

Volatility in Japanese financial asset prices: causes, effects and policy implications¹

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Introduction

Financial asset prices in Japan, as in many other countries, have shown wide fluctuations in recent years. Some week-to-week, or even month-to-month, fluctuations are to be expected from the very nature of financial asset prices, but large and persistent waves have also been observed on many occasions. This raises a number of issues, calling into question the validity of the efficient market hypothesis: (a) Are these fluctuations only a reflection of wide swings in the fundamentals themselves, e.g. long-run growth and inflation prospects? (b) If not, what are the factors behind this volatility? (c) Has the volatility affected real economic activity, aggravating economic cycles? (d) Are there policy implications to be drawn from the recent experiences?

In addressing these issues, this paper first tries to measure the volatility we have witnessed in stock and bond markets using decomposition analyses (Section 1). It then analyses the background to this volatility (Section 2), and goes on to see whether it has affected real economic activity, and if so how (Section 3). Some policy implications are discussed in the final section.

1. Decompositions approach to financial market volatility

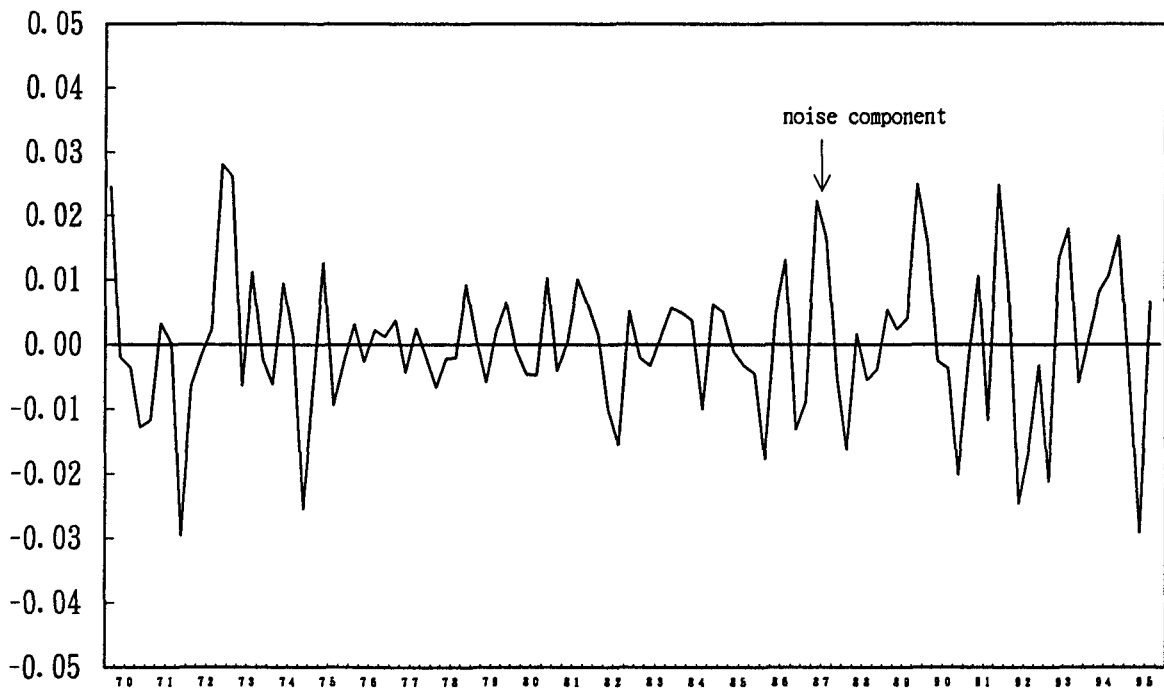
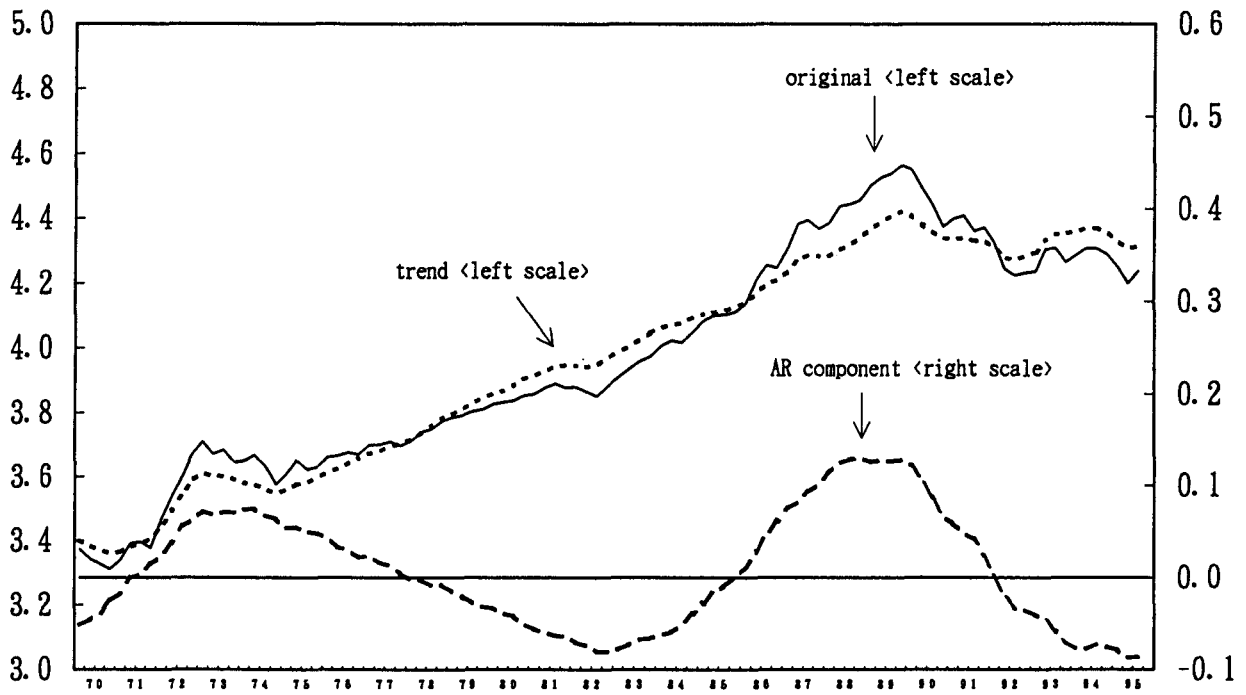
Many attempts have been made to determine whether there has been pure financial volatility - volatility in financial prices which is not related to fluctuations in real variables. They typically depended on certain models using some fundamental variables, and thus tended to be subject to criticism concerning specification or the choice of underlying theoretical models. In order to circumvent this problem, this paper employs a different approach: historical movements of financial prices and certain economic variables are decomposed into four components, namely, time-trend, cyclical (autoregressive <AR> component), seasonal, and noise components, without specifying the relationship between any sets of variables. The time-trend is assumed to be non-linear and smoothly varying. (For the detailed explanation of this methodology, see Appendix).

Decomposed components of major financial, real economic and price variables, except seasonal components, are shown in Charts 1 through 9. The stock price index and real economic and price variables were transformed into a logarithm form before the exercise. Some interesting features emerge from these decompositions:

- (i) The stock price index had an almost linear upward trend until the end of the 1980s, when it kinked and became flat (Chart 1). Its cyclical component shows large swings, as expected, and the swing since the mid-1980s has been particularly large. Its noise component also has become large since the late 1980s, after being relatively small in the late 1970s and early 1980s. Stock prices have indeed become more volatile.
- (ii) Long-term interest rates show a downward time-trend after the early 1980s, probably reflecting a gradual but persistent deceleration of inflation (Chart 2). The cyclical component of long-term interest rates indicates shorter swings than that of the stock price

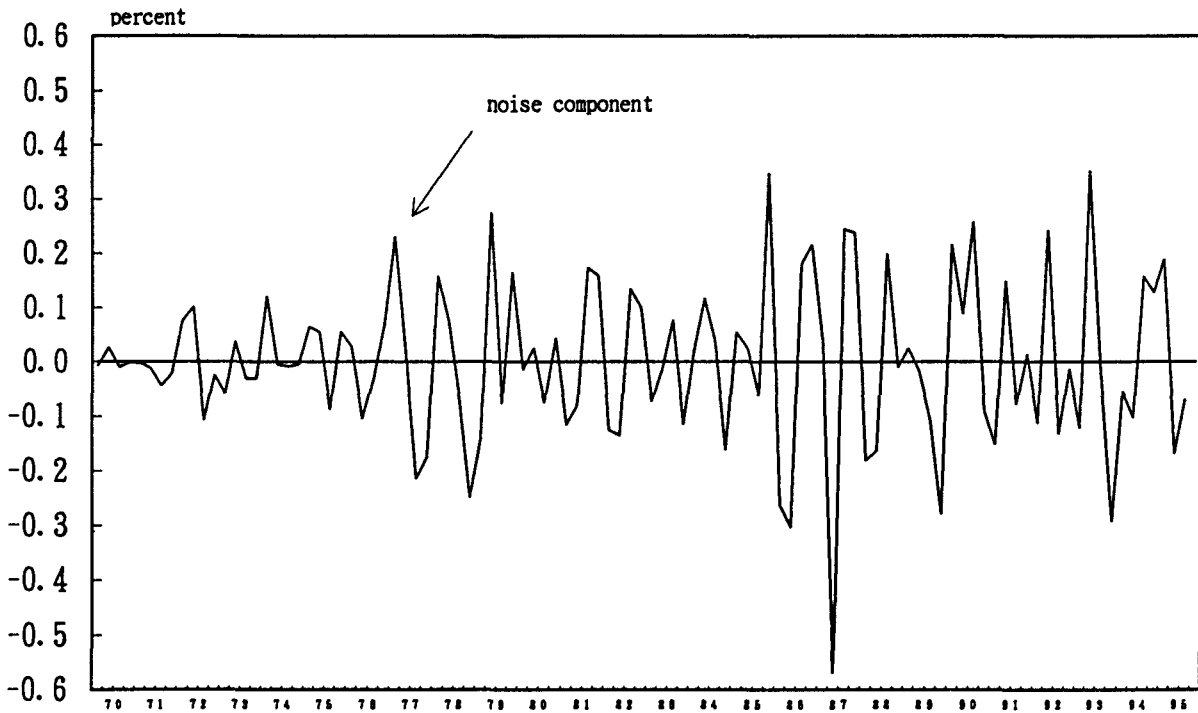
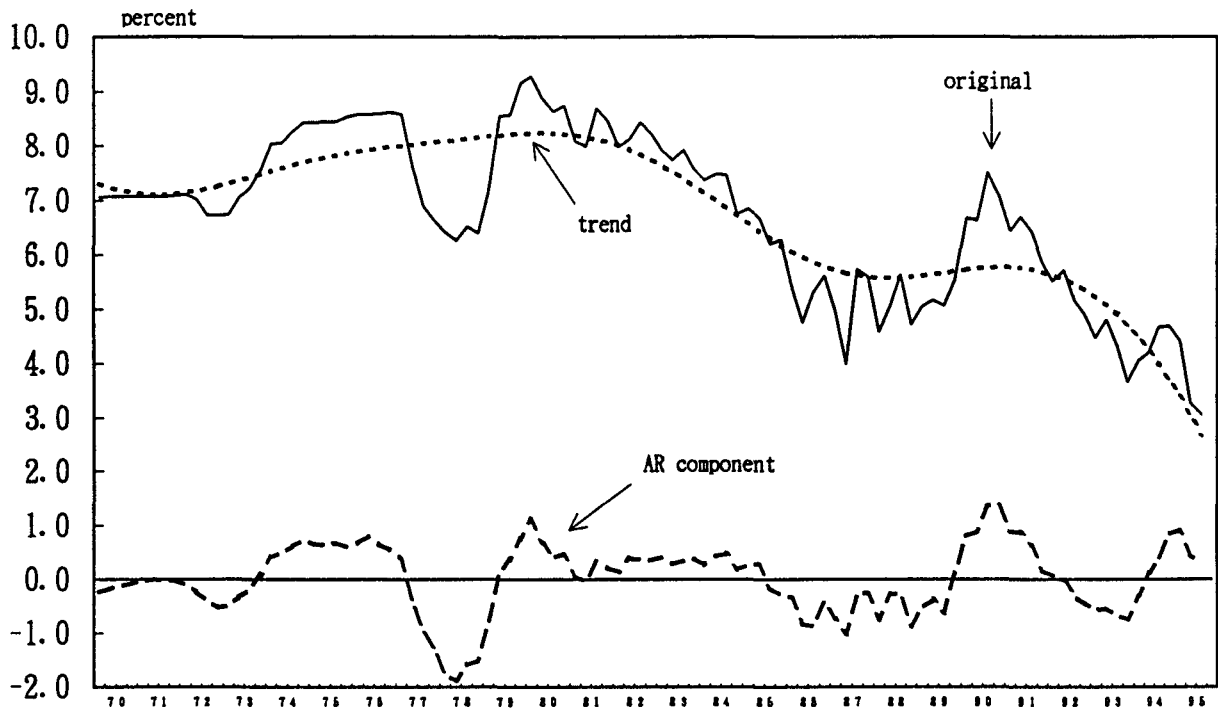
¹ Views expressed in this paper are those of the authors and do not necessarily reflect those of the Bank of Japan. The authors also thank Hideaki Shimizu for his support in empirical works.

Chart 1
Decomposition of the stock price index



Note: Original = log of Nikkei average index.

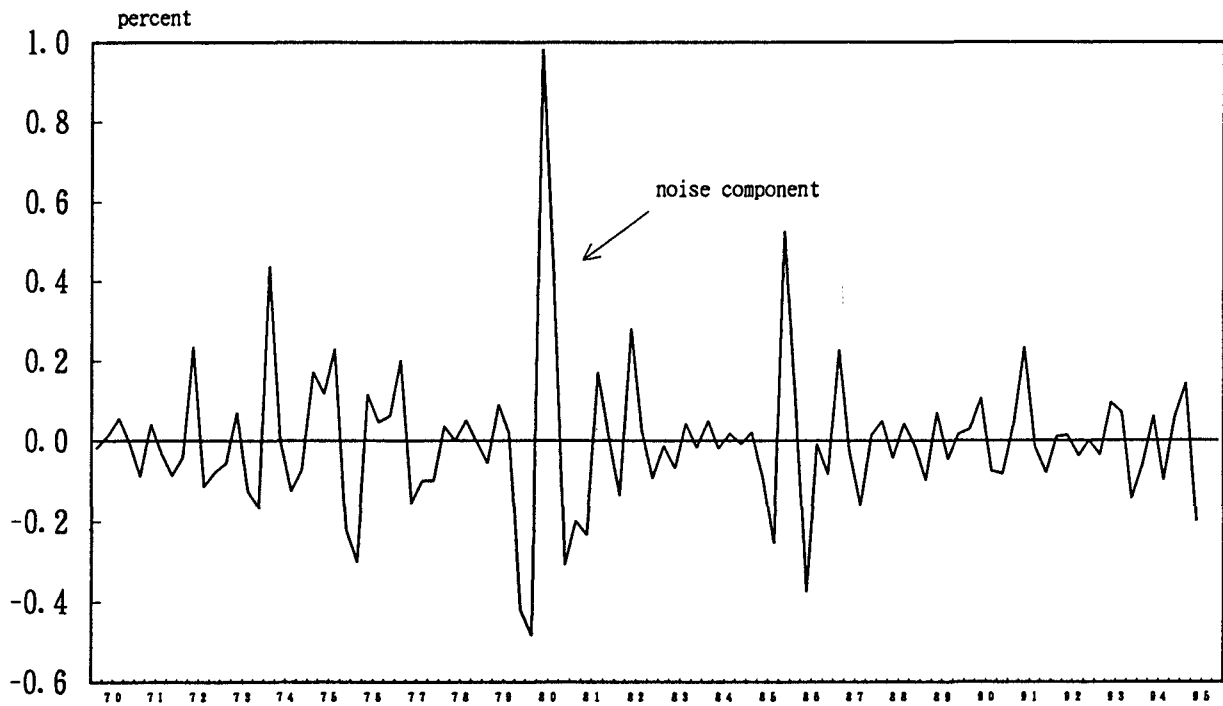
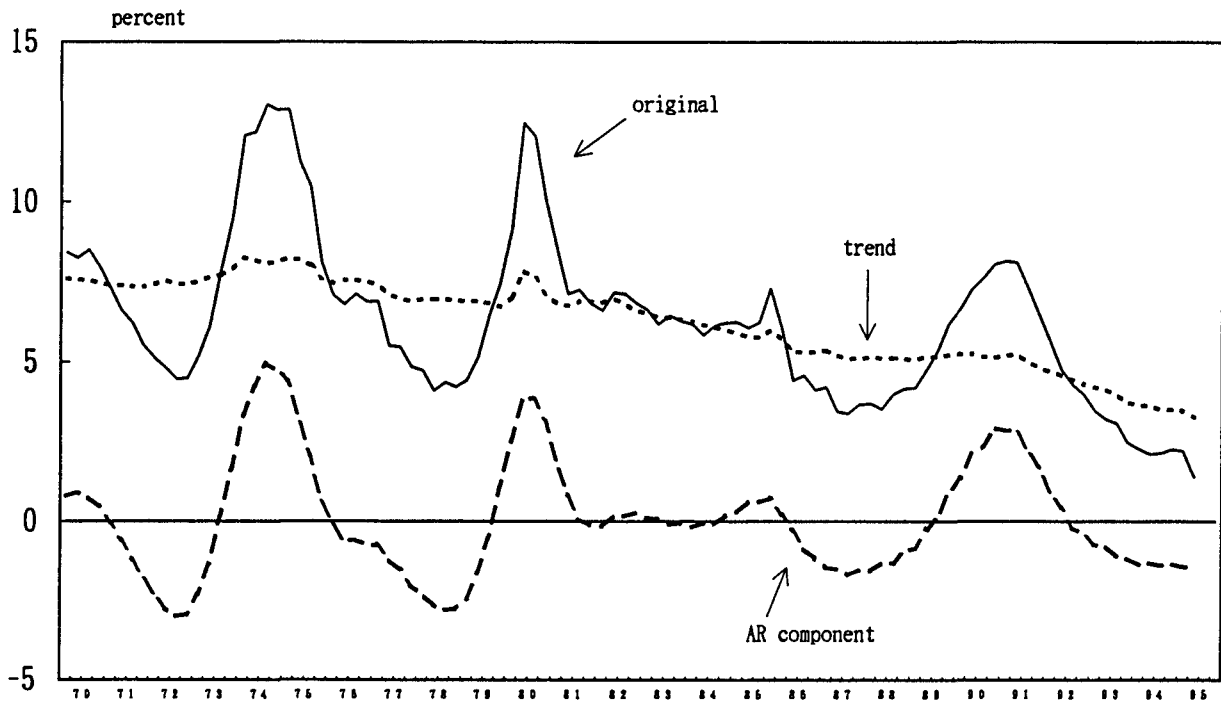
Chart 2
Decomposition of the long-term interest rate



