a decade ago. In this empirical literature, excess volatility of asset prices is identified as the residual from actual price minus "fundamentals." Thus, the stock market volatility debate is reduced to the identification problem of "fundamentals." One approach is (like Shiller's original work) to use *ex post* dividend payout in the present value relationship (3) to obtain approximate fundamental asset prices. Another approach is to use the time series model of dividends, for example West (1987). The econometric methods used in initial papers have been extensively criticized, but recent work which avoids these problems still finds excess volatility (see, Flood and Hodrick, 1990, Campbell, Lo, and MacKinlay, chap.7, 1994, for survey). However, recently the controversy has diminished. Although volatility tests have attracted considerable attention, as Summers (1991) noted "it is hard to identify people whose mind has been durably changed by this research." This is mainly because the finance profession is convinced that expected stock returns are time varying, and thus the predictability of returns became the focus of attention among researchers from the second half of the 1980s.[13]

[12] Rational investors will not invest in negative bubbles. So we should add the condition that $b_t \geq 0$ for all t.

[13] For example, Fama and French (1989), Lo and MacKinlay (1988), and Poterba and Summers (1988).

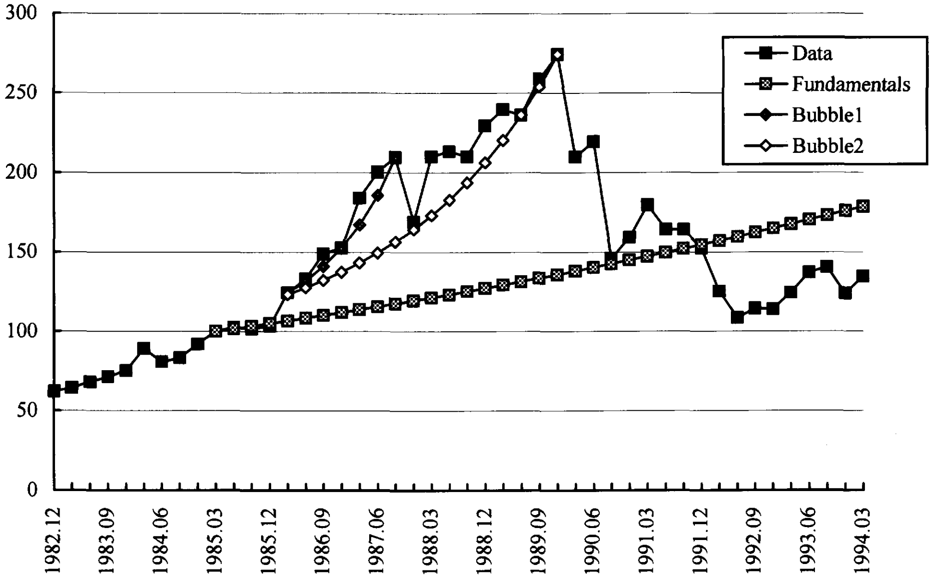
In a small sample, usual Shiller-type volatility tests cannot distinguish rational bubbles from the composite hypothesis that stock prices are more volatile than justified by rational forecasts of future dividends.[14] Thus, the reason for excess volatility or apparent deviation from fundamentals, if found, does not have to be rational bubbles. In order to distinguish empirically rational bubbles from other irrational models of excess volatility, we have to find some empirical implication unique to the rational bubble model. The rational stochastic bubble model implies an explosive path for asset prices. As the crash probability of the bubble increases, the price path of the bubble asset becomes more and more explosive and steeper. There is little evidence of such explosive behavior with respect to either stock or land prices, nor with respect to any stock market in developed countries for a sufficiently long period which could be compared to the bubble economy period in Japan. Asako et al. (1990) try to identify rational bubbles in the Japanese stock price index by distinguishing the explosive price path, but they found very limited evidence. They concluded that the source of the asset price boom in Japan was more likely to be irrational bubbles rather than rational bubbles. However, modeling and estimating stochastic bubbles is not sophisticated in Asako et al. (1990) or any other work in the literature.

Below, we attempt a direct calculation of the crash probability of the stochastic bubble, though admittedly simplistic, to see how likely the reality was caused by stochastic bubbles. Suppose that in March 1985, the stock price index, TOPIX, was exactly at "fundamental" value, and that after March 1985, fundamental value grew 6.5% per year (as shown by the thick solid line in Figure 6). Actually, the assumption of 6.5% is consistent with the increase calculated by the simple time trend. Then the realized stock price is above fundamental value by 117% in March 1986, by 178% in September 1987, and by 200% in December 1989. Provided that these values are correct, $\boldsymbol{p}$, the probability that the bubble will survive in the following period can be calculated using (8).

$$\boldsymbol{p} = (1+r)\left(\frac{b_t}{b_{t+x}}\right)^{-x} \tag{9}$$

[14] More precisely, rational bubbles might be the reason of the low power of a Shiller-type volatility test in small sample. We thank Prof. Flood for this comment.

Figure 6
Sample Bubble Paths



If we use the value in March 1986 as b_t (the initial bubble) and the value in September 1987 (just before the October crash) as b_{t+x}, p will be approximately 0.81 for quarterly data. This sample path is shown as "Bubble-1" in Figure 6. Given that today's stock price includes some bubble component, the bubble will last another three months with a probability of 81%. To support this sample path of "Bubble-1" in Figure 6, the bubble has to last 18 to 21 months. It thus means such a sample path will hold that long with a probability of 0.81^7=18.5%.

If we use the value in December 1989 (the highest price level and the largest deviation from fundamentals) as b_{t+x}, p will be approximately 0.925. This is "Bubble-2" in Figure 6. In the Bubble-2 case, the bubble has to last 42 to 45 months. Then the probability that Bubble-2 can persist is 26.5%.

Actual data seems to fit better the sample path in the first case. Finally, if we assume that the sample path switched from Bubble-1 to Bubble-2 after the October crash in 1987, such a sample path will be sustained with probability approximately 7% ("Bubble-3"). The calculation of p is sensitive to the choice of b_t and b_{t+x}, and the above values of p should be understood as maximum possible values. So the calculated probabilities that the bubbles survive along with the sample paths are also the largest possible values. For example, if the value at December 1985 is used as the initial condition b_t, the probability that Bubble-1 can be sustained will be 6%, so Bubble-3 will be about 2.5%.

Some researchers may observe that those probabilities are high enough so that the reality may be consistent with the stochastic bubble model, while others may think otherwise. But, even with rational stochastic bubbles, it is very hard to explain the boom in the Japanese stock market in the second half of the 1980s. In particular, the behavior of the stock price index after October 1987 hardly fits the rational bubble explanation.

