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Monetary Liquidity, Bank Credit, Corporate Leverage and Asset Prices in Japan, 1980–2000: A Vector Autoregression Analysis

Lu Liu

Wycombe Abbey School, High Wycombe, UK
lucyliu20090909@gmail.com

Abstract. From the 1980s to the early 2000s, Japan experienced a real estate bubble followed by a prolonged period of economic stagnation known as the "lost decade". This study examines the dynamic relationships among monetary liquidity, bank credit, corporate leverage, asset prices and real economic activity in Japan between 1980 and 2000. Using quarterly data from official sources covering 1980Q1 to 2000Q4, it estimates a six-variable vector autoregression (VAR) comprising M2, bank credit, corporate leverage, a real estate price index, the Nikkei 225 and real gross domestic product (GDP). Together, the variables represent a possible transmission sequence from monetary liquidity and bank credit to asset prices, corporate balance sheets and real economic activity. The estimated equations differ markedly in explanatory power. The real estate price equation has the strongest in-sample fit, with an adjusted R^2 of 0.672, and the first lag of M2 is positive and statistically significant at the 1% level in that equation. A positive change in real estate price growth is associated with a higher change in GDP growth in the following quarter, and a positive change in corporate leverage is associated with a higher change in bank credit growth two quarters later. By contrast, the M2 equation is not jointly significant, and the system does not explain changes in M2 well. Unit-root tests support first-differencing; the M2–real estate and real estate–GDP relationships persist with three lags, but the leverage–credit relationships weaken. These relationships are reported as dynamic associations rather than as evidence of causation.

Keywords: asset price bubble, bank credit, corporate leverage, monetary transmission, vector autoregression

1. Introduction

1.1. Background

1.1.1. Background information

From the 1980s to the early 2000s, Japan experienced a real estate bubble followed by a period of economic stagnation known as the "lost decade". The core bubble period was concentrated in the

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late 1980s, characterized by soaring asset prices, an overheating economy, and significant expansion of money supply and credit [1]. By the 1990s, the bubble economy had burst, leading to low gross domestic product (GDP) growth (averaging 1.2% between 1995 and 2002 [2]) and continual deflation.

Urbanisation (due to industrialisation), rising real incomes and corporate investment increased demand and prices of land in Tokyo and Osaka [3].

1.1.2. Explaining balance sheet transmission during the bubble formation phase

From the late 1970s through to the 1980s, financial liberalization allowed corporations to raise funds directly through capital markets instead of solely relying on bank loans. As large enterprises became less reliant on bank loans, banks started directing more credit towards real estate companies, non-bank financial institutions, and small and medium-sized enterprises. These customers proved to be much riskier than large manufacturing firms that banks traditionally financed, with land increasingly becoming collateral for loans [4].

In 1985, the Plaza Accord was an agreement reached by the Group of Five nations to depreciate the US dollar to reduce the US trade deficit, by appreciating the Yen and Deutschemark. The Yen appreciated from 231.90/dollar in 1985 to 121/dollar by 1988 [5], resulting in the exchange rate appreciating and exports falling, which was detrimental for the export-led economy of Japan. With the economy facing a recession, the Bank of Japan faced pressure to respond, and did so by adopting monetary policy easing, expanding the money supply and cheap credit [5]. An increase in M2 typically leads to a rise in bank credit, which in turn fuels a boom in the real estate and stock markets. Higher land prices increased collateral values, allowing banks to increase lending which households and firms used to further purchase real estate [1, 6, 7]. With overly optimistic expectations, a positive feedback loop was created, leading to the core bubble period of 1987–1990. In December 1989, the Nikkei 225 peaked at ¥38,915, approximately 3.1 times its 1985 level [1]. Real estate prices had now significantly diverged from economic fundamentals, increasing several fold in the late 1980s.

1.1.3. Explaining reverse transmission after a bubble bursts

Once the Japanese government and Bank of Japan realised that asset prices were increasing unsustainably, they adopted monetary tightening, raising interest rates to 6% by 1990, bursting the bubble [8]. As borrowing costs increased, asset prices fell as speculators could not buy real estate with cheap credit anymore, and new property development projects became less profitable. This was followed by a fall in collateral values relative to the outstanding loan, increasing corporate debt burdens and leading to banks tightening credit. In this period, banks accumulated many non-performing loans, leading to a banking crisis and reduced lending for all firms, even those participating in the real economy. Investment and consumption fell because of bank credit tightening and corporate deleveraging, slowing GDP growth, and resulting in deflationary pressures. Japan entered a long period of economic stagnation known as the "Lost Decade".

1.2. Research question

What were the dynamic relationships among monetary liquidity, bank credit, corporate leverage, asset prices and real economic activity in Japan between 1980 and 2000?

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1.3. Research gap

• While some studies focus on a specific stage of bubble formation or bursting, this paper uses quarterly data from 1980 to 2000, covering a relatively complete financial cycle. A further question is whether the formation and collapse of the bubble can be understood as a reversible balance-sheet process. In other words, did the same relationships that amplified economic expansion also contribute to the contraction after asset prices began to fall?

• Some studies discuss increases in the money supply and credit expansion together without making a clear distinction between: M2—monetary liquidity in the financial system; bank credit—actual financing provided by banks; and corporate leverage—actual debt incurred by corporations.

• Existing research often focuses solely on lenders or asset markets, without simultaneously linking bank credit to corporate balance sheets.

This study therefore uses a vector autoregression (VAR) model to examine the dynamic interactions among M2, bank credit, corporate leverage, real estate prices, stock prices and GDP in Japan from 1980Q1 to 2000Q4.

1.4. Aims and significance

1.4.1. Financial implications: distinguishing between the monetary channel and the credit channel

The study does not simply assess whether "M2 drives up real estate prices," but rather examines whether monetary liquidity is transmitted to asset markets and GDP through bank credit and corporate debt financing.

1.4.2. Implications at the intersection of finance and accounting: linking lenders and borrowers

Bank Credit represents the asset side of banks and the supply of loans; Corporate Leverage represents the liability structure of firms; and the real estate index reflects changes in asset valuations. This shifts the focus of the paper from general macroeconomic research to the study of balance sheet transmission.

1.4.3. Analytical and policy implications

Are expansionary and contractionary policies truly two completely opposite approaches? In Japan, monetary easing in the late 1980s was followed by tightening that coincided with the collapse of asset prices [8], and bank credit contracted in the 1990s despite renewed monetary easing [9]. If balance-sheet transmission were fully reversible, tightening would simply undo the effects of earlier easing. However, the balance-sheet mechanism may operate in reverse during monetary tightening [10], and falling collateral values, impaired bank lending and corporate deleveraging may cause the contraction to differ from the expansion. Distinguishing monetary liquidity, bank credit and corporate leverage indicates which links in the transmission sequence are visible in the Japanese data, and therefore which indicators, such as credit growth and asset prices, may need to be monitored alongside monetary aggregates [11].