Note: Original = ten-year government bond yields.

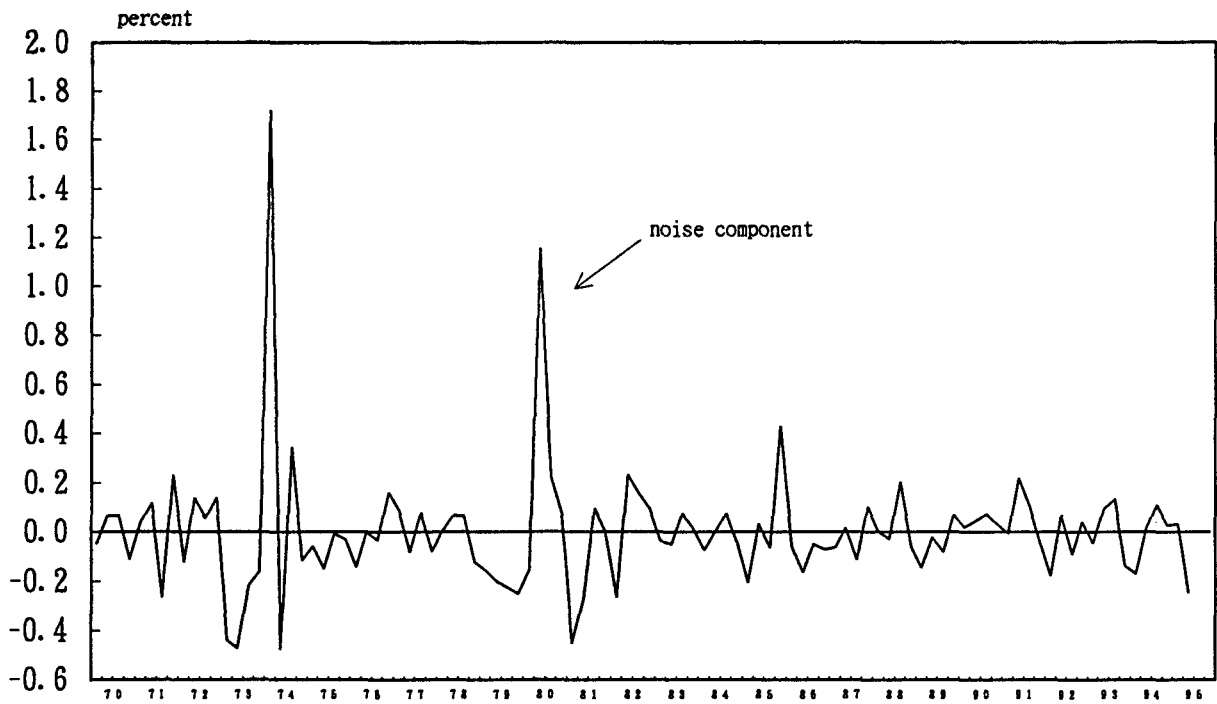
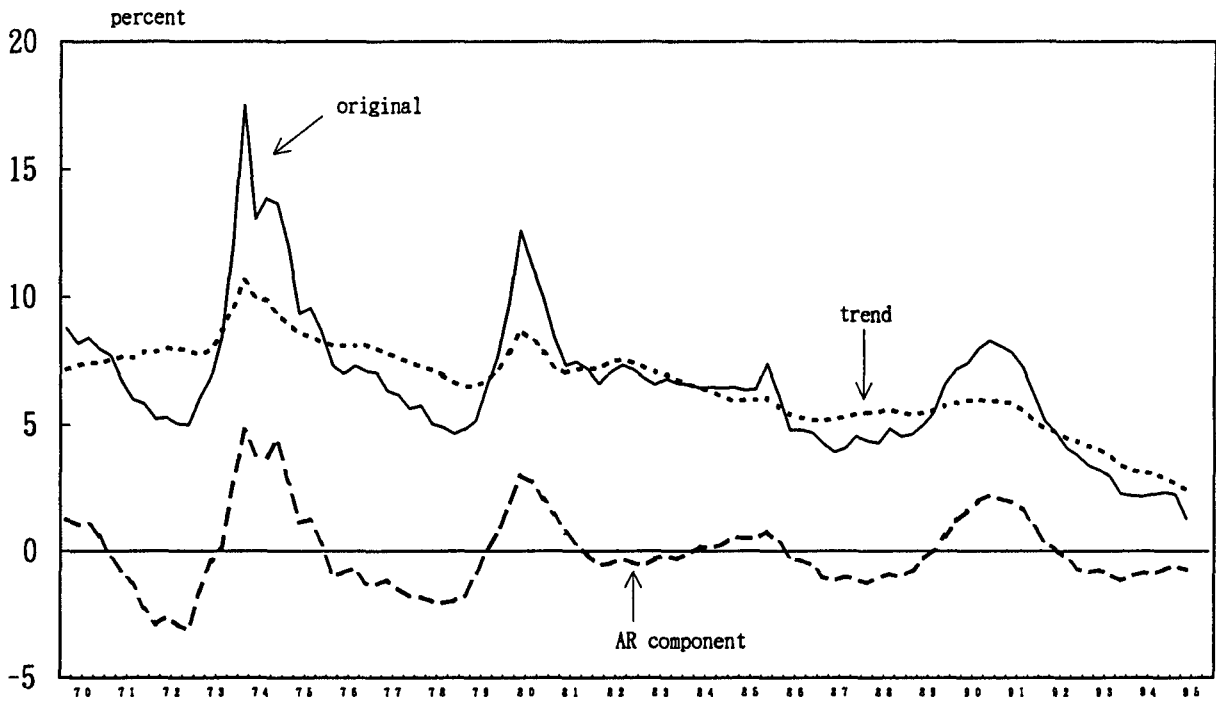
Chart 3

Decomposition of the overnight call rate



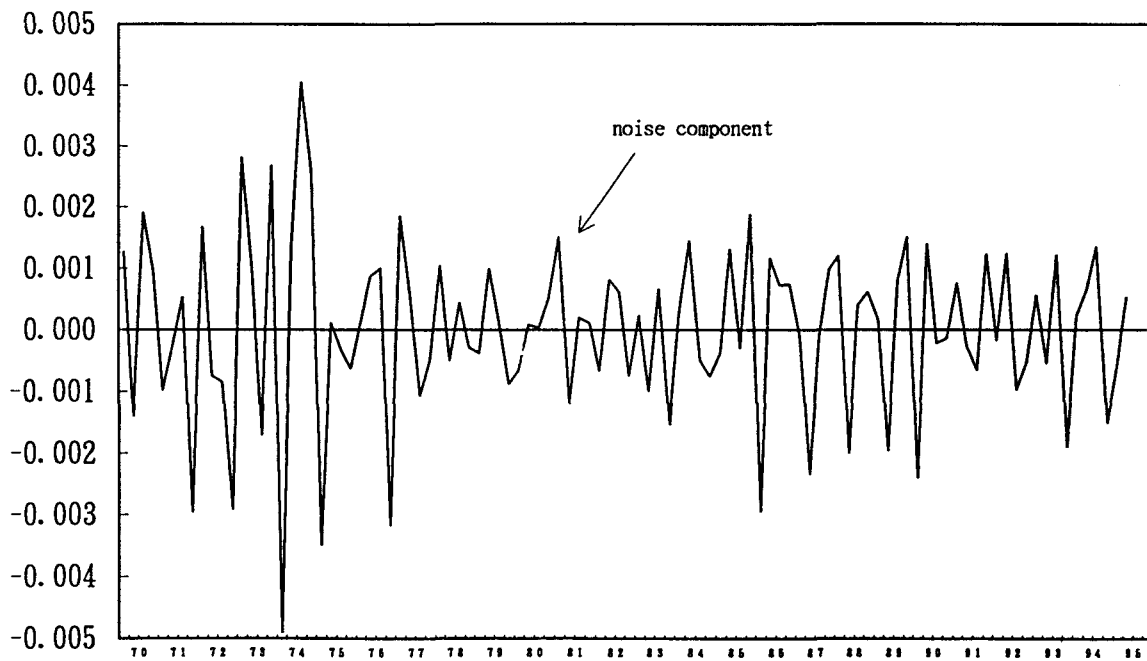
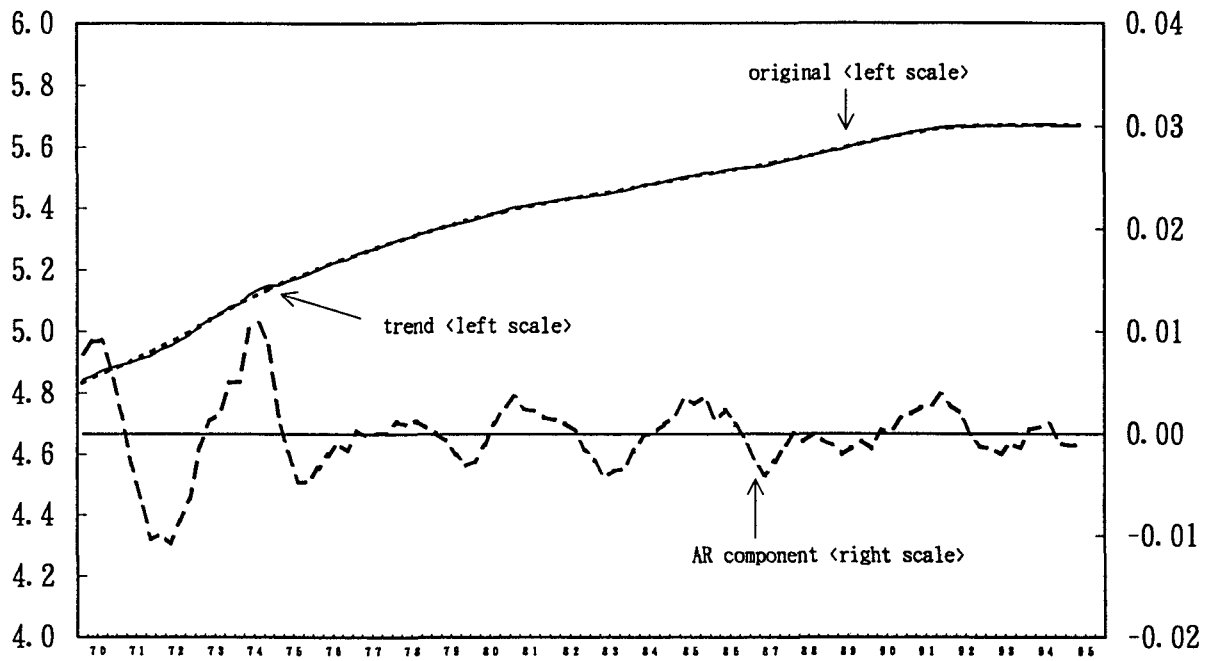
Note: Original = uncollateralised overnight call rate (collateralised overnight call rate prior to the first quarter 1987).

Chart 4
Decomposition of the three-month interest rate



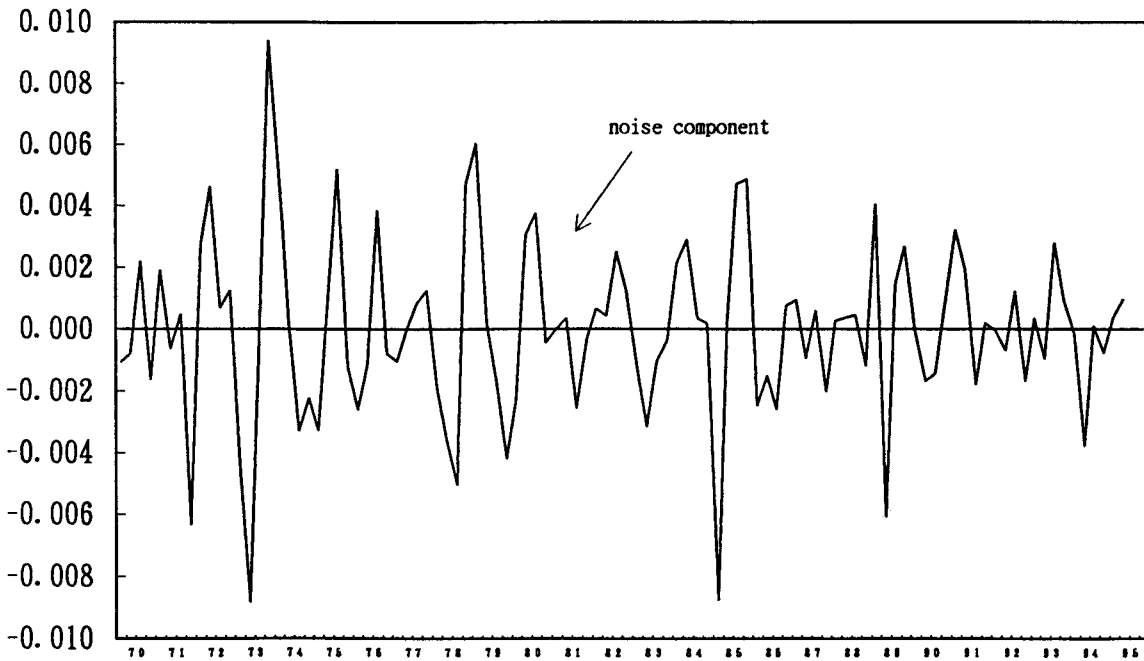
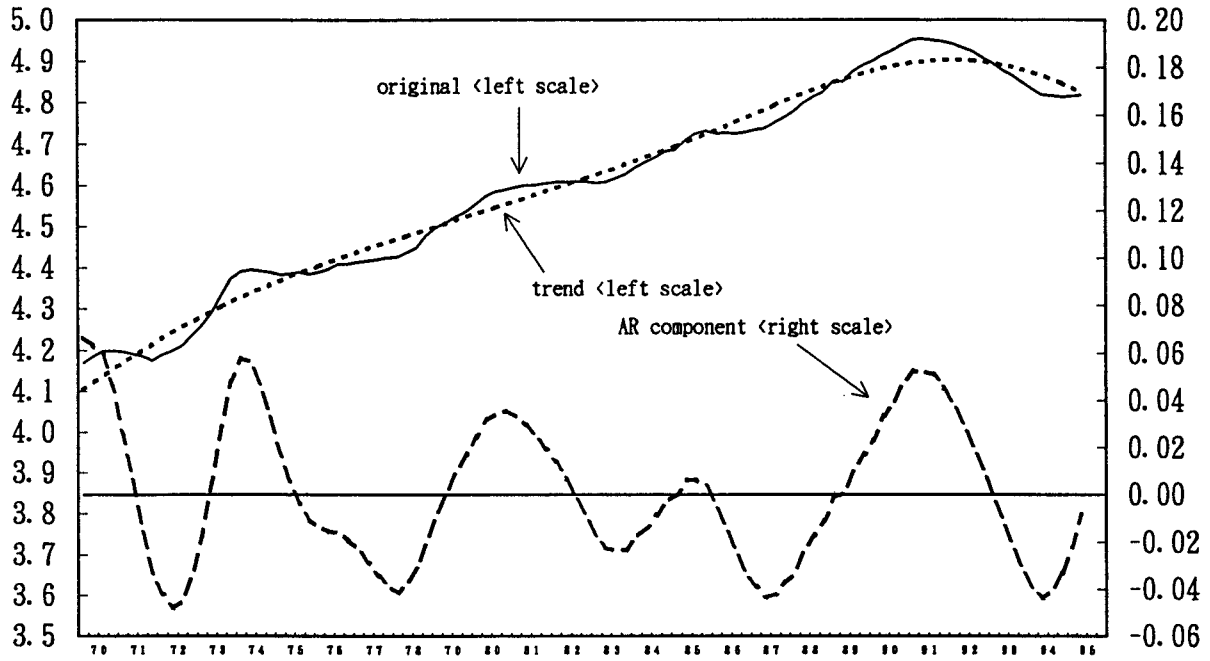
Note: CD rate (Gensaki (repo) rate prior to the third quarter 1979).