D. Expectation of Future Interest Rates and Term Structure

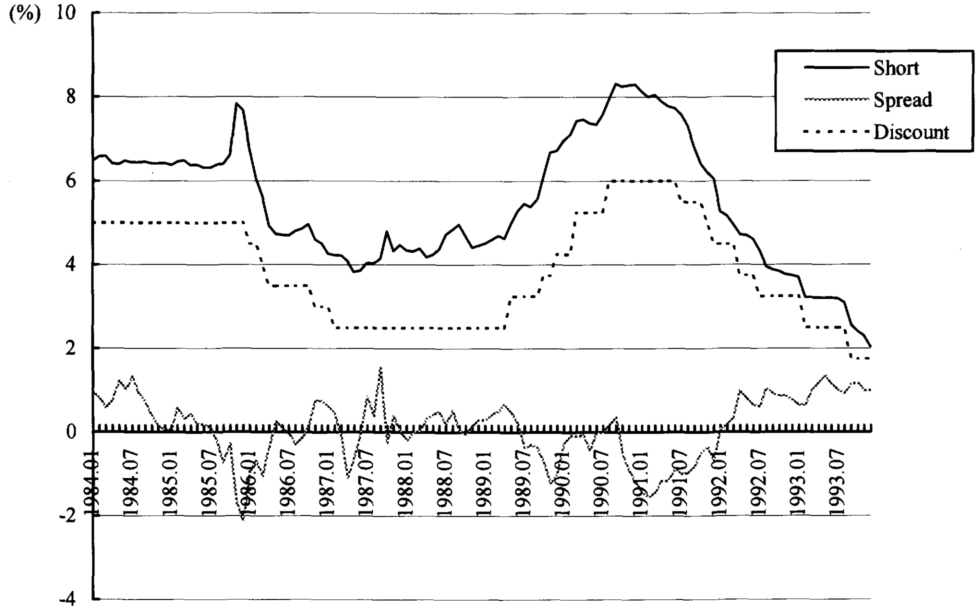
As discussed in subsection III.B, one possible explanation for the sharp increase in asset prices from 1986 to 1989 is that the public held irrational expectations about future real interest rates; if the decrease in real interest rates was thought to be permanent, this explanation seems to fit the behavior of asset prices in the 1980s. Asset prices should have increased sharply in 1986-1987, and then stay at a high level. On the other hand, rational bubbles, discussed in the previous subsection, predict that asset prices will take an explosive path which was not the case. The actual data in the last ten years can be simulated better with irrational expectations.

This possibility can be inferred from the entire term structure of interest rates or the long-short spread. The literature of the term structure of interest rates assumes rational expectations in testing the expectations hypothesis. Usually, the pure form of expectations theory is rejected statistically. However, Froot (1989) argued that the expectations hypothesis fits the data better if expectations are taken from surveys.[15] So, by giving up the rational expectations assumption, the market expectation of future short-term interest rates can be inferred from the current long-short spread.[16] Figure 7 shows the paths of the real interest rate, official discount rate, and the long-short spread. First, the sharp increase in the short-term rate right after the Plaza Agreement created the large negative spread in this period. After that, from mid-1986 to mid-1989, no significant pattern in the term structure can be observed

[15] See Campbell (1995) for a survey of term structure literature and interesting application to recent U.S. monetary policy experience.

[16] The short-term rate is the new CD issue rate (90-179 days). The long-term rate is the yield on government bonds listed on the Tokyo Stock Exchange (10-year bench-mark). Roughly speaking, Figure 7 corresponds to Campbell and Hamao (1993; Figure 4.7), although their sample period is November 1980-August 1990, whereas ours is January 1984-December 1993, and short-term rates are also different.

Figure 7
Long-Short Spread



from the graph. Campbell and Hamao (1993) explain it as the result of the change in the behavior of short-term interest rates due to a change in the conduct of monetary policy in this period. The short-term interest rate became more volatile and less predictable in the second half of the 1980s compared with the early 1980s. Responding to tight monetary policy from mid-1989, at first, the long-term rate did not change. It thus seemed that the market thought this policy change was only temporary. This may be one of the reasons that stock prices continued to rise until the very end of 1989. Then the market became convinced that monetary policy ought to be tightened so that the long-term rate caught up with the short-term rate. From 1991, the term structure has behaved in the usual manner: the short-term rate has been higher than the long-term rate during a period of monetary contraction, and lower when the official discount rate was decreasing.

E. Synthesis and Remaining Questions

In sum, the discussions in this section are as follows. In view of the neoclassical model and its expansion to include bubbles, asset price inflation from

1985 to 1989, and subsequent deflation, were caused by various factors. The initial shock in 1985 and 1986 may have belonged to "fundamentals," such as increased demand for commercial property in Tokyo, a higher productivity increase a many Japanese industries (the increase in "*g*"), and expansionary monetary policy (the decrease in "*r*").

However, there is a limit to the fundamentals story. Although the initial shock may have been land "fundamentals" in Tokyo, followed by monetary policy fundamentals, it is difficult to put together for different stages of asset price inflation. From 1985 to the end of 1986, economic growth prospects were weak, but asset prices were already rising. (A hard core believer in fundamentals might justify the increase in asset prices in this period by invoking rational expectations regarding the expansion of the economy in following years, but then it is difficult to justify the failure in foreseeing the crash at the beginning of the 1990s.) From 1986 to 1987, both the movement of interest rates and economic growth indicated that asset prices should increase. The direction was right. However, the magnitude of increase in stock and land prices is difficult to justify from the magnitude of decrease in "*r*" and/or increase in "*g*" unless the changes were perceived, wrongly, as permanent (say, for the next ten years or so).

From 1987 to early 1989, there was no news regarding fundamentals significant enough to explain further stock and land prices. Although real interest rates were still declining, that was due to higher inflation, which should have prompted investors to anticipate coming nominal interest hikes.

From early 1989 to the end of 1989 for stock prices, and the end of 1990 for land prices, there is little evidence which would have justified further rises in stock and land prices in the fundamentals model framework.

With these limitations in mind, some particular form of a stochastic bubble model was simulated. The model was designed to calculate the crash probability from actual rises in asset prices. Combining the fundamentals and bubbles stories, one could argue that early asset price rises, maybe until late 1987, were mostly explained by the fundamentals model with overly optimistic expectations on the part of investors. But some time after that, the asset market turned speculative. Once sown, the seed of speculatine bubbles (the beginning of stochastic bubbles) proceeded to grow, purely on expectations of further bubbles, until the crash came in the early 1990s.

However, even with this *ad hoc* integration of fundamentals and bubbles, questions remain. In particular, macroeconomic policy during the period in question may not be adequately captured by the call rate. Also, the relationship between stock and land price increases is not really addressed in this section. The following sections attempt to answer these questions.

IV. Macro-variables and Monetary Policy

In this section, we extend our VAR system in subsection II.B to include macro-variables, and consider the effect of monetary policy on asset prices. Later, we employ the framework for variance decomposition recently developed by John Campbell (Campbell, 1991, Campbell and Ammer, 1993) to further investigate the nature of asset price movements in Japan.

