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The Information Content of Financial and Economic Variables: Empirical Tests of Information Variables in Japan

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The main topic of this paper is "information variables" (or "indicators") of monetary policy, which work as criteria for setting the direction of monetary policy. After briefly surveying the notion and candidates of information variables, according to the studies mainly in the United States, empirical tests using Japan's data are conducted. It can be said that some information variables seem to be useful, but the results are mixed in general.

I. Introduction

One of the current topic on monetary policy in major industrial countries is about using "information variables" or "indicators" as reference points for establishing policy. For example, James Baker, then U.S. Treasury Secretary, was among those who proposed using "indicators" for international policy coordination, primarily for stabilizing exchange rates among major currencies (Baker 1987; also Lawson 1987). In another example, Manuel Johnson, then Vice Chairman of the U.S. Federal Reserve Board, suggested that information variables could yield useful information (e.g. on inflationary pressure) for managing domestic monetary policy (Johnson, 1988a, 1988b).

This paper will use the term "information variables" (or "indicators") in this second sense (i.e., in the context of domestic monetary policy). Its purposes are: first, to survey briefly recent discussions on intermediate targets as well as on information variables and, second, to test empirically the usefulness of information variables in managing of monetary policy in Japan.

The summary of this paper is as follows.

In the United States, financial deregulation has weakened the relationship between monetary aggregates and the ultimate target of monetary policy, prompting some to argue that the money supply as an intermediate target should be reexamined. It is also

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proposed to implement a new method of managing monetary policy based on information variables. Researches have been actively focused on the relative merits of various financial and economic indicators as information variables.

The difference between an intermediate target and an information variable is this: while the former presupposes a structurally causal relationship with the ultimate target, the latter is expected only to contain specific information that helps predict the ultimate target. So far as monitoring of these variables improves the predictability of the ultimate target, they could be used as criteria for setting the direction of monetary policy.

Empirical studies, which have been conducted primarily in the United States, show mixed results about the usefulness of information variables. Empirical tests performed on Japan's data indicate that, "nonterm M3+CDs" (M3+CDs adjusted for the liquidity of its components), commodity prices, interest rate spreads, and foreign exchange rates all fail as an intermediate target of the Consumer Price Index, but they contain specific information about the future price movement, indicating their potential usefulness as information variables in Japan. On the other hand, data limitation has precluded a definitive conclusion on the usefulness of land prices; the information content of stock prices has been consistently meager on the basis of data from the past 20 years or so, making it inappropriate to adopt stock prices as information variables.

II. Reexamining Intermediate Targets

A sound intermediate target must possess the following three characteristics: (1) it has a stable relationship with the ultimate target; (2) it can be controlled by the central bank; and (3) it can bolster the credibility of the central bank. An important corollary of the first requirement is that there must be a structurally causal relationship between the intermediate target and the ultimate target. From a statistical standpoint, this means that the intermediate target and the ultimate target must be cointegrated.

So far, money supply has most often been proposed as an intermediate target. In the United States, however, financial deregulation and innovation have reduced the usefulness of the money supply as an intermediate target. For this reason, several attempts recently have been made to redefine money supply measures in order to restore their applicability as an intermediate target.[1]

For example, Motley (1988) has classified M3 into nonterm-M3 and term-M3 on the basis of liquidity, and proposed that the former be emphasized in relation to the ultimate target. Given that the emergence of such new financial products as NOW accounts has diminished the uniqueness of demand deposits as a means of settlement, Motley argues that all financial assets with high liquidity (called "nonterm assets") that can be exchanged for goods and services on demand should be considered in regard to the ultimate

[1]See, for example, Belongia and Chalfant (1990).

target. His empirical estimation of the money-demand function suggests that nonterm M3 indeed has had a close relationship with such major economic variables as nominal GNP. We shall return to this point in a later section, where we apply Motley's hypothesis to Japan's data.

III. The Concept of Information Variables

Although various studies have made an explicit or implicit reference to information variables, which would be used as criteria in managing monetary policy,[2] each study has offered a slightly different definition or requirements for the term. In the following discussion, we require that an information variable "possesses information that is useful in predicting the ultimate target." Unlike an intermediate target, an information variable is not required to have a structurally causal relationship with the ultimate target. In other words, an information variable is expected only to improve the predictability of the target variable or to Granger-cause the target variable. Active researches along these lines have been conducted on information variables in recent years, primarily in the United States.

A. Principal information variables

1. Commodity prices

Wayne Angell of the Federal Reserve Board has proposed that the money supply be adjusted on the basis of the level and the change of a commodity price index (Angell, 1987). Garner (1989a) tested the usefulness of commodity price indexes both as an intermediate target and as an information variable. Assessing its usefulness as an intermediate target, his ADF tests found no evidence of cointegration between commodity price index and general price level; the commodity price index was thus shown to be inappropriate as an intermediate target, when the price stability is regarded as the main goal of monetary policy. To determine its usefulness as an information variable, he performed Granger tests and variance decomposition, and found that the commodity price index contains useful information about future inflation. A similar conclusion has been reached by Durand and Blöndal (1988) as well as by Boughton, Branson and Muttardy (1989). On the other hand, Furlong (1989), Baillie (1989) and McCallum (1989) have come to a negative conclusion about the usefulness of the commodity price index, primarily because of their different testing methodologies.

2. Interest rate spreads

A spread between long-term and short-term interest rates indicates, under certain assumptions, the difference in expected inflation rates across time. Mishkin (1988) has

[2]See, for example, McCallum (1989), Goodhart (1989), Friedman (1977, 1988a), Johnson (1988a, 1988b), Kohn (1989), McNees (1989), Lown (1989), Furlong (1989), Garner (1989a, 1989b) and Davis (1990).

proposed the following regression equation, as a means of empirically testing whether such an interest rate spread ($i_L - i_S$) holds information about the spread in expected inflation rates ($\pi_L - \pi_S$).[3]

$$\pi_L - \pi_S = \alpha + \beta (i_L - i_S) + e$$

A statistically significant estimate of β suggests that the interest rate spread holds information about the spread in expected inflation rate. The empirical results of Mishkin (1988), Browne and Manasse (1989) and Bernanke (1990) argued for the usefulness of the interest rate spread as an information variable.