Chart 5
Decomposition of nominal GDP



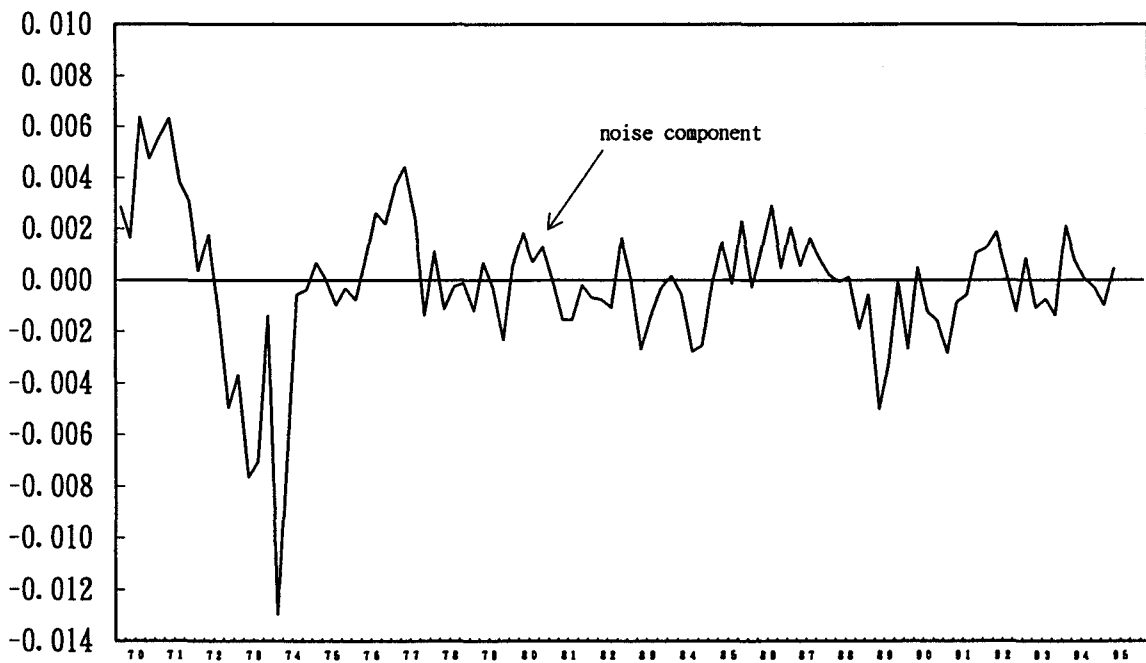
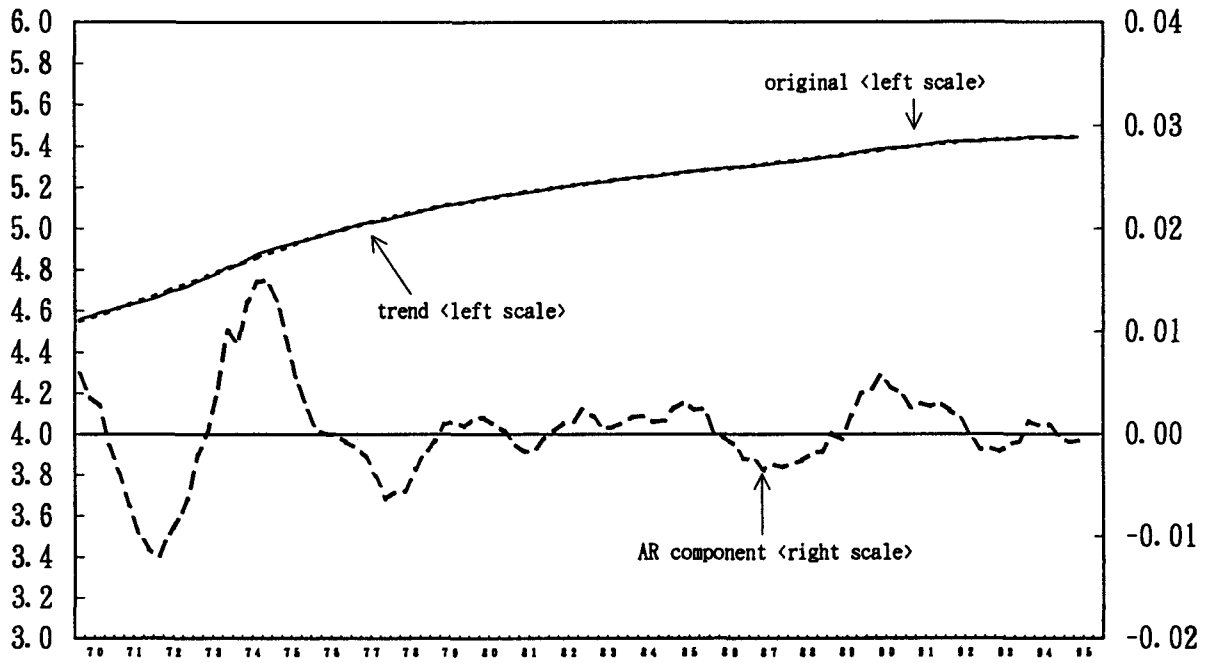
Note: Original = log of nominal GDP.

Chart 6
Decomposition of business fixed investment



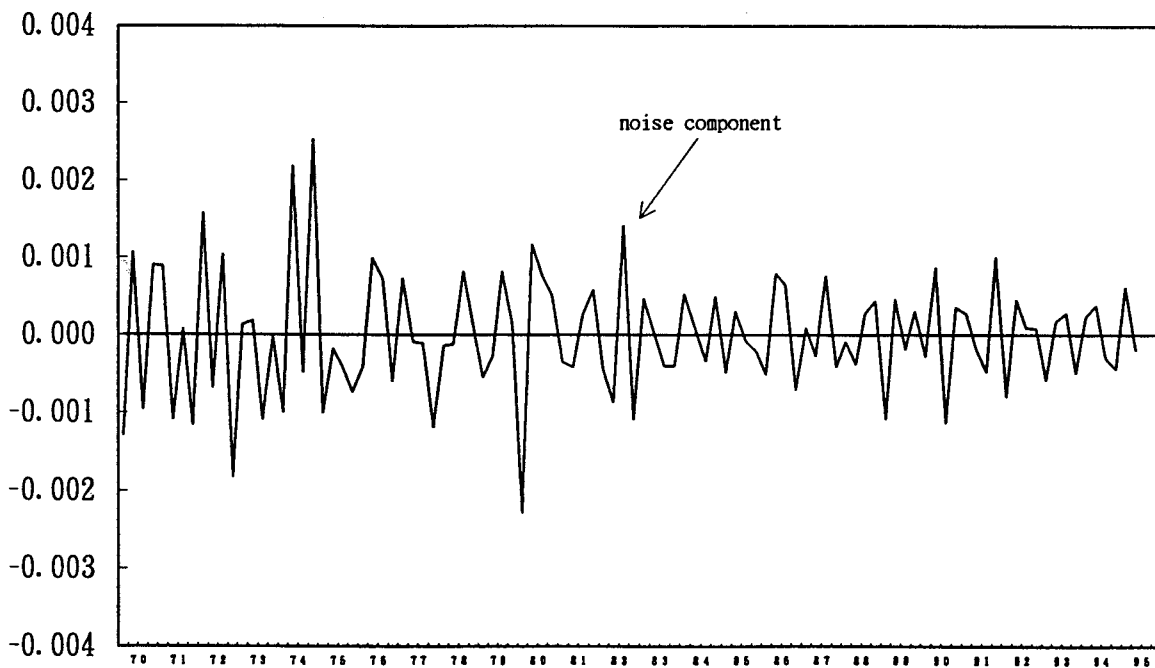
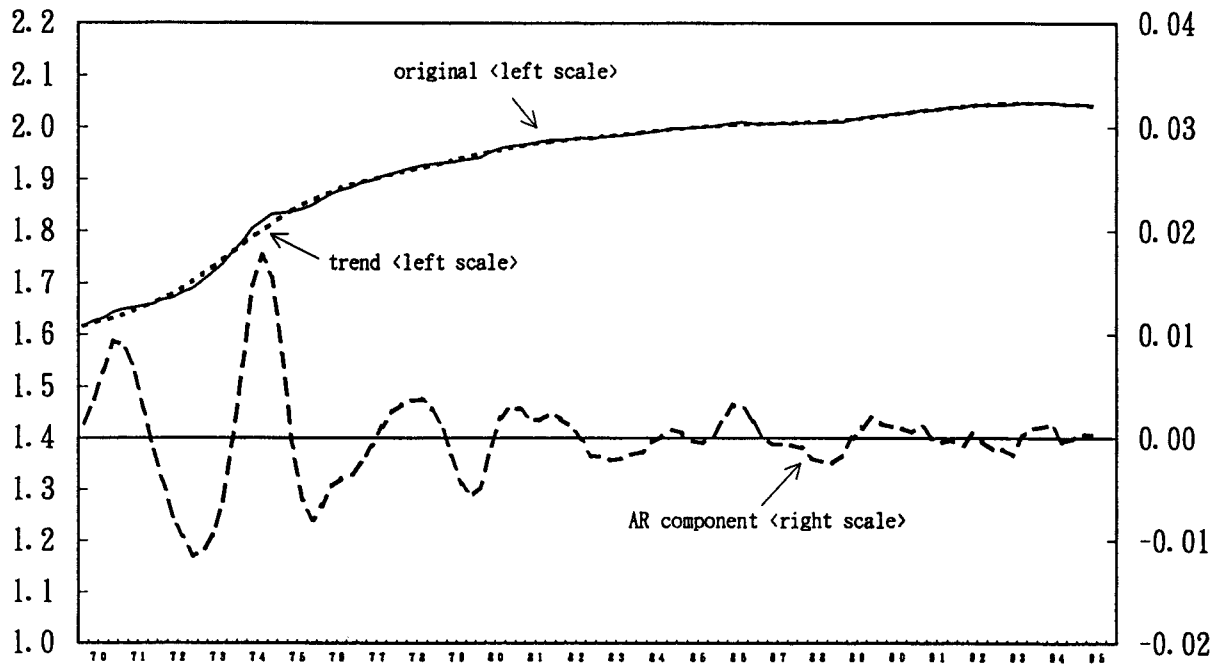
Note: Original = log of business fixed investment.

Chart 7
Decomposition of personal consumption



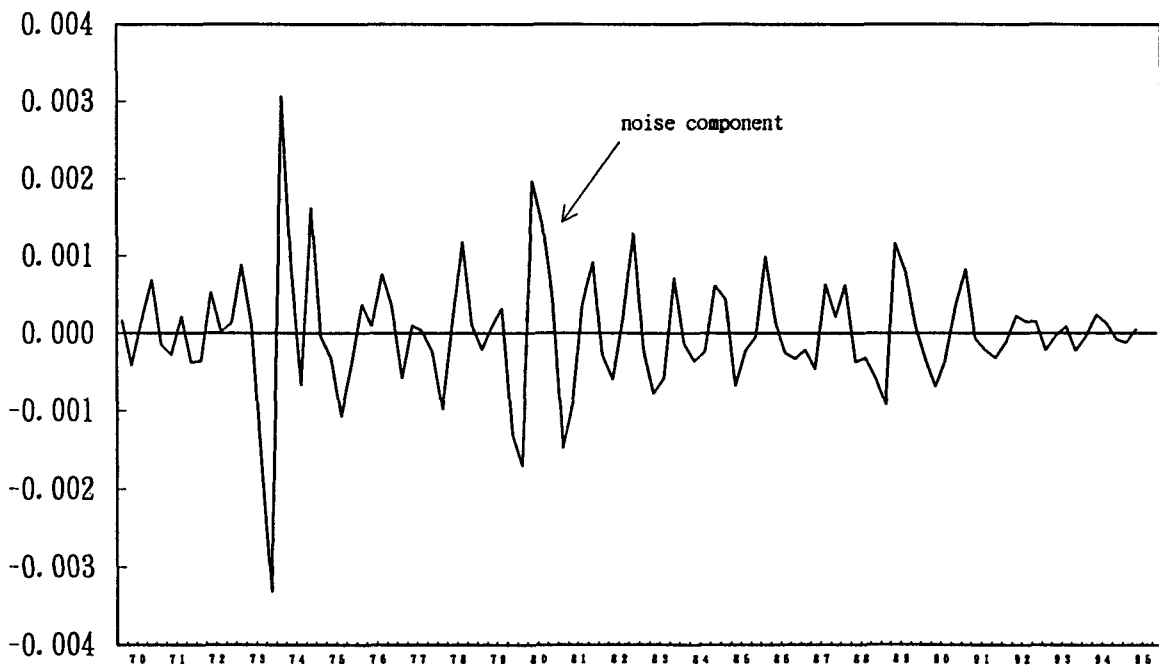
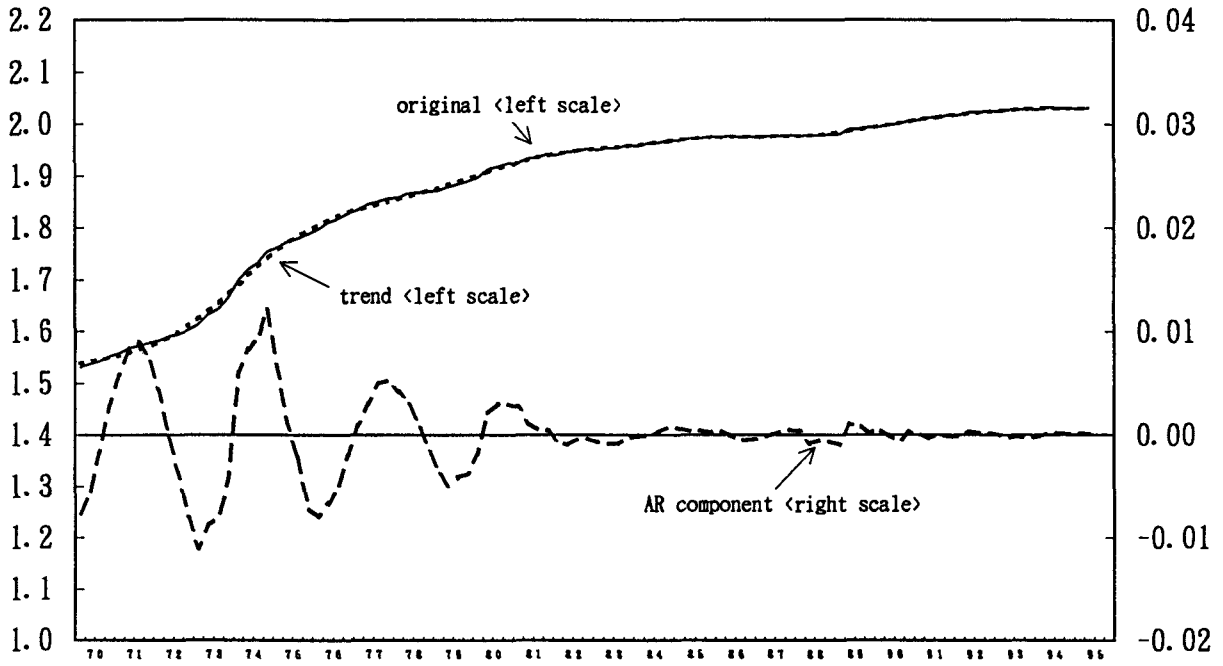
Note: Original = log of personal consumption.