A. Multivariate VAR

The new VAR system consists of the following variables: Excess Stock Returns (ESTOCK), Excess Land Returns (ELAND), Real Interest Rate (RRATE), the First Difference of Interest Rate (ARATE), the Growth Rate of Bank Loans to the Real Estate Sector (GLOAN), and the Log of Earnings-Price Ratio (LEPR). We find the growth rate of bank loans to the real estate sector (GLOAN) has high explanatory power for LAND. As for details of GLOAN, see Section III. We estimated the full sample, the second half of 1969 to the first half of 1993, which is constrained by the availability of GLOAN series, and the "pre-bubble" sub sample, the second half of 1969 to the first half of 1993. Dividing the samples at January 1985 might be more informative, but we have too few observations to draw conclusions using such sub samples.

Another variable that has to be explained is LEPR (the log of the earning/price ratio). We used LEPR as the "fundamentals" variable, instead of the log of the dividend/price ratio in Campbell's papers because the dividend/price ratio in the Japanese system behaves quite differently from in the U.S.[17] In Japan, the

[17] According to Modigliani-Miller theorem (in a world with perfect information and no corporate tax, among other things), there is no reason to believe that the dividend/price ratio is useful to predict asset returns. The dividend/price ratio turned out to be useful in predicting stock prices in the United States, probably because it signals to investors some information revealed to the firm's management. In the United States, the dividend/price ratio has been relatively stable, and its mean stays constant in the long run. If the signaling story of firms' dividend policy is true, dividends represent "fundamentals" in the future. So, there is a stable

dividend/price ratio has been steadily declining over the sample period, even before the bubble era, and fluctuation around the declining trend does not seem to signal anything. Furthermore, we found unit roots in both the dividend/price ratio and the log dividend/price ratio, though both of them were significant in explaining stock returns. This quite different behavior of aggregate dividends in Japan is perhaps a subject for another paper. Overall, we decided to use the earning/price ratio rather than the dividend/price ratio in our system. However, LEPR itself is not free from the unit root problem. We reject unit root in LEPR series for before January 1985, but cannot reject for the full sample. Ferson and Harvey (1994) studied various fundamental variables in the various national markets. From their study (especially Figure A.1-4 in their paper), we suspect that unit roots cannot be rejected for any other "fundamentals" variables for the period including January 1985-December 1991. But, the pre-bubble behavior of "fundamentals" variables in the Japanese market, other than the dividend-price ratio, is quite similar to that in other countries. This fact would support the view that the stock price boom from 1985 to 1990 cannot be rationalized by changes in fundamentals.

Tables 7 and 8 show the results of multivariate VAR. First, monetary policy apparently does affect asset prices. The result that ESTOCK causes ELAND in the sense of Granger causality in bivariate VAR in Section II should be interpreted as due to different transmission mechanisms of monetary policy to different asset prices. GLOAN is a very important factor in predicting both stock and land excess returns. ARATE Granger-causes the increase of excess asset returns only in ESTOCK regressions. This implies the bank lending channel is more important than the direct effect of interest rate changes for land price changes. Also, compared with the pre-bubble subsample, GLOAN is more significant in ELAND in regression, which suggests the credit channel was especially important in the bubble era. Second, as we found in the bivariate system, lagged ESTOCK and ELAND explains current ELAND. In particular, lagged ELAND is very strong in explaining current ELAND, which implies strong autocorrelations in ELAND.

(stationary) relationship between equity price and signal of its "fundamentals," even though both are non-stationary time series.

Table 7

Coefficients of VAR System Including Macro-variables

VAR(1): ESTOCK, ELAND, RRATE, GLOAN, ARATE, LEPR

A. Semi-Annual Data from 1969:II-1993:I

Dependent variable ESTOCK

$\bar{R}^2$: 0.0913, D.W.: 2.26

ESTOCK{1}	ELAND{1}	RRATE{1}	GLOAN{1}	ARATE{1}	LEPR{1}	Constant
−0.0568	−1.0308	2.0919	0.9847	−1.7290	3.5659	3.3761
(−0.3035)	(−1.5242)	(1.5345)	(2.0699)	(−1.2603)	(0.7886)	(0.2066)

Dependent variable ELAND

$\bar{R}^2$: 0.7864, D.W.: 1.6

ESTOCK{1}	ELAND{1}	RRATE{1}	GLOAN{1}	ARATE{1}	LEPR{1}	Constant
0.0499	0.6112	0.4911	0.2167	−0.0419	−0.3494	−3.7692
(1.9865)	(6.7356)	(2.6848)	(3.3944)	(−0.2279)	(−0.5759)	(−1.7187)

B. Estimate 1969:II-1985:I

Dependent variable ESTOCK

$\bar{R}^2$: 0.3220, D.W.: 2.53

ESTOCK{1}	ELAND{1}	RRATE{1}	GLOAN{1}	ARATE{1}	LEPR{1}	Constant
−0.5525	−1.8178	2.1833	1.6911	−3.5906	−7.0697	−33.2569
(−2.2785)	(−2.7910)	(2.0590)	(3.5184)	(−2.8572)	(−0.9971)	(−1.4215)

Dependent variable ELAND

$\bar{R}^2$: 0.8065, D.W.: 1.90

ESTOCK{1}	ELAND{1}	RRATE{1}	GLOAN{1}	ARATE{1}	LEPR{1}	Constant
0.1115	0.6326	0.5548	0.1272	−0.0867	0.6634	−0.0506
(2.4625)	(5.2029)	(2.8029)	(1.4181)	(−0.3694)	(0.5011)	(−0.0116)

Note: t-statistics in parentheses.

Table 8
Granger Causality Tests

A. Estimate 1969:II-1993:I
Variable

	To: ESTOCK	ELAND	RRATE	GLOAN	ARATE	LEPR
From:						
ESTOCK	0.0921	3.9462	0.2777	0.0261	0.2777	1.3922
	[0.7631]	[0.0537]	[0.6011]	[0.8725]	[0.6011]	[0.2448]
ELAND	2.3231	45.3678	1.8663	0.0160	1.8663	11.4188
	[0.1351]	[0.0000]	[0.1793]	[0.8999]	[0.1793]	[0.0016]
RRATE	2.3546	7.2083	10.2560	3.0146	12.9077	1.3468
	[0.1326]	[0.0104]	[0.0026]	[0.0900]	[0.0009]	[0.2526]
GLOAN	4.2847	11.5218	0.7215	20.5922	0.7215	8.3870
	[0.0448]	[0.0015]	[0.4006]	[0.0000]	[0.4006]	[0.0060]
ARATE	1.5883	0.0519	1.1944	0.6692	1.1944	0.7523
	[0.2147]	[0.8209]	[0.2808]	[0.4181]	[0.2808]	[0.3908]
LEPR	0.6219	0.3317	0.5305	4.8521	0.5305	352.9417
	[0.4349]	[0.5678]	[0.4706]	[0.0333]	[0.4706]	[0.0000]