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2. Literature review

2.1. Monetary transmission mechanisms and financial channels – theoretical studies

Several influential studies suggest monetary policy affects real economic activity through multiple interdependent financial channels, including the interest rate, credit and asset price channels [10]. Within the credit channel, Bernanke and Blinder [12] emphasise the importance of bank lending, while Bernanke and Gertler [13] argue that credit market frictions amplify traditional interest rate effects of monetary policy through the bank lending and balance sheet channels. Bernanke, Gertler and Gilchrist [14] formalise the balance sheet mechanism through the financial accelerator, and Mishkin [10] suggests this mechanism may operate in reverse during monetary tightening. Furthermore, the asset price channel transmits monetary policy by affecting collateral values; Kiyotaki and Moore [15] argue that credit constraints and collateral values perpetuate economic shocks through a collateral feedback loop. Taken together, these studies show that monetary transmission does not depend solely on interest rates, but also on credit conditions, borrower balance sheets and asset prices.

Previous studies combine theoretical and empirical approaches to investigate monetary transmission. Theoretical studies include Bernanke and Gertler [13] and Mishkin [10], and dynamic general-equilibrium models, linking variables such as collateral, net worth and output [15] and leverage and the external finance premium [14]. Empirically, Bernanke and Blinder [12] use VAR and Granger causality tests, incorporating variables such as consumer price index (CPI) inflation and bank loan measures. Together, these studies provide a theoretical and empirical basis for examining the interaction between monetary policy, bank credit and asset prices in Japan.

2.2. Japan bubble formation – application

Studies of Japan's asset-price bubble in the late 1980s emphasise the interaction of loose monetary policy, credit expansion, rising asset prices and financial deregulation in the bubble formation. Ito and Iwaisako [8] link monetary easing and real-estate credit expansion to rising asset and collateral values, arguing that the asset-price bubble could not be explained by fundamentals alone. Similarly, Kim and Moreno [16] proposed that tighter bank capital requirements in the late 1980s may have strengthened the response of bank lending to stock-price movements, and Ogawa and Kitasaka [17] argued that credit expansion and asset prices were mutually reinforcing. Hoshi and Kashyap [18] explained how financial deregulation changed borrowing and bank lending behaviour, whereas Okina and Shiratsuka [6] and Shiratsuka [19] emphasised euphoric expectations, subdued CPI inflation, and policymakers' underestimation of risk in the bubble formation. Several studies suggested that the collateral-credit feedback reversed after the bubble burst [6, 16].

The literature combines descriptive, time-series and bank-level panel research approaches. Hoshi and Kashyap [18] compare Japanese and U.S. firms' dependence on bank finance, using firm level and real estate related data. Comparatively, Okina and Shiratsuka [6] used Taylor-rule analysis to compare hypothetical and actual Bank of Japan policy rates, and Shiratsuka [19] provides a descriptive time-series analysis, both focusing on the late 1980s to 1990s. Empirical studies mainly use macroeconomic VAR models [8, 16] and dynamic bank-level panel models [17], examining variables including asset prices, bank lending, interest rates and output.

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2.3. Lost decade

Following the collapse of Japan's asset-price bubble, the economy entered a prolonged stagnation commonly known as the "Lost Decade". Several studies argue that falling asset prices and weakened bank balance sheets impaired monetary transmission, while distorted bank incentives contributed to credit misallocation and prolonged stagnation. Bayoumi [20] identified disrupted financial intermediation and bank lending as a central source of the slowdown. Banking and balance-sheet weakness reduced the effectiveness of the credit channel [9, 21], leading to bank credit contraction despite monetary easing [9]. By contrast, Hayashi and Prescott [22] argued that weak total factor productivity, rather than banking-system failure, was the principal source of stagnation. Peek and Rosengren [23] found that troubled banks continued lending to weak firms to avoid recognising non-performing-loan losses. Caballero, Hoshi and Kashyap [24] showed that zombie lending delayed firm exit and restructuring, lowering productivity and prolonging stagnation.

The literature combines growth accounting and neoclassical modelling with VAR and firm- or bank-level panel analysis. For example, Hayashi and Prescott [22] used a neoclassical growth model and growth accounting. Bayoumi [20] and Morsink and Bayoumi [9] estimated VAR models using quarterly Japanese macroeconomic data. Both studies incorporated variables like output, prices, monetary conditions and bank lending. Comparatively, Nagahata and Sekine [21] estimated corporate investment functions using firm-level panel data. Peek and Rosengren [23] used related firm- and bank-level panel data. Caballero, Hoshi and Kashyap [24] estimated a firm-level panel regression.

2.4. Evidence from broader financial crisis literature

Cross-country studies identify rapid credit growth and leverage as predictors of financial crises and deeper recessions and slower recoveries, while low CPI inflation does not guarantee financial stability [11, 25, 26]. A related literature compares Japan's experience with China's real-estate expansion and examines possible policy lessons [7, 27]. Liu [7] finds that land prices in both countries respond to money and credit shocks, although the timing and magnitude differ, possibly reflecting differences in financial deregulation and reliance on bank credit.

The broader literature uses long cross-country panels [26], local-projection methods [25], and signal-extraction methods for early-warning indicators from credit and asset-price gaps [11]. Japan-China comparisons combine generalised VAR analysis [7] and comparative descriptive evidence [27].

In conclusion, the reviewed literature surrounding monetary transmission mechanisms and financial channels, the formation, collapse and stagnation following the Japanese bubble economy, and broader financial crises provide a great foundational framework for this study. However, there remain gaps in whether the formation and collapse of the bubble can be understood as a reversible balance-sheet process, whether an increase in M2 necessarily drives bank credit expansion, and focusing largely on lenders or asset markets, without linking bank credit to corporate balance sheets; these are questions this study aims to provide an answer to.

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3. Methodology

3.1. Variable selection and definition

This study constructs a six-variable VAR system comprising M2, bank credit, corporate leverage, the real-estate price index, the Nikkei 225 and real GDP. The discussion first distinguishes the monetary and credit variables. M2 measures monetary liquidity within the financial system and represents the overall monetary environment and potential liquidity shocks. Bank credit measures the financing actually provided by domestic banks to the private non-financial sector. This study distinguishes between these two variables; an increase in M2 indicates an expansion in the money supply but does not necessarily mean that banks provide more loans to firms and households. Together, they allow the study to examine whether monetary expansion is transmitted to the real economy through the bank-credit channel and whether a dynamic transmission relationship exists between them. Taken together, the variables represent a possible transmission sequence from monetary liquidity and bank credit to asset prices, corporate balance sheets, and real economic activity.

