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Asset Prices, Financial Liberalization and the Process of Inflation in Japan

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Abstract

This paper examines the extent to which the Japanese asset price cycle of the 1980s was determined by monetary factors, the real business cycle, and financial liberalization. Strong evidence is found of a shift in the relationships between monetary factors and land price inflation in the early 1980s. In particular, the estimated parameters of a vector autoregression imply that the transmission of monetary factors to asset prices was greater in the 1980s than in the 1970s. A key conclusion is that monetary shocks led to more asset price inflation and less consumer price inflation in the 1984-93 period than during 1970-83.

JEL Classification Numbers:

G12, E31, E44, C32

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Contents

Summary

This paper examines the relationship in Japan between asset price inflation and macroeconomic variables, and in particular monetary factors. The focus is on land price inflation, rather than stock price movements; while stock prices are difficult to model empirically, land prices generally move systematically in response to changes in economic fundamentals. Several related questions are investigated: (1) was there a structural break in the way monetary factors affected asset prices in the 1980s; (2) did monetary factors contribute importantly to asset price inflation in the 1980s; (3) what accounted for the divergent behavior of asset prices and consumer prices; and (4) is there support for the view that the effects of monetary factors were "concentrated" in asset markets rather than in goods markets?

The paper finds strong evidence of a shift in the relationships between monetary factors and land prices in the early 1980s: in particular, the parameters of an estimated vector autoregression imply that the transmission of monetary factors to asset prices was greater in the 1980s than in the 1970s. A key conclusion is that monetary shocks led to more asset price inflation and less consumer price inflation in 1984-93 than during 1970-83. This "shift in regime"--which is largely attributed to the effects of financial liberalization--concealed the true, unsustainable, nature of the rise in asset prices in the late 1980s, which may explain why policymakers did not fully perceive the implications of allowing the asset price inflation to proceed as far as it did.

I. Introduction

During 1986-93, asset prices in Japan moved through a dramatic and broadly symmetric cycle. Land values doubled, and corporate equity values tripled; these increases were followed by almost equal declines. At the same time, consumer price inflation remained relatively low--compared with inflation in other industrial countries, and with inflation in Japan in the late 1970s and early 1980s. Because the asset price cycle in Japan has been costly in terms of lost output and financial distress, it would be useful to identify the factors that caused these dramatic asset price movements. An important unanswered question is why were the sharp increases in asset prices and private indebtedness allowed to persist; that is, why were these developments perceived as sustainable, rather than as manifestations of inflationary pressures?

One explanation that has received some attention is that the asset price inflation could not be forecast *ex ante* on the basis of available macroeconomic or other fundamental economic information. This characterization has been likened to a "bubble" phenomenon--a label that is adopted here for brevity--and has been interpreted to mean that the dramatic asset price increases were not closely related to fundamental economic factors. An alternative explanation that has not been examined is that there was a "regime switch" in the mid-1980s--the result of financial market reform and other structural changes--that made it difficult to accurately interpret economic and policy developments at the time. The structural changes in financial markets and in the tax treatment of real estate and equity investment in the 1980s, for example, might have been construed, *ex ante*, as justifying a sustainable re-evaluation of asset values relative to a basket of consumption goods. From this perspective, the asset price cycle initially might have been perceived as being driven by economic fundamentals; and later in the process, the structural changes made it difficult to properly assess the stance of macroeconomic policies.

The evaluation of these alternative hypotheses is not a matter of merely academic or historical interest. If the asset price inflation was indeed a bubble, then there was little that could or should have been done to prevent or eliminate the sharp fluctuations in the asset price cycle, except to send a strong (monetary) signal early in the process that further asset market speculation would ultimately be very costly to speculators. By contrast, the regime-switch hypothesis leaves open at least two related possibilities: macroeconomic policy inadvertently fueled the asset price inflation; and the monetary policy framework in use at the time was inadequate for assessing the stance of policy and its influence on the real economy. If this second hypothesis is correct, then lessons may be drawn from the recent asset price cycle for conducting macroeconomic policy in the 1990s.

This paper examines the relationship between macroeconomic variables and asset price inflation in the 1980s. The focus is on land price inflation, rather than on stock price movements; although stock prices are notoriously difficult to model empirically, real estate prices generally

move in response to changes in fundamental economic factors, including the business cycle and monetary factors. The paper also examines several related questions: (1) was there a structural break in the way monetary factors, in particular, affected asset prices in the 1980s; (2) did monetary factors contribute importantly to asset price inflation in the 1980s; (3) what accounted for the divergent behavior of asset prices and consumer prices; and (4) is there evidence supporting the view that the effects of monetary factors were heavily concentrated in asset markets rather than in goods markets.

Section 2 briefly reviews the relevant asset price and balance sheet developments and then examines in more detail the alternative hypotheses and important unresolved issues regarding the asset price cycle in Japan. Section 3 attempts to quantify the extent to which macroeconomic factors, and in particular monetary factors, influenced the land price cycle in the late 1980s and to provide evidence about the regime switch and the other issues. A final brief section summarizes the empirical results. An appendix briefly examines the time series properties of the data and other statistical issues.

II. Key Developments and Issues

1. The Asset Price and Balance Sheet Adjustments

Because the important facts characterizing the asset price cycle in Japan have been examined in detail in previous studies, this section briefly highlights the salient features of these adjustments. 1/ As mentioned, between 1985 and 1990 land prices doubled, and equity prices tripled. The average price of residential land in large urban centers rose 13 percent annually between 1985 and 1990, and equity prices rose 31 percent annually over the same period (Chart 1).

The turnaround in asset prices coincided with a change in the stance of monetary policy in early 1990. From its peak in 1990, the average price of land in the six largest Japanese cities declined by 36 percent through the end of 1993 (an average annual decline of about 14 percent). Likewise, equity prices (as measured by the Nikkei 225) plunged from a high of nearly 39,000 in February 1990 to a low of about 14,000 in August 1992; the stock

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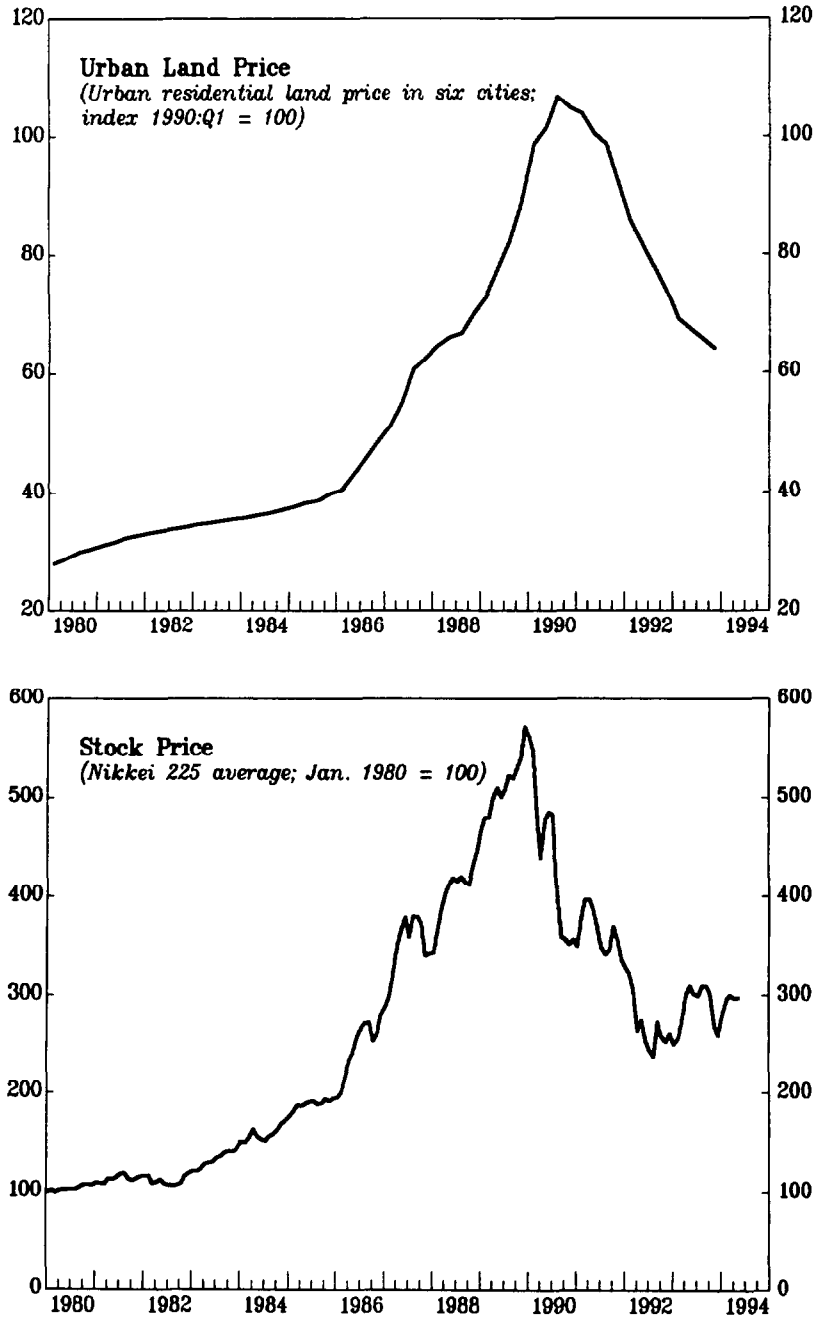
1/ Asset price and balance sheet adjustments occurred in other industrial countries--including the United States, the United Kingdom, the Nordic countries, Australia, and New Zealand, and have been examined in detail in previous issues of the IMF's World Economic Outlook; see also Schinasi and Hargraves (1993), which synthesizes this work. Adjustments in Japan have been described in fuller detail in, "Analysis of Movements in Asset Prices Since the Mid-1980s," which will be reprinted in International Monetary Fund (1994).

Chart 1. Urban Land and Stock Prices



Sources: Japan Real Estate Institute, Bulletin of Japan Land Prices, and Nikkei News Services.

market then rebounded and has traded in a price range between 18,000 and 21,500 in the first half of 1994.

