Asset Price Fluctuation and Price Indices

Shigenori Shiratsuka

Since the late 1980s, the Japanese economy has experienced tremendous rise and fall of asset prices and large fluctuations of real economic activity, while the general price level has remained relatively stable. Such developments have raised the question of whether monetary policy should target asset prices rather than conventional price indices. This paper focuses on how to make use of information inherent with asset price fluctuations in the monetary policy judgment. To this end, it investigates the possibility of incorporating asset price data into inflation measures by extending the conventional price index concept into a dynamic framework. The main conclusion of this paper is as follows. Although the concept of such extensions of the conventional price index is highly evaluated from a theoretical viewpoint, it is difficult for monetary policy makers to expect it to be more than a supplementary indicator for monetary policy judgment. This is because (1) reliability of asset price statistics is quite low, compared with the conventional price indices; and (2) asset price changes do not necessarily mean that the future price changes, because there are a lot of sources for asset price fluctuation besides the private-sector expectation for inflation.

Key words: Asset price; Intertemporal cost of living index; Dynamic equilibrium price index; Monetary policy; Information variable

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I. Introduction

Looking at Japan's macroeconomic development since the late 1980s, the so-called "bubble era," asset prices rose and declined tremendously, and business conditions fluctuated remarkably, while consumer and wholesale prices remained relatively stable. Such developments raised questions of whether monetary policy should have targeted asset prices rather than conventional price indices.[1] In general, asset prices reflect market participants' expectations about the future, and market expectations seem to have played an important role behind the scene of the bubble economy. Keeping this question in mind, I examine the possibility of constructing a reliable inflation measure that includes asset price information from the theoretical and practical viewpoints.[2]

As far as monetary policy tries to achieve the medium- to long-run sustainable price stability, it is insufficient to monitor the fluctuation of the conventional price indices that reflect only information on the current inflation.[3] By contrast, asset prices provide monetary policy makers with useful information in the sense that vividly reflects the private-sector expectation for inflation.[4] Moreover, the dynamic extension of the conventional price index concept indicates that asset prices are a desirable proxy for the future inflation. Alchian and Klein (1973) first proposed an intertemporal cost of living index (ICLI) to trace the intertemporal changes in the cost of living that is required to achieve a given level of intertemporal utility. Then, Shibuya (1992) formulated the ICLI as a practical index formula and named it the dynamic equilibrium price index (DEPI).

However, given the importance of asset price information, it difficult for monetary policy makers to employ such inflation measures as one of the core indicators in monetary policy judgment. This is because such inflation measures are hardly operational, since they are too unreliable to be used in any formal assessment of the expected future course of inflation. Therefore, monetary policy makers cannot expect asset prices to be more than supplementary indicators of inflation pressures.[5]

1. See, for example, Noguchi (1992), Suzuki (1995), and Okina (1993). Matsushita (1995), the former Governor of the Bank of Japan, stated the role of asset prices in conducting monetary policy as follows:

   > In pursuit of price stability, however, we believe that it is not appropriate to treat the stability of asset prices, such as those of land and stocks, on the same basis as general price stability, and to include it in the goal of monetary policy. As asset prices move in response to the private-sector expectations for economic growth, it is impossible to establish any clear criteria, such as that zero inflation is desirable as in the case of general prices.

2. When we consider the problems concerning the relationship between asset prices and monetary policy, the credit channel is emphasized in the transmission mechanism that the fluctuation of asset prices affects real economic activity. In addition, it is also an important point of discussion that financial crisis often occurs as an aftermath of significant drops in asset prices. For the issues such as the relationship between asset price fluctuation and credit constraint, and the impact on financial system stability, see, for example, Hoshi (1996), who surveys the recent researches on these issues.
3. See Shiratsuka (1997) for the discussion on the practical definition of price stability as an objective of monetary policy.
4. For the discussion on the role of asset prices as an information variable for monetary policy judgment, see Borio *et al.* (1994). In addition, in relation to the argument in Bernanke and Woodford (1997), it should be noted that it is not the case that monetary policy makers can respond mechanically to private-sector inflation forecasts, since such a policy response leads to indeterminacy of rational expectation equilibria. However, this paper concludes that asset price information, while containing useful information on the future course of inflation and other macroeconomic fluctuations, is too inaccurate to be adopted by monetary policy makers as a policy target variable.
5. Goodhart (1995) and his discussants (Bockelmann [1995] and Bruni [1995]) raise a similar argument on the feasibility of constructing a reliable inflation measure by combining the current price index and asset prices.