Corporate leverage measures the extent to which firms rely on interest-bearing debt for financing. The corporate leverage ratio is calculated as follows:

$$\text{Leverage}_t = (\text{Short-term borrowings}_t + \text{Long-term borrowings}_t + \text{Bonds}_t)/\text{Total assets}_t \quad (1)$$

where the subscript t denotes the quarter, and all items refer to corporations in all industries excluding finance and insurance.

Highly leveraged firms may be more sensitive to changes in financing conditions, asset prices and repayment pressure. The real estate price index reflects the market value of land and residential property; property is commonly used as collateral, meaning that changes in real estate prices may affect the borrowing capacity of firms and households. Therefore, rising real estate prices may strengthen collateral values, whereas falling prices may weaken corporate balance sheets.

The Nikkei 225 reflects stock-market valuation and investors' expectations of firms' future earnings. Stock prices and real estate prices are both asset-price indicators, but the stock index more directly represents capital-market conditions and corporate valuation. Real GDP measures investment, consumption, production and overall economic activity, making it the principal indicator of real economic activity. Real GDP is used instead of nominal GDP, as it reduces the influence of changes in the general price level. Changes in stock-market valuation may be dynamically related to real economic activity through corporate financing, wealth effects and investment expectations. Therefore, the study examines the dynamic association between stock-market movements and real GDP.

3.2. Data sources and sample period

The sample covers 1980Q1–2000Q4, including the expansion preceding the bubble, the late-1980s asset-price boom, the collapse of the bubble and the prolonged adjustment during the 1990s, allowing dynamic relationships to be examined across these stages. Most of the data used was collected from the Federal Reserve Economic Data (FRED) database; the original frequency of M2 was monthly (from 1955 to 2017) [28], bank credit was end-of-quarter (from 1963 to 2025) [29], and the Nikkei 225 was daily (from 1949 to 2026) [30]. For all these variables the unit used is percent change. The property index had an original frequency of quarterly (from 1956 to 2025) [31],

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adopting the unit of percent per annum. The data used for calculating the corporate leverage ratio (unitless) was collected from the Ministry of Finance (from 1954 Q2 to 2026 Q1) [32], with an original frequency of quarterly. The real GDP data was collected from the Cabinet Office of Japan (from 1980 Q1 to 2009 Q3) [33]; its original frequency was quarterly, with the unit of billions of Japanese Yen. Official data provides traceability, consistent definitions and full coverage.

3.3. Data pre-processing

In standardizing the data, the sample is restricted to 1980Q1–2000Q4 and all six variables are aligned by year and quarter. Monthly M2 is converted to quarterly averages; daily Nikkei 225 observations are converted to average quarterly data. Quarterly leverage is calculated using equation (1), with all numerator and denominator items drawn from the same Ministry of Finance reporting period. Seasonally adjusted real GDP is converted to its quarter-on-quarter growth rate, expressed as a decimal. M2, bank credit and the Nikkei 225 are expressed as quarter-on-quarter percent changes, house prices as the percent change from the same quarter of the previous year, and corporate leverage as a ratio.

4. Descriptive statistics & time series

4.1. Descriptive statistics

The six variables that will be investigated are real GDP, M2, bank credit, house-price growth, corporate leverage and stock-price growth. All the variables share the same sample period of 1980Q2 to 2000Q4 with a quarterly frequency. Table 1 reports their descriptive statistics.

Table 1. Descriptive statistics

Variable	Mean	Std. Dev.	Skewness	Kurtosis	P value (Jarque–Bera test)
Real GDP Growth	0.007221	0.010148	0.187614	2.801499	0.73
Stock Price Growth	1.264682	7.799495	−0.106423	2.893360	0.91
House Price Growth	2.754371	5.667325	0.473769	2.034991	0.04
Bank Credit	1.322921	1.747702	−0.326083	2.764104	0.44
M2	1.451607	0.936017	0.208035	2.175519	0.23
Corporate Leverage	0.436920	0.022118	−0.788490	2.437226	0.01

Figure 1 presents the descriptive statistics for quarterly real GDP growth during the sample period, in the form of quarterly growth rate expressed as a decimal. The mean value was 0.007221, indicating that real GDP recorded an average quarterly growth rate of approximately 0.72%. The standard deviation was 1.01 percentage points, indicating substantial variation around the mean. Compared with the mean, the standard deviation of 1.01 percentage points suggests that GDP growth was relatively volatile during the sample period. The values ranged from a minimum of −1.86% to a maximum of 3.14%, showing that economic growth experienced a relatively wide range of variation. The Jarque–Bera test produced a p-value of 0.732279. Since the p-value was above 0.05, the null hypothesis of normality could not be rejected at the 5% significance level, providing insufficient evidence to conclude that the distribution of GDP has deviated from normality.

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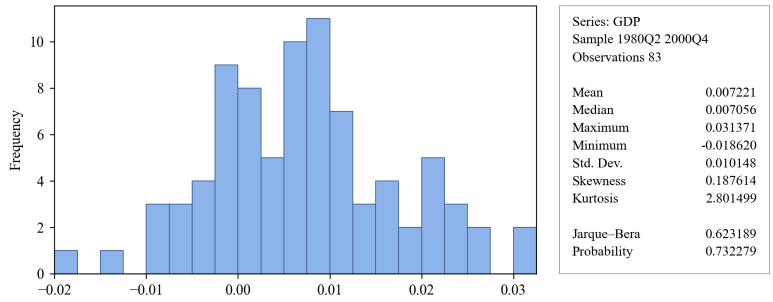


Figure 1. Real GDP growth (source: [33])

The skewness value of leverage ratio (−0.788490) suggests it was moderately left-skewed, whereas the skewness value of house price growth (0.473769) demonstrates moderate right-skewness. The kurtosis values of all six variables were below the normal-distribution benchmark of 3, suggesting a flatter and lighter-tailed distribution relative to a normal distribution.

For M2, the data is presented as quarterly percent change/growth rate (Figure A1). The mean value was 1.451607, indicating that M2 recorded an average quarterly growth rate of approximately 1.45%. The standard deviation was 0.936 percentage points, indicating moderate variation around the mean. The values ranged from a minimum of −0.32% to a maximum of 3.97%, showing that M2 experienced a relatively wide range of variation compared to the mean.

Stock price growth is presented as quarterly percent change (Figure A2). The mean value was 1.264682, indicating that the stock price increased by an average of approximately 1.26% quarterly. Its standard deviation was 7.80 percentage points, suggesting a substantial variation around the mean. Compared with the mean, the standard deviation of 7.80 percentage points suggests that stock-price growth was relatively volatile during the sample period. The variable ranged from a minimum of −17.01% to a maximum of 19.92%, demonstrating a relatively wide range of variation during the sample period.