The sharp asset price adjustments were accompanied by equally dramatic changes in private sector balance sheets. Total private sector indebtedness expanded quite rapidly in the mid- to late 1980s, both in absolute terms and relative to GDP (Chart 2). Liabilities of the household and business sectors expanded markedly (Chart 3 and Table 1, respectively), and in turn this growth was reflected in the rapid expansion in the banking and nonbank financial sectors.

The balance sheet expansion in the late 1980s left households, businesses, and financial institutions unusually vulnerable to the effects of a tightening of monetary conditions in early 1990. Once asset prices began to decline, the asset sides of private sector balance sheets deteriorated sharply, leaving many private sector agents with highly leveraged positions. Moreover, the very deep and prolonged recession and the associated decline in disposable incomes and profits made it difficult for households and businesses to meet existing obligations and at the same time maintain their spending levels. As a result, both consumer expenditures and investment outlays were constrained, as an increasing share of income was devoted to servicing existing debt levels and to reducing debt to more normal levels.

Reflecting these adjustment efforts, the private sector's ratio of debt to GDP leveled off and then declined slightly through the end of 1992 (the last year for which there is data). Experience in other countries suggests that further downward adjustments are likely to occur in the period ahead--in both the household and business sectors. Households have reduced debt levels somewhat, and their net wealth has clearly been affected by the asset price deflation. Similarly, businesses have been more conscious of their leverage ratios and have pared back their debt ratios. The most difficult adjustments in the period ahead are likely to be in the financial sector.

2. Alternative Explanations and the Role of Monetary Factors

An important unresolved question about the asset price cycle in Japan is why the sharp increases in asset prices and private indebtedness were taken for something other than a manifestation of inflationary pressures created by overexpansionary macroeconomic policies. 1/ One possible explanation, which has been supported by empirical studies, is that there was a large, unexplained bubble component to the sharp and prolonged rises in both land and equity prices in Japan. For example, simulations below based on a single-equation model of asset prices and using data during the period 1970:QI-1984:Q4 show that the information available through 1985--the beginning of the asset price cycle--was not sufficient to accurately

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1/ For an analysis of this question see Schinasi (1994).

Table 1. Selected Indicators of Financial Balance 1/

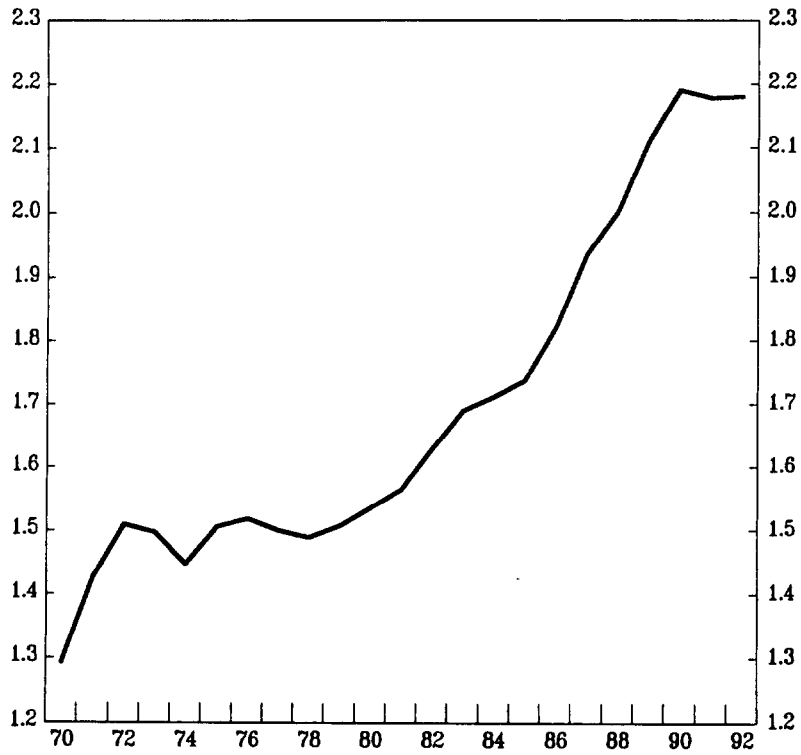
	1970-74	1975-79	1980-84	1985	1986	1987	1988	1989	1990
Household assets	5.23	4.96	6.15	6.49	7.26	8.55	9.03	9.82	9.70
Household liabilities	0.62	0.67	0.82	0.89	0.92	1.01	1.07	1.12	1.16
Household net worth	4.61	4.29	5.32	5.61	6.34	7.54	7.95	8.71	8.54
Business assets	3.48	3.52	3.76	3.85	4.19	4.75	5.04	5.38	5.07
Business liabilities	1.91	1.90	1.94	1.98	2.00	2.12	2.16	2.17	2.23
Business net worth	1.57	1.61	1.82	1.88	2.20	2.63	2.88	3.21	2.85
Business net interest payments	49.32	63.06	53.63	46.67	44.35	40.81	38.72	40.94	49.14
Business debt-equity ratio	2.52	2.70	2.35	2.01	1.42	1.26	0.98	0.78	1.26

Source: EPA, National Income Accounts (various issues).

1/ Household data as percent of disposable income; the business sector is defined as the nonfinancial corporate sector as a percent of GDP, except the debt-equity ratio and business interest payments, which are in percent of available income.

Chart 2. Total Private Nonfinancial Sector Debt[1]

(In percent of GDP, end of period)

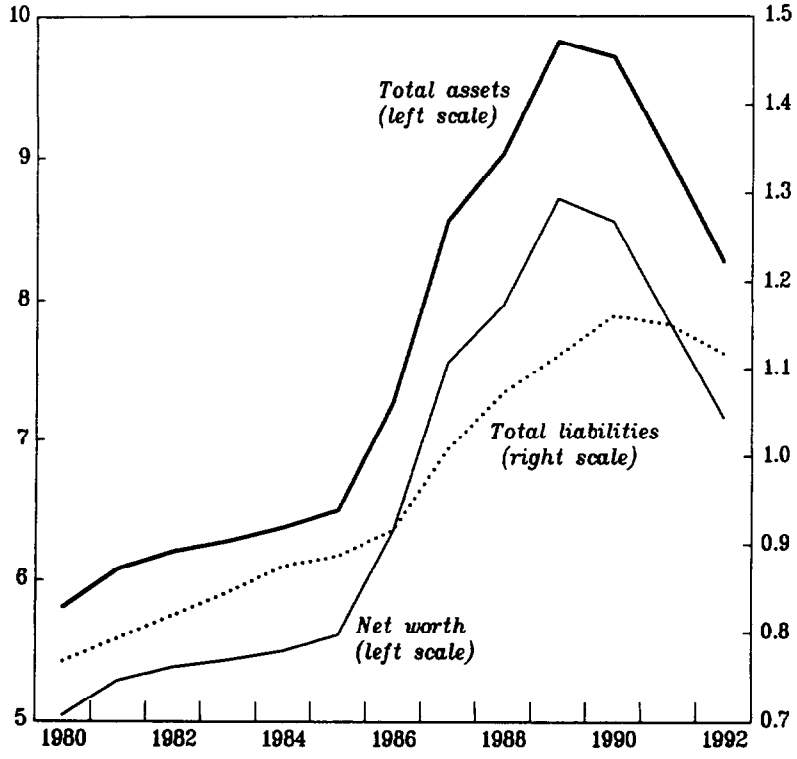


Sources: Economic Planning Agency, National Income Accounts.

[1]Total financial liabilities of the private nonfinancial sectors less trade credits.

Chart 3. Household Sector Balance Sheet

(In percent of disposable income)



Sources: Economic Planning Agency, National Income Accounts.

forecast the sharp rise in land prices. This conclusion holds even when the actual future values of the explanatory variables (other than the lagged dependent variable) over the forecasting period were used in the simulations. Although this exercise cannot statistically verify or falsify the existence of a bubble component in asset prices, it does forcefully illustrate how difficult it would have been in the mid-1980s to pinpoint the forces driving asset prices in the early stages of the inflation cycle.

An unexplored alternative explanation is that the asset price movements were driven by economic fundamentals, but that the confluence of structural changes in financial markets and expansionary macroeconomic policies made it difficult to interpret accurately the sharp and persistent increases in asset prices. In Japan, there were many significant developments in the early 1980s--such as the structural changes in financial markets and the tax treatment of real estate and equity investment--that might have altered in fundamental ways the relationships between macroeconomic variables and asset prices. 1/ These structural changes, which could have been perceived as raising the demand for assets, may have provided reasonable rationalization for believing that assets--in particular, real estate and corporate equities--were undervalued relative to consumption goods. In the initial stages of the boom in asset values, therefore, it was not unreasonable to continue to maintain the stance of monetary policy and, in effect, acquiesce to the rapid run-up in the relative price of real estate values and other asset prices.