In this context, the following two points are crucial: (1) policy implication of asset price fluctuation differs in accordance with the sources of asset price changes; and (2) acceptability of remarkably high weight for asset prices, suggested from the theoretical foundation, is questionable. More precisely, it is very difficult to interpret asset price information as a monetary policy indicator due to the possibility of elements in asset prices that reflect bubbles in the private-sector expectations and/or structural changes in the economy. In addition, reliability of the current price indices is by far higher than that for asset prices. While the current price indices are also affected by measurement errors, their reliability is far higher than asset price statistics.[6] Therefore, it seems quite difficult to construct a reliable price index that includes asset price information.

The rest of the paper is constructed as follows. In Chapter II, I discuss the possibility of incorporating asset price information into an inflation measure by extending the static price index concept into a dynamic framework. Then, I compute the DEPI and empirically examine the role of asset prices as an information variable for monetary policy in Chapter III. In Chapter IV, I explore the difficulties monetary policy makers will be faced with, if such a dynamic inflation measure that reflects the asset price fluctuations as well as the current inflation is employed as the core indicator for monetary policy judgment. In Chapter V, I discuss the optimal inflation measure for monetary policy makers. Finally, in Chapter VI, I summarize the major results of this paper, and conclude it. In the appendices, I explain the theoretical foundation of the dynamic price index concept, and estimate the observation errors in the consumer price index (CPI), with its disaggregated data.

II. Extension of Price Index to Dynamic Framework

In this chapter, I explore the possibility of constructing a price index that incorporates asset price data from the theoretical viewpoints. Then, I extend the conventional price index concept into the dynamic framework by taking into account the intertemporal optimization of consumer behavior.

A. Intertemporal Cost of Living Index

When we discuss price indices as a measure of change in cost of living, we always focus on the current consumption activity, and consider price indices as measures for tracing price changes from the base period up to the current period.[7] However, consumer behavior possesses a dynamic nature so that current consumption depends closely on the future path of consumption. Moreover, since monetary policy tries to achieve the medium- to long-run sustainable price stability, it is insufficient to monitor the fluctuation of the conventional price indices that reflect only information on the current inflation. Therefore, it would be reasonable to extend the conventional

6. Although it is true that the current price indices are also affected by measurement errors, their reliability is far higher than asset price statistics. For the discussion on the measurement errors in the Japanese CPI, see Shiratsuka (1998, 1999).

7. For the details of theoretical foundation of price indices, see, for example, Shiratsuka (1998, 1999) and Pollak (1989).

price index concept into the dynamic framework so as to trace intertemporal changes in the cost of living.

Alchian and Klein (1973) proposed the idea of the intertemporal cost of living index (ICLI) that traces the intertemporal changes in the cost of living that are required to achieve a given level of intertemporal utility.[8] In this case, since price information for future goods and services is not readily available from futures markets, an alternative measure to extract such information must be devised. Considering the intertemporal maximization problem for a household, its budget constraint is its lifetime income.[9] If we take into account intangible assets such as human capital as well as tangible assets, total amounts of assets correspond to the claim to future consumption.

In this case, asset prices can be interpreted as prices of sources to purchase goods and services in the future. In other words, we can take asset prices as a proxy for future prices for goods and services.[10] Based on such discussion, it might be the case that monetary policy makers should take into account the fluctuation of asset prices as well as the current price indices such as the GDP deflator and the CPI.