B. Estimate 1969:II-1985:I
F-Tests, Dependent variable ESTOCK

	To: ESTOCK	ELAND	RRATE	GLOAN	ARATE	LEPR
From:						
ESTOCK	5.1914	6.0637	0.4608	0.0847	0.4608	2.7043
	[0.0315]	[0.0210]	[0.5035]	[0.7734]	[0.5035]	[0.1126]
ELAND	7.7895	27.0702	1.3708	0.2313	1.3708	18.4632
	[0.0099]	[0.0000]	[0.2527]	[0.6348]	[0.2527]	[0.0002]
RRATE	4.2394	7.8560	8.8560	2.5806	10.5339	1.7588
	[0.0501]	[0.0096]	[0.0064]	[0.1207]	[0.0033]	[0.1968]
GLOAN	12.3788	2.0109	0.8671	12.6155	0.8671	9.8311
	[0.0017]	[0.1685]	[0.3607]	[0.0016]	[0.3607]	[0.0044]
ARATE	8.1637	0.1365	0.0038	1.6441	0.0038	4.9941
	[0.0085]	[0.7149]	[0.9511]	[0.2115]	[0.9511]	[0.0346]
LEPR	0.9941	0.2511	0.4725	3.7951	0.4725	114.0187
	[0.3283]	[0.6207]	[0.4982]	[0.0627]	[0.4981]	[0.0000]

Note: F-statistics. Significance levels in brackets.

B. Variance Decomposition

Next, we use variance decomposition for asset returns proposed by Campbell (1991) and Campbell and Ammer (1993) to further investigate our VAR system.[18] Campbell's basic framework is the following accounting equation for the (unexpected) asset excess return:[19]

Eu	=	*Ec*	−	*Er*	−	*Ee*	(10)
Unexpected excess return		News about cash flows		News about real interest rate		News about future excess returns	

Note that Equation (10) is not a behavioral model, but a dynamic accounting identity that imposes internal consistency on expectations of the (representative) investor. This identity implies the following covariance relationship:

$$\begin{aligned}\text{Var}\,(Eu) = {} & \text{Var}\,(Ec) + \text{Var}\,(Er) + \text{Var}\,(Ee) \\ & - 2\text{Cov}\,(Ec, Er) - 2\text{Cov}\,(Ec, Er) + 2\text{Cov}\,(Er, Ee)\end{aligned} \tag{11}$$

In practice, *Eu* is estimated as the residuals of the excess return regression. *Er* and *Ee* are calculated from the residuals of the excess return and real interest rate regressions using VAR coefficients. And *Ec* is equal to (*Er* + *Ee* + *Eu*) by definition.

The early volatility test papers (LeRoy and Porter, 1981; Shiller, 1981) are criticized because of the difficulty in modeling and estimating dividend time series. This point is emphasized by Marsh and Merton (1986). The same criticism applies equally to VAR systems including dividends. The key insight in Campbell's approach is that, by using equation (10), the difficulty in estimating the stochastic process of cash flow (dividends or rents) can be avoided.

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18 See also Campbell, Lo, and MacKinlay (1996), chapter 7. The formulation in this paper follows Campbell and Ammer (1993).

19 By the linear approximation procedure, (10) can be rewritten as:

$$e_{t+1} - E_t e_{t+1} = (E_{t+1} - E_t)\left\{\sum_{j=0}^{\infty} \rho^j \Delta d_{t+1+j} - \sum_{j=0}^{\infty} \rho^j r_{t+1+j} - \sum_{j=0}^{\infty} \rho^j e_{t+1+j}\right\}$$

where: e is excess return; Δd is dividend growth (first difference of log dividend); r is the real interest rate; and ρ the discount rate implied by the log-linear approximation procedure. If constant dividend-price ratio (D/P) is assumed, $\rho = (1 + D/P)^{-1}$. See Campbell and Ammer (1993) for details.

One difficulty in carrying out Campbell-type variance decomposition is the choice of discount factor ρ for land.[20] Denoting the dividend/price ratio (or the rent/price ratio for real estate) by *D/P*, ρ is equal to $(1+D/P)^{-1}$. Ueda (1992) estimated the rent/price ratio based on micro data of real estate companies' rental revenues and real estate assets. According to Ueda, the average *P/D* ratio for 1970-80 was 19.3 (i.e., annual *D/P* = 5.18%); for 1980-85, 15.3 (6.54%); and for 1986-89, 31.5 (3.17%). Ito and Nosse-Hirono (1993), using advertised prices and rents in the trade magazine, calculated the D/P ratio for the Tokyo apartment market for the 1980s from micro data. It fluctuated between 17 and 32, so their study is consistent with Ueda's estimation. On the other hand, the annual D/P of stocks was 1.71% in 1980, 0.45% in 1989 (the peak of the boom), and 0.74% in 1992.[21]

In the empirical study below, we use ρ = 0.993, which is implied by the dividend/price ratio of stocks, for the variance decomposition of both stock and land returns. Although the choice of ρ would not dramatically change the result, we have to bear in mind the potential problem of the discount factor in the following discussions.

Table 9 shows the result of variance decompositions. Our results greatly differ from Campbell and Ammer (1993). Campbell and Ammer showed that most of the unexpected excess returns are explained by news about future excess returns and that the share of dividend innovations is less than 20%. Our results, shown in Table 9, indicate that for Japanese stocks, news about future dividends is the most important factor. However, considering the negligible level of dividends in Japan, it is puzzling to find the variance of news about future dividends being so large.

One explanation is the difference in the data frequency. Campbell and Ammer used a monthly frequency, while the present paper uses a six-month frequency. As Campbell and Ammer themselves noted, variation in expected returns causes transitionary variation in stock prices while dividend news causes permanent variation. So dividend news becomes more important for longer time intervals (Campbell and Ammer, 1993, p.22). In other words, by using low frequency data, important information about the short-term mean reverting behavior of stock prices is averaged out.

Comparison of the full sample estimation and the pre-bubble sub sample (-85:1)

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[20] We thank Professor Campbell for his comments which have helped the following discussion.

[21] However, if we compare the rent/price ratios of large cities in the world (Noguchi, 1989, chapter 3), Tokyo's rent/price ratio is much lower than that for other cities like New York and London.

gives some interesting information about stock returns. First, the unconditional variance of unexpected excess returns *Eu* (= the residual from the ESTOCK regression) is much larger in the full sample than in the pre-bubble sub sample. The ESTOCK regression in Table 7 also tells us that the fitting measured by corrected R^2 ($\bar{R}^2$) is much better for the pre-bubble sub sample. Finally, in the earlier version of our paper, parameter stabilities in asset return regressions are examined using the rolling Chow test. There was no significant structural break found, but the likelihood-ratio statistics is highest in the first half of 1985 in the ESTOCK regression. All this evidence suggests that the mechanism that determines asset returns changed after 1985. On the other hand, if we look at the shares of variables in variance decomposition, in the pre-bubble sub sample, dividend news and interest news are more important, while expected returns news is less. Before the bubble period, fundamentals, such as interest rates and dividends, contributed to explaining stock and land price behavior, while after the second half of 1985, factors other than fundamentals became relatively more important. This is consistent with our view in Section III that the stock price boom in the second half of the 1980s cannot be justified by changes in "fundamentals."