In hindsight, a working hypothesis for understanding the dramatic asset price developments is that the prevailing monetary policy framework, together with dramatic changes in financial structures, monetary transmission mechanisms, and other important structural changes, made it difficult to distinguish sustainable adjustments in asset prices from unsustainable price increases (see Schinasi (1994)). In the initial stages of the increase in asset prices in Japan, it was presumed that the asset price increases were adjustments in relative prices in response to fundamental structural changes--including asset-market-specific tax reforms. As a result, there was a prolonged period during which inflationary pressures accumulated. Moreover, the combination of real,

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1/ Extensive reform measures since 1984 have included liberalization of interest rates on deposits; the easing of restrictions on large time deposits, CDs, and money market certificates; and the introduction of markets for commercial paper, futures and options, and offshore transactions. Recent legislative reforms have further lowered barriers between banking and securities brokerage, permitting banks to establish subsidiaries that provide brokerage services and allowing securities firms to establish banking subsidiaries. In addition, tax provisions created incentives for the construction of apartment houses and condominiums, and changes in the capital gains treatment of real estate transactions encouraged upgrade purchases.

financial, and institutional structural changes in Japan created an environment in which inflationary pressures were channeled to, and concentrated and recycled in, asset markets for a prolonged period of time. 1/

3. Casual Empirical Evidence and Unresolved Issues

There is strong support for the concentration hypothesis. First, Japan entered the 1980s with a highly regulated financial system, which was then liberalized rapidly: ceilings on deposit interest rates were liberalized in the early 1980s; Japanese nonbank financial institutions were allowed to compete with established banks; foreign financial institutions were allowed to enter the market; and new financial instruments were allowed. In this new competitive environment there were incentives to venture into new markets--in particular, real estate markets--as traditional borrowers shifted into other forms of financial intermediation. All of these changes led to a financial environment in which bank balance sheets were adjusting rapidly and in which both bank credit and deposits were expanding rapidly. 2/ During this kind of rapid change--which was occurring in many other industrial countries as well--it was difficult to judge accurately the stance of monetary policy. 3/

Second, growth in both the monetary aggregate, M2 + CDs, and the credit aggregate, total private credit, remained very high throughout most of the 1980s. Moreover, growth in both of these financial aggregates exceeded growth in real GDP by a fairly wide margin, representing potential inflationary pressure. The difference between this "money gap" and inflation averaged 3 1/4 percent of GDP a year, and the difference between the "credit gap" and inflation averaged 3 3/4 percent of GDP a year in the 1980s (Chart 4). To obtain estimates of the potential "overhang" of the money stock or the stock of credit relative to the national accounts

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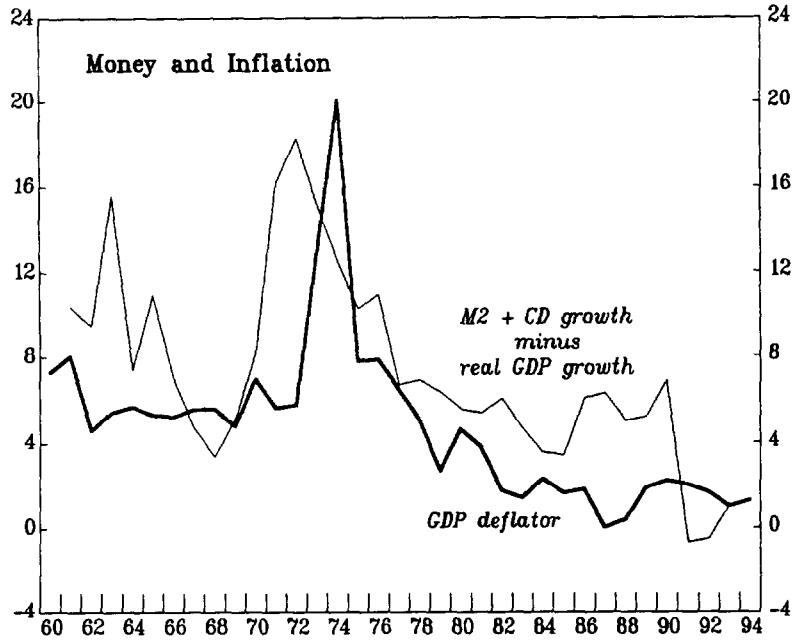
1/ The concentration hypothesis is that in many industrial countries, including Japan, the confluence of macroeconomic policies, financial liberalization, and other structural changes created an environment in which excess liquidity and credit were channeled to specific groups active in asset markets, including large financial and nonfinancial institutions, high-income earners, and wealthy individuals. These groups responded to the economic incentives associated with the structural changes and borrowed heavily to accumulate assets in global markets--such as real estate, corporate equities, art, and precious commodities. Apparently, the excess credit was recycled in asset markets several times over. The structural changes that occurred in Japan are detailed in the preceding footnote. For a brief but more general discussion of the reasons that inflationary pressures may have been concentrated in asset markets, see Schinasi and Hargraves (1993), pp. 18-20.

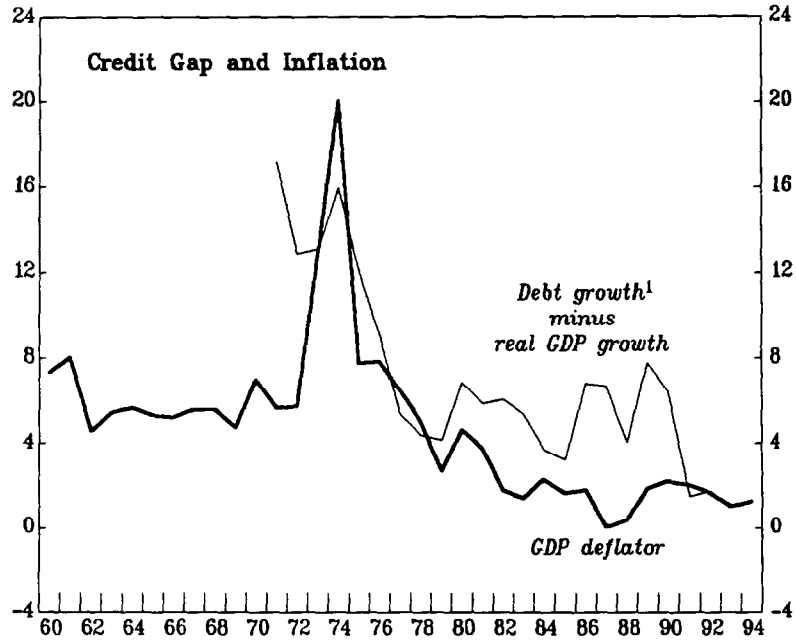
2/ For further details see Hargraves, Schinasi, and Weisbrod (1993).

3/ For example, see Bank for International Settlements (1984); and Bank for International Settlements (1986).

Chart 4. Money, Debt, and Inflation

(In percent)





Source: IMF staff calculations.

[1]Total financial liabilities of the private nonfinancial sectors less trade credits.

measures of economic activity, the year-by-year gaps should be accumulated, and this suggests a considerable overhang.

Third, and in strong support of the concentration hypothesis, the dramatic asset price adjustments in the 1980s did not initially pass through to goods markets in Japan, as they had in the 1970s (Chart 5). In most other countries that experienced asset price inflation, increases in the consumer price index (and the GDP deflator) did reflect the underlying inflationary pressures that were present, albeit in some cases with a long delay; by contrast, in Japan inflation (measured by the GDP deflator) did not rise significantly in the 1980s and did not fully reflect the demand pressures that were present in the real estate and corporate equity markets. This represented a departure from patterns that prevailed in the 1970s, when inflationary pressures tended to raise asset prices initially and were then transmitted relatively rapidly to goods prices. In the 1980s, by contrast, conventional measures of inflation, such as those based on consumer price indices or GDP deflators, remained relatively low during most of the period in which asset prices were rising at double-digit rates. That goods prices did not rise commensurately with asset prices provided some confirmation for the initial judgment that the asset price increases were sustainable.

When viewed together, these factors--structural change in the financial sector, money and credit growth in excess of GDP, and a breakdown in the relationship between asset and goods prices--suggest that monetary factors played a key role in the asset price cycle in the late 1980s, that there was a shift in the transmission of monetary policy to inflation between the 1970s and the 1980s, and that, as a result, inflationary pressures may have been concentrated in asset markets.

Although previous studies have tried to examine the causes of these sharp adjustments in Japan, most of the issues discussed above, with few exceptions, have not been examined empirically or tested . 1/ The following section attempts to provide some empirical evidence on these important issues.

1/ One exception is Samiei and Schinasi (1994), which demonstrates that monetary factors have been an important determinant of land price inflation in Japan during the period 1970-92. In addition, monetary factors were more important in the 1980s than in the 1970s--suggesting a shift in the monetary transmission process.

III. A Multiequation Model of Land Prices and Inflation

1. A Vector-Autoregression Model

To examine these issues empirically, this section provides estimates of a standard vector autoregression (VAR). 1/ Previous studies have used a single-equation approach, which requires strong assumptions about the dynamic relationships among variables and which ignores the fact that the explanatory variables are not exogenous. VAR allows for the exploration of empirical regularities and relationships with a minimum of assumptions; it also allows for the determination of the dynamic structure of relationships. A drawback of making fewer assumptions is a loss of specificity about the underlying structural relationships among the variables in the system. 2/

Land price inflation in Japan is assumed to be determined by several factors within the context of a more general macroeconomic system. These include: monetary and financial conditions (that is, interest rates and other measures of monetary stance); the general condition of the Japanese economy (that is, its position in the business cycle); and inflation. Because the complexity of a VAR system increases dramatically as the number of variables in the system increases, the equation system focuses on five variables, which are allowed to be jointly determined: land price inflation, consumer price inflation, the output gap, a policy-determined interest rate, and the growth rate of a policy-related financial aggregate (either a monetary or credit aggregate). 3/ The variables are defined as follows:

r	=	call money rate
m	=	growth in M2 + CDs, or growth in total private credit
y	=	real GDP output gap
π_L	=	land price inflation
π	=	consumer price inflation.

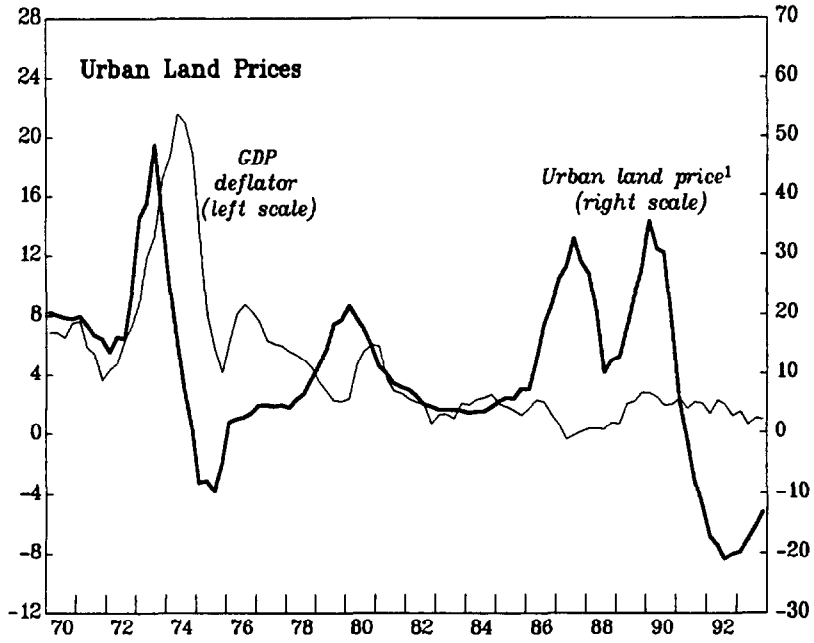
1/ See Sims (1980).