Bank credit is presented as quarterly percent change (Figure A3). Bank credit had a mean value of 1.32292, suggesting an average quarterly growth rate of approximately 1.32%. The standard deviation was 1.75 percentage points, suggesting moderate variation around the mean; it had a range of −3.10% (minimum) to 4.53% (maximum).

The corporate leverage ratio (Figure A4) had a mean of 0.436920, equivalent to approximately 43.69% if the variable is expressed as a proportion. Its standard deviation was 0.0221, or 2.21 percentage points, suggesting that the leverage ratio was relatively stable compared with the growth-rate variables. The leverage ratio ranged from a minimum of 38.60% to a maximum of 46.93%, indicating a relatively narrow range of variation. The Jarque–Bera test produced a p-value of 0.007845, which is below 0.05. Therefore, the null hypothesis of normality is rejected at the 5% level, providing sufficient evidence that the distribution of corporate leverage has deviated from normality.

House price growth is presented as percent change per annum, with a quarterly frequency (Figure A5). The mean value was 2.754371, indicating that house price growth increased by an average of approximately 2.75% per annum. Its standard deviation was 5.667325, or 5.67 percentage points, suggesting substantial variation around the mean. The variable ranged from a minimum of −4.96% to a maximum of 15.22%, demonstrating a relatively wide range of variation during the sample period. The Jarque–Bera test produced a p-value of 0.042309, which is below 0.05. Therefore, the null hypothesis of normality was rejected at the 5% significance level, suggesting that the distribution deviated from normality.

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4.2. Time series

Figure 2 reveals that bank credit growth remained at a generally high level during the first part of the sample period before declining, whilst being volatile throughout. During the period from 1980 to 1989/1990, bank credit remained relatively high from approximately 1% to 4%. However, this trend reversed around 1990, after which the variable declined overall, with fluctuations, until reaching a trough in 1993Q2. After 1993, bank credit growth generally increased for some time before falling again. The series reached its maximum of approximately 4.5% in 1989Q3, and minimum of approximately −3.1% in 1993Q2. Taken together, the figure indicates that bank credit growth began at a high level, subsequently decreasing and becoming increasingly volatile during the latter part of the sample period. However, the chart alone does not establish what caused these changes.

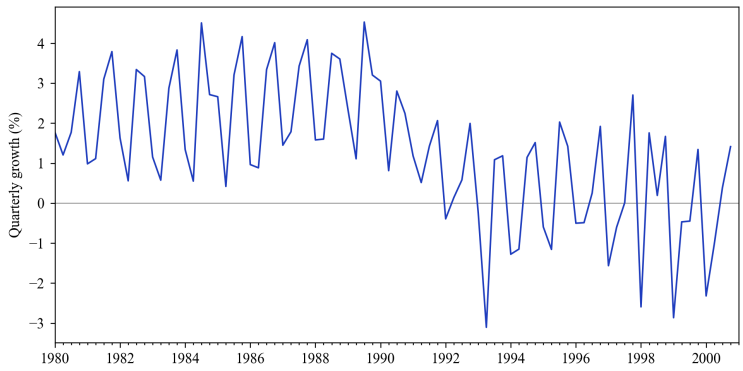


Figure 2. Quarterly growth in bank credit [1980Q1–2000Q4] (percentage) (source: [29])

Figure 3 shows an overall rise and subsequent decline in the corporate leverage ratio. During the period from 1980Q1 to 1993Q3, the variable rose from approximately 0.384 (38.4%) to 0.469 (46.9%). These are respectively the minimum and maximum values. The leverage ratio experienced particularly rapid growth between 1984 and 1988 and remained relatively high until the mid-1990s. The series suggests that corporate leverage accumulated during the 1980s and early 1990s before entering a period of deleveraging, although the figure alone cannot determine the causes of this reversal. This trend reversed around 1993, after which the variable began to decrease with some volatility. All things considered, the figure indicates that the corporate leverage ratio increased steadily until 1993, after which it entered a stage of volatile decline.

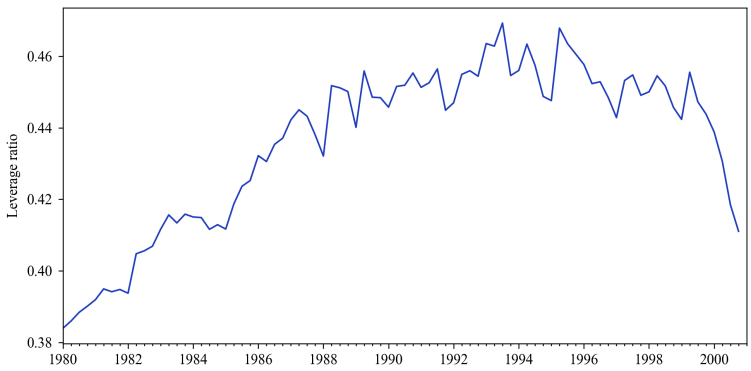


Figure 3. Quarterly corporate leverage ratio [1980Q1–2000Q4] (source: [32])

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Figure 4 displays substantial changes in quarterly house-price growth over the sample period. Growth declined from approximately 14% in 1980 until around 1986, after which the trend reversed. It then rose sharply and reached its maximum value of about 15% around 1990Q3. Following this peak, house-price growth fell rapidly and reached its minimum value of approximately −5% in 1993Q1, indicating a contraction rather than merely slower growth. A modest recovery occurred between 1993 and 1995, although the series weakened again toward the end of the sample period. Overall, the figure demonstrates the volatile behaviour of house price growth in the period, but the chart alone cannot establish the causes of these changes.

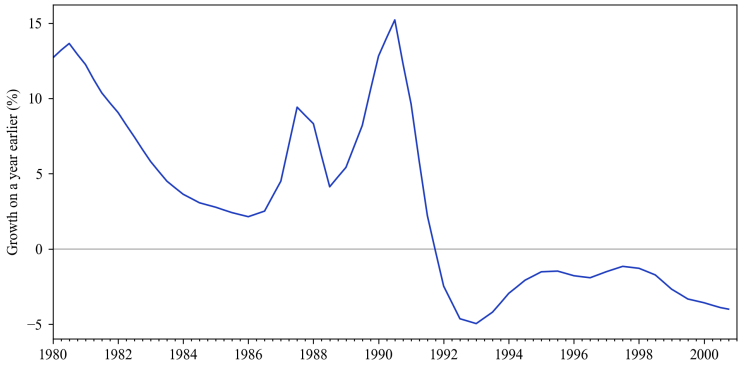


Figure 4. Quarterly house price growth [1980Q1–2000Q4] (source: [31])

4.3. Stationarity tests and lag selection

Before the VAR is estimated, each series is tested for a unit root with the augmented Dickey–Fuller (ADF) test [34, 35]. The test regression includes an intercept, the lag length is chosen by the Schwarz criterion (SC) from a maximum of 11 lags, with all lag lengths compared on a common sample, and p-values follow MacKinnon [36]. Because the outcome can depend on the lag length, the test is repeated with the lag length chosen by the Akaike information criterion (AIC). Table 2 reports the results for each series as described in Table 1 and for its first difference.