B. Dynamic Equilibrium Price Index

Although the ICLI has good features from a theoretical perspective, it is too abstract to base the practical price index on it. Shibuya (1992) proposed a practical index formula based on the ICLI, and named it a dynamic equilibrium price index (DEPI), which incorporates dynamic elements into a realistic price index formula. To this end, Shibuya (1992) employs a one-good and time-separable Cobb-Douglas utility function, instead of the general form of preference assumed in Alchian and Klein (1973), to derive the DEPI as a weighted geometric mean of the current price index (the GDP deflator) and asset price changes (changes in the value of the national wealth),[11] as shown in equation (1):[12]

$$DEPI = \left(\frac{p_0^B}{p_0^A}\right)^{\alpha_0} \times \left(\frac{q_0^B}{q_0^A}\right)^{1-\alpha_0}, \qquad (1)$$

8. See also Goodhart (1995), Shigehara (1990), and Carlson (1989) for the discussion on the incorporation of dynamic elements into price indices. In addition, Shiller (1993) examines the possibility of constructing dynamic price indices from the viewpoint of providing hedging instruments against the fluctuation of asset prices, which might affect living standards of the public. Santoni and Moehring (1994) pointed out that negative correlation between real return on assets and expected inflation rates is caused by the exclusion of dynamic elements in the price indices.
9. A necessary condition for this discussion is that there exists a perfect capital market, which makes it possible to borrow money with collateral of all tangible and intangible assets.
10. See Appendix 1 for the details on the theoretical foundation of the ICLI.
11. In calculation of the DEPI, we should use asset prices for the value of overall asset, which covers all the intangible assets such as human capital. Shibuya (1992) used the data on national wealth in the *Annual Report on National Accounts* (Economic Planning Agency), which has the broadest coverage among the readily available data sources. However, its coverage of intangible assets, which consists largely of households' assets, is very limited. I will discuss this point in Chapter IV.
12. Shibuya (1992) assumed that marginal productivity is constant over the time, in the process of derivation of equation (1). I will discuss problems associated with this assumption in Chapter IV.

where $\alpha_0 = \rho/(1 + \rho)$, and α_0 and ρ represent the weight for the current goods and services, and time preference, respectively.[13]

III. Asset Prices as a Leading Indicator of Inflation

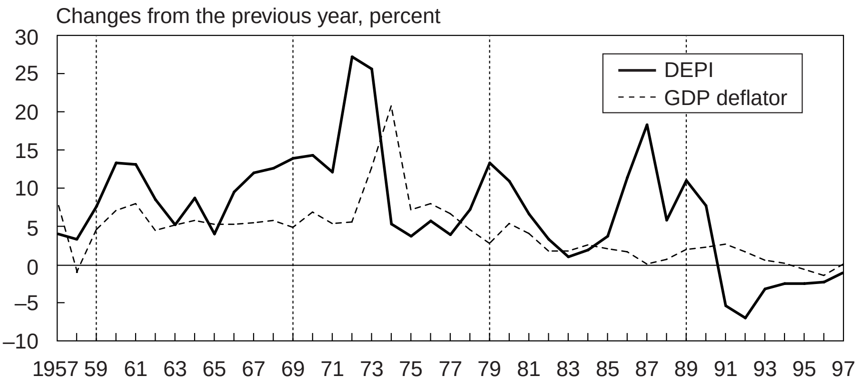
In this chapter, I compute the DEPI by following the methodology in Shibuya (1992), and examine the information content of asset prices as a leading indicator of inflation.

A. Calculation of DEPI

I calculate the DEPI by following the methodology described in Appendix 2 of Shibuya (1992), where the weights for the GDP deflator and national wealth (hereafter, aggregate asset price index) are assumed to be 0.03 and 0.97, respectively. Figure 1 plots the movements of the DEPI from 1957 to 1997.[14]

This figure shows the large divergence between the DEPI and the GDP deflator during the late 1960s, the early and late 1970s, and the early 1980s. Focusing on the development since the mid-1980s, the DEPI rose sharply from 1986 to 1990, while the GDP deflator remained relatively stable, and then the growth rate of the DEPI turned negative from 1991. During this period, the inflation rate in the GDP deflator accelerated until 1991, and the inflation rate was subdued from 1992. Such development of the DEPI might be interpreted as an understatement of the inflationary pressure in the late 1980s and the deflationary pressure from the early 1990s.[15]