3. Others

Pointing to another information variables, exchange rate, which has been long considered a factor in determining the price level through various channels, is often remarked as an important variable by scholars and central bankers (Johnson, 1988a; Leigh-Pemberton, 1986). It is also said that capacity utilization has some relationship with changes in the inflation rate (Bauer, 1990). In Japan, land prices and stock prices have also received much attention.

B. Information variables and policy management

To use information variables in managing monetary policy, the following three general issues must be resolved at the outset: (1) how to find appropriate information variables; (2) how to utilize signals obtained from two or more information variables; and (3) whether the use of information variables should be made public. Concerning the second issue, Johnson (1988b) suggested to select several important information variables, and to change policy when all components of such "basket" hold the same message.

IV. Empirical Results Based on Japan's Data

In the preceding sections, we have briefly overviewed debates on the reexamination of intermediate targets and discussions on information variables in the United States. It is possible to apply the same arguments to Japan's situation, because financial liberalization and innovation are thought to have weakened the relationship between the money supply and the general price level during the past several years.[4] In the following section, therefore, the same methodologies are applied to Japanese data.

To be specific, the validity of the liquidity-based decomposition of M3+CDs in

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[3]Realized (ex post) inflation rates are used as proxies for expected inflation rates. See Mishkin (1988).

[4]See, for example, Yoshida and Rasche (1990).

Japan is tested,[5] and then whether major information variables contain information about the ultimate target in Japan is examined. It is assumed that the ultimate target of Japanese monetary policy is price stability,[6] so that all the tests on information variables below will consider their relationship to the Consumer Price Index (CPI).[7]

A. Usefulness of the liquidity-based decomposition of M3+CDs

As noted in Section II, Motley (1988) argued that one should decompose M3 according to liquidity, and that only "nonterm" component should be emphasized in relation to the ultimate target instead of M1 and M2. Following this argument, Japanese M3+CDs are decomposed according to the same criterion, and Motley's money-demand function is estimated with data. Its applicability as an intermediate target and an information variable is also tested.

M3+CDs can be decomposed as follows. The substance of nonterm M3 lies in its high liquidity (i.e., it can be easily withdrawn and used to purchase goods and services). Consequently, nonterm M3 should include all of M1 (ignoring the existence of the compensating balances required of corporations) and checking deposits of net M3 (i.e., M3−M2). Moreover, it should include a certain portion of the time deposits held by individuals[8] (such as postal savings certificates that have been held for more than six months[9]), since they can be easily withdrawn and used to purchase goods and services.

In the analysis below, two types of nonterm M3 are employed[10]: (1) adding the portion of postal savings certificates to M1+nonterm net M3 (referred to as nonterm $M3_A$) and (2) adding quasi-money held by individuals to $M3_A$[11] (referred to as $M3_B$). Then Motley's money-demand function is estimated for each of the following three pairs:

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[5]Related studies also include studies of divisia measures of the monetary aggregate and of P*. See, for example, Ishida (1984) and the Bank of Japan (1990) for their applications to Japan.

[6]The information-variable approach can also be applied to other policy targets, such as the nominal GNP and the unemployment rate.

[7]The CPI is often used in empirical studies in the United States. Needless to say, the GNP deflator would be another choice.

[8]In contrast to the United States, where checks are the predominant means of settlement (which means that settlement funds are concentrated in checkable deposits), settlements in Japan are mostly in cash. This means that the more liquid portion of time deposits in Japan may contain a large amount of settlement funds.

[9]Postal savings certificates that are held within six months are unlikely to be redeemed since the penalty makes the rate of return lower than that on demand deposits. However, postal savings certificates that are held for more than six months can be easily redeemed, and their rate of return exceeds that on demand deposits. Therefore, the following measure contains funds that potentially can be used to purchase goods and services:

$$R_t - \sum_{i=0}^{5} D_{t-i}$$

where R_t is the outstanding balance of postal savings certificates in period t, and D_t is the value of new postal savings certificates purchased in period t. In the analysis below, this measure is included in nonterm M3.

[10]Most M3 data are end-of-period, but it makes a limited use of period average data.

[11]The same argument that was applied to postal savings certificates can be applied to quasi money held by individuals to some extent.

nonterm $M3_A$ and term $M3_A$; nonterm $M3_B$ and term $M3_B$; and M2+CDs and net M3 (see Table 1). To see whether Motley's results are borne out in Japan, the same methodologies are used in terms of lag structure and choices of variables.

When nonterm $M3_A$ and nonterm $M3_B$ are used, we find that the statistical significance and absolute values of many of the coefficients increased after the 1980s. This tendency is particularly noticeable for the change of the nominal GNP (important for its effects on the price level) and for the change of interest rates (important for their applications in managing monetary policy), consistent with the results reported by Motley (1988). In contrast, when M2+CDs are used, no statistically significant relationship with the change of the no-nominal GNP is found, although the standard errors of the estimated equation are relatively small.

Admittedly, the data used here are preliminary, and Motley's specification of the regression equation is not so general. Subject to these limitations, however, the empirical results reported here point to the analytical usefulness of decomposing money on the basis of liquidity in Japan.

1. Appropriateness as an intermediate target (cointegration test)

Next, apart from Motley's money-demand function, the appropriateness of nonterm M3 as an intermediate target is examined by testing for cointegration between nonterm M3 and the CPI.[12] The estimation results of ADF tests (Table 2) cannot support the existence of cointegration at the 10 percent level of significance, indicating that it is not appropriate to use nonterm M3 as an intermediate target (essentially the same results were obtained for estimation based on the data from only the 1980s). According to this test, M2+CDs are also inappropriate as an intermediate target.

2. Information content

Granger tests are now used to see whether nonterm $M3_A$ and nonterm $M3_B$ possess information on the monthly movements of the CPI,[13] —that is, whether they qualify as information variables (Table 3).[14]

The estimation results indicate that the statistical significance of nonterm M3 increased in the 1980s. This is consistent with the earlier result in which the statistical fit of Motley's money demand function improved in the 1980s when nonterm M3 was used. In the 1980s, nonterm M3 outperformed M2+CDs in terms of statistical significance, which suggests the usefulness of nonterm M3. It should be remembered, however, that the

[12]Non-stationarity of the major time series were checked prior to performing the cointegration tests. LM tests were used to determine the lag structure of estimation equations.