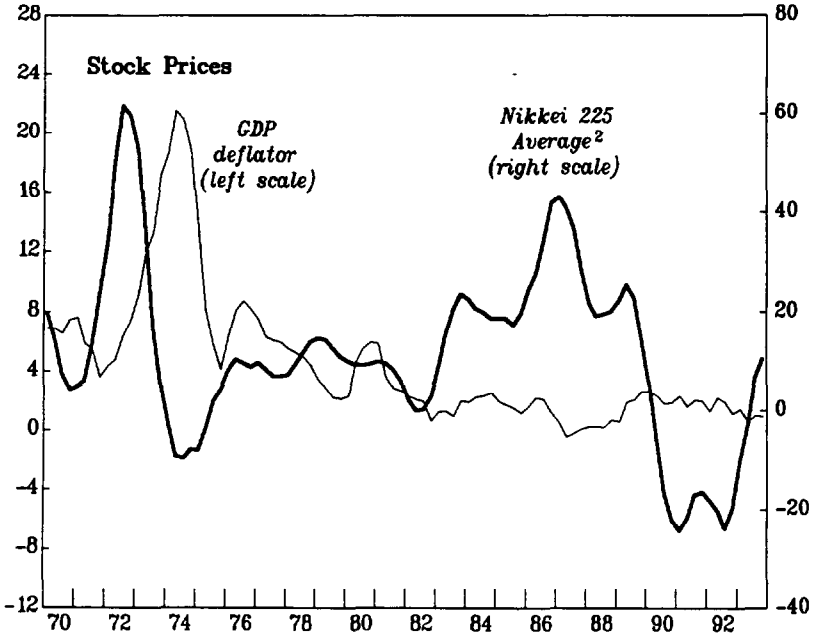
2/ A disadvantage of the standard VAR approach is that the underlying behavioral relationships that may exist cannot be identified; the estimated parameters are reduced-form estimates, and care must be exercised in interpreting the implications of the estimated equations.

3/ Other variables that were included are a measure of fiscal policy and alternative measures of the monetary stance, such as the exchange rate, but they did not alter the results in important (or even notable) ways.

Chart 5. Asset Prices and GDP Deflator

(In percent a year)





Sources: For housing price, Japan, Real Estate Institute, Bulletin of Japan Land Prices. For stock price, WEFA, Inc. data base.

[1]Urban residential land prices in six largest cities.
[2]The series are smoothed using a four-quarter centered moving average.

With $X_t' = (r_t, m_t, y_t, \pi_{Lt}, \pi_t)$--where a prime (') indicates the transpose operator--the basic model to be estimated is:

$$X_t = \sum_{i=1}^{4} A_i X_{t-i} + u_t$$

where the A_i are (5 × 5) matrices of parameters to be estimated. That is, each of the five variables in the equation system is assumed to be determined by four lagged values of each variable in the system, including its own lagged values. 1/ The errors are assumed to be identically and independently distributed, with zero means and constant variances and covariances.

The estimated VAR does not provide estimates of structural parameters, but it does provide unconstrained estimates of the relationships among the variables in the system. The information provided by VAR can be represented in three useful and related forms: estimates of the autoregressive parameters (and the associated test statistics), which relate each variable to the other system variables; variance decompositions, which provide estimates of the share of the variance of each variable that is explained by the other variables in the system; and impulse response functions, which indicate how the variables respond to various orthogonal shocks. 2/ In examining land price inflation, for example, the estimated autoregressive parameters on monetary factors can be jointly tested for their statistical significance; the variance decomposition can be examined to determine the importance of monetary innovations (that is, monetary policy changes) in determining the variation in land prices; and the impulse response function can be used to examine the reaction of land price inflation to a monetary innovation.

To construct the variance decompositions and the impulse response functions, the variables in the system must be ordered according to their contemporaneous exogeneity (see Sims (1980)). The following ordering is adopted initially: the call money rate; either the monetary or credit aggregate; business cycle conditions; property prices; and, finally, general inflationary pressures. Later, to check for robustness, the order is changed to see if the empirical results are sensitive to the original ordering of the variables.

The initial ordering of variables is not arbitrary, however. The call money rate is assumed to be the most contemporaneously exogenous variable in

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1/ The parameters are estimated using ordinary least squares, which is in this case the full-information maximum-likelihood estimator. See Appendix for the determination of the lag length.

2/ In a standard VAR, the orthogonal innovations are obtained from the Choleski decomposition of the covariance matrix.

the system because the Bank of Japan uses the call money rate as its operating instrument in the short run. This does not mean that the call money rate is assumed to be unaffected by the other variables in the system, such as business cycle conditions; but innovations in the call money rate in any given quarter affect all of the other variables in the system, whereas innovations in other variables do not affect the call money rate in the same quarter. Innovations in the call money rate are assumed to affect directly the banks' cost of funds, which in turn affects monetary conditions by altering the behavior of financial institutions and their balance sheets. Monetary conditions are represented in the model either by growth on the liability side of the banking system (growth in M2 + CDs) or the asset side of the banking system (growth in private credit). Innovations in both the call money rate and the financial aggregate are then presumed to affect the general condition of the economy, as summarized in the output gap; and innovations in monetary conditions and the output gap are presumed to affect land price inflation, and so on.

2. Empirical Results

Using the estimated VAR parameters, variance decompositions, and impulse response functions, several issues are examined: (1) was there a regime switch in the 1980s compared with the 1970s; (2) what role did monetary factors play in the land price inflation in the 1980s; (3) did the process of consumer price inflation also change; and (4) were the effects of monetary factors more highly concentrated in asset prices, and less concentrated in consumer prices in the 1980s compared with the 1970s.

a. Was There a Regime Switch in the 1980s?

Because of the financial changes that occurred in Japan in the 1980s, it is unlikely that the structure of an estimated model would remain stable during the period 1970-93--this is probably what accounts for the inability of models estimated through 1985 to predict asset prices accurately in the mid- to late 1980s and early 1990s. Unfortunately, it is difficult to construct variables that would allow for precise estimates of the effects of financial liberalization, for example, or changes in the tax treatment of real estate investment.

The alternative strategy followed here is to split the sample into two periods, with the intention of capturing the shift in underlying regimes: one period in which the financial system in Japan was tightly regulated, and a second period in which the financial system had more or less been liberalized. Although it is not possible to determine with precision when the Japanese economy entered the liberalized regime, the shift is treated as having occurred in the period 1982-84, for two reasons. First, although liberalization began well before 1982-84, the full effects of financial liberalization would take some time to take hold. Second, the global economy experienced a prolonged recession in the early 1980s. To prevent these transitional factors from affecting the statistical tests, several breakpoints, beginning in 1983 and ending in 1985, were examined.

By comparing the residuals of the model estimated over the entire sample with those estimated over the various subsamples defined by the breakpoints (that is, by performing likelihood ratio tests) it is possible to test the hypothesis that the model parameters were constant over the entire sample period. The various likelihood ratio tests reject the hypothesis of parameter constancy for all of the alternative sample periods in the 1980s that were tried (see Appendix). For example, when the liberalized regime was assumed to begin in the first quarter of 1984, the *F*-test of a structural break is significant at the 9 percent level when M2 + CDs is used as the financial aggregate and at the 1 percent level when private credit is used as the financial aggregate (see Table 1). As discussed in the next subsection, this evidence of a structural change in the VAR system is supported by empirical evidence provided in the estimated equation for land price inflation and is consistent with the results reported in Samiei and Schinasi (1994). The remainder of this subsection documents the changes in the estimated land price and consumer price inflation equations estimated over two fixed sample periods: the "regulated" regime during 1970:Q1-1983:Q4 and the "liberalized" regime during 1984:Q1-1993:Q4.

To illustrate the nature of the regime switch, Charts 6 and 7 present a comparison of model predictions (static simulations) of land price inflation and consumer price inflation, respectively, using the estimated land price and consumer price equations. The top panel of Chart 6 presents the within-sample predictions of the land price inflation equation when its parameters are estimated in the first period, 1970:Q1-1983:Q4. Despite the wide variation in land price inflation in the regulated regime, the within-sample predictions indicate that the model describes the movement in land price inflation reasonably well in the 1970s. 1/ Using the parameters estimated in the regulated regime, the model's out-of-sample predictions of land price inflation were generated for the liberalized regime, using the actual observations on the explanatory variables, 1984:Q1-1993:Q4, including the lagged dependent variable (see the middle panel). The model estimated in the regulated regime fails to predict land price inflation accurately in the liberalized regime. By contrast, as shown in the bottom panel, the within-sample predictions of the land price inflation equation estimated in the liberalized regime tracks actual land price inflation reasonably well. Note that casual empiricism (see Chart 6) suggests that there was a fairly wide variation in land price inflation in both regimes, suggesting that the structural break is not attributable <u>directly</u> to a shift in the behavior of the land price data.