Figure 1 DEPI and GDP Deflator



Note: For the details of the calculation method of the DEPI, see Shibuya (1992).
Source: Economic Planning Agency, *Annual Report on National Accounts.*

13. α_0 can be written as $\alpha_t = (1 + \rho)^{-t}/\sum_{s=0}^{\infty}(1 + \rho)^{-s}$ in general form, and are the normalized factors of time preference, which add up to one. Thus, when we calculate the DEPI on a monthly and quarterly basis, we have to use the rate of time preference transformed into a monthly and quarterly basis.
14. I will discuss the appropriateness of the DEPI weights estimated in Shibuya (1992) in Chapter III.
15. Shibuya (1992, 1995) pointed out that the large fluctuation of the DEPI suggested a phenomenon of disequilibrium dynamics in the economy.

B. Statistical Relationship between Asset Prices and Inflation

Next, I statistically test the hypothesis that asset prices are a leading indicator of inflation. To this end, I conduct two types of empirical exercises. First, I check the Granger causality among various macroeconomic indicators, including the GDP deflator and aggregate asset price index, with various setups of vector autoregression (VAR) models. Second, I examine the robustness of Granger causality from asset prices to the GDP deflator over the time with rolling regression across the full sample period.

1. Granger causality among various setups of VAR models

First, I check the Granger causality from asset prices to inflation in various setups of VAR models.

The variables used in the VAR models are as follows: (1) first log difference of the GDP deflator (DLCP); (2) first log difference of the aggregate asset price index (DLAP); (3) first log difference of real GDP (DLRY); (4) long-term interest rate (long-term prime lending rate, LR); and (5) first log difference of M2+CD (DLNM). All the series are annual basis, since the aggregate asset price index is available in only annual basis, and the estimation period is from 1957 to 1997.

Using these variables, I examine the robustness of Granger causality from the aggregate asset price index to the GDP deflator in three setups of VAR models: (1) two-variable VAR model with only the GDP deflator and aggregate asset price index; (2) four-variable VAR model with the GDP deflator, aggregate asset price index, real GDP, and long-term interest rate; and (3) five-variable VAR model with all the above variables. In all three VAR models, one-year lags are chosen by the criteria of minimizing the Akaike's information criteria (AIC).

Table 1 summarizes the results for Granger causality test in three setups of VAR models. In all cases, the aggregate asset price index Granger causes the GDP deflator at least at the 5 percent statistical significance. On the contrary, the GDP deflator does not Granger cause the aggregate asset price index, except for the five-variable VAR model at 20 percent significance.

These results indicate that asset price fluctuations contain specific information about the future price movement, suggesting the potential usefulness of asset prices as an information variable in Japan.

2. Granger causality from asset price to inflation over time

Next, I conduct the second empirical exercise to check the robustness of the Granger causality from the asset prices to the inflation over time. To this end, I conduct three types of rolling regressions on the aforementioned five-variable VAR model with 15-year, 20-year, and 25-year sample periods.

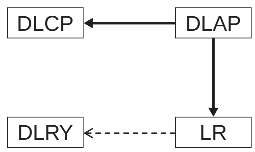
Table 1 Granger Causality Test with Different Setup of VAR Models

[1] Two-Variable VAR Estimation

Dependent variable	Independent var.	
	DLCP	DLAP
DLCP	15.749 (0.000)	21.024 (0.000)
DLAP	0.171 (0.682)	29.893 (0.000)

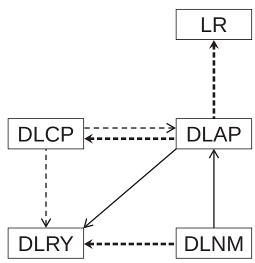
[2] Four-Variable VAR Estimation

Dependent variable	Independent variables			
	DLCP	DLAP	DLRY	LR
DLCP	7.282 (0.011)	10.549 (0.003)	0.598 (0.444)	0.519 (0.476)
DLAP	0.798 (0.378)	16.529 (0.000)	0.353 (0.556)	0.982 (0.328)
DLRY	0.807 (0.375)	0.256 (0.616)	20.835 (0.000)	2.850 (0.100)
LR	0.435 (0.514)	11.326 (0.002)	0.068 (0.796)	133.663 (0.000)