Results of land returns regressions, also in Table 9, are even more dramatic. The sum of variances of news about future rents exceeds the variance of excess returns. This is due to the high predictability (small variance of *Eu*) and the high autocorrelations of excess returns. Note that the variance of news regarding future

Figure 8
Unexpected Excess Returns and Future Excess Returns

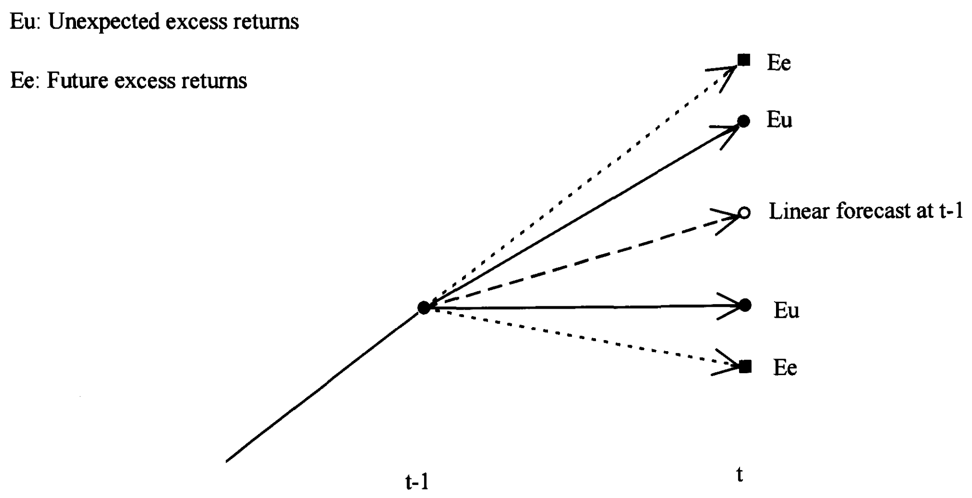


Table 9
Variance Decomposition for Asset Prices

Eu: Unexpected excess returns.

Ec: News about future dividends/rents.

Er: News about future real interest rates.

Ee: News about future excess returns.

A. (S-1) Covariance/Correlation Matrix of Stock Returns

a. Full sample, 1969:II-1993:I

	Eu	*Ec*	*Er*	*Ee*
Eu	157.7809	**0.7252**	**0.0729**	**−0.5869**
Ec	91.8068	101.5797	**0.0744**	**0.0776**
Er	2.9973	2.4518	10.7030	**−0.3675**
Ee	−68.9714	7.3211	−11.2485	87.5410

b. Sub sample, 1969:II-85:I

	Eu	*Ec*	*Er*	*Ee*
Eu	81.1310	**0.6932**	**−0.2401**	**−0.5059**
Ec	50.6758	65.8698	**0.2850**	**0.1959**
Er	−6.3395	6.7815	8.5962	**0.2916**
Ee	−24.1158	8.4125	4.5248	28.0035

B. (S-2) Variance Decomposition for Stock Returns

Sample period	1969:II-1993:I	1969:II-1985:I
Shares of		
var *Ec*	0.6438	0.8119
−2cov(*Ec,Er*)	−0.0311	−0.1672
−2cov(*Ec,Ee*)	−0.0928	−0.2074
var *Er*	0.0678	0.1060
2cov(*Er,Ee*)	−0.1426	0.1115
var *Ee*	0.5548	0.3452

C. (L-1) Covariance/Correlation Matrix of Land Returns

a. Full sample, 1969:II-1993:I

	Eu	Ec	Er	Ee
Eu	2.8405	**0.2117**	**−0.7467**	**0.3321**
Ec	2.1971	37.9129	**0.0075**	**0.9306**
Er	−4.1174	0.1508	10.7030	**−0.3169**
Ee	3.4739	35.5650	−6.4348	38.5259

b. Sub sample, 1969:II-85:I

	Eu	Ec	Er	Ee
Eu	2.8274	**0.3617**	**−0.8704**	**0.4591**
Ec	4.5238	55.3294	**−0.2528**	**0.9762**
Er	−4.2913	−5.5123	8.5962	**−0.4317**
Ee	5.9877	56.3179	−9.8172	60.1474

D. (L-2) Variance Decomposition for Land Returns

Sample Period	1969:II-1993:I	1969:II-1985:I
Shares of		
var Ec	13.3471	19.5687
−2cov(Ec,Er)	−0.1062	3.8991
−2cov(Ec,Ee)	−25.0411	−39.8366
var Er	3.7680	3.0403
2cov(Er,Ee)	−4.5307	−6.9442
var Ee	13.5629	21.2727

Note: The numbers above the diagonal (shown in bold face) in the covariance matrices are correlations.

excess returns (*Ee*) is larger than the variance of unexpected excess returns (*Eu*), and *Ee* and *Eu* are highly correlated. Our VAR system is like an investor using only very recent history (one lag), and forecasting the future by using a linear projection. So if the price of land increases, the investor (VAR system) predicts a further increase in excess returns in the near future (Figure 8). Within the linear projection framework, this result implies the explosive or unstable path of excess land returns. This is another way to describe the predictability and autocorrelation of land returns. As will be discussed in the next section, predictability may not necessarily imply the inefficiency of the land market or unexploited arbitrage opportunities. So the expectation accounting equation, Equation (10), which is based on the assumption of a perfect, frictionless capital market, may be failing to capture the true relationship of land returns and other variables. Too large a share of *Ec* variance is just a consequence of this fact.

V. Lending Constraints and Transaction Costs Models

The characteristic of land returns described in the previous sections leads us to the necessity of a model which can explain their autocorrelations and predictability. In this section, particular kinds of non-neoclassical models which pay special attentions to the nature of real estate transactions are explained, and attempts will be made to evaluate them empirically.

As we have seen, the neoclassical model of asset price determination needs a strong assumption of future information, in that future dividends (rents) are assumed to be known (or that at least their probability distribution is known to all participants, and that investors are assumed to be risk neutral). Bubbles (explained in detail in Section III. C) are also precluded. Monetary policy in the neoclassical model is represented solely by the interest rate level, which is relevant as the discount factor.

Causal evidence suggests that quantitative variables like bank lending are relevant in the process of asset price inflation. In the perfect neoclassical world, price immediately jumps to the right level responding to news about fundamentals, so that, in an extreme case, transactions (change of ownership) do not necessarily take place, while price variables summarize the information adequately. However, in the real world, a price increase usually occurs parallel with heavy transactions, reflecting heterogeneous information or expectations among investors. Moreover, payments cannot be readily arranged by investors with liquidity constraints unless investor information and expectations are shared by banks too. Then, it matters how much banks are willing to finance the projects which require acquisition of land or stock.