A similar structural break is apparent in the consumer price inflation time series (see Chart 7). The parameters estimated in the regulated regime describe quite well the within-sample movements in consumer price inflation, but they do not provide an accurate description of consumer price movements

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1/ The next subsection presents dynamic simulations of the land price equation using projected values of the lagged dependent variable.

in the liberalized regime, again suggesting a structural break. The bottom panel of this chart shows that when the model's parameters are re-estimated using the data in the liberalized regime, the model describes consumer price developments reasonably well.

b. The Role of Monetary Factors in Land Price Inflation

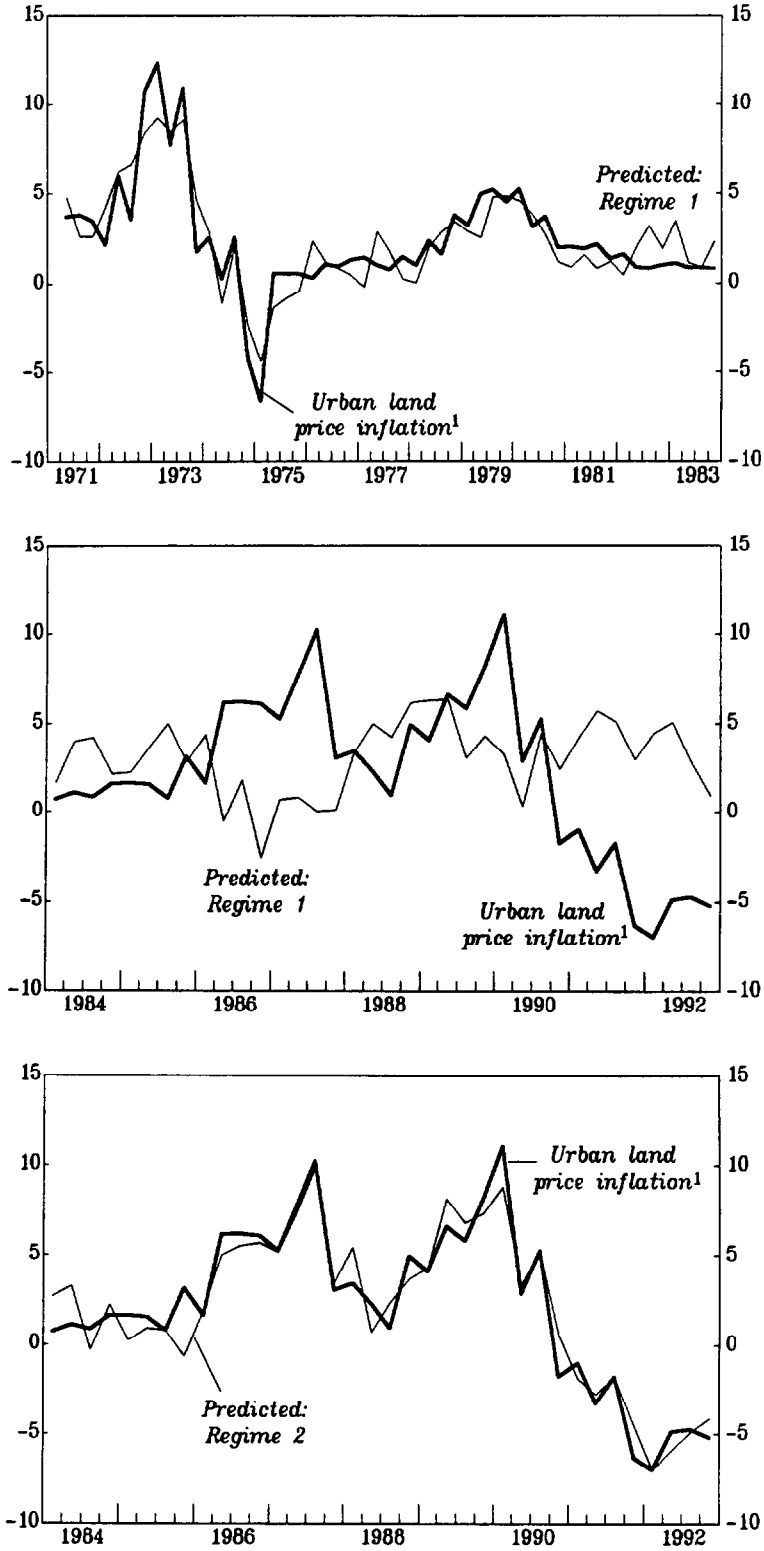
An important feature of the estimated land price equation is that monetary factors (the call money rate and either the money or credit aggregate) together played an important role in the determination of land price inflation; moreover, credit and interest rates together were significantly more important in explaining land price inflation in the 1980s than in the 1970s. This is clear from the marginal significance levels of the estimated coefficients (Tables 2 and 3), from the implied variance decompositions (Tables 4 and 5), and from the estimated impulse response functions (discussed below).

Variance decompositions, which quantify the percentage contribution of each variable to the variation in land price inflation, are shown in Table 4. The share of the variation in land price inflation accounted for by monetary factors increases significantly in the second period, regardless of whether M2 + CDs or private credit is assumed to be the relevant financial aggregate. With M2 + CDs as the financial aggregate, the contribution of monetary factors to the variation in the land price inflation increases from a share of 50 percent in the 1970s to over 80 percent in the 1980s; with total private credit as the financial aggregate, the contribution of monetary factors to the variation in the land price inflation increases from a share of 35 percent in the 1970s to 75 percent in the 1980s. Note that when M2 + CDs is assumed to be the financial aggregate, the contribution of the call money rate becomes negligible in the second period; in contrast, the contribution of the call money rate remains important and increases when credit is assumed to be the financial aggregate. Finally, note that the output gap accounted for almost one-fourth of the variation in land price inflation in the 1970s, regardless of the choice of financial aggregate. In the 1980s, however, the output gap accounted for less than 10 percent of the variation in land price inflation because of the dominance of monetary factors.

Variance decompositions are sensitive to the ordering of the variables according to their presumed exogeneity. One way of examining the robustness of a variable's contribution is to alter the order of the variables. When the monetary variables were placed last in the ordering (that is, assuming that monetary factors were affected by contemporaneous innovations in the other variables), the contribution of M2 + CDs to the variation in land price inflation declined in the 1980s, whereas that of private credit increased substantially in the 1980s (see Table 5). Thus, the contribution of M2 + CDs to the variation in land price inflation in the 1980s is not robust, but that of total private credit is. The changes in the contribution of the call money rate and the output gap noted above in the discussion of the initial ordering of variables are also robust.

Chart 6. Predictions of Land Price Inflation Using Private Credit as the Financial Aggregate

(In percent a quarter)

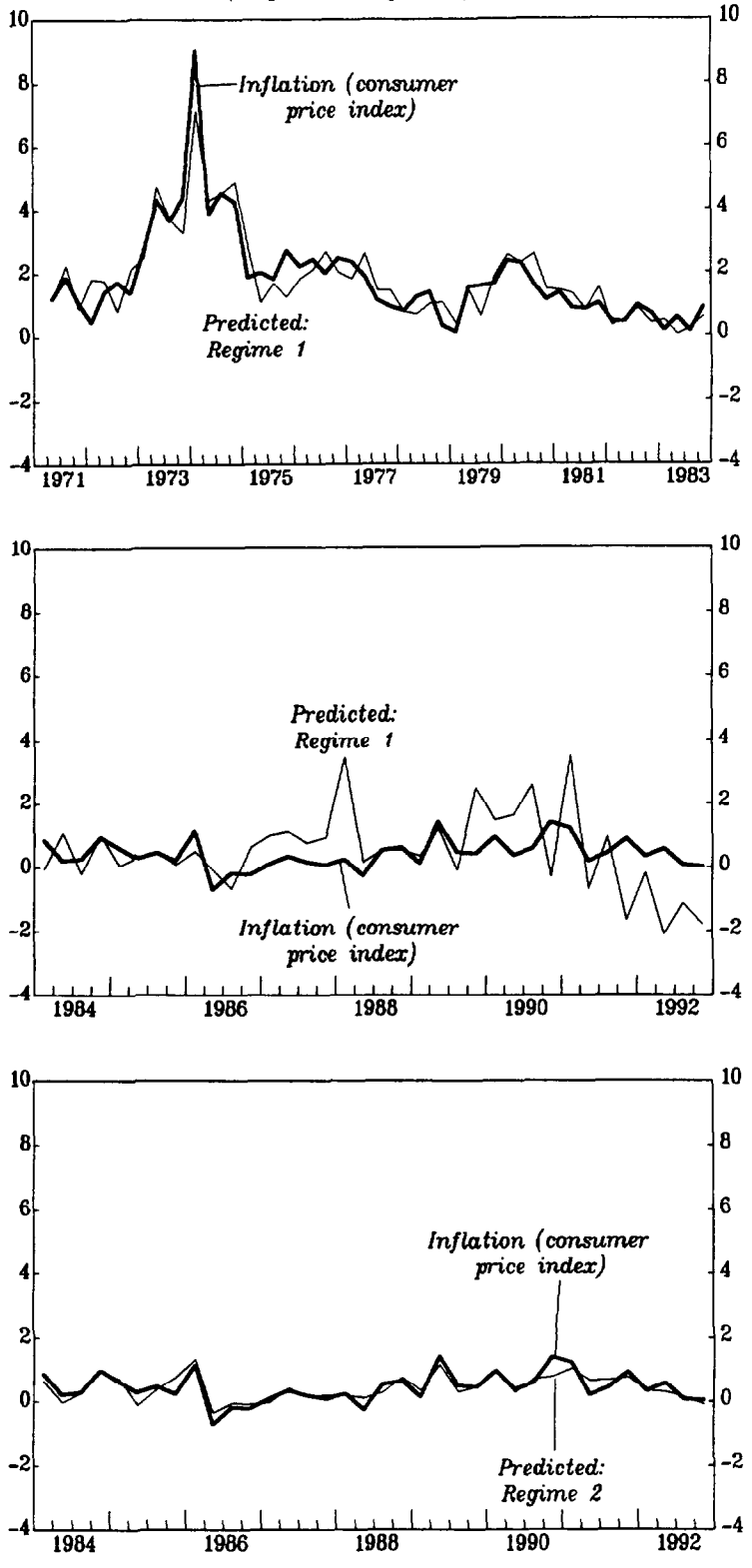


Source: IMF staff calculations.

[1]Urban residential land prices in six largest cities.

Chart 7. Predictions of Consumer Price Inflation Using Private Credit as the Financial Aggregate

(In percent a quarter)



Source: IMF staff calculations.