Chart 8
Decomposition of the GDP deflator



Note: Original = log of the GDP deflator.

Chart 9
Decomposition of the consumer price index (CPI)



Note: Original = log of CPI (excluding perishables).

index. The extent of the fluctuations became large around 1980-81, 1990-91 and 1993-95. The noise component of long-term interest rates fluctuated more widely after the mid-1980s.

- (iii) Decompositions of short-term interest rates (overnight call rate and three-month rate) show that the cyclical components fluctuated widely around 1980-81 and 1990-91, while their noise components tended to stabilise after the late 1980s (Charts 3 and 4).
- (iv) Among real economic variables, business fixed investment has a slightly different picture after decomposition when compared to nominal GDP and personal consumption (Charts 5-7). Concerning the time-trend, nominal GDP and personal consumption have had similar linear upward trends, but they have flattened somewhat since 1990. On the other hand, business fixed investment shows a clear kink around 1991 from an upward to a downward trend. The cyclical component for business fixed investment shows larger fluctuations after the mid-1980s, while the movements of the cyclical components for nominal GDP and personal consumption have been relatively stable. Finally, no significant difference is seen among the noise components of the three, in that the degree of volatility of the component for each variable shows no significant change after the large fluctuation in the early 1970s.
- (v) For price variables, the upward trends have gradually become less steep since the late 1970s, reflecting the deceleration of inflation (Charts 8 and 9). Variability of both the cyclical and the noise components have also tended to stabilise since the early 1980s, with the cyclical components fading out almost completely.

Table 1

Regression among trend components

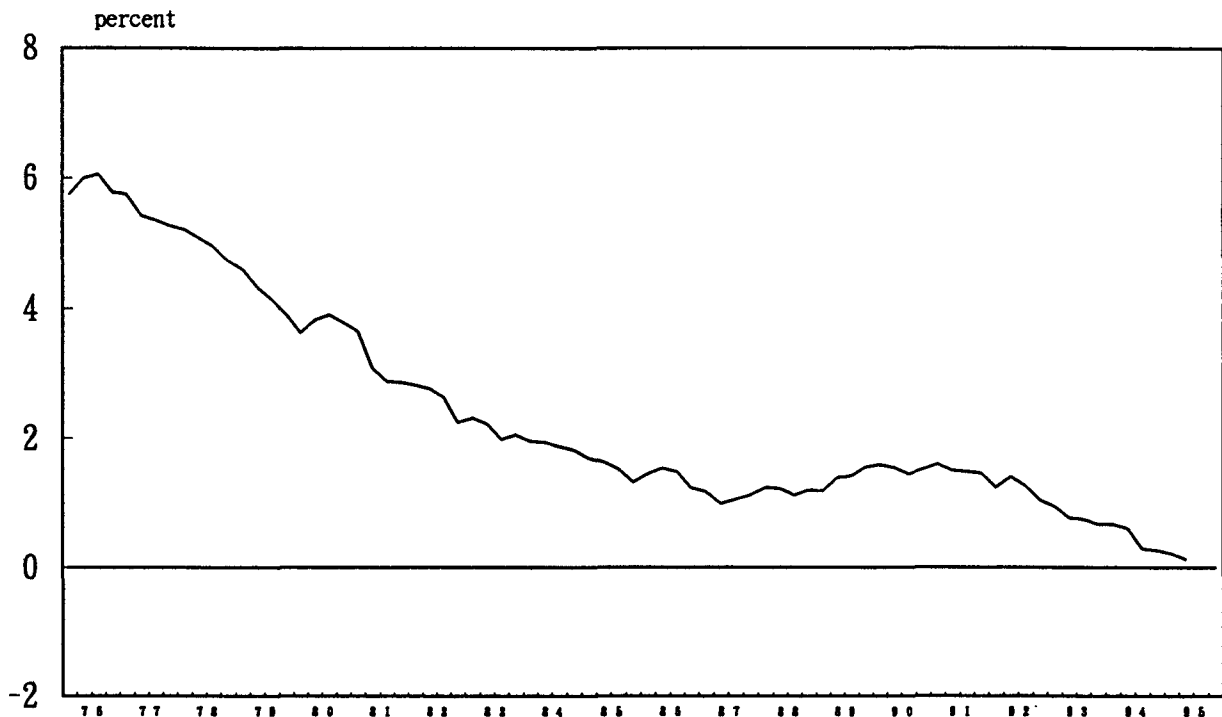
①	<p>Estimated model: $TS_t = \alpha + \beta TY_t + u_t$ TS_t: trend component of stock price index TY_t: trend component of nominal GDP</p>
Estimation result:	<p>$\hat{\alpha} = -3.164 (0.533)$ $\hat{\beta} = 1.323 (0.098)$</p> <p>Newey-West adjusted standard errors are in parentheses (with Bartlett weights, truncation lag = 34) $R^2 = 0.938$ $S.E. = 0.084$ $D.W. = 0.039$ Period: 1970 Q1 - 1995 Q2</p>
②	<p>Estimated model: $TS_t = \alpha + \beta TY_t + \gamma R_t + u_t$ TR_t: trend component of long-term interest rate</p>
Estimation result:	<p>$\hat{\alpha} = -1.761 (0.370)$ $\hat{\beta} = 1.134 (0.055)$ $\hat{\gamma} = -0.057 (0.018)$</p> <p>Newey-West adjusted standard errors are in parentheses (with Bartlett weights, truncation lag = 34) $R^2 = 0.965$ $S.E. = 0.063$ $D.W. = 0.071$ Period: 1970 Q1 - 1995 Q2</p>

When comparing the respective components of financial and economic variables mentioned above, the following propositions can be made:

- (i) Despite the large fluctuations in the cyclical component, the stock price index shows a relatively smooth linear upward trend until the end of the 1980s, after which the trend became flat. This seems to correspond roughly to that of nominal GDP. Thus, the movement of the stock price index seems anchored to that of nominal GDP in the very long run. In fact, a regression analysis shows that the trend of the stock price index is largely explained by that of nominal GDP (Table 1). Furthermore, if we add the trend of long-term interest rates to the explanatory variables, the explanatory power becomes higher, as is suggested by theory.
- (ii) Long-term and short-term interest rates show similar downward trends, particularly since the late 1970s. These downward trends in nominal interest rates seem to be explained by the downward trend in the rate of inflation (Chart 10).

Chart 10

Trend of annual GDP deflator changes



- (iii) Variability in the cyclical component of the stock price index increased between the late 1980s and the early 1990s, deviating from that of nominal GDP, which did not increase. This implies that the cyclical swing of the stock price index is not fully accounted for by the fluctuation of nominal GDP. The cyclical component of long-term interest rates also shows certain swings during this period, but the pattern of swing is different from that of stock prices and the cyclical developments in long-term interest rates do not seem to substantially account for the deviation of the stock price index from nominal GDP. To ascertain this further, we estimated a vector autoregressive (VAR) model for four variables, namely, the cyclical components of short and long-term interest rates, the stock price index and nominal GDP, and conducted a variance decomposition. The result

shows that 90% of the variations in the stock price index stem from its own shocks, and only a very marginal part is attributable to shocks in long-term interest rates or nominal GDP (Table 2).

- (iv) For long-term interest rates, developments in the cyclical component are broadly in line with those in short-term rates. However, variability of their cyclical component sometimes deviated from that of short-term interest rates, notably in 1994-95, suggesting that long-term interest rates moved more widely during that period than is justified by the movement of short-term interest rates. This is reflected in the variance decomposition result of the VAR mentioned in (iii) above: on average, roughly 30% of the variations in long-term interest rates is attributable to shocks in short-term rates. Thus, short-term interest rates have a substantial impact on long-term interest rates, but a larger portion of long-term interest rate variations is explained by their own shocks.
- (v) A large swing in the cyclical component of the stock price index preceded very large fluctuations in that of business fixed investment in the early 1990s. Thus, a close relationship between the volatility of the stock price index and that of business fixed investment is suggested. We will return to this later.
- (vi) The volatility of the noise components of the stock price index and long-term interest rates tended to increase since the mid-1980s, while that of short-term interest rates and real and price variables has shrunk or shown no significant change. Taken at its face value, this relatively low degree of correlation between the noise components of financial prices and those of monetary policy or goods market-related variables suggests that there are irregular shocks in asset markets which do not affect other markets. There are two possible interpretations for this. First, it may mainly reflect the difference in the speed with which financial and goods markets adjust to shocks. Thus, financial markets react to shocks even though they may eventually turn out to be temporary or just noise, while goods markets digest and eliminate noises which cancel each other out. Second, financial asset markets react more vividly to information that might affect the future conduct of monetary policy. They are selective in this sense.

Table 2
Variance decomposition based on VAR model
 (1980 Q1 - 1995 Q2)

LHS variable	RHS variable			
	<i>r</i>	<i>R</i>	<i>S</i>	<i>Y</i>
<i>r</i>	80	13	3	3
<i>R</i>	32	62	2	3
<i>S</i>	7	3	90	0
<i>Y</i>	8	10	1	81

r: three-month CD rate

R: ten-year government bond yields

S: stock price index

Y: nominal GDP.

Note: Quarterly change of AR components is used; variance decomposition at 20-quarter horizon; innovations orthogonalised in the order the variables appear.

Summarising, the very long-run trends of stock prices and long-term interest rates are largely in line with the fundamentals. That is, the trend in long-term interest rates is basically determined by those of short-term interest rates and inflation, while the trend in stock prices is

determined by those of nominal GDP and long-term interest rates. Thus, there seems to be little need for concern about excess volatility or misalignment of financial prices in the long run. On the other hand, the very short-run volatility (quarter-to-quarter volatility) of financial prices does not seem closely related to that of real economic variables, probably for the reasons mentioned above. Between these two extremes, cyclical movements of financial prices, particularly stock prices, often show significant divergence, or misalignment, compared with what is implied by the fundamentals. In contrast to the very short-term volatility, this might cause erratic movements in real activities, notably investment, and thus merits further analysis.

2. Volatility of financial prices

Now, we go on to investigate the background of volatility in the cyclical components of stock prices and long-term interest rates. In order to do so, we need a more precise measure of variability, and in the following we will use sample standard deviations (SSD) of the de-trended cyclical component of the series on a backward rolling (twelve samples for quarterly data) basis.

2.1 Stock prices

The SSD of the cyclical component of the stock price index, shown in Chart 11, was quite high in the late 1980s and the early 1990s, while the SSD of nominal GDP has been small and stable since the beginning of the 1980s. The SSD of the cyclical component of long-term interest rates, on the other hand, shows roughly parallel movements to that of the stock price index since the mid-1980s (Chart 12). However, the SSD of the long-term interest rate does not look large enough to account for the whole of the unprecedentedly large SSD of the stock price index. Although nothing concrete concerning the determination of stock prices can be said from these observations alone, it is obvious that stock prices were much more volatile between the mid-1980s and the early 1990s than either nominal GDP or long-term interest rates, for the latter of which volatility also increased substantially during this period.

What is the main cause of this volatility in stock prices in the late 1980s? In order to see this, we used a simple present value model to first examine the level of current earnings needed to account for the actual level of stock prices, if long-term expectations were stable. Chart 13 is the result of this exercise: on the assumption that the risk premium is constant at 2.7%² and that the long-run expected growth rate of current earnings is equal to the rate of potential real GDP growth plus trend inflation, the expected current earnings per share works out to be more than four times higher than actual earnings at their peak. Even if we allow for the then prevailing bullish sentiments regarding the corporate earnings profile, this is clearly unreasonable. Furthermore, this persistent divergence between the implied and realised earnings means that market participants did not correct their biased estimates of corporate profits even after they were proved wrong. This casts doubt on the validity of the efficient market hypothesis. Thus, even though the cyclical volatility of stock prices partly reflected unsustainable expectations and their eventual correction, there remains a large part which cannot be explained even by a very large swing in expectations concerning current corporate earnings.

If fluctuations in expected current earnings and/or interest rates cannot wholly explain the volatility of stock prices, variable risk premia suggest themselves as another source. In most empirical works, the risk premium of holding risky financial assets is assumed to be time-invariant. Theoretically, however, it is not unreasonable to assume a time-variant risk premium, which depends first on the degree of uncertainty concerning key variables such as expected future real growth of consumption, inflation, holding period return on the asset, etc., and second on the degree of investors' risk aversion.

2 The historical average of the yield spread between 1976-95.

Chart 11

**Sample rolling standard deviations of AR components -
the stock price index and nominal GDP**

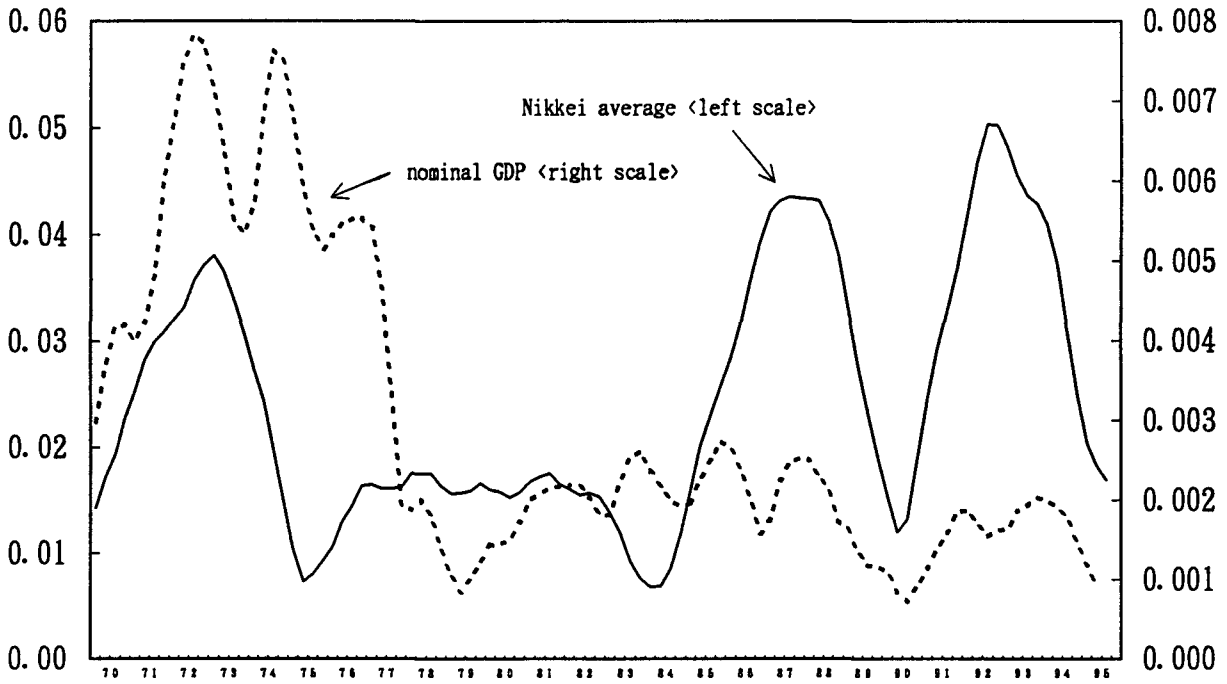
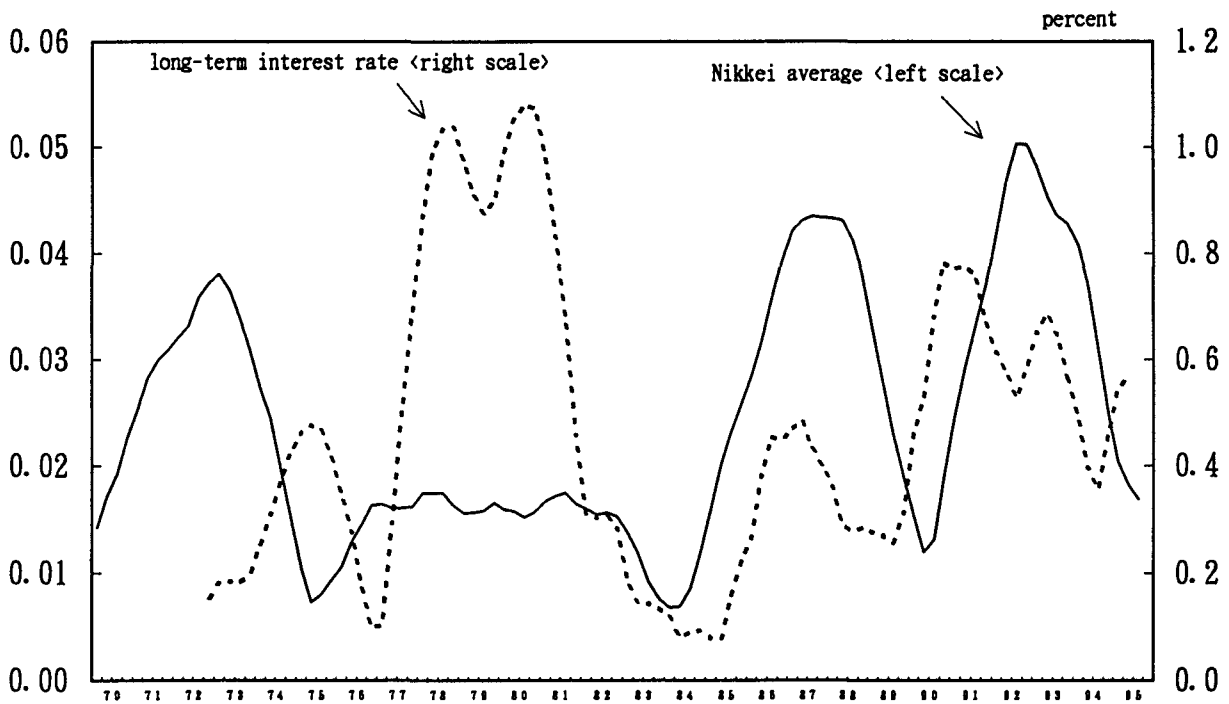