Models to be explored in this section will be similar to those that emphasize the effect of a firm's credit condition on its investments (Fazzari, Hubbard, and Petersen, 1988; Hoshi, Kashyap, and Scharfstein, 1991; Kashyap, Stein, and Wilcox, 1993). These models explain how investment could be dependent on bank lending. Firms may face a liquidity constraint, which means that a firm's credit worthiness becomes important when the firm is facing a liquidity constraint due to potential lenders not being convinced of the quality of projects. Hence, if there are some ways to get around this principal-agent problem, investment will be higher. For example, in Hoshi, Kashyap, and Scharfstein, the information problem is assumed to be alleviated among group (keiretsu) companies. If the firm can put up some collateral or any other kind of front-loading bonds, it also serves to solve the agency problem.

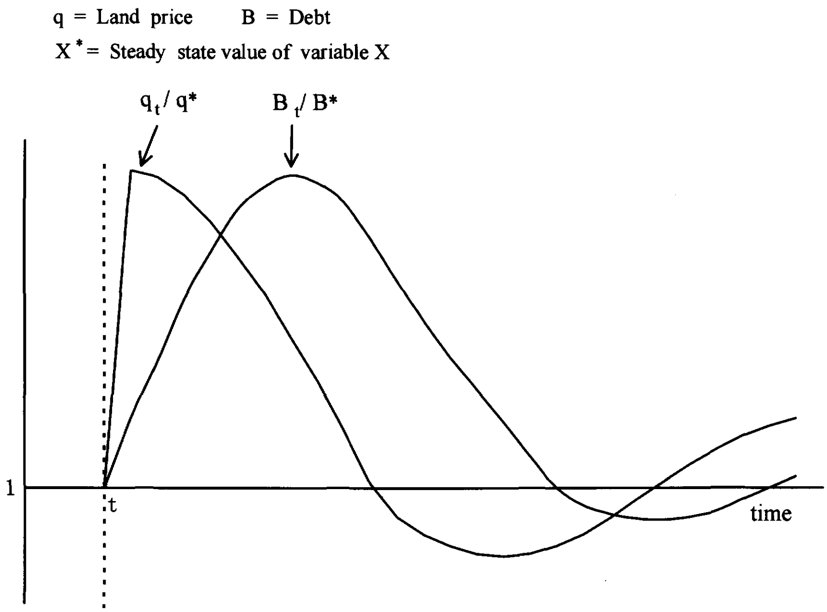
There are two ways to describe the importance of collateral. The first is based on asymmetric information, emphasized in Stiglitz and Weiss (1981). Suppose that there are two types of borrowers, good and bad, and lenders cannot differentiate between the two. A lending rate increase will squeeze out more good borrowers than bad. So an optimal solution when lenders cannot verify the quality of borrowers may result in credit rationing. Suppose that asset price inflation (either stock or land price) occurs, and that borrowers hold some assets to be used as collateral. Then the increase in collateral value of the borrowers' assets will enhance credit lines for lending and, consequently, the net worth of the credit-constrained borrower. This will further increase the stock price of the borrower, and the collateral value of (other) firms' assets. The second approach to the use of collateral is based on the enforceability of contract and the possibility of renegotiation, often known as the "incomplete contracts" approach to financial contracting. Even in a world of perfect information, it may be difficult to enforce the contract. When we consider the possibility of renegotiating contracts for hold up and/or deducting debt payments in the event that the borrower firms' business did not work out, lenders first want collateral. Thus, bank lending will be an increasing function of collateral, and the story after that is exactly the same as in the case of information asymmetry.

Scharfstein (1994) presented a model of multiple equilibria, in which, depending on public expectation of either "high collateral price - low cost of capital" or "low collateral price - high cost of capital", equilibrium is attained. Kiyotaki and Moore (1995) built a model based on the incomplete contract approach, and derived procyclical deterministic dynamics of land prices.[22] When Kiyotaki and Moore's model is put into our empirical perspective, the following transpires. First, a productivity shock pushes up output so that demand for land will increase too. Land prices go up, triggering just a further increase. Such land price dynamics are predictable in the sense that they are deterministic, but do not necessarily mean an arbitrage opportunity. As land prices go up, the debt and investment of firms also increase because firms are able to borrow more as the collateral value of real estate goes up. This further boosts economic activity. On the other hand, stock prices respond to the shock in GNP contemporaneously, so that stock prices seemingly lead land prices. Since the stock price of the firm embodies the value of the real estate held by the firm, stock prices also go up with land prices. But this mechanism will not continue forever. When land prices become too high, the price effect chokes demand for land so that finally land prices will begin to go down. Then the "multiplier effect" works in the opposite downward direction. Land prices go down, corporate debt and investments decline, and the whole economy slows down. Kiyotaki and Moore presented a sophisticated dynamic general equilibrium model, however their model also has some drawbacks. In our context, the most important shortcoming is that there is no room for monetary shocks. For example, they imply that the value of collateral leads the debt of the representative firm. In other words, land price Granger-causes the amount of bank loans. This is because the value of collateral determines the amount of loans in their model (Figure 9). This is a very strong implication, and it is hard to believe that it does hold in practice.

Another important aspect of imperfection in the real estate market has recently been modeled by Stein (1995). It is observed that, in the housing market, trading volume is high when prices are going up, and low when prices are coming down. He explained this fact by the effect of large downpayments having to be paid in housing market transactions. This theory also predicts that once a large positive shock hits the market, it will have a multiplier effect. Because those who sold real estate got enough money for a downpayment, demand for real estate will further increase. It is commonly said that from 1985 to 1988, land price appreciation first began to be seen with respect to real estate for commercial use in the Tokyo metropolitan area, and then the boom spread to other big cities and real estate for residential use. This has been

[22] However, they made some stringent assumptions. In their model, liquidity constrained firms borrow as much as they can so that either all firms are always liquidity constrained or they are not maximizing profits. There is no Tobin's q in their model. Also they assume perfect foresight.

Figure 9
Land Price and Debt of the Firm



Source: Kiyotaki and Moore (1995)

formally studied by Nishimura (1990). This fact perfectly fits the transaction cost view: the initial shock increased the price of real estate for commercial use in Tokyo. It raised the collateral value of landowners, and led the increase in land prices in other areas and for other uses.

There are only few empirical studies about this issue. Yoshino (1992) studied Japanese non-bank financial institutions, whose presence in the Japanese financial system became prominent in the late 1980s.[23] Those firms rely heavily on borrowing from large financial institutions. In the bubble economy period non-banks played important roles as lenders to real estate firms. The large banks used them as an indirect way to lend to risky borrowers. (Many non-banks belong to financial *keiretsu*, corporate groups in Japan.) In the appendix of his paper, Yoshino found that large bank lending to non-banks and real estate companies was significant in explaining land price changes. Hamao and Hoshi (1991) also suggested that the "Stock Granger-

[23] Typical "non-banks" include consumer loan, (small) credit card, leasing, and housing loan specialized companies.

causes Land" result in their bivariate VAR can be explained by the collateral hypothesis.