Table 2. F-Tests for Lagged Values of Explanatory Variables: Broad Money (M2 + CDs)

(Significance levels are in parentheses)

	Land Price Inflation		Consumer Price Inflation	
	1970-83	1984-92	1970-83	1984-92
Call money rate	1.50	0.30	2.10	2.20
	(0.24)	(0.87)	(0.12)	(0.12)
M2 + CDs	7.10	2.60	3.50	1.00
	(0.00)	(0.08)	(0.02)	(0.45)
Output gap	3.20	0.60	0.90	1.10
	(0.03)	(0.69)	(0.47)	(0.40)
Land price inflation	0.60	1.90	1.20	0.20
	(0.69)	(0.17)	(0.35)	(0.93)
Consumer price inflation	2.60	1.10	3.60	1.40
	(0.06)	(0.39)	(0.02)	(0.29)
Memorandum				
R^2 (coefficient of determination)	0.88	0.88	0.87	0.65
$\bar{R}^2$ (adjusted $\bar{R}^2$)	0.77	0.69	0.76	0.12
Observations	51.00	39.00	51.00	39.00
Degrees of freedom	27.00	15.00	27.00	15.00
Standard error	1.50	2.60	0.75	0.43

Source: IMF staff calculations.

Table 3. F-Tests for Lagged Values of Explanatory Variables: Credit Consistent with National Accounts

(Significance levels are in parentheses)

	Land Price Inflation		Consumer Price Inflation	
	1970-83	1984-92	1970-83	1984-92
Call money rate	0.70	1.20	0.80	2.60
	(0.60)	(0.35)	(0.53)	(0.09)
Private credit	2.10	5.40	2.60	2.90
	(0.11)	(0.01)	(0.06)	(0.07)
Output gap	2.20	1.20	1.60	1.90
	(0.10)	(0.34)	(0.21)	(0.17)
Land price inflation	0.30	1.80	1.90	1.00
	(0.86)	(0.18)	(0.13)	(0.46)
Consumer price inflation	1.40	2.90	5.40	2.70
	(0.27)	(0.07)	(0.00)	(0.08)
Memorandum				
R^2 (coefficient of determination)	0.88	0.95	0.94	0.91
$\bar{R}^2$ (adjusted)	0.64	0.80	0.74	0.53
Observations	51.00	36.00	51.00	36.00
Degrees of freedom	27.00	12.00	27.00	12.00
Standard error	1.90	2.00	0.79	0.47

Source: IMF staff calculations.

Table 4. Variance Decompositions for the Land Price and Consumer Price Equations: Monetary Variables First in the Ordering

(Percent of total variance) 1/

	Interest Rate	M2+CDs	Output Gap	Land Price	Consumer Prices	Monetary Combined
Land price equation						
First period	19	30	22	18	10	50
Second period	3	80	6	4	8	83
Consumer price equation						
First period	12	38	13	9	27	50
Second period	27	38	10	2	24	64

	Interest Rate	Credit	Output Gap	Land Price	Consumer Prices	Monetary Combined
Land price equation						
First period	22	14	23	28	13	35
Second period	27	48	8	11	6	75
Consumer price equation						
First period	18	15	14	16	36	34
Second period	25	35	19	10	12	60

Source: IMF staff calculations.

1/ Percent of the total variance at the twentieth quarter (that is, in the long run).

Table 5. Variance Decompositions for the Land Price and Consumer Price Equations: Monetary Variables Last in the Ordering

(Percent of total variance) 1/

	Output Gap	Land Price	Consumer Prices	Interest Rate	M2+CDs	Monetary Combined
Land price equation						
First period	13	22	12	25	28	53
Second period	3	38	37	3	19	22
Consumer price equation						
First period	9	13	31	16	32	48
Second period	12	22	48	8	10	18

	Output Gap	Land Price	Consumer Prices	Interest Rate	Credit	Monetary Combined
Land price equation						
First period	20	31	20	18	10	28
Second period	15	13	13	26	33	59
Consumer price equation						
First period	10	19	43	14	15	28
Second period	29	9	18	17	27	45

Source: IMF staff calculations.

1/ Percent of the total variance at the twentieth quarter (that is, in the long run).

One interpretation of the estimated land price equations is that there was a change in the transmission of monetary factors to real estate markets in the 1980s. Under this interpretation, the change in the transmission process led to two important structural changes: first, bank credit (bank assets) played a more important role in the 1980s than in the 1970s; second, bank credit played a more important role in determining land price inflation than did bank deposits (bank liabilities). This may imply that bank credit became a more important indicator of inflationary pressures in the 1980s. If this structural change is sustained, it will have important implications for the conduct of monetary policy in the 1990s.

To assess further the relative importance of the transmission processes of money versus credit, and to examine how well the estimated equations track the actual path of land price inflation in the 1980s, Chart 8 presents dynamic simulations of the land price equation using M2 + CDs as the financial aggregate, and Chart 9 presents dynamic simulations for the model using total private credit as the financial aggregate. The lines labeled "regime 1" represent the dynamic simulation of the model when the parameters are estimated over the regulated regime, and the lines labeled "regime 2" represent the dynamic simulation of the model when the parameters are estimated in the liberalized regime.

The simulations are "dynamic" in the sense that the path of inflation is simulated using the forecasted values of the lagged dependent variable, but actual data are used for the other explanatory variables. 1/ These dynamic simulations provide information about whether the land price inflation could have been accurately forecasted by the model had the evolution of the monetary policy variables and the output gap been known.

As the charts show, regardless of the financial aggregate used for estimation, the parameters estimated using data in the liberalized regime perform very well and are significantly better than the parameters estimated using data in the regulated regime. Indeed, the simulations of regime 1 in each case suggest that fundamental macroeconomic variables could not explain very well the land price inflation--implying that it might be a "bubble." Also note that, although growth in M2 + CDs performs reasonably well as a

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1/ These simulations use actual data for nonprice variables (the call money rate, the financial aggregate (either M2 + CDs or private credit), and the output gap), but projected values for the lagged price variables. To examine the explanatory power of the lagged dependent variable, the simulation was run assuming coefficients of zero on lagged values of land price inflation. For the equation using total private credit, the only difference in the simulation was that land prices overshot the peak for about two quarters--and by about 10-15 percent--and then turned downward and followed a path parallel to the one presented in Chart 9; this is what is suggested by the variance decompositions presented in Tables 4 and 5, in which the contribution of lagged values in land price inflation to the total variation of land price inflation was less than 10 percent.

financial aggregate, growth in total private credit clearly dominates the monetary aggregate, which confirms the information contained in the variance decompositions. 1/

c. The Consumer Price Inflation Equation

An important additional manifestation of the apparent regime shift was a breakdown in the 1980s in the relationship between consumer price inflation and the other variables in the estimated system. In the 1970s, lagged values of M2 + CDs, consumer prices, and the call money rate were fairly important variables in the estimated consumer price inflation equation, and these determinants together explained a very high share of the overall variation of consumer price inflation in the first subsample period. In the 1980s, however, these marginal contributions declined, and the explanatory variables together have very little explanatory power--as represented by the adjusted coefficient of determination, $\bar{R}^2$.

In contrast, when private credit is used as the financial aggregate, the marginal significance of lagged values of private credit and the call money rate improve, and that of lagged values of consumer price inflation declines. In addition, with private credit as the aggregate, the marginal significance of the output gap is greater than when broad money is the financial aggregate. Overall, the equation with private credit holds up fairly well, and monetary factors (the call money rate and private credit) were more important in determining goods-price inflation in the 1980s than in the 1970s. 2/

As discussed earlier, the hypothesis that there was a structural break in the early to mid-1980s in the model is illustrated by the static simulations of the consumer price inflation equation (see Chart 7). Chart 10 shows two dynamic simulations for consumer prices. The line labeled "regime 1" represents a dynamic simulation of the consumer price inflation equation using coefficients estimated in the regulated data regime, whereas "regime 2" uses the model coefficients estimated using the data in the liberalized data regime. These simulations clearly show that,

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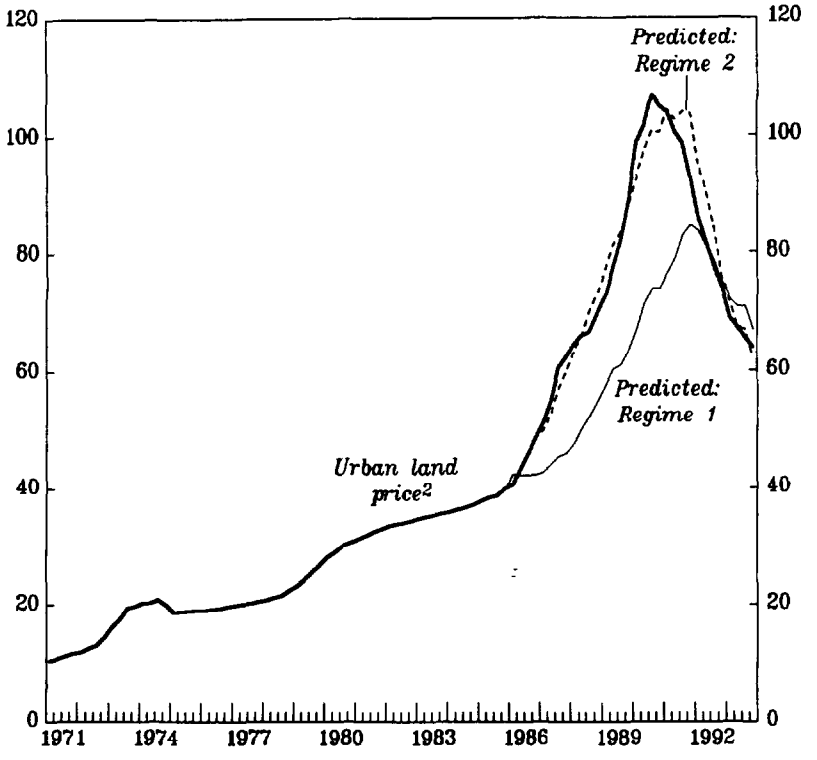
1/ When full dynamic simulations are run--that is, using the estimated forecasted values of all of the explanatory variables, including estimated values of r, m, y, π_L, and π--the models do not perform very well. But as the "dynamic" simulations show, this is largely because of the errors in forecasting r, m, and y.