Chart 12

**Sample rolling standard deviations of AR components -
the stock price index and long-term interest rate**



Note: Backward twelve-quarter rolling. Long-term interest rate: ten-year government bond yields.

With the assumption of a time-variant risk premium, we can reverse the calculations in Chart 13 to see how, at any given yield spread (earnings yield minus long-term interest rates) and expected long-run earnings growth, the risk premium in the stock market must have moved over time. Chart 14 is the result of such an exercise, with the long-run expected rate of nominal earnings growth set in the same way as before. As the chart shows, the risk premium thus calculated has fluctuated fairly widely, in the range between less than zero³ to nearly 8%. What is noteworthy is that the surge in stock prices in the late 1980s can be explained, even assuming stable expectations for earnings growth, by a narrowing of the risk premium from around 4% to the then unprecedented low of nearly zero.

In order to see to what extent this narrowing of the risk premium in the late 1980s can be attributable to the reduced degree of uncertainty, we calculated sample variances of historical returns on stocks, on the not too implausible assumption that, as this variance increases, investors demand a larger risk premium. The results in Charts 15 and 16 show that the sample variance of holding period return on stocks, calculated ex post, did not decrease sufficiently to justify the narrowing of the premium by almost 4 percentage points during this period. If we concentrate on the shorter sub-period from 1988 to 1989, when the variance of historical returns narrowed rapidly, it is not unreasonable to assume that the risk premium also narrowed. For the late 1980s as a whole, however, it is difficult to say that investors saw much reduced uncertainty in holding stocks.

If reduced risk cannot account for the significant portion of the swing in the risk premium, another possible source is a change in investors' attitude toward risk. There is ample circumstantial evidence that investors became much less sensitive to risks in late 1980s. (Some of them might have become risk-lovers.) A substantial increase in the trading volume of stocks (Chart 17) is one such piece of evidence. The so-called bandwagon effect seems also to have been at work,⁴ and it is not possible to separate the overshooting of expectations and the change in risk premia. It is, nonetheless, plausible that the degree of risk aversion of investors shifted somewhat during this period with the entry of many newcomers (mostly individuals) into the stock market. It does not seem likely, though, that the attitude of investors as a whole shifted so drastically as to account for the large fall in the risk premium.

If neither the fluctuations in current earnings nor the change in risk premia can fully account for the very large swing in stock prices, a natural interpretation is that longer-term expectations concerning real growth and inflation were quite unstable. In fact, if we relax the assumption used in the previous calculations about the expected long-term growth rate of nominal earnings, we see that an upward revision of about 3 percentage points in these expectations could cause a rise in stock prices of the magnitude we witnessed. But was a 3 percentage point increase in such expectations likely to have occurred?

An annual survey by the Economic Planning Agency reveals corporate managers' medium to long-term expectations for real growth. This does show that they had indeed become more optimistic in the late 1980s (Chart 18). The signal from the stock market may have contributed to this, but in any case the magnitude is well short of 3 points. As regards inflation, the actual deceleration precludes a conspicuous surge in inflationary expectations, as far as goods and service prices are

3 The risk premium thus calculated became negative during the early 1994, but it is not likely that investors became "risk lovers." Rather, it is attributable to an excessive rise in long-term interest rates. As will be discussed later, long-term interest rates rose during this period owing to an unwarranted expectation of a near-term monetary tightening.

4 There is some evidence which supports the proposition that bandwagon effects were indeed at work. There were many occasions during 1986-89 when the stock price index kept rising for more than seven consecutive trading days. In one episode, it rose for thirteen successive trading days, which, if the efficient market hypothesis holds, is extremely unlikely to occur.

Chart 13

Implied earnings per share in stock markets

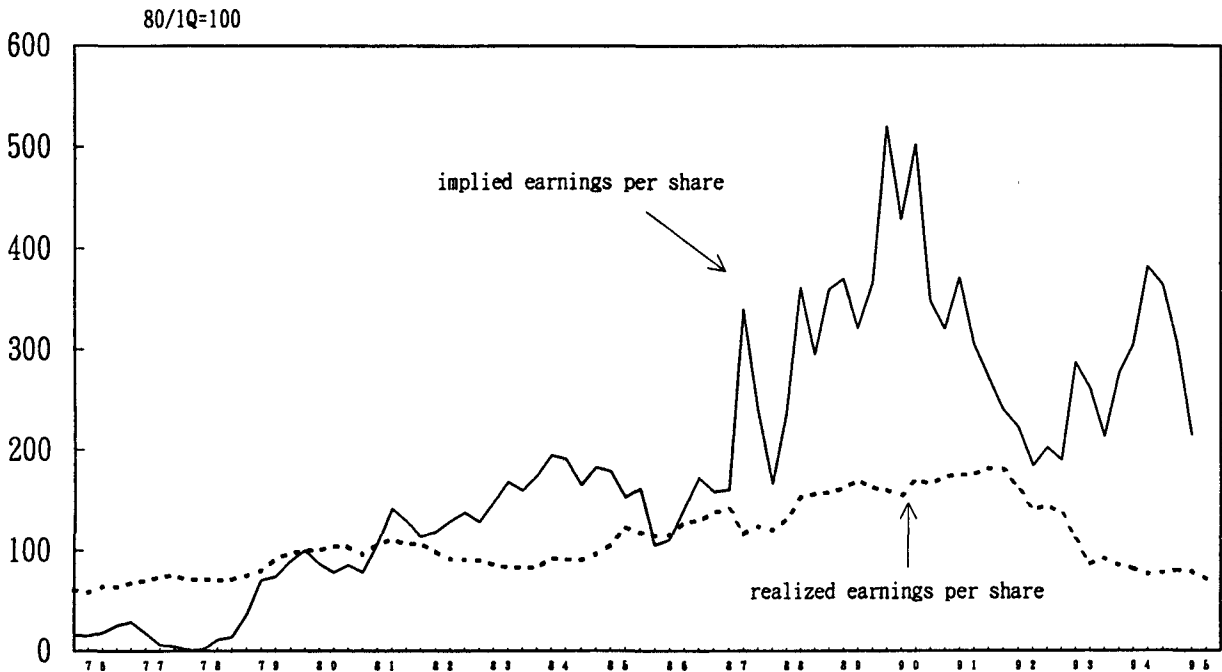
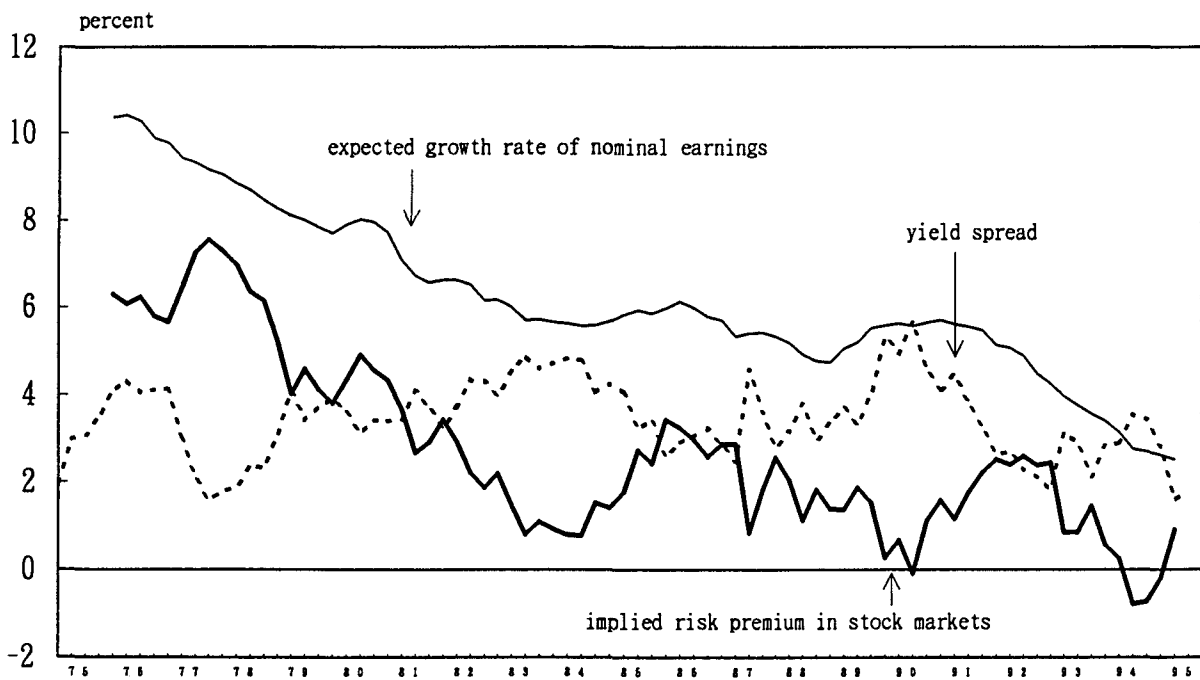


Chart 14

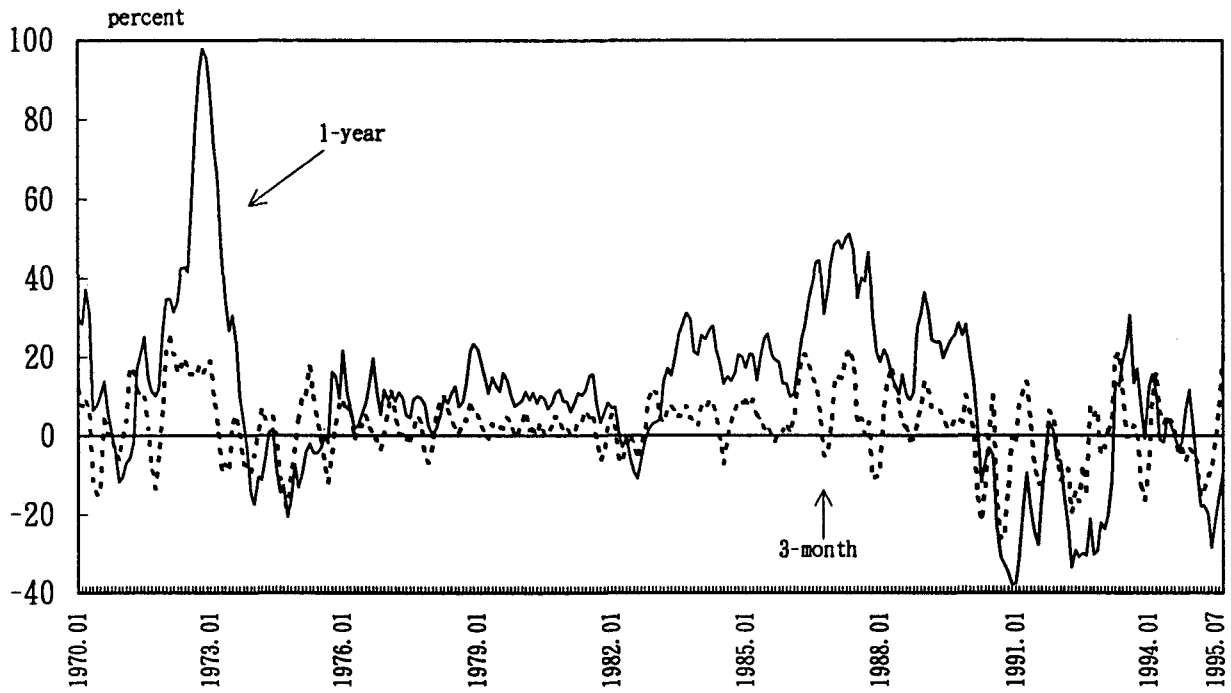
Implied risk premium in stock markets



Note: Expected growth rate of nominal earnings is set to equal "estimated real potential GDP growth rate plus trend of annual GDP deflator changes".

Chart 15

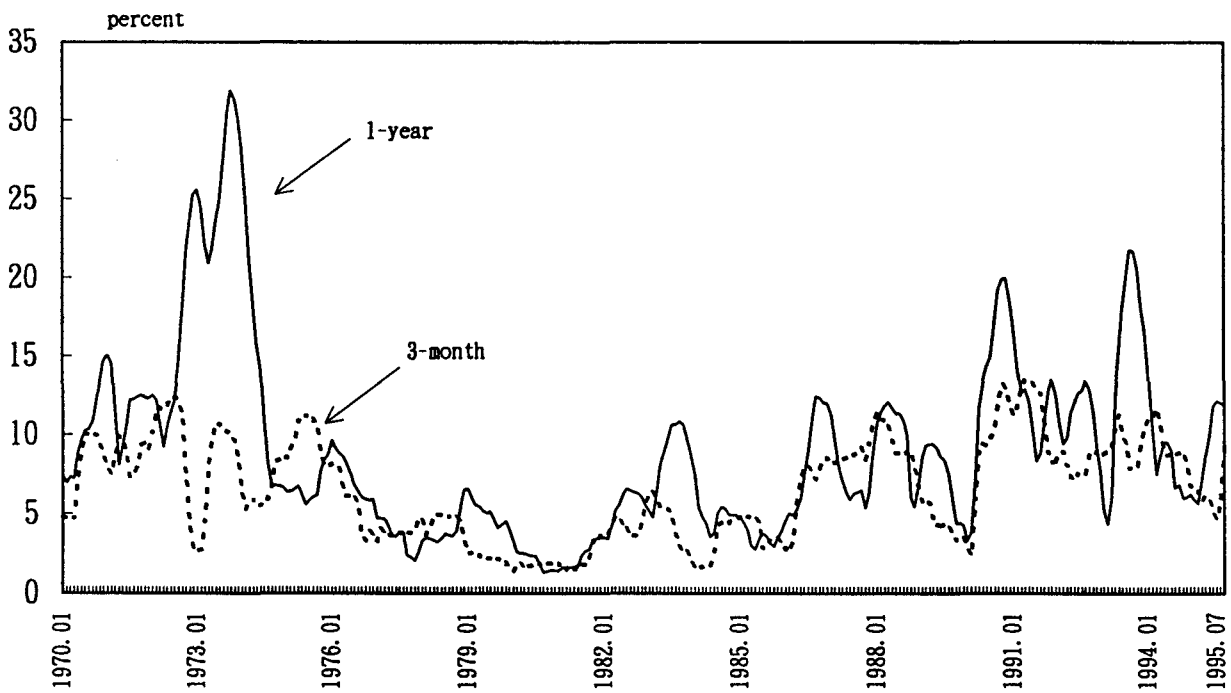
Holding period returns on three-month and one-year stocks



Note: Dividends are excluded.