[13]Monthly data were used in the analysis below to maintain a sufficient degree of freedom. However, quarterly data might also be used to minimize short-term noise in data.

[14]AIC and other criteria are used to determine the lag structure. The same procedure was followed in other Granger tests and variance decompositions in the rest of this paper.

Table 1

Estimation of the Motley-Type Money Demand Function in Japan

	Nonterm $M3_A$				Term $M3_A$			
	1970s		1980s		1970s		1980s	
	Coefficient estimate	t-statistic	Coefficient estimate	t-statistic	Coefficient estimate	t-statistic	Coefficient estimate	t-statistic
Constant	0.009	1.525	−0.002	0.165	0.014	2.900	−0.031	4.364
$\Delta \log M_{t-1}$	0.021	0.154	0.047	0.479	0.373	2.888	0.025	0.188
$\Delta \log Y_t$	0.066	2.214	0.092	4.247	−0.082	3.864	−0.057	3.302
$\Delta GS3_t$	−0.002	1.473	−0.010	2.847	−0.000	0.390	0.007	2.424
$\Delta GS3_{t-1}$	−0.001	0.852	−0.015	3.847	−0.002	1.477	0.008	2.699
$\Delta LOANS_t$	0.001	0.332	0.001	0.356	0.009	5.059	0.003	1.964
$\Delta LOANS_{t-1}$	0.001	2.689	0.005	2.381	−0.005	2.489	−0.005	3.053
$\log M_{t-1}$	−0.035	0.089	−0.113	2.902	0.016	0.519	0.041	1.915
$GS3_{t-1}$*	−0.005	1.002	−0.058	6.697	−0.009	1.643	−0.051	4.249
$\log Y_{t-1}$*	1.138	25.078	0.687	6.628	1.068	23.785	0.945	6.517
SEE	0.136		0.0123		0.0106		0.0089	
DW	2.399		1.860		2.610		1.677	

	Nonterm $M3_B$				Term $M3_B$			
	1970s		1980s		1970s		1980s	
	Coefficient estimate	t-statistic	Coefficient estimate	t-statistic	Coefficient estimate	t-statistic	Coefficient estimate	t-statistic
Constant	0.013	3.336	−0.004	0.787	0.012	1.950	0.050	4.949
$\Delta \log M_{t-1}$	0.144	1.097	−0.026	0.262	0.462	3.475	−0.073	0.548
$\Delta \log Y_t$	0.022	1.433	0.049	4.422	−0.083	2.904	−0.080	3.232
$\Delta GS3_t$	−0.001	1.088	−0.009	4.581	−0.002	1.060	0.016	3.910
$\Delta GS3_{t-1}$	−0.001	1.558	−0.009	4.151	−0.001	0.755	0.014	3.191
$\Delta LOANS_t$	0.003	2.588	0.003	2.739	0.009	3.450	−0.000	0.103
$\Delta LOANS_{t-1}$	0.003	1.831	0.002	1.512	−0.006	2.231	−0.006	2.617
$\log M_{t-1}$	−0.013	0.611	−0.078	3.583	−0.005	0.125	0.060	2.437
$GS3_{t-1}$*	−0.007	1.257	−0.055	6.565	−0.008	1.550	−0.050	3.396
$\log Y_{t-1}$*	1.147	24.964	0.693	6.801	1.003	22.275	1.114	6.267
SEE	0.0071		0.0067		0.0156		0.0135	
DW	2.284		1.804		2.421		1.624	

Table 1 (continued)

	M2 + CDs				Net M3A			
	1970s		1980s		1970s		1980s	
	Coefficient estimate	t-statistic	Coefficient estimate	t-statistic	Coefficient estimate	t-statistic	Coefficient estimate	t-statistic
Constant	0.004	1.448	0.011	2.625	0.037	9.318	0.007	1.614
$\Delta \log M_{t-1}$	0.541	2.773	0.318	2.366	0.067	0.648	0.683	4.490
$\Delta \log Y_t$	−0.012	0.822	−0.011	1.268	0.017	1.435	−0.009	1.069
$\Delta GS3_t$	−0.021	2.086	0.003	2.126	0.001	1.065	−0.002	1.697
$\Delta GS3_{t-1}$	−0.001	3.180	−0.005	3.306	−0.001	1.990	0.003	2.365
$\Delta LOANS_t$	0.002	0.877	0.002	2.757	0.006	5.115	0.004	4.857
$\Delta LOANS_{t-1}$	0.001	0.376	−0.001	0.885	−0.002	1.558	−0.004	5.257
$\log M_{t-1}$	−0.027	1.325	0.013	1.187	−0.092	6.425	−0.004	0.362
$GS3_{t-1}$*	−0.005	0.931	−0.050	4.524	−0.011	1.816	−0.010	5.735
$\log Y_{t-1}$*	1.053	22.274	0.850	6.425	1.323	24.240	0.126	6.750
SEE	0.0069		0.0046		0.0052		0.0036	
DW	2.226		2.279		1.889		2.641	

Note: The variables are as follows: M = money supply; Y = nominal GNP; GS3 = 3 month gensaki rate; and LOANS = the value of bank credit outstanding.