2/ When the five-equation system was expanded to include the exchange rate as a third monetary factor, the land price equation was qualitatively unaffected; in addition, lagged values of the exchange rate made a statistically significant marginal contribution, the call money rate and the financial aggregate remained significant, and the overall fit improved. Regarding the estimated consumer price equation, the most important difference was that the contribution of monetary factors to the variation in consumer price inflation increased.

Chart 8. Dynamic Simulations Using Two-Equation Subsystem and M2 + CDs as the Financial Aggregate [1]

(Index, 1990:Q1 = 100)



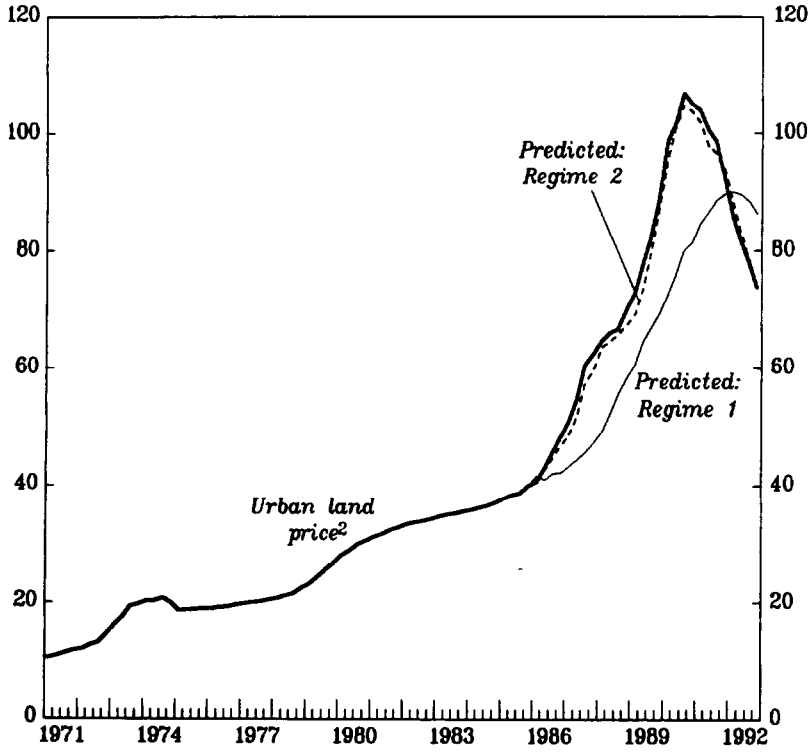
Source: IMF staff calculations.

[1]Using estimated land price and consumer price equations from estimates of the five-equation system.

[2]Urban residential land prices in six largest cities.

Chart 9. Dynamic Simulations Using Two-Equation Subsystem and Private Credit as the Financial Aggregate[1]

(Index, 1990:Q1 = 100)



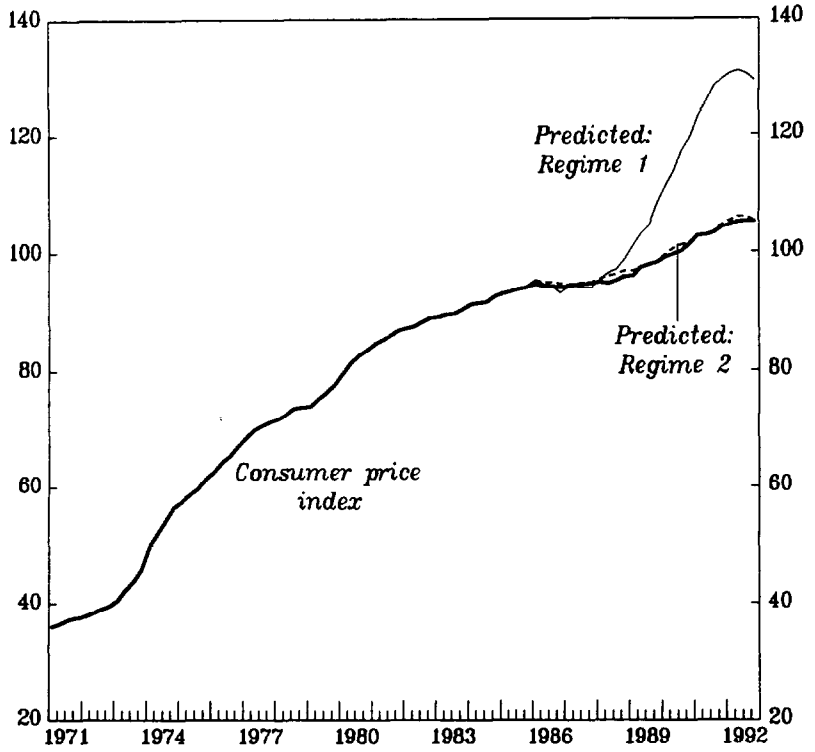
Source: IMF staff calculations.

[1]Using estimated land price and consumer price equations from estimates of the five-equation system.

[2]Urban residential land prices in six largest cities.

Chart 10. Dynamic Simulations Using Two-Equation Subsystem and Private Credit as the Financial Aggregate[1]

(Index, 1990 = 100)



Source: IMF staff calculations.

[1]Using estimated land price and consumer price equations from estimates of the five-equation system.

given the actual evolution of the call money rate, credit growth, and the output gap, the model estimated over the regulated regime would predict greater inflation on average than either the model estimated over the liberalized data regime or actual consumer price developments.

d. The Concentration of Monetary Shocks in Land Prices

Taken together, the "dynamic" simulations for both price equations suggest that the concentration hypothesis discussed earlier cannot easily be rejected. The five-equation model estimated over the liberalized data regime clearly suggests that the actual evolution of monetary variables in the mid- to late 1980s led to more land price inflation and less consumer price inflation than would have been predicted by the model estimated over the regulated regime.

These results imply that a money or credit shock to the equation system would lead to a concentration of inflationary pressure in land prices and not in goods prices in the liberalized data regime compared with the regulated data regime. This can be examined directly by examining the impulse response functions implicit in the estimated land price and consumer price inflation equations. The response of land price inflation and consumer price inflation to both a monetary and credit shock are shown in Charts 11 and 12, respectively. The impulse response functions suggest that both monetary and credit shocks were more heavily concentrated in asset markets than in goods markets in the liberalized regime than they were in the regulated regime.

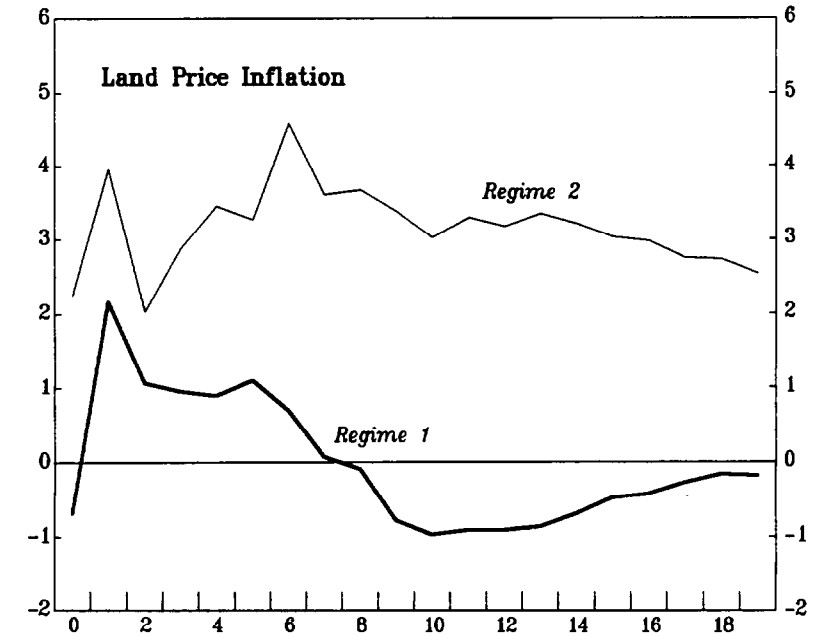
IV. Conclusions

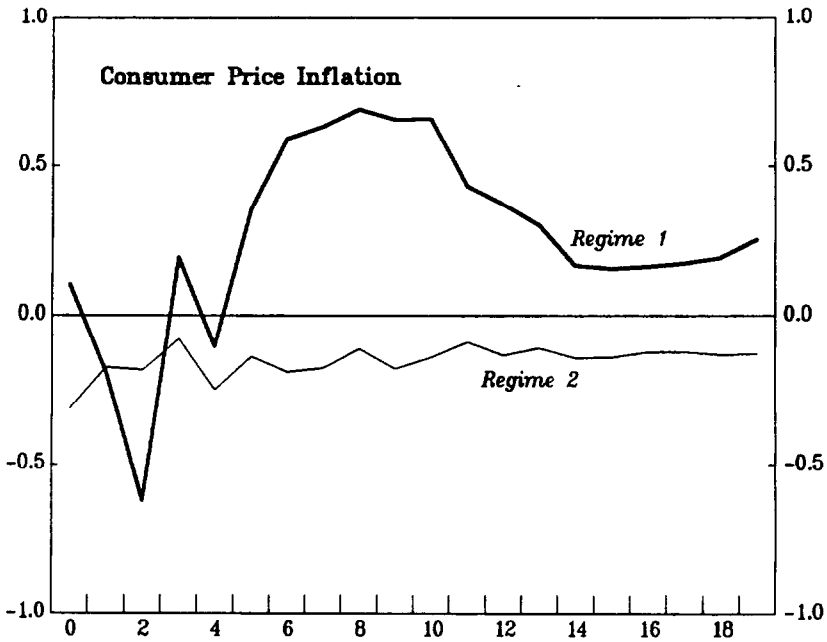
An important conclusion to be drawn from the preceding analyses is that movements in land price inflation in Japan in the 1980s can be explained quite well by a relatively unrestricted multi-equation model that includes monetary factors, the output gap, and consumer price inflation--with monetary factors being most important. A second important conclusion is that the hypothesis that there was no regime switch in the period 1970-93 is strongly rejected by the data. Specifically, a feature of the estimated system of equations is that the dynamic forces that determined land price and consumer price inflation were quite different in the period 1970-83 from those in 1984-93: in the second period there was a sizable increase--a doubling--in the contribution of monetary factors to the variation in land price inflation; and both land price and consumer price inflation in the second period were more affected by total private credit than by M2 + CDs. In addition, the view that "inflationary pressures" in the 1980s were highly concentrated in asset prices is broadly supported by the estimated model; a "monetary shock" (or a "credit shock") leads to more land price inflation and to less consumer price inflation when the model is simulated using parameters estimated over the period 1984-93 than when the parameters are estimated over the period 1970-83. Thus, a key conclusion of this paper is that while monetary expansion typically led to consumer price inflation

before the mid-1980s, it has since tended to manifest itself in asset price inflation, because of structural changes.