Table 2. Augmented Dickey–Fuller unit-root tests, 1980Q2–2000Q4, with lag lengths in parentheses

Series	Level ADF (lag)	Level p-value	Difference ADF (lag)	Difference p-value	Difference p-value, lag by AIC (lag)
Real GDP Growth	−3.060 (2)	0.030	−14.266 (1)	<0.001	<0.001 (1)
M2	−2.428 (0)	0.134	−10.772 (0)	<0.001	<0.001 (0)
Bank Credit	−0.792 (5)	0.821	−4.437 (4)	<0.001	0.002 (6)
Corporate Leverage	−2.120 (0)	0.237	−10.077 (0)	<0.001	0.048 (3)
Stock Price Growth	−6.061 (0)	<0.001	−10.987 (1)	<0.001	<0.001 (5)
House Price Growth	−1.924 (9)	0.321	−2.167 (8)	0.218	0.038 (10)

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At the 5% level, a unit root is rejected in levels for real GDP growth ($p = 0.030$) and stock price growth ($p < 0.001$), but not for M2, bank credit, house price growth or corporate leverage. In first differences, a unit root is rejected for five of the six series. For house price growth, the first difference does not reject a unit root when the lag length is chosen by SC ($p = 0.218$), but rejects it when the lag length is chosen by AIC ($p = 0.038$) or by SC with each lag length evaluated on its own maximum sample (four lags, $p = 0.010$). House price growth is measured relative to the same quarter of the previous year, so adjacent observations overlap; this induces serial correlation that is likely to lengthen the selected lag and reduce the power of the test. For the other five series, the conclusions are unchanged under either alternative.

On this basis, all six series enter the VAR in first differences, which gives the system a common stationary form. The first difference has a different meaning for the two types of variable. For the five growth-rate variables, $D(\cdot)$ is the change in the growth rate from one quarter to the next; for example, D(GDP) is the change in real GDP growth. For corporate leverage, D(LEVERAGE) is the quarterly change in the ratio itself. Relative to the underlying levels, the growth-rate variables are therefore differenced twice (for house prices, a change over four quarters followed by a change over one quarter), whereas corporate leverage is differenced only once, so the six series are not all differenced twice. Real GDP growth and stock price growth are already stationary in levels, and their first differences are taken for uniformity rather than because the ADF results require it. Differencing an already stationary series tends to produce negative serial correlation, which should be kept in mind when interpreting the negative own-lag coefficients in the D(GDP) and D(STOCK) equations.

The lag order of the differenced VAR is assessed with the sequential modified likelihood-ratio (LR) test, the final prediction error (FPE), AIC, SC and the Hannan–Quinn criterion (HQ) [37], computed for zero to four lags on a common sample of 78 observations (1981Q3–2000Q4). As Table 3 shows, the criteria do not agree. SC selects one lag, whereas LR, FPE, AIC and HQ select three. The VAR is estimated with two lags, an intermediate order. Each additional lag adds six coefficients to every equation, so a VAR(2) estimated on 80 observations leaves 67 residual degrees of freedom per equation, compared with 60 for a VAR(3) estimated on 79 observations. Because two lags are not selected by any single criterion, the sensitivity of the main coefficients to this choice is reported after the VAR estimates.

Table 3. Lag-order selection criteria for the first-differenced VAR, with selected orders marked by an asterisk

Lag	LogL	LR	FPE	AIC	SC	HQ
0	−101.741	–	6.382E-07	2.7626	2.9439	2.8352
1	−5.100	175.936	1.352E-07	1.2077	2.4767*	1.7157
2	58.239	105.565	6.814E-08	0.5067	2.8634	1.4501
3	138.457	121.356*	2.285E-08*	−0.6271*	2.8173	0.7518*
4	172.691	46.524	2.591E-08	−0.5818	3.9503	1.2325

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4.4. Results

4.4.1. D(CREDIT)

The bank credit equation has an R^2 of 0.446 and an adjusted R^2 of 0.347, suggesting that the equation has moderate explanatory power. The equation has an F-statistic of 4.502 and $p < 0.001$; therefore, the null hypothesis that all lagged coefficients are jointly zero is rejected at conventional levels, suggesting the equation is jointly significant. The first own-lag coefficient of bank credit is −0.608 (t = −5.14), while the second own-lag coefficient is −0.424 (t = −3.66). Both own-lag coefficients are significantly negative, indicating short-run correction in changes in bank credit. The bank-credit equation identifies a statistically significant predictive relationship with lagged corporate leverage; the second-lag coefficient of corporate leverage is 87.897 (t = 2.52), which is significant at the 5% level ($|t| \geq 2.00$). The coefficient is also in the positive direction, suggesting that a positive change in corporate leverage is associated with a higher subsequent change in bank-credit growth two quarters later. No other variables are significant at the 5% level.

4.4.2. D(GDP)

The GDP equation has an R^2 of 0.593 and an adjusted R^2 of 0.520, suggesting the equation has relatively strong explanatory power, and is jointly significant, with an F-statistic of 8.128 and $p < 0.001$. The first own-lag coefficient of GDP is −0.866 (t = −8.67), and the second own-lag coefficient is −0.652 (t = −6.37), indicating short-run correction in changes in GDP. GDP shares cross-variable relationships with real estate prices; the first-lag coefficient of real estate prices is 0.004905 (t = 2.87) and is significant at the 5% level in the positive direction. A positive change in real estate-price growth is associated with a higher change in GDP growth in the following quarter. The second-lag coefficient of real estate prices is −0.003047 (t = −1.96) and is only marginally significant at the 10% level, suggesting an initial positive effect followed by a partial reversal.

4.4.3. D(real estate price)

The real estate price equation has the highest explanatory power among the six equations, indicating that the lagged variables in the estimate explain a relatively large proportion of the changes in real estate prices. It has an R^2 of 0.722 and adjusted R^2 of 0.672, suggesting relatively strong in-sample fit. The equation has an F-statistic of 14.512, suggesting it is jointly significant. The first own-lag coefficient of real estate prices is 0.879 (t = 7.38), indicating strong positive persistence in changes in real estate prices. The first-lag coefficient of M2 is 0.537 (t = 3.12) and is positive and statistically significant at the 1% level, providing strong evidence that an increase in M2 predicts a rise in real estate prices in the following quarter. The second-lag coefficient of GDP is −19.415 (t = −2.73) and is negatively significant at the 1% level. This suggests that a positive change in GDP growth is associated with a negative change in real estate-price growth two quarters later. The first lag coefficient of corporate leverage is only marginally significant at the 10% level and should not be treated as a main finding.