** indicates that the estimates are obtained from long-run equation.*

Table 2
ADF Tests of CPI and Nonterm M3

Dependent variable	Nonterm $M3_A$	Nonterm $M3_B$	M2 + CDs
CPI	1.97	1.09	1.63
Monetary aggregates	1.63	0.84	1.32

Note: Data in logarithms. "Dependent variable" is the one that is used in the first stage of estimation.
Sample period: 1971/IQ ~ 89/IVQ

Table 3

Tests of Granger Causality from Nonterm M3 to CPI (P-value)

Information set: Nonterm $M3_A$, CPI, and two additional variables as shown below
Number of lags: 2 months

(%)

Additional variables in the information set	Full sample	1970s	1980s
Nikkei Commodity Price Index; Yen/dollar exchange rate	92.3	84.8	3.2
3-month gensaki rate; Yen/dollar exchange rate	73.2	78.2	3.1
3-month gensaki rate; Nikkei Commodity Price Index	99.9	93.7	1.7
Nikkei Commodity Price Index; Mining and Manufacturing Production Index	83.7	82.8	1.7

Information set: Nonterm $M3_B$, CPI, and two additional variables as shown below
Number of lags: 2 months

(%)

Additional variables in the information set	Full sample	1970s	1980s
Nikkei Commodity Price Index; Yen/dollar exchange rate	87.4	73.1	7.6
3-month gensaki rate: Yen/dollar exchange rate	69.3	80.6	6.8
3-month gensaki rate; Nikkei Commodity Price Index	99.4	84.2	4.5
Nikkei Commodity Price Index; Mining and Manufacturing Production Index	78.9	77.6	4.6

Note: All variables (except for gensaki rate) are annual log-differences (for CPI and exchange rate) or monthly log-differences (for all the others). All results are expressed in P-value (the level of significance).
Sample period: 1971/1 ~ 89/12

disadvantage of nonterm M3 lies in the additional time to obtain data on postal savings.[15]

B. Usefulness of principal information variables

Next, empirical analyses of several financial and economic indicators are performed to test their usefulness as information variables in Japan. Specifically, we first test the appropriateness of each indicator as an intermediate target, then test its appropriateness as an information variable. The candidates for information variables are commodity price indexes, interest rate spreads, and foreign exchange rate (which are discussed in Section III), and land prices and stock prices, which have received some attention in recent years in Japan.

1. Commodity prices

The Nikkei Commodity Price Index, calculated by the Nihon Keizai Shimbun, is the principal index of yen-denominated commodity prices in Japan. Since a large share of raw materials in Japan are imported, the Reuter Index (denominated in sterling) and the OCI Index (denominated in SDRs) are also used for reference purposes, after converted into yen terms. The entire sample covers the period from the first quarter of 1970 to the fourth quarter of 1989. The period is also divided into two subperiods, with the first from the first quarter of 1970 to the fourth quarter of 1979 (inclusive of the two oil crises), and the second from the first quarter of 1980 to the fourth quarter of 1989. For estimation involving the OCI Index, whose reporting began in January 1983, however, the sample covers only the period from the first quarter of 1983 to the fourth quarter of 1989.

—Appropriateness as an intermediate target (cointegration test)

Before examining the appropriateness of commodity prices as information variables, we examine their appropriateness as intermediate targets by using ADF tests to see whether a commodity price index and the CPI are cointegrated (Table 4).[16] The estimation results cannot support the hypothesis that the CPI and the commodity price indexes are cointegrated at the 10 percent level of significance. Thus, the results suggest that they do not have stable long-term relationships and that using commodity prices as inter-

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[15]Variance decomposition analysis indicates that, in a system containing nonterm $M3_A$ (or nonterm $M3_B$), CPI, the Nikkei Commodity Price Index, the foreign exchange rate and the gensaki rate, nonterm M3 explains only around one percent of the prediction error variance for the CPI. This also suggests that caution should be exercised before accepting nonterm M3.

[16]Baillie (1989) performed a brief empirical analysis of commodity prices as applied to Japan. In another test of commodity prices in Japan, Boughton, Branson and Muttardy (1989) suggested that commodity prices showed cointegration with the rate of inflation but not with the CPI level. Because this type of test presupposes that the CPI level follows I(2) process, there is a possibility that annual changes of the CPI and a commodity price index both follow I(1) process, and are cointegrated. However, the results of Baillie (1989) and Boughton, Branson and Muttardy (1989) suggest that the Japanese CPI follows I(1) process, which means that annual changes of the CPI (which is highly likely to be stationary) and a commodity price index, by definition, cannot be cointegrated.

Table 4
ADF Tests of CPI and Commodity Price Indexes

Commodity price index	Dependent variable	Full sample	1970s	1980s
Nikkei Commodity Price Index	CPI	1.56	2.71	2.09
	Commodity Price Index	2.20	2.90	2.15
Reuter Commodity Price Index	CPI	1.86	2.02	2.15
	Commodity Price Index	1.97	2.83	2.21
OCI Commodity Price Index	CPI	2.25		
	Commodity Price Index	2.18		

Note: Data in logarithms. Reuter Index and OCI Index are expressed in yen terms.
Sample period: 1970/IQ ~ 89/IVQ

mediate targets is inappropriate.

—Information content

Next, we test the appropriateness of commodity prices as information variables. First, we use Granger tests to see whether a commodity price index (here the Nikkei Commodity Price Index) contains information about monthly movements of the CPI (Table 5).

We find that, when the length of lags is set at six months, there is statistically significant evidence of Granger causality from the commodity price index to the CPI in many instances. However, when the length of lags is set at twelve months, the level of significance fell in the 1980s. For the 1970s, therefore, it is possible to argue that the commodity price was a useful information variable in predicting future changes in the general price level. But, for the 1980s, Granger tests alone cannot furnish conclusive evidence. Therefore, following Garner (1989b), variance-decomposition analysis is used (Table 6). The results indicate that the innovations of the commodity price index explain a substantial portion of the prediction error variance for the CPI both for the 1970s and the 1980s. The commodity price index is thus seen as a useful information variable in the 1980s.

2. Foreign exchange rate

—Appropriateness as an intermediate target (cointegration test)

To examine the appropriateness of the exchange rate as an intermediate target, tests for the long-term relationship between the yen/dollar exchange rate and the CPI are first conducted.[17] An important point here concerns purchasing power parity (PPP): it is

[17]An effective exchange rate may be used instead of the yen/dollar exchange rate. In this case, it is necessary to calculate a weighted average of the CPIs in several countries.