[3] Five-Variable VAR Estimation

Dependent variable	Independent variables				
	DLCP	DLAP	DLRY	LR	DLNM
DLCP	5.620 (0.024)	4.959 (0.033)	0.000 (0.998)	0.033 (0.857)	0.956 (0.335)
DLAP	1.768 (0.193)	6.773 (0.014)	0.386 (0.539)	0.006 (0.937)	3.130 (0.086)
DLRY	2.385 (0.132)	3.152 (0.085)	5.234 (0.028)	0.201 (0.657)	6.116 (0.019)
LR	0.274 (0.604)	6.671 (0.014)	0.005 (0.944)	98.183 (0.000)	0.191 (0.665)
DLNM	0.988 (0.327)	0.055 (0.816)	0.000 (1.000)	0.702 (0.408)	23.310 (0.000)



Notes: 1. M2+CD is connected series of the following two series: (1) annual average of outstanding at the end of each month in 1956–69; and (2) annual average of average outstanding of each month in 1970–97.
2. Figures in the table are *F*-values and *P*-values (in the parentheses).

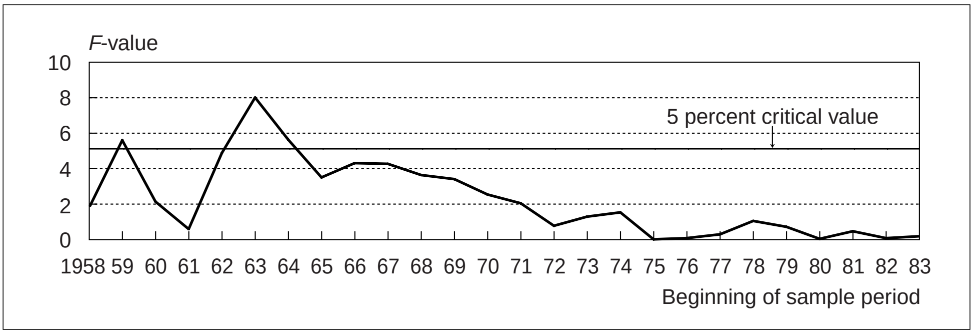
Sources: Bank of Japan, *Economic Statistics Annual*; Economic Planning Agency, *Annual Report on National Accounts*.

Granger's causality
Significant at 1 percent level: lead → lag
Significant at 5 percent level: lead → lag
Significant at 10 percent level: lead → lag
Significant at 20 percent level: lead → lag

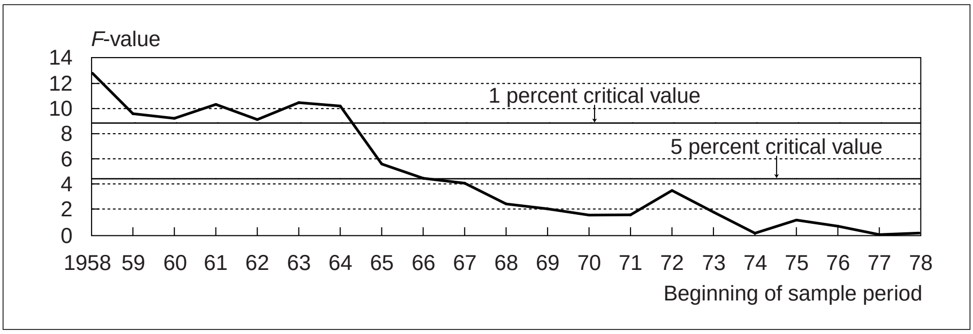
Figure 2 shows the estimation results for the Granger causality from asset prices to inflation over time. The Granger causality from the aggregate asset price index to the GDP deflator is highly significant in the earlier sample periods. However, it is increasingly insignificant in the sample periods beginning in the mid-1960s and later on.