In the remainder of this section, some predictions of the loan constraint story are examined using the bank loan data, as Yoshino (1992) did. Yoshino's paper used data after 1978, while we use data starting in 1968. In order to lengthen the time series, we limit bank loans to those to real estate companies. Also, Yoshino's data are new loans for equipment funds, but our data comprise outstanding loans and discounts for both equipment and operating funds.

Figure 10 shows the growth rates of land prices and bank loans to the real estate sector. From this graph, it is clearly seen that bank loans lead land prices. Table 10 summarizes the regression results for determinants of real land price inflation (GLAND). The increase in the interest rate (ARATE) is insignificant once lagged variables are included. This is not supportive evidence for a neoclassical model. (Using the real interest rate level instead of ARATE does not change any results in Tables 10 and 11, but real interest is less significant in all regressions.) On the other hand, the growth rate of loans to real estate companies (GLOAN) is an important factor in explaining GLAND. Current GLOAN becomes insignificant when lagged variables are included, but lagged GLOAN is even more significant. Own lagged

Figure 10
Bank Lending and Land Price

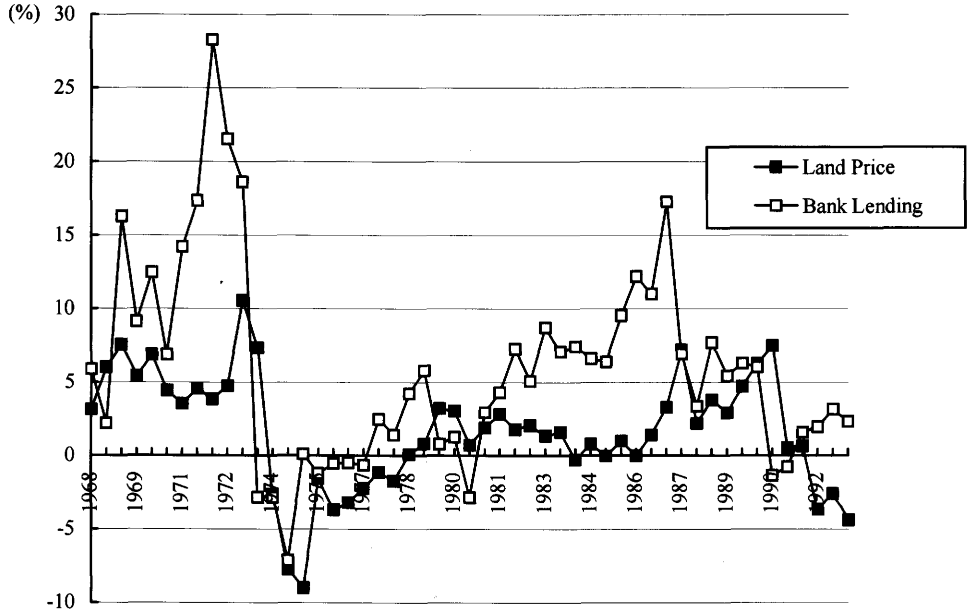


Table 10
Determinants of Land Price

Semi-annual data from 1969:I to 1993:I

Dependent variable: GLAND (growth rate of real land price)

$\bar{R}^2$: 0.5584, D.W.: 1.52, S.Sq.R.: 282.8015

Constant	GGNP	GLOAN	ARATE	INFL
−0.9044	0.9283	0.1934	0.9119	−0.4144
(−1.1575)	(3.8781)	(3.1818)	(3.5314)	(−2.3472)

$\bar{R}^2$: 0.4747, D.W.: 1.01, S.Sq.R.: 336.4150

Constant	GGNP	GLOAN	GMONEY	INFL
−2.0987	0.8009	0.0708	0.4490	−0.1071
(−2.2933)	(2.7776)	(0.8725)	(2.1467)	(−0.5296)

$\bar{R}^2$: 0.7967, D.W.: 1.63, S.Sq.R.: 115.4169

	Constant	GLAND	GGNP	GLOAN	ARATE	INFL
	−1.1500		0.3299	−0.0186	0.0272	−0.9894
	(−1.9532)		(1.7121)	(−0.3255)	(0.1239)	(−4.9845)
1 lag		0.4740	0.4165	0.2123	0.2370	0.4707
		(4.1380)	(2.0662)	(3.6851)	(1.0959)	(2.4084)

$\bar{R}^2$: 0.8296, D.W.: 2.02, S.Sq.R.: 96.7461

	Constant	GLAND	GGNP	GLOAN	GMONEY	INFL
	−1.7486		0.0676	−0.0894	0.3711	−0.7876
	(−3.0142)		(0.3546)	(−1.6179)	(2.1467)	(−3.6143)
1 lag		0.5330	0.3649	0.1553	0.1178	0.4489
		(5.7834)	(1.9658)	(2.7657)	(0.6691)	(2.1643)

Notes: 1. t-statistics in parentheses
2. Definition of variables:
GGNP: Growth rate of real GNP
ARATE: Interest rate (call rate) change from the previous period
INFL: Inflation rate (measured by the GNP deflator)
GLOAN: Growth rate of outstanding real bank loans to the real estate sectors
3. S.Sq.R. = Sum of squared residuals

Table 11

Determinants of Bank Loans to Real Estate Companies

Semi-annual data from 1969:I to 1993:I

Dependent variable: GLOAN (growth of real bank loans to the real estate sector)

A. $\bar{R}^2$: 0.3453, D.W.: 1.11, S.Sq.R.: 1413.5754

Constant	GGNP	GLAND	ARATE	INFL
3.3491	0.5184	0.9669	−1.4215	−0.0776
(1.9703)	(0.8430)	(3.1818)	(−2.3005)	(−0.1853)

B. $\bar{R}^2$: 0.4308, D.W.: 1.05, S.Sq.R: 1142.6566

Constant	GGNP	GLAND	GMONEY	INFL
0.1130	−0.0078	0.2403	1.6148	−1.4876
(0.0633)	(−0.0135)	(0.8752)	(4.1206)	(−3.5028)

C. $\bar{R}^2$:0.5283, D.W.: 2.37, S.Sq.R.: 902.7309

	Constant	GLOAN	GGNP	GLAND	ARATE	INFL
	0.7615		0.4147	−0.1456	−1.0266	−1.1505
	(0.4425)		(0.7476)	(−0.3255)	(−1.7372)	(−1.6771)
1 lag		0.6549	0.3297	0.2788	−0.3154	0.7392
		(4.2278)	(0.5548)	(0.7304)	(−0.5153)	(1.2885)

D. $\bar{R}^2$: 0.6020, D.W.: 2.30, S.Sq.R.: 761.6633

	Constant	GLOAN	GGNP	GLAND	GMONEY	INFL
	−0.7695		0.0120	−0.7037	1.5588	−2.0629
	(−0.4268)		(0.0225)	(−1.6179)	(3.4793)	(−3.0749)
1 lag		0.5888	0.5648	0.3894	−0.5383	0.5372
		(4.0838)	(1.0487)	(1.1224)	(−1.1002)	(0.9599)

Note: See notes for Table 10.

variables of GLAND are also important in determining current GLAND.