Table 5

Tests of Granger Causality from Nikkei Commodity Price Index to CPI (P-value)

Information set: Nikkei Commodity Price Index, CPI, and two addition variables as shown below

(%)

Additional variables in the information set	Full sample	1970s	1980s
	Number of lags: 6 months		
High-powered money; Mining and Manufacturing Production Index	0.0	0.0	3.2
High-powered money; 3-month gensaki rate	0.2	0.8	2.5
High-powered money; Yen/dollar exchange rate	0.6	6.8	29.6
M1; Mining and Manufacturing Production Index	0.0	0.1	7.2
M1; 3-month gensaki rate	0.2	1.6	4.2
M1; Yen/dollar exchange rate	0.1	4.4	10.5
	Number of lags: 12 months		
High-powered money; Mining and Manufacturing Production Index	0.0	0.6	71.2
High-powered money; 3-month gensaki rate	0.0	0.2	38.6
High-powered money; Yen/dollar exchange rate	0.0	0.3	95.4
M1; Mining and Manufacturing Production Index	0.0	0.4	41.6
M1; 3-month gensaki rate	0.0	0.9	35.6
M1; Yen/dollar exchange rate	0.0	2.7	78.0

Note: All variables (except for gensaki rate) are first log-differences.
Sample period: 1970/1 ~ 89/12

Reference: When CPI is expressed as an annual log-difference

(%)

Additional variables in the information set	Full sample	1970s	1980s
	Number of lags: 6 months		
High-powered money; Mining and Manufacturing Production Index	0.0	0.5	26.7
M1; Mining and Manufacturing Production Index	0.0	0.0	26.0
	Number of lags: 12 months		
High-powered money; Mining and Manufacturing Production Index	0.0	0.2	30.8
M1; Mining and Manufacturing Production Index	0.0	0.0	41.8

Note: This follows Garner (1989b). All other variables are first log-differences.
Sample period: 1970/1 ~ 89/12

Table 6
Variance Decomposition of CPI

Information set: CPI, M1, Nikkei Commodity Price Index (NS), and yen/dollar exchange rate (YD)

Month	1970s				1980s			
	CPI	M1	NS	YD	CPI	M1	NS	YD
	Number of lags: 6 months							
2	97.4	0.0	2.3	0.4	99.4	0.2	0.2	0.2
6	66.1	1.4	30.6	1.9	81.8	3.5	6.4	8.2
12	29.0	6.0	63.9	1.1	47.9	2.6	19.1	30.4
24	14.9	10.7	70.4	4.0	36.7	2.1	21.9	39.3
	Number of lags: 12 months							
2	96.0	0.0	3.1	0.8	99.6	0.3	0.2	0.0
6	56.7	4.4	31.0	7.9	73.1	0.9	14.2	11.8
12	18.1	25.4	51.7	4.8	37.6	5.5	31.9	25.0
24	4.4	76.2	17.1	2.3	26.1	9.1	42.2	22.6

Note: All variables are annual log-differences (for CPI and exchange rate) or first log-differences (for all the others). The ordering of diagonalization is as shown in the row. Similar results were obtained for the explanatory power of Nikkei Commodity Price Index, when the gensaki rate or Mining and Manufacturing Production Index was used in place of the yen/dollar exchange rate.
Sample period: 1970/1 ~ 89/12

essential to consider foreign CPIs as well as the Japanese CPI, when we are identifying the long-term relationship between the exchange rate and the CPI, because foreign inflation can appreciate the nominal value of the yen even if the Japanese CPI is stable. For this reason, the long-term relationship between the exchange rate and PPP (between Japan and the United States) must be checked.

If we know the PPP exchange rate in period $t-k$ (PPP_{t-k}), the theoretical PPP rate in period t (PPP_t) is expressed by

$$PPP_t = PPP_{t-k} \times \frac{CPI_t^J}{CPI_t^U}$$

where CPI_t^J is the Japanese CPI normalized by CPI_{t-k}^J, and CPI_t^U is the U.S. CPI normalized by CPI_{t-k}^U. Consequently, if the actual yen/dollar exchange rate is consistent with PPP in the long run, the exchange rate and the relative CPI between Japan and the United States should be cointegrated. The results of ADF tests are reported in Table 7.

According to these results, we cannot find cointegration at the 10 percent level of significance, indicating that the yen/dollar exchange rate and the relative CPI between

Table 7
ADF Tests of Purchasing Power Parity

	PPP	CPI
Relative CPIs between Japan and the U.S.	2.15	1.52
Reference: CPI^J only	1.71	1.87

Note: Data in logarithms.
Sample period: 1970/IQ ~ 89/IVQ

Table 8
Tests of Granger Causality from Yen/Dollar Exchange Rate to CPI (P-value)

Information set: Yen/dollar exchange rate, CPI, and two additional variables as shown below
Number of lags: 6 months

(%)

Additional variables in the information set	Full sample	1970s	1980s
High-powered money; Nikkei Commodity Price Index	36.5	54.5	29.0
M1; Nikkei Commodity Price Index	29.9	40.0	16.4

Note: All variables are first log-differences.
Sample period: 1970/1 ~ 89/12

Japan and the U.S. (that is, the theoretical PPP rate) do not have a stable long-term relationship. This means that targeting the exchange rate is not a reliable way to achieve price stability.

—Information content

Next, in order to examine whether the exchange rate can be used as an information variable for annual changes in the monthly CPI over a relatively short term, Granger tests on the yen/dollar exchange rate are conducted, where the information set includes the CPI, the yen/dollar exchange rate, the Nikkei Commodity Price Index, and high-powered money (Table 8; because of the short-term nature of this analysis, the U.S. CPI is not considered). The estimation results indicate that the relative statistical significance of the exchange rate increased in the 1980s. When we remember the earlier results showed that (1) the statistical significance of commodity prices in Granger tests deteriorated in the 1980s when the yen/dollar exchange rate was included in the information set (Table 5) and that (2) the explanatory power of the yen/dollar exchange rate increased in variance-decomposition analysis in the 1980s (Table 6), it is possible to say that the usefulness of the exchange rate as an information variable is increasing.

3. Interest rate spreads

The spread between long-term and short-term interest rates represents the difference in the expected rates of inflation if the real interest rate is assumed constant. In the empirical tests below, combinations of the following interest rates are tested: the yield on 10-year government bonds, the yield on 5-year interest-bearing bank debentures, the issuing rate of 6-month CDs, 1 to 3-month gensaki rates, and the overnight interest rate (because of data limitation, the sample for many tests covers the period from January 1980 to December 1989). In some cases, tests are conducted in subsample periods. The tests entail checking the value and t-statistics of coefficient β in the following regression equation. The estimation method is ordinary least squares (OLS), and the difference between inflation rates (annual changes, monthly data) that correspond to the periods of interest rates are regressed on the interest spreads (Table 9, 10).[18]

$$\pi_L - \pi_S = \alpha + \beta(i_L - i_S) + e$$

where π_L and π_S are long- and short-term inflation rates, and i_L and i_S are long- and short-term nominal interest rates, respectively.