4.4.4. D(corporate leverage)

Corporate leverage has an R^2 and adjusted R^2 of 0.248 and 0.113 respectively; the F-statistic is 1.840, with an overall p-value of approximately 0.059. The equation is only marginally significant at the 10% level and has relatively weak explanatory power. The first-lag coefficient of bank credit is

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−0.001305 (t = −2.99), thus a higher change in bank-credit growth predicts a lower subsequent change in the corporate leverage ratio. However, this result should not be interpreted directly as evidence that credit expansion causes corporate deleveraging.

4.4.5. D(M2)

For M2, the $R^2 = 0.161$ and adjusted $R^2 = 0.011$, demonstrating weak explanatory power. The F-statistic is 1.070, with an overall p-value of approximately 0.399; therefore, the equation is not jointly significant. M2 has no statistically significant own-lag coefficients and none of the variables are significant at the 5% level. The first lag of bank credit has a p-value of approximately 0.083, and the second lag of GDP has a p-value of roughly 0.094; both are only marginally significant at the 10% level. The current VAR system does not explain changes in M2 well.

4.4.6. D(stock price)

The stock-price equation has an R^2 of 0.364 and an adjusted R^2 of 0.250, indicating moderate explanatory power. The equation is jointly significant with an F-statistic of 3.200. The first own-lag coefficient of stock prices is −0.415 (t = −3.64), and the second own-lag coefficient is −0.465 (t = −4.16), indicating negative short-run reversal in changes in stock prices. The first-lag coefficient of corporate leverage is 323.276 (t = 2.01), borderline significant at the 5% level in the positive direction. An increase in corporate leverage therefore predicts a rise in stock prices in the following quarter. However, M2, bank credit, GDP and real estate prices are not significant at the 5% level, suggesting that the stock-price equation shows limited statistically significant cross-variable relationships with these variables.

4.4.7. VAR estimate

Table 4 and Table 5 report the VAR estimates for the adjusted sample 1981Q1–2000Q4 (80 observations after adjustments), with standard errors in parentheses and t-statistics in square brackets, and Table 6 reports the system statistics.

Table 4. VAR estimates for the D(GDP), D(M2) and D(CREDIT) equations

Regressor	D(GDP)	D(M2)	D(CREDIT)
D(GDP(-1))	−0.866177	6.426939	−27.71785
	(0.09991)	(4.81837)	(17.4949)
	[−8.66961]	[1.33384]	[−1.58434]
D(GDP(-2))	−0.651535	8.366536	0.051183
	(0.10227)	(4.93234)	(17.9087)
	[−6.37056]	[1.69626]	[0.00286]
D(M2(-1))	0.002131	−0.140375	−0.050055
	(0.00247)	(0.11921)	(0.43284)
	[0.86196]	[−1.17752]	[−0.11564]
D(M2(-2))	−0.003357	−0.092284	0.089861

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Table 4. (continued)

	(0.00259)	(0.12508)	(0.45415)
	[−1.29441]	[−0.73779]	[0.19787]
D(CREDIT(-1))	0.000382	0.057300	−0.607759
	(0.00067)	(0.03254)	(0.11815)
	[0.56552]	[1.76085]	[−5.14388]
D(CREDIT(-2))	0.000979	0.032609	−0.424235
	(0.00066)	(0.03190)	(0.11584)
	[1.48010]	[1.02212]	[−3.66237]
D(LEVERAGE(-1))	0.274669	10.32815	51.51272
	(0.19607)	(9.45578)	(34.3327)
	[1.40090]	[1.09226]	[1.50040]
D(LEVERAGE(-2))	−0.131836	−4.243829	87.89665
	(0.19938)	(9.61538)	(34.9122)
	[−0.66124]	[−0.44136]	[2.51765]
D(STOCK(-1))	−0.000181	0.007262	−0.016217
	(0.00014)	(0.00669)	(0.02431)
	[−1.30738]	[1.08476]	[−0.66723]
D(STOCK(-2))	6.85E-05	0.008495	0.006622
	(0.00014)	(0.00657)	(0.02385)
	[0.50261]	[1.29325]	[0.27765]
D(HOUSE(-1))	0.004905	0.101573	0.150585
	(0.00171)	(0.08251)	(0.29958)
	[2.86701]	[1.23105]	[0.50266]
D(HOUSE(-2))	−0.003047	−0.091036	−0.083358
	(0.00155)	(0.07489)	(0.27190)
	[−1.96202]	[−1.21567]	[−0.30657]
C	5.17E-05	−0.010729	−0.105772
	(0.00109)	(0.05264)	(0.19113)
	[0.04739]	[−0.20381]	[−0.55339]
R-squared	0.592802	0.160873	0.446414
Adj. R-squared	0.519871	0.010581	0.347264
Sum sq. resids	0.006003	13.96311	184.0788
S.E. equation	0.009466	0.456513	1.657542
F-statistic	8.128269	1.070406	4.502424

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Table 4. (continued)

Log likelihood	266.3833	−43.69076	−146.8486
Akaike AIC	−6.334582	1.417269	3.996214
Schwarz SC	−5.947502	1.804348	4.383294
Mean dependent	−0.000144	−0.013741	−0.023436
S.D. dependent	0.013661	0.458948	2.051615

Table 5. VAR estimates for the D(LEVERAGE), D(STOCK) and D(HOUSE) equations

Regressor	D(LEVERAGE)	D(STOCK)	D(HOUSE)
D(GDP(-1))	0.048506	−71.28298	5.028208
	(0.06463)	(82.0243)	(6.95412)
	[0.75053]	[−0.86905]	[0.72306]
D(GDP(-2))	−0.016290	−70.36293	−19.41502
	(0.06616)	(83.9645)	(7.11861)
	[−0.24623]	[−0.83801]	[−2.72736]
D(M2(-1))	0.000229	−1.096601	0.536516
	(0.00160)	(2.02938)	(0.17205)
	[0.14306]	[−0.54036]	[3.11832]
D(M2(-2))	−0.002425	−0.518384	0.104006
	(0.00168)	(2.12928)	(0.18052)
	[−1.44519]	[−0.24345]	[0.57613]
D(CREDIT(-1))	−0.001305	−0.237844	−0.024822
	(0.00044)	(0.55395)	(0.04696)
	[−2.98893]	[−0.42936]	[−0.52853]
D(CREDIT(-2))	−0.000287	0.866277	0.055681
	(0.00043)	(0.54310)	(0.04604)
	[−0.67096]	[1.59507]	[1.20930]
D(LEVERAGE(-1))	−0.187299	323.2764	22.91040
	(0.12683)	(160.968)	(13.6471)
	[−1.47676]	[2.00832]	[1.67878]
D(LEVERAGE(-2))	−0.046814	198.4110	0.294084
	(0.12897)	(163.685)	(13.8774)
	[−0.36298]	[1.21215]	[0.02119]
D(STOCK(-1))	0.000107	−0.415014	−0.011422
	(9.0E-05)	(0.11396)	(0.00966)