In sum, the empirical results suggest that financial deregulation, which took place in the late 1970s and throughout the 1980s, had an important influence in redirecting the influence of monetary factors toward asset markets.

Chart 11. Impulse Response to M2 + CDs[1]

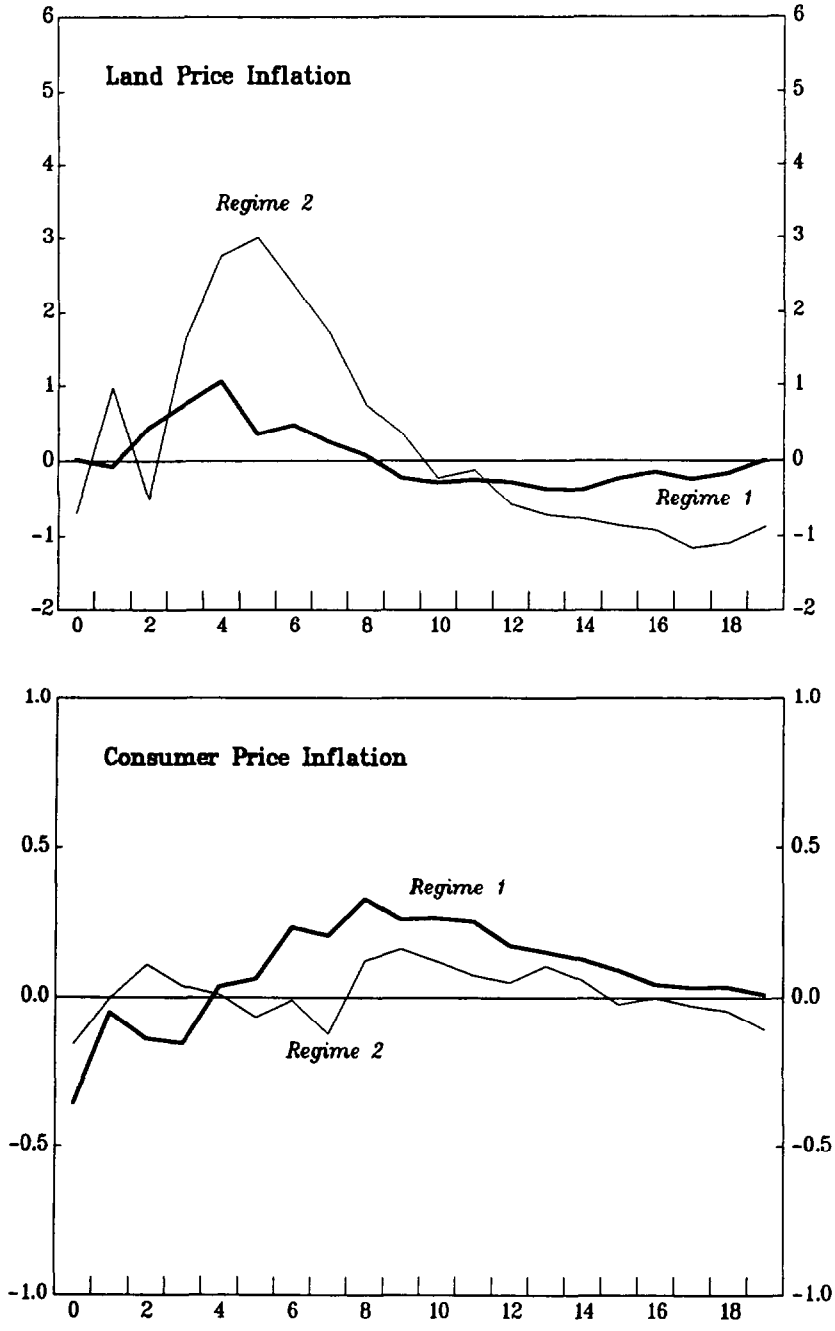




Source: IMF staff calculations.

[1]Impulse responses have been normalized by monetary shock. Thus, a response of 1.0 means that the variable responds 1.0 times the standard error of the innovation.

Chart 12. Impulse Response to Private Credit[1]



Source: IMF staff calculations.

[1]Impulse responses have been normalized by credit shock. Thus, a response of 1.0 means that the variable responds 1.0 times the standard error of the innovation.

Vector-Autoregression Modeling

This appendix consists of three brief sections that deal with: the time-series properties of the data; the number of lags to include in the VAR model; and evidence of a structural break in the model.

1. Time Series Properties

Before estimating the VAR model, the time-series properties of the different variables were examined to ensure efficient estimation. Standard unit root tests were used to determine the time-series properties of the variables. These unit root tests suggest that all the variables are stationary (Table A1).

The number of lags included in these tests was chosen by "testing down" for the highest significant lag. Monte Carlo simulations suggest that this selection mechanism will choose the correct number of lags as the number of observations increases (see Campbell and Perron (1991)).

The augmented Dickey-Fuller and the Phillips-Perron tests reject the presence of a unit root for all variables except for land inflation and relative land inflation. Two possible reasons can explain why these tests failed to reject the null hypothesis of a unit root for land inflation and relative land inflation. First, it is well known that these tests have low power to discriminate between a moderately high persistent series and a true unit root. Second, the tests could fail to recognize a stationary series when the series contains a break, as is the case with land price series.

2. Lag Length

Following Lütkepohl (1985), we have calculated the Hannan-Quinn and Schwarz test for four VAR models (Table A2). The first two models use M2 + CDs as the monetary aggregate, one with the land price inflation and the other with relative land price inflation. The third and fourth models use credit as the monetary aggregate, one with land price inflation and the other with relative land price inflation.

The tests suggest that four lags are appropriate for all models except the model with credit and land inflation, where three lags are selected. However, for consistency in the degrees of freedom, we have chosen to estimate all four models with four lags.

3. Structural Breaks

To test for a structural break in the VAR model, log-likelihood ratio tests were performed. The 120 coefficients ((5 equations × 5 variables × 4 lags) + (4 seasonal dummies × 5 equations)) of the unconstrained model were estimated over two different subsamples, while the coefficients of the constrained model were not allowed to vary and were estimated over the entire sample.

Table A1. Unit Root Tests

Series	ADF 1/	PP 2/	Critical Values 3/ 5 percent	10 percent
Output gap	-3.15	-3.14	-3.29	-3.03
M2+CDs	-2.87	-2.92	-3.29	-3.03
Credit	-1.58	-3.24	-3.29	-3.03
Interest rate	-3.75	-2.41	-3.29	-3.03
Inflation	-2.32	-3.58	-3.29	-3.03
Land inflation	-2.14	-2.97	-3.29	-3.03
Relative land inflation	-2.34	-2.71	-3.29	-3.03

1/ Augmented Dickey-Fuller test.
2/ Phillips-Perron test.
3/ Taken from Gilkey and Schmidt (1989), Table 1 (n = 100).

Table A2. Lag Length Tests 1/

Lag	Land Inflation (1)	Land Inflation (2)	Relative Land Inflation (1)	Relative Land Inflation (2)
		M2 + CD's		
1	58.01	57.61	60.26	59.85
2	58.11	57.29	57.15	56.33
3	58.50	57.26	58.99	57.76
4	56.46*	54.82*	55.34*	53.68*
5	61.95	59.87	59.87	57.78
6	62.27	59.74	59.40	56.88
7	60.20	57.24	60.45	57.49
8	64.22	60.81	65.27	61.86
		Credit		
1	61.29	60.88	59.84	59.43
2	58.27	57.45	57.45	56.64
3	55.28*	54.04*	60.60	59.37
4	61.30	59.64	56.46*	54.80*
5	56.95	54.86	57.73	55.65
6	59.47	56.95	60.12	57.60
7	58.30	55.34	61.56	58.60
8	65.15	61.73	63.05	59.64

1/ (1) and (2) correspond to the Hannan-Quinn and Schwarz tests; an asterisk (*) denotes the lag length selected.

Two VAR models were tested for structural breaks (Table A3). The first model uses M2 + CDs as the monetary aggregate, while the second uses credit; both use land inflation as the asset price. The test results find statistically significant evidence to support the hypothesis that there was a break in the model in the early 1980s.

Table A3. Likelihood Ratio Tests for Structural Breaks

	System with M2 + CDs		System with Credit	
Break	χ^2	Marginal significance	χ^2	Marginal significance
1982:Q4	150.43	0.03	185.29	--
1983:Q1	144.20	0.07	179.35	--
1983:Q2	144.37	0.06	171.03	--
1983:Q3	143.19	0.07	171.16	--
1983:Q4	141.16	0.09	173.03	--
1984:Q1	141.61	0.09	175.26	--
1984:Q2	139.33	0.11	182.55	--
1984:Q3	140.78	0.09	183.24	--
1984:Q4	141.08	0.09	188.88	--
1985:Q1	145.03	0.06	193.49	--
1985:Q2	148.49	0.04	202.04	--
1985:Q3	146.60	0.05	204.94	--
1985:Q4	160.67	--	215.47	--

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