According to the results reported in the tables, such spreads as (3-month gensaki rate − overnight rate) and (5-year bank debenture yield − 3-month gensaki rate) roughly correspond to the actual changes in inflation, and that stable relationships exist across subsamples (Table 10). Thus, these interest rate spreads can be considered candidates for information variables. However, when we plot these two interest rate spreads across time, we find that in the short-term, movements in the spreads did not closely correspond to the ex post movements of the CPI, and that the strength of their relationships differ across time (Figures 1 and 2). These points suggest that caution should be exercised in using interest rate spreads as information variables.

4. Land and stock prices

—Appropriateness as an intermediate target (cointegration test)

First, ADF tests are conducted to see whether land and stock prices are cointegrated with the CPI in order to determine the appropriateness of these variables as intermediate targets (Table 11).[19] The empirical results indicate no statistically significant cointegra-

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[18]In the analysis reported here, annual changes in the CPI are used for π_L and π_S, because information variables for the general index of inflation are searched. However, it is also possible to use the annualized rate of CPI changes over the maturity of a long- and a short-term financial instrument. Mishkin (1989a) has applied this methodology to Euro-yen deposit rates and Japanese CPI inflation, and obtained a statistically significant result for the interest rate spreads over a relatively short period.

[19]As a measure of land prices, the Urban Land Price Index (the average of the six largest cities as well as the average of all cities; semi-annual data) is used, which is published by the Japan Real Estate Institute; for stock prices, the TOPIX of the Tokyo Stock Exchange and the Nikkei Average are used.

Table 9
Estimation Results of Interest Rate Spreads

Interest rate spread	Coefficient estimate	t-statistic
1M gensaki rate–overnight rate	0.18	1.34*
2M gensaki rate–overnight	0.28	1.36*
3M gensaki rate–overnight	0.29	2.12**
CD rate–overnight rate	1.03	3.71***
Bank debenture yield – 1M gensaki rate	0.22	0.53
Bank debenture yield – 2M gensaki rate	0.50	1.22
Bank debenture yield – 3M gensaki rate	2.22	11.59***
Bank debenture yield – CD rate	0.53	3.07***
Government bond yield – 1M gensaki rate	0.09	7.07***
Government bond yield – 2M gensaki rate	0.97	5.46***
Government bond yield – 3M gensaki rate	1.71	12.42***

*Note: *, **, and *** indicate that the statistic is significant at 10, 5 and 1 percent, respectively.*

Table 10
Estimation Results of Interest Rate Spreads (Subsamples)

Interest rate spreads	1970/1 – 79/12	1980/1 – 84/12	1985/1 – 89/12
3-month gensaki rate – overnight rate	1.64*	2.27**	2.03**
CD rate – overnight rate	–	1.39*	1.74**
Bank debenture yield – 3-month gensaki rate	8.88***	1.91**	–

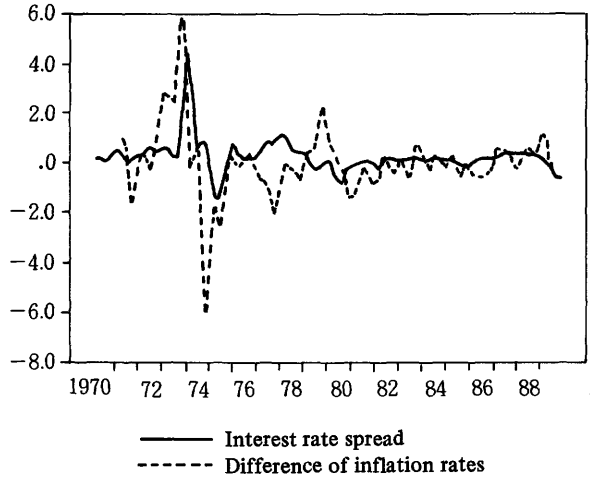
*Note: *, **, and *** indicate that the statistic is significant at 10, 5, and 1 percent, respectively.*

Table 11
ADF Tests of Land/Stock Prices and CPI

Dependent variable	Land prices in all cities	Land prices in 6-big cities	TOPIX	Nikkei Average
CPI	2.49	1.82	1.10	0.96
Each land/stock price index	2.97*	1.04	0.24	0.94

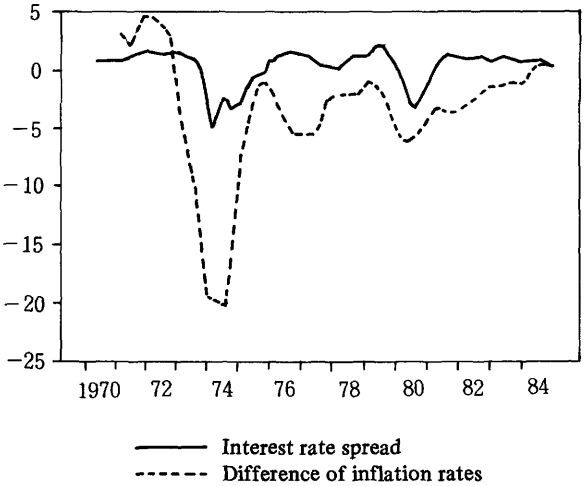
*Note: *indicates that the statistic is significant at 10 percent. Data in logarithms.*
Sample period: 1970/IQ ~ 89/IIQ

Figure 1. Movements of Interest Rate Spread and Difference of Inflation Rates
(moving average: gensaki rate (3 month) – overnight rate)



Note: The difference of inflation rates (DIR (3 month-overnight)) is calculated as follows:
DIR (3 month-overnight) = INFL (t + 3) - INFL (t)
where t is the month when the spread is observed, and INFL (t) is the inflation rate of the t-month.