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Table 5. (continued)

	[1.19215]	[−3.64188]	[−1.18219]
D(STOCK(-2))	3.01E-05	−0.465391	0.003567
	(8.8E-05)	(0.11182)	(0.00948)
	[0.34115]	[−4.16194]	[0.37628]
D(HOUSE(-1))	0.000454	−1.666800	0.878763
	(0.00111)	(1.40457)	(0.11908)
	[0.41066]	[−1.18670]	[7.37954]
D(HOUSE(-2))	−0.000199	0.598719	−0.141293
	(0.00100)	(1.27480)	(0.10808)
	[−0.19789]	[0.46966]	[−1.30732]
C	0.000366	−0.761290	−0.047075
	(0.00071)	(0.89613)	(0.07597)
	[0.51814]	[−0.84953]	[−0.61962]
R-squared	0.247828	0.364311	0.722159
Adj. R-squared	0.113110	0.250457	0.672397
Sum sq. resids	0.002512	4046.390	29.08479
S.E. equation	0.006123	7.771350	0.658864
F-statistic	1.839610	3.199794	14.51211
Log likelihood	301.2311	−270.4572	−73.04264
Akaike AIC	−7.205777	7.086431	2.151066
Schwarz SC	−6.818698	7.473510	2.538145
Mean dependent	0.000262	−0.170705	−0.211664
S.D. dependent	0.006502	8.976316	1.151122

Table 6. VAR system statistics

System statistic	Value
Determinant resid covariance (dof adj.)	2.82E-08
Determinant resid covariance	9.72E-09
Log likelihood	56.85350
Akaike information criterion	0.528663
Schwarz criterion	2.851138
Number of coefficients	78

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4.4.8. Sensitivity to the lag order

Table 7 reports the main coefficients re-estimated with one and three lags, each on the longest sample available up to 2000Q4. With three lags, the first-lag coefficient of M2 in the real estate price equation remains positive and significant at the 5% level (t = 2.36), as do the first-lag coefficient of real estate prices in the GDP equation (t = 2.26), the second-lag coefficient of GDP in the real estate price equation (t = −2.42) and the first-lag coefficient of corporate leverage in the stock-price equation (t = 2.39). By contrast, the second-lag coefficient of corporate leverage in the bank-credit equation falls to 12.633 (t = 0.59), and the first-lag coefficient of bank credit in the corporate leverage equation is only marginally significant at the 10% level (t = −1.92). With one lag, the M2 coefficient in the real estate price equation remains significant (t = 3.75), whereas the real estate price coefficient in the GDP equation (t = 0.53) and the leverage coefficient in the stock-price equation (t = 0.07) are not. The M2 equation is not jointly significant under any of the three lag orders.

Table 7. Main VAR coefficients under one, two and three lags, with t-statistics in square brackets

Equation	Regressor	VAR(1)	VAR(2)	VAR(3)
D(HOUSE)	D(M2(-1))	0.615	0.537	0.439
		[3.75]	[3.12]	[2.36]
D(HOUSE)	D(GDP(-2))	n.a.	−19.415	−24.933
			[−2.73]	[−2.42]
D(GDP)	D(HOUSE(-1))	0.000605	0.004905	0.004377
		[0.53]	[2.87]	[2.26]
D(CREDIT)	D(LEVERAGE(-2))	n.a.	87.897	12.633
			[2.52]	[0.59]
D(LEVERAGE)	D(CREDIT(-1))	−0.001155	−0.001305	−0.000994
		[−3.32]	[−2.99]	[−1.92]
D(STOCK)	D(LEVERAGE(-1))	11.248	323.276	387.104
		[0.07]	[2.01]	[2.39]
D(M2)	Joint F-test p-value	0.530	0.399	0.553
	Observations	81	80	79

The estimated VAR(2) is stable, as all eigenvalues of its companion matrix have a modulus below one (the largest is 0.718). However, the adjusted portmanteau test rejects the null hypothesis of no residual autocorrelation up to eight lags for the one-, two- and three-lag models ($p < 0.001$ in each case) [37]. The standard errors in Tables 4, 5 and 7 may therefore be inaccurate, and the significance levels reported above should be read as approximate.

5. Discussion

The estimates provide a mixed answer to the research question. The clearest relationship links monetary liquidity with subsequent asset prices. An increase in M2 growth is followed by higher

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real estate price growth in the next quarter, and this association remains significant with one, two and three lags. In contrast, the lags of M2 are not significant in the bank-credit equation ($t = -0.12$ and 0.20), and the lags of bank credit are not significant in the real estate price equation ($t = -0.53$ and 1.21). Within this system, the association between M2 and real estate prices therefore does not appear to operate through quarter-to-quarter changes in bank credit. This bears on the distinction between monetary liquidity and bank credit drawn in the methodology, since an expansion in M2 did not, in these data, predict a subsequent acceleration in bank lending. The positive association between M2 and subsequent real estate price growth is in line with Liu [7], who finds that land prices respond to money and credit shocks, although the present estimates do not identify shocks.

The absence of a significant short-run link between bank credit and real estate prices does not mean that the two moved independently. Figures 2 and 4 show that both credit growth and house price growth were high in the late 1980s and fell sharply after 1990. Because the VAR is estimated in changes of growth rates, it captures quarter-to-quarter dynamics and largely removes such low-frequency co-movement. The collateral–credit feedback described in the literature [15, 17] may therefore operate over horizons that a short-lag VAR in differences does not detect.

The second relationship links asset prices with real activity. A positive change in real estate price growth is associated with a higher change in GDP growth in the following quarter, followed by a partial reversal, and a positive change in GDP growth is associated with lower real estate price growth two quarters later. The first of these associations is consistent with the view that rising property values strengthen collateral and borrowers' balance sheets [14, 15], but it holds with two and three lags and not with one, so it is less robust than the M2 relationship. Stock price growth, by contrast, shows no significant lagged association with GDP growth ($t = -1.31$ and 0.50), so the link between stock-market valuation and real activity that motivated the inclusion of the Nikkei 225 is not supported in this specification.

The evidence on the link between lenders and borrowers is weaker. In the two-lag model, a rise in corporate leverage is followed by higher bank-credit growth two quarters later, and higher bank-credit growth is followed by a lower change in the leverage ratio. Neither relationship is robust, as the first disappears with three lags and the second becomes marginal. The descriptive evidence is nonetheless informative. The leverage ratio continued to rise after bank credit growth had peaked in 1989Q3 and reached its maximum in 1993Q3, by which time house price growth had already been negative since 1991Q4 (Figures 2–4). This sequence is consistent with evidence that troubled banks continued lending to weak firms [23] and that such lending delayed restructuring [24], although the aggregate data used here do not distinguish between borrowers.