In Table 11, we looked at the determinants of GLOAN. GLAND is significant in explaining GLOAN if only current variables are used as right-hand side variables. Once lagged variables are introduced GLAND becomes insignificant. ARATE is also insignificant if the lagged variables are included. Its own lagged variables and current growth rate of money (GMONEY) are the most important factors in explaining GLOAN. But, since lagged GMONEY is insignificant, it is not clear if GMONEY causes GLOAN, or the other way around, or if both are responding to some other factor(s).

Overall, the messages from Tables 10, 11, and Figure 10 are very clear. In the determination of land prices, quantitative variables (GLOAN, GMONEY) play much more important roles than the interest rate. Our results do support the lending constraint view, but do not support Kiyotaki and Moore's naive prediction about Granger causality between land price and debt. There is evidence that current and past bank loan amounts determine land price, however the land price increase does not cause the increase in bank loans. Also in the bivariate VAR shown in Table 12, Kiyotaki and Moore's prediction is directly tested. Again, there is strong evidence that the bank loans Granger-cause the land price, but the land price does not cause bank loans.

In sum, results in this section are consistent with the following view. An initial shock seems to be a sudden increase in bank loans. This may have been caused by monetary policy which allowed credit (restraint) expansion rather than lowering official/interbank interest rates or by financial liberalization which allowed banks to diversify (or, in retrospect, blindlessly take on risk) and expand their loan portfolios. Then the initial shock of increased loans prompted an increase in demand for fixed investment and land, which in turn led to higher stock prices and land prices. Once stock and land prices started to increase, the multiplier effect implied by theory (the Kiyotaki-Moore model and the transaction cost model) worked. Increases in stock prices made it possible to raise more funds by direct financing and invest more, which increased demand for land. Increases in land prices increased collateral values, so that firms could borrow more and invest more. Once this process continues for several periods, one might expect that the markets attract some speculative behavior. Those who make financial bets on further increases in stock and land prices are rewarded with capital gains, so they increase the size of their bets and attract new comers to the betting game. However, it is difficult to differentiate between price

Table 12
Bivariate VAR(1); GLAND and GLOAN

Semi-annual data from 1969:I to 1993:I

A. Dependent variable GLAND

$\bar{R}^2$: 0.7471, D.W.: 1.44

Variable	Coeffcient	t-statistic
GLAND{1}	0.6279	7.4796
GLOAN{1}	0.2253	4.7923
Constant	−0.6240	−1.3573

F-tests

Variable	F-statistic	Significance level
GLAND	55.9449	0.0000
GLOAN	22.9664	0.0000

B. Dependent variable GLOAN

$\bar{R}^2$: 0.4827, D.W.: 2.07

Variable	Coeffcient	t-statistic
GLAND{1}	−0.0385	−0.1836
GLOAN{1}	0.7204	6.1311
Constant	2.4093	2.0968

F-tests

Variable	F-statistic	Significance level
GLAND	0.0337	0.8551
GLOAN	37.5898	0.0000

Note: Including more lags and using subperiod did not change the basic results above.

increases due to fundamentals (say, productivity increases) and those due to bubbles (say, speculation) in empirical results of this section. The Kiyotaki-Moore model, as well as the neoclassical model of the previous section, preclude the existence of rational and irrational bubbles.

VI. Conclusions

In this paper, the behavior of Japanese stock and land prices has been discussed, with particular focus on the boom and bust of the last ten years. Our empirical results suggest the following chain of events. First of all considerable comovement between stock and land prices was consistent with the theory that emphasizes the relationship between the collateral value of land for cash flow constrained firms. The initial seed of bubbles was most likely sown by a sharp increase in bank lending to the real estate sector. Asset price inflation from mid-1987 to mid-1989 was largely consistent with the movement of fundamentals. However, neither the stock price increase in the second half of 1989 nor the land price increase in 1990 could be explained by any model of fundamentals or rational bubbles.

Findings in the paper are suggestive of the existence of stochastic bubbles, although no clear-cut evidence could be discovered. Empirical results show that bank lending was important in the determination of land prices in Japan, especially in the beginning of the bubble in 1986. The link is due to the borrowing constraint that the firm faces in their investment decision, as well known in theoretical literature like Kiyotaki and Moore (1995) and Stein's transaction (downpayment) cost model.

There are a few caveats. There are obvious difficulties in establishing evidence for "bubbles" in stock and land prices. First, as briefly noted in Section IV, tests for bubbles and fads in asset prices require calculating fundamentals which involves many simplifying assumptions, in particular those regarding the expectation of future variables. Hence, it was examined first whether the pattern of asset price behavior was consistent with other economic variables, without discussing about asset prices so much, and which caused which. Our conclusion was that, after mid-1987, the direction of asset prices was consistent with that of fundamentals. Section II also showed that Japanese stock and land prices were explained by each other and became more predictable. What was unresolved then was an initial increase in asset prices in 1986. One strong suspect for the initial shock is the increase in bank lending, which was emphasized in detail in Sections IV and V.

Second, the asset price boom and bust from the mid-1980s to mid-1990s is just a one-time event in several decades. Some might think that the boom was not a bubble at all, but even they would agree that the boom will not occur again for some time on the same magnitude as observed in the last ten years. As it is often criticized about empirical studies on the long-run swing in stock prices (Poterba and Summers, 1986, for example), it is very hard to give a fully persuasive empirical argument for such a low frequency event. Sophisticated econometric techniques which depend on asymptotics cannot be reliable because of the small sample bias.

Several issues are left for future research. First, we discussed the effect of monetary policy on asset prices, but we did not cover the conduct of monetary policy itself. It would be interesting to examine the monetary policy from a viewpoint of tradeoff between the asset price inflation and international policy coordination, in particular maintenance of an implicit target zone of the yen/dollar exchange rate. Also, a structural change in the money demand function around 1985 due to rapid financial deregulation would be an important factor in this regard.

The role of demographic dynamics is another important issue for the determination of land prices. The Japanese economy will face a sharp decline in the younger populations in the next fifty years. In the neoclassical world, land prices should be determined by demand for land, which is heavily dependent on population and the supply of land. So far, our analysis in Section IV and related research like Ito (1993) and Sachs and Boone (1988) assumed a constant population growth rate in their models. The effect of the demographic factor on Japanese housing demand, like Mankiw and Weil (1989) did for the U.S. economy, would be an interesting research topic.

With all these caveats, this study at least sheds some light on the linkage between the stock and land price inflation processes, which did not attract a proper level of attention previously. The linkage is important to understand how an initial shock can be propagated through financial markets. Our work suggests dynamic interaction, which lends itself to a view that land and stock prices are connected, providing clues to the asset price inflation process. Once a shock occurs, there is a multiplier effect between stock and land prices.

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