Figure 2. Movements of Interest Rate Spread and Difference of Inflation Rates
(moving average: bank debenture yield (5 year) – gensaki rate (3 month))



Note: The difference of inflation rate is calculated as follows:
DIR (5 year – 3 month) = INFL (t + 60) – INFL (t + 3)

tion between the index of land prices in large cities and the CPI, while there is at least partially significant cointegration between the index of land prices in all cities and the CPI. On the other hand, stock prices have no stable long-term relationship with the CPI.

—Information content

Next, the appropriateness of land and stock prices as information variables is tested. First, we conduct Granger tests on land prices (Table 12). The information set is chosen from land prices, M1, commodity prices, interest rates and the exchange rate. (Because data on land prices are available only semi-annually, the land data are transformed to quarterly data by interpolation in order to preserve a sufficient degree of freedom.)

The estimation results reject the presence of Granger causality from land prices to the CPI at the 10 percent level of significance in many instances during the 1980s. This probably reflects the fact that the increases in land prices during the second half of the 1980s continued while there was no corresponding increase in the CPI. For the 1970s, however, Granger causality was statistically significant, indicating that land prices led the CPI chronologically. This conclusion is reinforced by the results of variance decomposition analysis (Table 13).

It should be noted, however, that (1) the sample period contains only two episodes of major land price inflation (in the early 1970s and in the late 1980s) and (2) interpolated data may lack reliability. The results reported above thus remain tentative, and further, more rigorous analysis is needed to determine the information content of land prices.

Table 12

Tests of Granger Causality from Land Prices to CPI (P-value)

Information set: CPI, M1, one of the land price indexes and one additional variable as shown below

Number of lags: 5 quarters

(%)

Additional variables in the information set		Full sample	1970s	1980s
Index of land prices in all cities	Nikkei Commodity Price Index	56.7	3.4	11.2
	3-month gensaki rate	1.0	0.9	49.4
	Yen/dollar exchange rate	26.2	1.7	76.5
Index of land prices in 6-big cities	Nikkei Commodity Price Index	6.4	15.3	0.6
	3-month gensaki rate	0.0	2.0	59.4
	Yen/dollar exchange rate	0.1	0.4	41.1

Note: All variables (except for gensaki rate) are annual log-differences (for CPI and exchange rate) or quarterly log-differences (for all the others).

Sample period: 1970/IQ ~ 89/IVQ

Table 13
Variance Decomposition of CPI

Information set: CPI, M1, yen/dollar exchange rate (YD) and index of land prices in 6-big cities (BIG)
Number of lags: 5 quarters

Quarter	1970s				1980s			
	CPI	M1	YD	BIG	CPI	M1	YD	BIG
2	95.2	2.2	2.5	0.1	82.6	0.2	0.0	17.2
4	61.2	5.7	7.8	25.4	63.4	0.4	27.5	8.8
8	23.4	43.5	7.5	25.6	65.6	1.1	25.2	8.1
12	24.9	34.3	13.2	27.5	65.0	2.1	23.0	9.9

Note: All variables are annual log-differences (for CPI and exchange rate) or quarterly log-differences (for all the others). Similar results were obtained for the explanatory power of land prices when Nikkei Commodity Index or gensaki rate was used in place of yen/dollar exchange rate.
Sample period: 1970/IQ ~ 89/IVQ

Table 14
Tests of Granger Causality from Stock Prices to CPI (P-value)

Information set: CPI, M1, one of the stock price indexes and one additional variable as shown below
Number of lags: 13 months

(%)

Additional variables in the information set		Full sample	1970s	1980s
TOPIX	Nikkei Commodity Price Index	13.8	12.0	11.9
	3-month gensaki rate	7.8	0.2	40.3
	Yen/dollar exchange rate	6.6	16.9	79.9
Nikkei Average	Nikkei Commodity Price Index	14.0	10.4	15.2
	3-month gensaki rate	14.3	1.8	68.7
	Yen/dollar exchange rate	9.7	10.3	92.1

Note: All variables (except for gensaki rate) are annual log-differences (for CPI and exchange rate) or monthly log-differences (for all the others).
Sample period: 1970/1 ~ 89/12

Table 15
Variance Decomposition of CPI

Information set: CPI, M1, Nikkei Commodity Price Index (NS), gensaki rate (GS) and Nikkei Average (NK)
Number of lags: 13 months

Month	1970s					1980s				
	CPI	M1	NS	GS	NK	CPI	M1	NS	GS	NK
2	94.3	0.0	0.9	3.3	1.5	97.6	0.0	0.1	0.1	2.3
6	64.7	6.3	13.0	10.5	5.5	63.9	0.5	16.2	14.5	4.9
12	29.7	14.1	45.6	5.9	4.7	32.3	2.5	47.4	7.1	10.4
24	14.2	27.0	34.0	13.9	10.9	36.7	9.8	39.9	4.3	9.3

Information set: CPI, M1, Nikkei Commodity Price Index (NS), yen/dollar exchange rate (YD), and Nikkei Average (NK)
Number of lags: 13 months

Month	1970s					1980s				
	CPI	M1	NS	YD	NK	CPI	M1	NS	YD	NK
2	98.4	0.3	0.7	0.2	0.3	94.3	2.4	0.6	0.1	2.7
6	69.4	4.0	23.5	2.6	0.5	70.3	8.2	9.4	2.5	9.6
12	30.0	16.1	47.6	2.6	3.7	27.2	17.6	43.9	2.9	8.4
24	17.5	53.9	18.6	1.6	8.4	17.0	21.7	51.7	1.2	8.5

Note: All variables (except for gensaki rate) are annual log-differences (for CPI and exchange rate) or monthly log-differences (for all the others).
Sample period: 1970/1 ~ 89/12

Similar tests on monthly movements of stock prices are then conducted. Granger causality tests generally reject a causal relationship between stock prices and the CPI, although there was some evidence of significant Granger causality in the 1970s (Table 14). Variance decomposition analysis, based on five variables, also indicates that the stock price indexes contain only single-digit explanatory power in many cases (Table 15). We may conclude that stock prices contain little information about the movement of the general price level.

C. Usefulness of an information-basket rule

Johnson (1988b) suggested a policy management rule that, after selecting important information variables, we change the stance of monetary policy when all the variables in

such a "basket" hold the same message. In this section, the usefulness of such an information-basket rule is tested. Following Johnson (1988b), commodity prices, interest rate spreads, and foreign exchange rates are selected as the information variables.