Chart 16

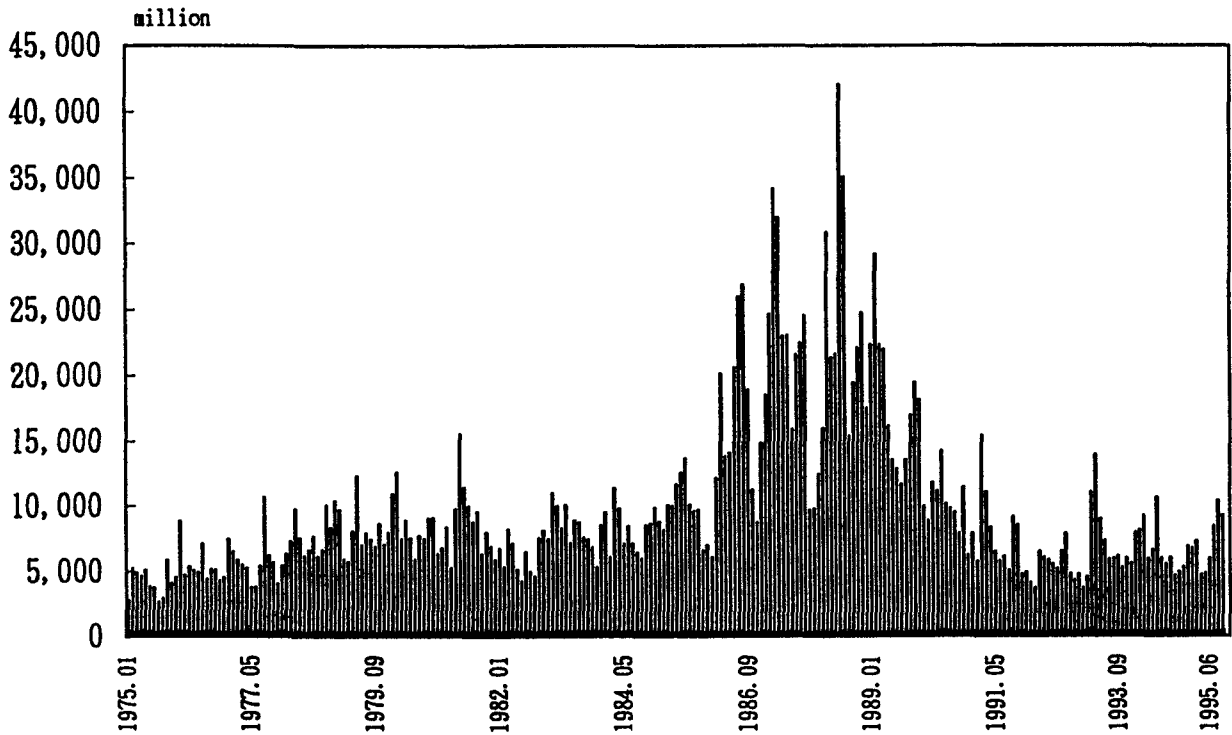
Sample rolling standard deviations of stock returns



Note: Backward twelve-quarter rolling.

Chart 17

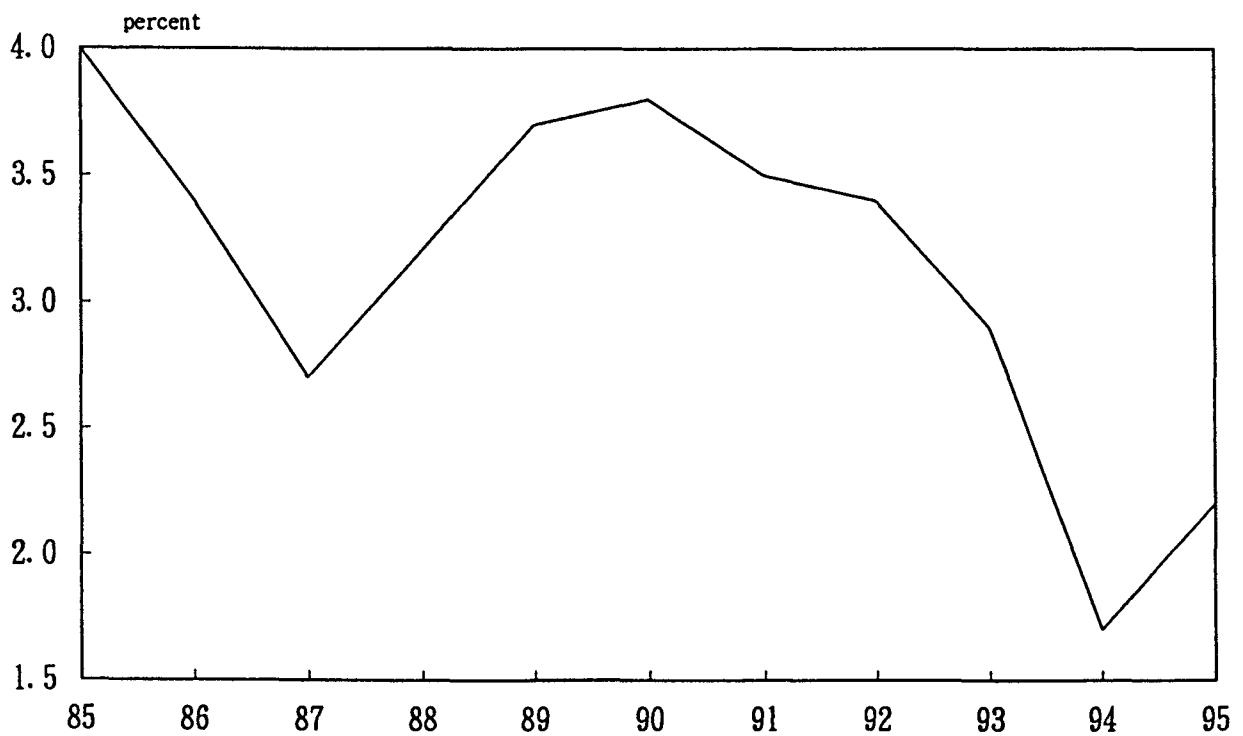
Trading volume of the Tokyo Stock Exchange



Note: Session I.

Chart 18

Medium-term growth projections by corporate managers



Note: Arithmetic averages of projected real GDP growth for the coming three years as of January each year.

concerned, but the sharp rise in asset prices as well as the rapid increase in monetary aggregates could have: (a) led to a higher corporate earnings profile than suggested by nominal GDP; and/or (b) prevented general inflationary expectations from subsiding despite the actual stability of goods prices.

All in all, it is not possible to single out *the* cause. Many factors must have worked together, and the resultant rise in stock prices themselves affected expectations, resulting in a substantial misalignment that lasted for a couple of years.

2.2 Long-term interest rate

The SSDs of the cyclical components of long-term and short-term interest rates are shown in Chart 19. Since the late 1970s, variability of the cyclical components of both has moved in a broadly similar fashion. It may be noted in this context that regulations concerning bond trading had been gradually lifted by around 1978-79, and bond prices have moved much more flexibly since then. Compared with stock prices, long-term interest rates are much less volatile in both magnitude and persistence.

However, there exist periods when variability of long-term and short-term interest rates moved in opposite directions. One such case is 1994 and 1995, when the SSD of the cyclical component of long-term interest rates increased despite the continued decrease in that of short-term interest rates. During this period, long-term interest rates rose and fell without any corresponding movements in short-term interest rates. One possible explanation of this overshooting and subsequent fall of long-term interest rates is that the risk premium fluctuated widely; investors' expectations regarding the relative yields of holding Japanese long-term bonds may have been considerably affected because of the volatile movements of yields on US bonds and the fluctuation in foreign exchange rates. However, as the variability of the cyclical component of the dollar/yen exchange rate was fairly stable in 1994 and 1995, as shown in Chart 20, this explanation does not seem to hold.

A more plausible explanation is that investors' expectations are quite sensitive to the expected future course of short-term interest rates, and that market participants were overreacting to signs regarding the future conduct of monetary policy. Thus, bond market yields soared in the spring of 1994, when a series of economic data gave rise to hasty views that a tightening of monetary policy was imminent. That this was an overreaction on the part of long-term bond holders can be confirmed from an estimation of the simple expectations model of the term structure for one-year bank debentures. As shown in Chart 21, the term structure model with the assumption of perfect foresight⁵ gives a very large positive residual during 1994. This implies that bond traders had consistently anticipated a rise in short-term interest rates in the near future, which never materialised.

3. Financial volatility and real economic activity

In Section 1 we looked at the link between the cyclical components of real and financial variables. The task of this section is to explore the linkage between the volatility in stock and bond markets and that in real activity. For this purpose the SSDs of the cyclical components of the stock price index and long-term interest rates, along with those of business fixed investment and personal consumption, are compared.

⁵ The perfect foresight model of the term structure states that the one-year and three-month interest rate spreads should be expressed as the sum of future three-month rate differentials in the coming three quarters.

Chart 19

**Sample rolling standard deviations of AR components -
short and long-term interest rates**

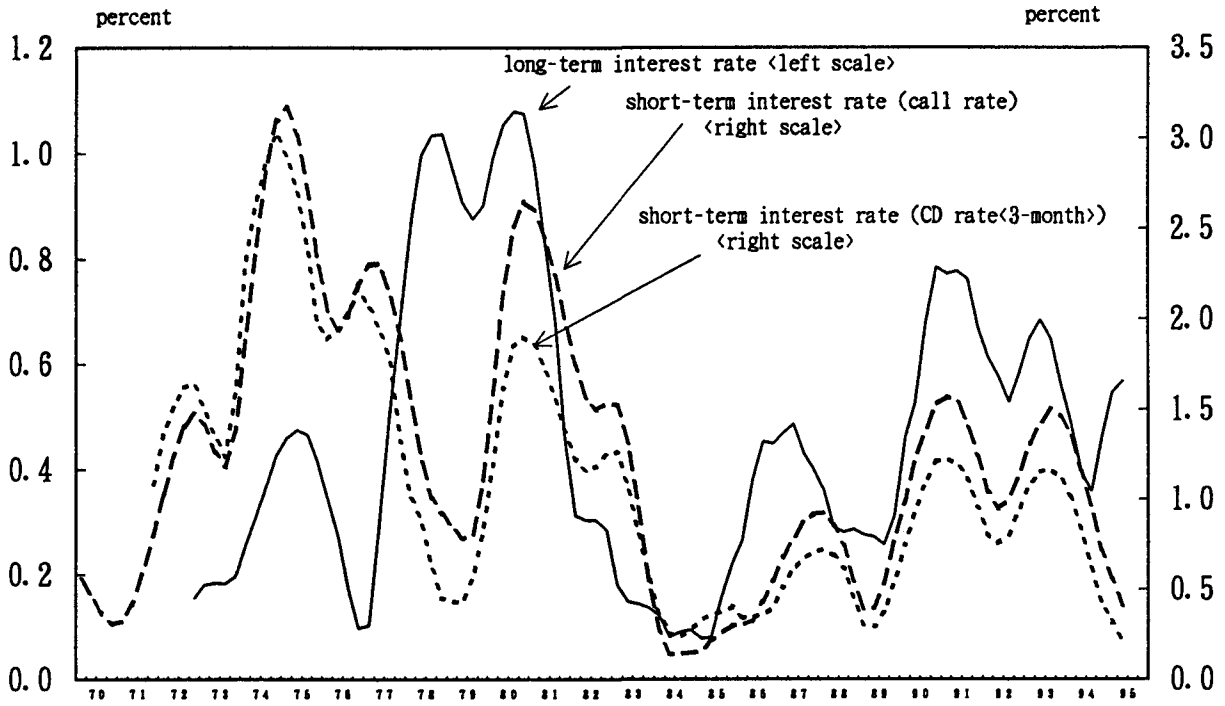
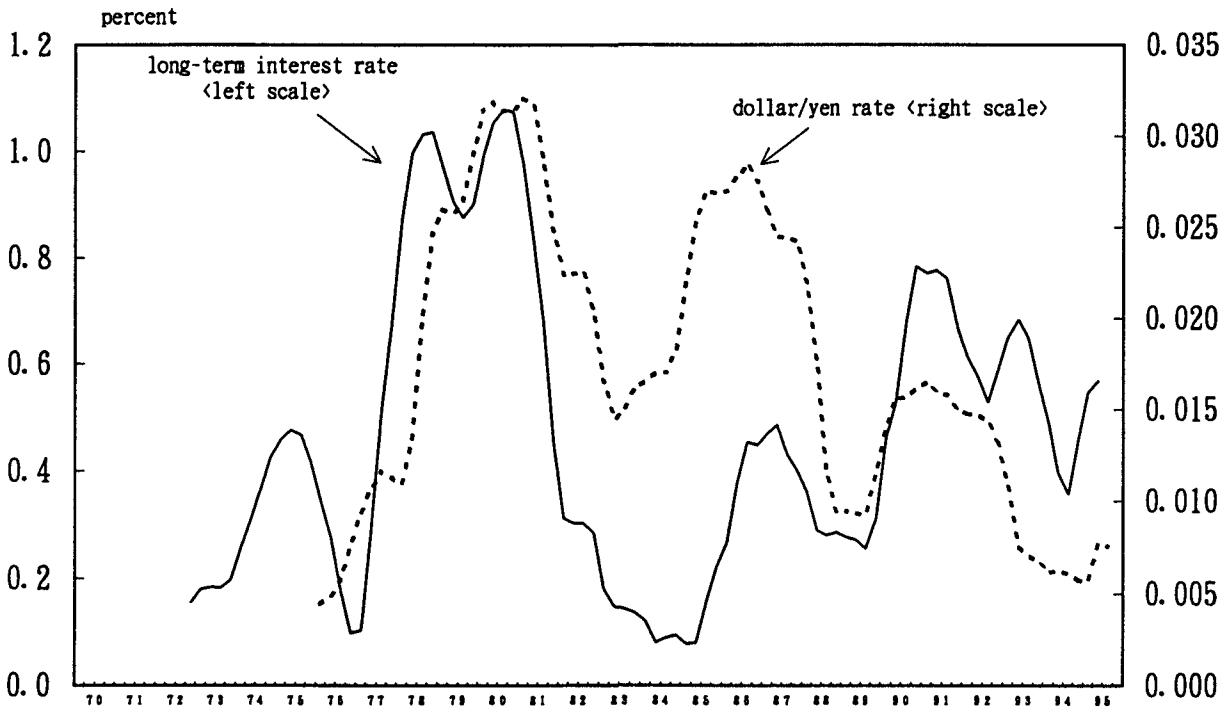


Chart 20

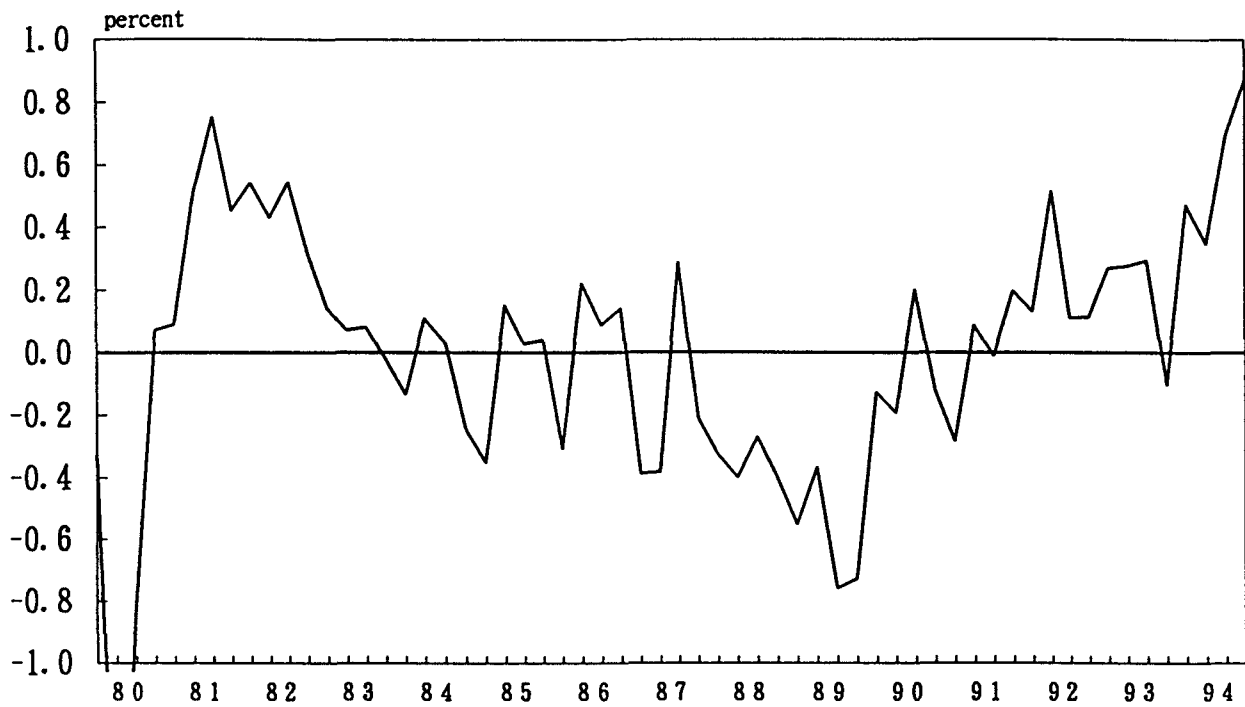
**Sample rolling standard deviations of AR components -
the long-term interest rate and dollar/yen rate**



Note: Backward twelve-quarter rolling. Short-term interest rate: CD rate (Gensaki (repo) rate prior to the third quarter 1979); long-term interest rate: ten-year government bond yields. Dollar/yen rate is expressed in logarithms.