These results bear on whether the formation and collapse of the bubble can be understood as a reversible balance-sheet process. The VAR imposes the same coefficients on the whole sample, so it treats increases and decreases symmetrically and cannot by itself test whether the contraction mirrored the expansion. The time-series evidence suggests that it did not. M2 growth was positive in 33 of the 36 quarters from 1992 to 2000, averaging 0.63% per quarter, yet house price growth was negative in every quarter from 1991Q4 to 2000Q4, and bank credit growth was negative in 17 of those 36 quarters. This pattern accords with the finding that bank credit contracted despite monetary easing [9], and suggests that, in Japan's experience, the expansionary and contractionary phases were not mirror images. It is also consistent with the argument that credit growth and asset prices deserve attention during expansions, when imbalances accumulate [11].

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6. Conclusion

This study examined the dynamic relationships among monetary liquidity, bank credit, corporate leverage, asset prices and real economic activity in Japan between 1980 and 2000 using a six-variable VAR estimated on quarterly data. The relationships are uneven across the system. Higher M2 growth is followed by higher real estate price growth, and this is the most robust result. Real estate price growth is positively associated with subsequent GDP growth, although less robustly. The links between bank credit and corporate leverage are present with two lags but depend on the lag order, and there is no evidence that M2 growth predicted subsequent bank credit growth or that stock price growth predicted GDP growth. Changes in M2 itself are not explained by the system. Combined with the time-series evidence that house prices and bank credit remained weak through the 1990s while M2 continued to grow, the findings suggest that the expansion and contraction phases were not symmetric and that expansionary and contractionary policies may not be exact opposites.

The study has several limitations. The estimates describe dynamic associations and do not identify causal effects, and no impulse responses based on identified shocks are reported. A single linear VAR with constant coefficients cannot test whether the relationships differed between the boom and the bust. Estimating the system in differences of growth rates removes low-frequency co-movement and over-differences real GDP growth and stock price growth, which are already stationary. The lag order is not selected by a single criterion, the residuals show autocorrelation, and the sample contains only 80 observations. Bank credit is not seasonally adjusted, and its growth is systematically higher in the third and fourth quarters, which may affect the bank-credit equation. The system also omits the policy interest rate. Future research could estimate separate models for the expansion and contraction phases, trace impulse responses to identified shocks, and add the policy rate to the system.

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Appendix

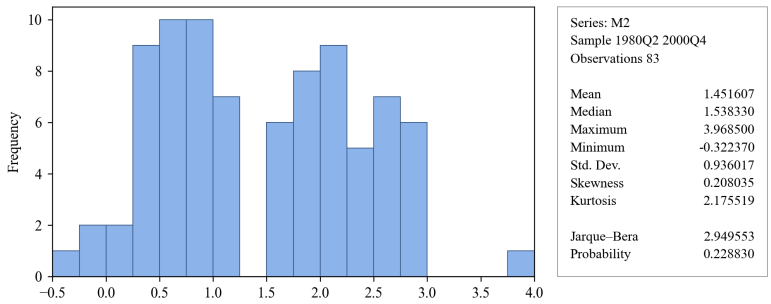


Figure A1. M2 (source: [28])

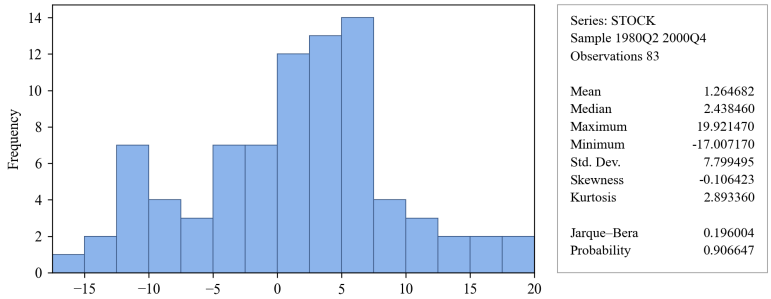


Figure A2. Stock price growth (source: [30])

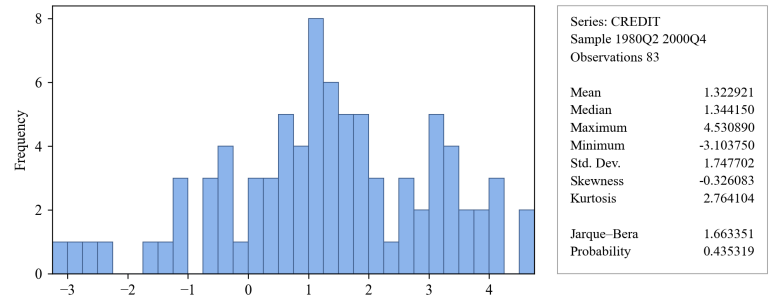


Figure A3. Bank credit (source: [29])

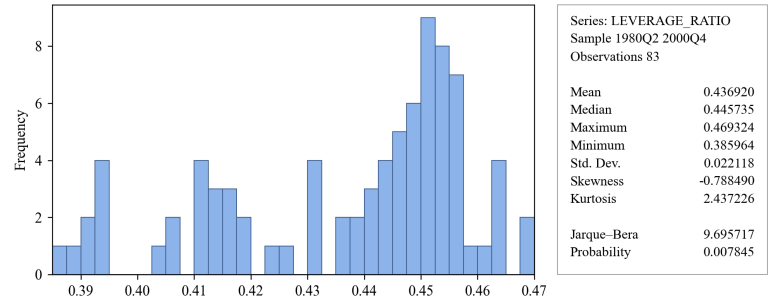


Figure A4. Corporate leverage ratio (source: [32])

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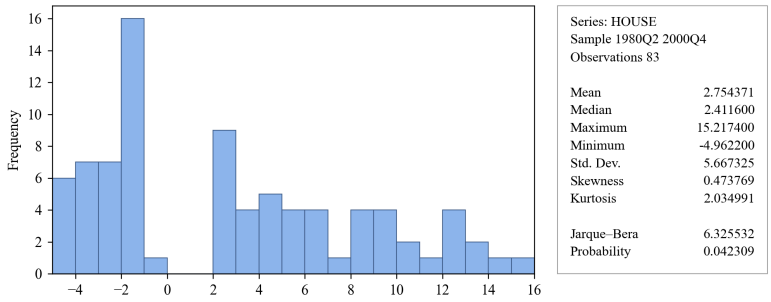


Figure A5. House price growth (source: [31])