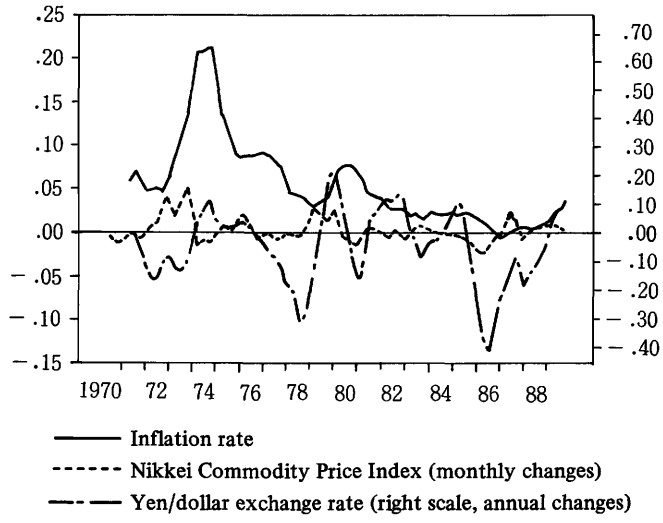
Figures 3 and 4 plot the interest rate spread (3-month gensaki − overnight rate), the commodity price index, the foreign exchange rate and the inflation rate across time. Although the interest rate spread (which gives information about the difference of (expected) inflation rates) cannot be interpreted just the same way as the other two variables (which give information on the inflation rate), the information has been tentatively extracted from these three variables. It can be said that all of the three variables move broadly in the same directions (1) in the second half of 1973, (2) in the second half of 1979, (3) in the first half of 1980, (4) through 1981, (5) through 1985, and (6) from late 1986 to early 1987. For each of these periods, the subsequent movements of inflation are observed:

(1) After an increase in the three indicators, inflation accelerated after about one year;
(2) After an increase in the three indicators, inflation accelerated after about half a year;
(3) After a decline in the three indicators, inflation decelerated after a little less than a year;
(4) While all of the three indicators increased, inflation maintained its decelerating trend;
(5) After the decelerating trend of the three indicators, inflation gradually subsided;
(6) After the accelerating trend of the three indicators, inflation accelerated moderately.

Although the basket of information variables may seem to offer fairly good information about the direction of inflation, it can give a misleading signal as is seen in (4). Furthermore, it is hard to recognize the time lag and the extent of the inflationary pressure. Considering these facts, we should conclude that Johnson's basket rule is useful but imperfect. It would be necessary to improve it further.

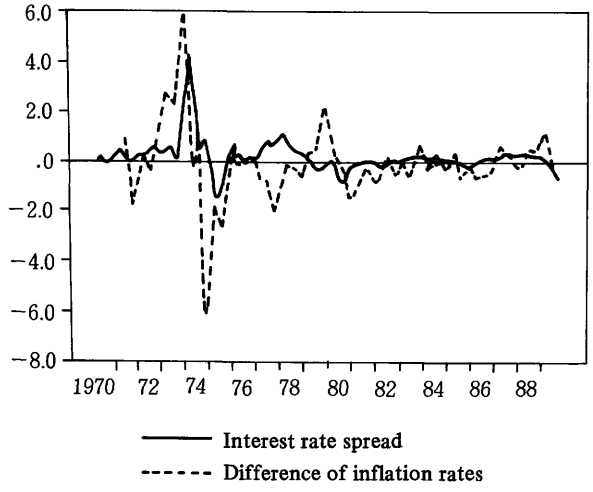
We can summarize our empirical results as follows. First, empirical tests based on Japanese data indicate that commodity prices, interest rate spreads and the foreign exchange rate contain at least partial information about the future CPI movement. On the other hand, stock and land prices did not contain sufficient information to predict the CPI movement, at least based on the data obtained from the past 10 years or so. Second, although a basket of information variables can provide some information about the direction of inflation, it can also mislead. Further analysis is needed before an information-basket rule would be used in managing monetary policy.

Figure 3. Movements of Commodity Price, Yen/Dollar Exchange Rate and CPI (moving average)



Note: All variables are in logarithms

Figure 4. Movements of Interest Rate Spread and Difference of Inflation Rates (moving average: gensaki rate (3 month) – overnight rate)



Note: See Figure 1.

Summary of Empirical Results from Japanese Data

	Appropriateness as an intermediate target (cointegration with the CPI)	Appropriateness as an information variable	
		1970s	1980s
Nonterm M3	X	X	O
Commodity prices	X	O	O
Foreign exchange rate	X	X	Δ
Interest rate spreads	–	O	O
Land prices	X	Δ	X
Stock prices	X	X	X

Reference: Summary of Empirical Results from Foreign Data

	Appropriateness as an intermediate target	Appropriateness as an information variable
Nonterm M3	O Motley (1988)[a]	...
Commodity prices	X Garner (1989a) Baillie (1989) Durand and Blöndal (1988)	O Garner (1989a) Durand and Blöndal (1988) Boughton, Branson and Mutterdy (1989) Δ Furlong (1989) X McCallum (1989) Baillie (1989)
Interest rate spreads	–	O Mishkin (1988, 1989b) Browne and Mannase (1989) Bernanke (1990)[b]
Credit aggregates	–	O Fackler (1988)[c]

Note: o, Δ, X *indicate that the appropriateness of the variable (either as an intermediate target or as an information variable) was generally accepted, accepted under certain conditions, or generally rejected, respectively.*

[a] *In terms of the empirical fit of Motley's money demand function, and not in terms of cointegration.*

[b] *He also tested spreads as information variables for the default risk and the stance of monetary policy.*

[c] *Appropriateness as an information variable for nominal GNP.*

V. Conclusion

In the United States, there recently have been active discussions about reassessing intermediate targets as well as about the usefulness of information variables. This paper has examined these discussions in the light of Japanese data.

For both the United States and Japan, while some studies indicate that several variables are useful in improving the predictability of the general price movement, the overall empirical results are mixed. However, in Japan's environment of increasing financial liberalization and innovation, the concept of information variables provides an important approach to thinking about monetary policy. The usefulness of such an approach must be examined further.

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