Chart 21

Residual of estimated expectations model of the term structure



Estimated model: $SP_t = \beta_1 \sum_{i=1}^3 \Delta r_{t+i} + c + u_t$

SP_t : Spread between one-year bank debentures yields and three-month CD rate at time t .

Δr_{t+i} : Differential of three-month CD rate between time $t+i-1$ and $t+i$.

c : Constant term.

Estimation results: $\beta_1 = 0.328$

$\beta_2 = 0.133$

$\beta_3 = 0.214$

$\bar{R}^2 = 0.271$; S.E. = 0.454; D.W. = 0.762.

Period: 1980 Q1 - 1994 Q4.

From Chart 22 it can be observed that the large SSD of the cyclical component of the stock price index after the mid-1980s preceded an increase in the SSD of the cyclical component of business fixed investment in the early-1990s. On the other hand, no substantial change in the SSD of the cyclical component of personal consumption can be observed in recent periods, and it shows no clear correlation with that of the stock price index (Chart 23). Similarly a close relationship between the SSD of long-term interest rates and that of business fixed investment is observed, particularly in recent periods, although the correlation seems simultaneous rather than either one leading. No close relation is observed with personal consumption, as in the case of the stock price index (Charts 24 and 25). Thus, there are hints that the increased variability of investment may have been caused by the financial price volatility, but we cannot be certain of their causal relationship just from these observations.

As a next step towards understanding the response of real economic variables to financial shocks, we introduced vector autoregressive models. Three-variable models are used, taking the cyclical components of the stock price index, long-term interest rates and a real variable (business fixed investment or personal consumption). Two estimation periods were used, the entire period 1980-95 and the sub-period 1987-93, the latter being a period of noticeable swings in financial prices. Estimation results, according to the F-tests (Chart 26), essentially show that changes in the cyclical component of the stock price index were a significant factor in explaining the subsequent change in that of business fixed investment, if we take the sub-period after 1987. This implies that business fixed investment during the so-called bubble period was significantly influenced by past stock price movements. On the other hand, the cyclical component of the stock price index has no significant explanatory power in the case of personal consumption. Changes in the cyclical component of long-term interest rates were also found to be significant in this case, but most of their estimated coefficients have wrong, i.e. positive, signs.⁶ That business fixed investment was considerably more sensitive than personal consumption during 1987-93 can also be seen from an estimation of impulse response functions, which show how they react to a one standard deviation shock in the stock price index (Chart 26).

Some maintain that corporate managers basically rely on fundamentals, or real variables, rather than on temporary fluctuations in market valuation when making investment decisions and that consequently investment would be less volatile than financial prices as real variables fluctuate much less. This may be true with regard to very short fluctuations, but our estimation results indicate that the stock price volatility of medium-term nature, i.e. the divergence of the cyclical component of stock prices from fundamentals which persists for a couple of years, has been affecting business fixed investment, especially for the recent period. Managers seem to have been significantly affected in their investment decisions by the firm's market valuation (in relation to the replacement cost of physical capital). This was so even when stock prices deviated from fundamentals, and, therefore, were incorrect, if it persisted for a certain period. In such circumstances, then, the information transmission role of stock markets functioned very poorly, and hence the wrong signals may have pushed corporations to raise more funds from the equity markets, and to undertake more investment projects, than was sustainable over the long term.

Another potential source of the high sensitivity of investment to the stock price shock may be the role of property or land as a collateral. As land prices fluctuate, the value of collateralisable assets, and hence net worth of corporations, fluctuates too, which affects both stock prices and investment. The surge in land prices in Japan between the late 1980s and 1990, and the subsequent fall since then, seem to have substantially affected the real economy through changing the availability of finance using land as collateral.

⁶ Response of business fixed investment to the shock on long-term interest rate changes has positive signs for more than a year as the change in long-term interest rates has a significant positive contemporaneous correlation with that in the investment.

Chart 22

**Sample rolling standard deviations of AR components -
the stock price index and business fixed investment**

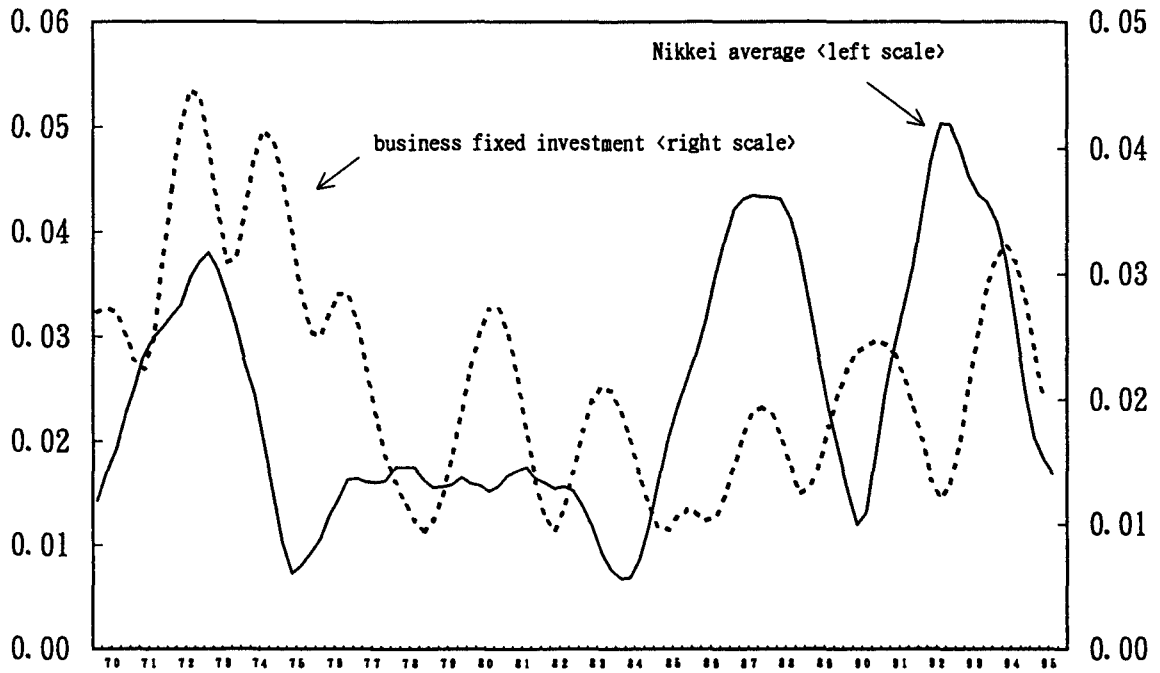
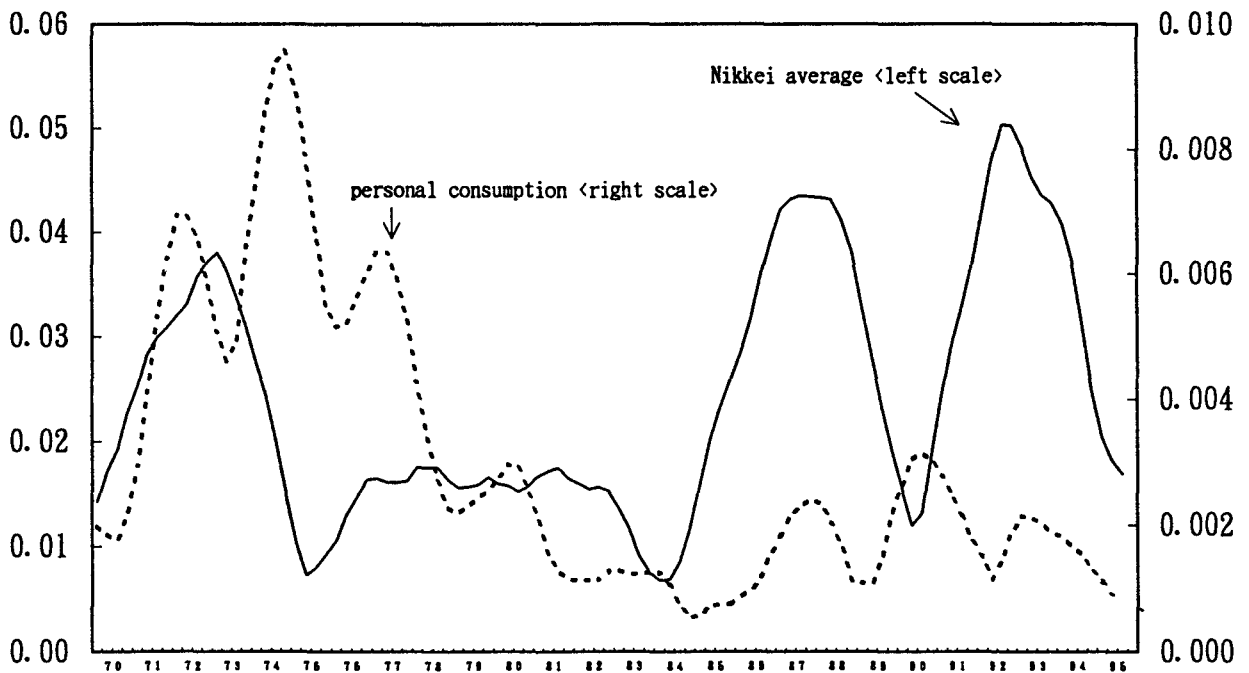


Chart 23

**Sample rolling standard deviations of AR components -
the stock price index and personal consumption**



Note: Backward twelve-quarter rolling.

Chart 24

**Sample rolling standard deviations of AR components -
the long-term interest rate and business fixed investment**

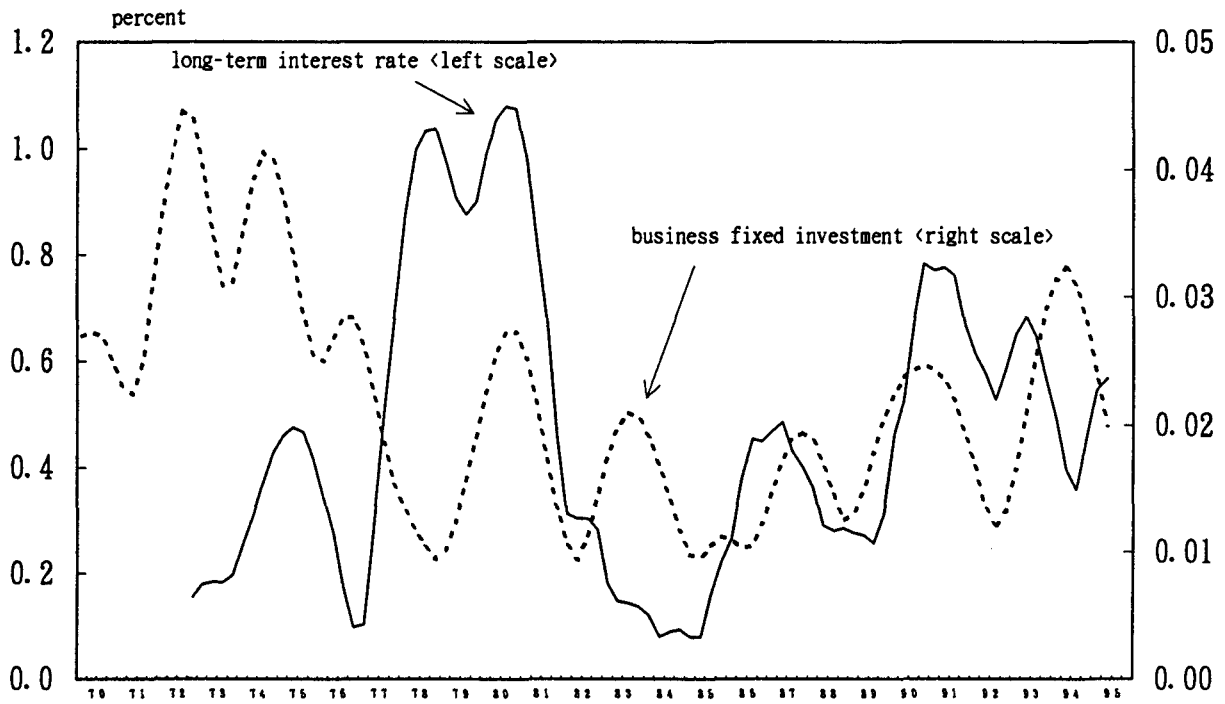
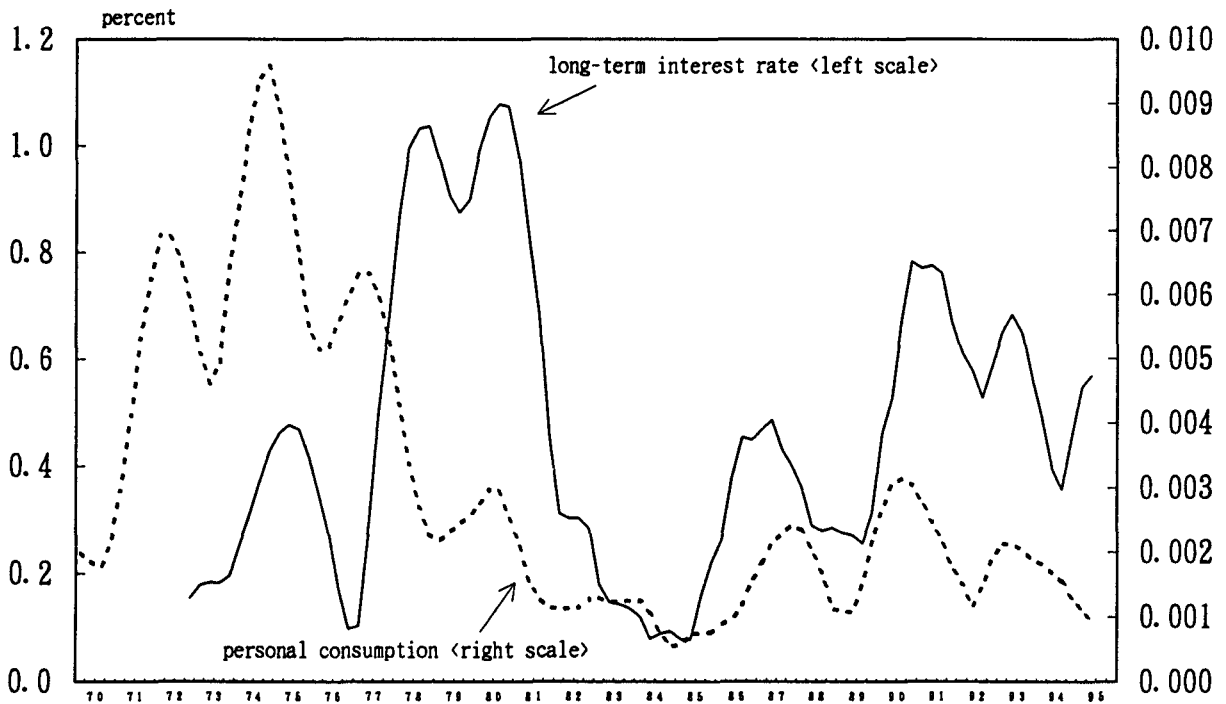


Chart 25

**Sample rolling standard deviations of AR components -
the long-term interest rate and personal consumption**

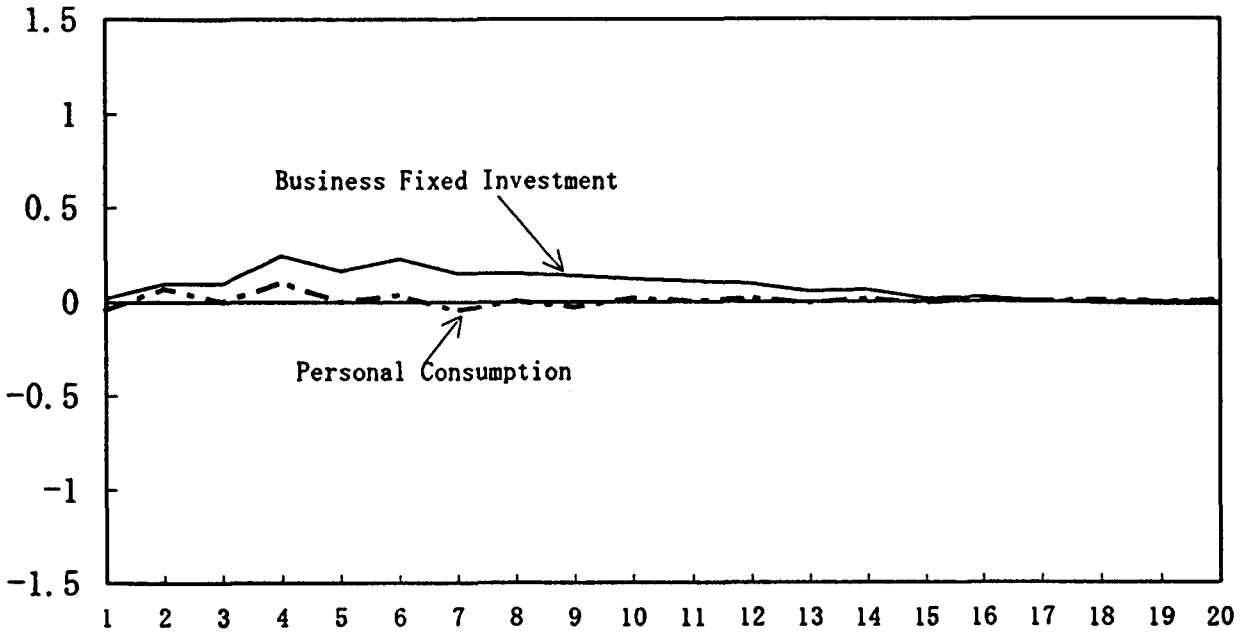


Note: Backward twelve-quarter rolling. Long-term interest rate: ten-year government bond yields.

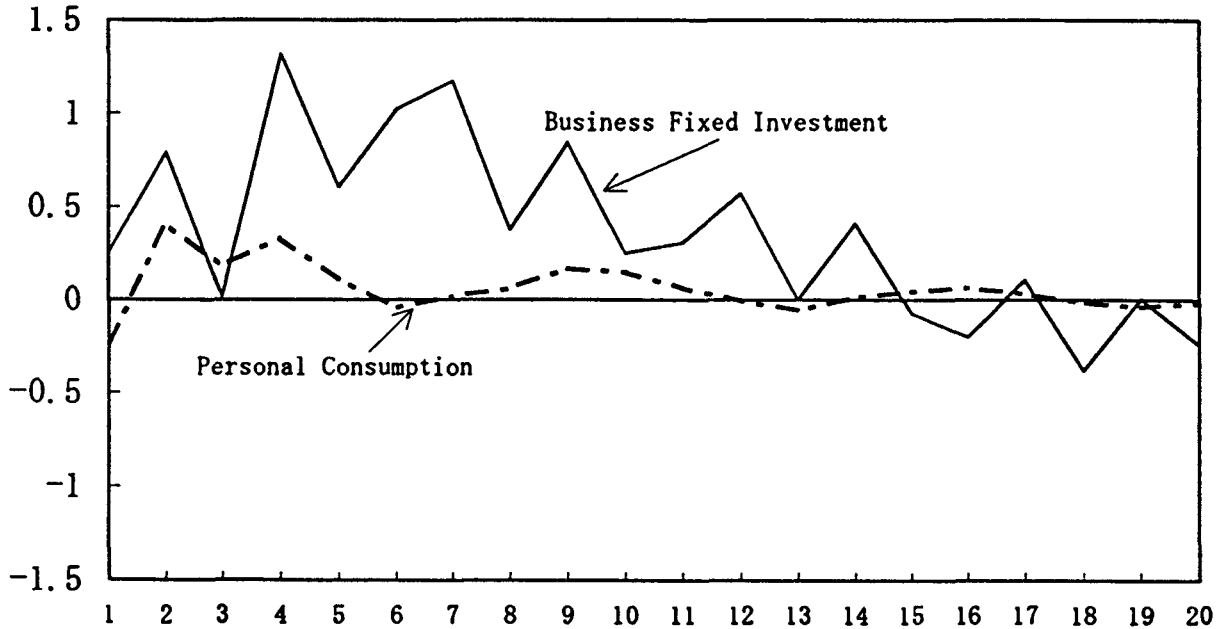
Chart 26

Impulse responses (case for stock price shock)

First quarter 1980 - second quarter 1995



First quarter 1987 - fourth quarter 1993



Note: Using quarterly changes of AR components of the stock price index, business fixed investment and personal consumption.

F-values of coefficients of the change in the stock price index

	1980 Q1 - 1995 Q2	1987 Q1 - 1993 Q4
Business fixed investment	0.29	3.51*
Personal consumption	0.15	1.70

* Significant at 5%.

Conclusions and policy implications

Large swings in stock prices and long-term interest rates can be thought of as an amalgamation of three waves with different cycles. First, there is a very long-run wave which basically reflects trends in fundamentals, such as the real growth rate and inflation. As such, there is little role for economic policy to actively intervene. In contrast, there is a very short-run wave, say quarter to quarter, which seems uncorrelated with real economic activities. To the extent wrong prices are corrected on their own, this short-term wave should not worry the authorities very much. In between the two, however, there is volatility of a kind which persists for a certain period (several quarters to a couple of years). This results in a misalignment of financial prices, which in turn can affect real variables in an untoward way. Moreover, it is quite difficult to tell beforehand whether the second type of short-run wave might turn into a more prolonged one.

Stock prices in Japan showed persistent volatility, or misalignment, between the mid-1980s and the early 1990s. A number of factors seem to have contributed to the former: the very bullish outlook then prevailing regarding the expected future nominal growth rate; the shrinking of the risk premium, which reflected both the reduction in the perceived degree of uncertainty and the less risk-averse attitude of investors. Moreover, the very misalignment seems to have led to more bullish expectations regarding nominal growth and stock prices. Long-term interest rates moved less erratically than stock prices in general, but there was a recent case of temporary overshooting and its correction. This episode seems to have been a result of the overreaction of bond traders to the news which potentially affects monetary policy. It is noteworthy that market participants could hold incorrect views for as long as a year or more.

Concerning the question of the effects of financial price volatility on real economic activity, short-term volatility does not seem to matter much. In cases where misalignment persists for as long as a couple of years, especially in the case of stock prices, real variables start to react to these wrong financial price signals. Resources would be allocated inefficiently as a consequence. In a world of perfect labour and capital mobility, such misallocations would be frequent but short-lived, but there are many rigidities and sunk costs in investment and labour markets so that misallocation, once allowed to take place, would entail considerable economic welfare losses.

It was once hoped that financial markets, as they grow in size and depth, would show tendencies toward self-correction of excesses. That turned out to be true for very short-term fluctuations, or noises, but our empirical analyses show that there were times when markets tended to aggravate fluctuations and misalignments, through wrong expectations and/or reduced risk premia. While we cannot say in general what gives rise to such misalignments, it seems that financial asset prices respond more vividly than real variables to information concerning nominal quantity or monetary policy.

There are two sets of policy implications to be drawn from these findings. First, the central bank cannot avoid having a view of financial developments: while it may not be able to say what financial asset prices are correct, it must know when they are obviously incorrect and are likely to remain so for some time. In other words, the central bank has to know what information financial asset prices are conveying, and must evaluate that information. While the case for direct intervention in the stock market would be much harder to make than in the case of foreign exchange market intervention, there may be occasions when such actions are justified.

Secondly, the central bank needs to provide markets with consistent and stable signals, in order to avoid wide swings in perceptions about monetary policy. This precludes fine-tuning, which can result in overreaction by market participants. Rather, the central bank should try to stabilise expectations concerning its monetary policy. This is an argument in favour of rules - provided that any yardstick chosen would be adhered to in a medium-term framework.

APPENDIX

Kitagawa and Gersch method for decomposing an economic time series

The method employed in this paper was developed by Kitagawa and Gersch (1984). As a basic premise, their method follows a stochastic process. The following are its main features:

- (i) Trends are characterised by a perturbed stochastic difference equation which differs from the conventional method of estimating trends with deterministic curves assumed to exist.
- (ii) A smoothness prior based on the Bayesian probability distribution is used in the formulation and is represented by a state space model. By using a smoothness prior, the Bayesian approach attempts to reach a more appropriate solution that covers the traditional sampling theory. Combining the Bayesian approach with the model criterion gives the method great practical applicability.
- (iii) Stochastic trends and other components of original series are estimated simultaneously. This is distinguished from the conventional method which intuitively fits the deterministic trend or differences the series to obtain a stationary process.

1. Smoothness priors of economic time series components

An observed time series $y(n)$ can be decomposed into a trend $t(n)$, a globally stationary stochastic factor $v(n)$, a seasonal factor $s(n)$, and an observation noise $\varepsilon(n)$ as

$$y(n) = t(n) + v(n) + s(n) + \varepsilon(n). \quad (1)$$

A smoothness prior of each component on the right-hand side of equation (1) is as follows: the trend component $t(n)$ satisfies a k -th order stochastically perturbed difference equation

$$\nabla^k t(n) = w_1(n); \quad w_1(n) \sim N(0, \tau_1^2), \quad (2)$$

where $w_1(n)$ is an i.i.d. (individually and identically distributed) sequence and ∇ denotes a difference operator $\nabla t(n) = t(n) - t(n-1)$. For $k=1$, equation (2) is a random walk model and a stochastic term is effective up to two previous periods for $k = 2$. τ_1^2 measures the relative degree of smoothness, which is estimated from the actual series.

A smoothness prior of the stationary stochastic component $v(n)$ is assumed to satisfy an AR model of order p , which is constrained to be stationary,

$$v(n) = \alpha_1 v(n-1) + \dots + \alpha_p v(n-p) + w_2(n); \quad w_2(n) \sim N(0, \tau_1^2), \quad (3)$$

where $w_2(n)$ is an i.i.d. sequence.

The seasonal factor $s(n)$ may be nearly the same in every year. The stochastic term is introduced to accommodate a changing seasonal pattern. Then the seasonal model's stochastic process is

$$s(n) = -\{s(n-1) + s(n-2) + \dots + s(n-L+1)\} + w_3(n); \quad w_3(n) \sim N(0, \tau_3^2),$$

where $w_3(n)$ is an i.i.d. sequence.

2. State space representation of smoothness priors

Smoothness priors of each component are represented by a state space model. The state space model for the observations $y(n)$ is

$$\begin{aligned} x(n) &= Fx(n-1) + Gw(n) \\ y(n) &= H(n)x(n) + \varepsilon(n), \end{aligned} \quad (4)$$

where F , G , and $H(n)$ are matrices. $w(n)$ and $\varepsilon(n)$ are assumed to be zero mean i.i.d. normal random variables. $x(n)$ is a state vector that includes trend, stationary, and seasonal components.

The general state space model for the time series $y(n)$ that includes components and observation errors is written in the following form:

$$\begin{aligned} x(n) &= \begin{bmatrix} F_1 & & 0 \\ & F_2 & \\ 0 & & F_3 \end{bmatrix} x(n-1) + \begin{bmatrix} G_1 & & 0 \\ & G_2 & \\ 0 & & G_3 \end{bmatrix} w(n) \\ y(n) &= [H_1 \ H_2 \ H_3(n)]x(n) + \varepsilon(n). \end{aligned} \quad (5)$$

In equation (5), matrices F , G , and $H(n)$ in equation (4) are constructed by the component models (F_j, G_j, H_j) , $(j=1, \dots, 3)$. In order $(j=1, \dots, 3)$, these models represent the trend stationary AR, and seasonal component models, respectively.

An example of a state space model that incorporates each of the above constraints is given as follows:

$$\begin{bmatrix} t(n) \\ t(n-1) \\ \vdots \\ t(n-k+1) \\ v(n) \\ v(n-1) \\ \vdots \\ v(n-p+1) \\ s(n) \\ s(n-1) \\ \vdots \\ s(n-L+2) \end{bmatrix} = \begin{bmatrix} C_1 & \cdots & C_{k-1} & C_k \\ 1 & \cdots & 0 & 0 \\ \vdots & \cdots & \cdot & \cdot \\ 0 & \cdots & 1 & 0 \\ & & & \alpha_1 \cdots \alpha_{p-1} \alpha_p \\ & & & 1 \cdots 0 \ 0 \\ & & & \vdots \cdots \cdot \cdot \\ & & & 0 \cdots 1 \ 0 \\ & & & & -1 \cdots -1 \ -1 \\ & & & & 1 \cdots 0 \ 0 \\ & & & & \vdots \cdots \cdot \cdot \\ & & & & 0 \cdots 1 \ 0 \end{bmatrix} \cdot \begin{bmatrix} t(n-1) \\ t(n-2) \\ \vdots \\ t(n-k) \\ v(n-1) \\ v(n-2) \\ \vdots \\ v(n-p) \\ s(n-1) \\ s(n-2) \\ \vdots \\ s(n-L+1) \end{bmatrix} + \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ \vdots & \cdot & \cdot \\ 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \\ \vdots & \cdot & \cdot \\ 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \\ \vdots & \cdot & \cdot \\ 0 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} w_1(n) \\ w_2(n) \\ w_3(n) \end{bmatrix}$$

$$\begin{aligned} y(n) &= [1 \ \cdots \ 0 \ 1 \ \cdots \ 0 \ 1 \ \cdots \ 0]x(n) + \varepsilon(n) \\ x(n) &= [t(n) \ \cdots \ t(n-k+1) \ v(n) \ \cdots \ v(n-p+1) \ s(n) \ \cdots \ s(n-L+2)], \end{aligned}$$

where C_i , $(i=1, \dots, k)$ reflects the trend constraint in equation (2). System noise vector $w(n)$ and observation noise $\varepsilon(n)$ are assumed to be normal i.i.d. with zero mean and diagonal covariance matrices

$$\begin{bmatrix} w(n) \\ \varepsilon(n) \end{bmatrix} \sim N \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} Q & \\ & \sigma^2 \end{pmatrix} \right],$$

where

$$w(n) = \begin{bmatrix} w_1(n) \\ w_2(n) \\ w_3(n) \end{bmatrix}; \quad Q = \begin{bmatrix} \tau_1^2 & & \\ & \tau_2^2 & \\ & & \tau_3^2 \end{bmatrix}.$$

Recursive Kalman filtering and smoothing yields estimates of the state vector $x(n)$ and the likelihood for the unknown variances. Likelihoods are computed for different constraint order models. The unknown variances $\tau_1^2, \tau_2^2, \tau_3^2, \sigma^2$ and the unknown AR coefficients $\alpha_i, (i=1, \dots, p)$ in the state space model are estimated by the maximum likelihood method.

References

- Kitagawa, Genshiro and W. Gersch (1984): "A smoothness priors-state space modeling of time series with trend and seasonality", *Journal of the American Statistical Association*, Vol. 79.
- Naniwa, Sadao (1986): "Trends estimation via smoothness priors-state space modeling", *Monetary and Economic Studies*, Bank of Japan, No. 1, Vol. 4.