Figure 2 Granger Causality from Asset Price to GDP Deflator over Time

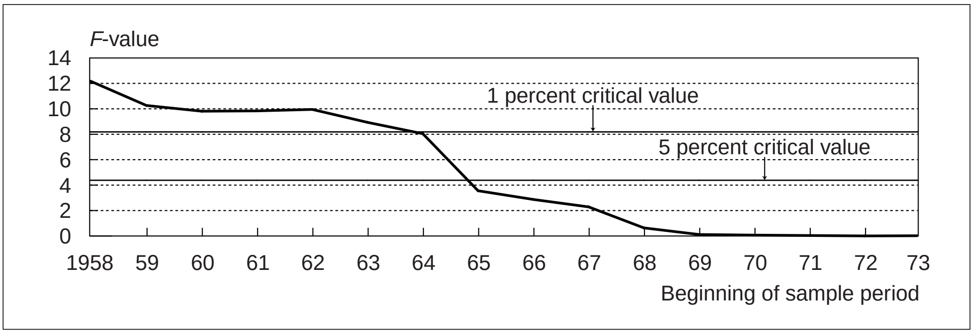
[1] 15-Year Rolling Regressions



[2] 20-Year Rolling Regressions



[3] 25-Year Rolling Regressions



This result suggests that the usefulness of asset prices as an information variable for inflation development depends on the macroeconomic environments. As a result, it is important to examine the factors behind the asset price fluctuations to extract a meaningful policy implication.

IV. Practical Problems in the DEPI

In this chapter, I examine the practical problems inherent in the DEPI, which make it less attractive to employ as a target indicator.

A. Appropriateness of Weight for Asset Prices

The weight for the current price index in the DEPI (α_0) is calculated from the time preference (ρ), based on the formula of $\alpha_0 = \rho/(1 + \rho)$. Shibuya (1992) employed the modified golden-rule (equilibrium condition of neoclassical growth model with considering the optimization behavior of households)[16] to estimate this parameter value. In more detail, the rate of time preference is estimated as 0.03, deducting the rate of depreciation as 0.06, the growth rate of labor as 0.01, the rate of technological progress as 0.03 from the real return on assets as 0.13, thus implying that the weights for the current price index and the asset prices are equal to 0.03 and 0.97, respectively.

Although the price index formula for the DEPI is the weighted geometric mean of the current price index and asset prices, the movement of the DEPI is almost identical to that of asset prices, because the weight for asset prices is very close to one. As a result, if the DEPI is employed to evaluate the inflation development, it is almost equivalent to look at the asset price movement.

Moreover, the recent estimation results for the consumption-based capital asset pricing model (CAPM) suggest the possibility of overstatement of the current inflation, even if time preference is assumed as 0.03. For example, Hamori (1996) estimated the Euler equation by assuming the general form of time-separable utility function, and obtained a time preference (ρ) around 0.01.[17] If this parameter value is employed, the weights for current price and asset price are 0.01 and 0.99, respectively. Therefore, the weight for asset prices is likely to be much larger, since this result holds regardless of the property of the production function.

16. For the details of modified golden rule, see, for example, Barro and Sala-i-Martin (1995).
17. In general, time preferences are estimated as an inverse number of gross rate of time preference ($1/(1 + \rho)$) in the consumption Euler equation. Estimation results with monthly data shown in Hamori (1996) range from 0.985 to 0.995. These figures correspond to the time preference of 0.01 on an annual basis.

Consider how the weights for the current price index and asset prices will be affected when the planning horizon of economic agents varies. Table 2 shows the simulation results. It suggests that the weights for asset prices exceed 0.9 when the planning horizon of economic agents becomes longer than 10 years, thus indicating that the impact of asset price fluctuation becomes dominant.

Table 2 Planning Horizon and Weight for DEPI

Planning horizon	Discount factor = 0.03		Discount factor = 0.01	
	Current price	Asset price	Current price	Asset price
2	0.507	0.493	0.502	0.498
4	0.261	0.739	0.254	0.746
6	0.179	0.821	0.171	0.829
8	0.138	0.862	0.129	0.871
10	0.114	0.886	0.105	0.895
20	0.065	0.935	0.055	0.945
30	0.050	0.950	0.038	0.962
40	0.042	0.958	0.030	0.970
50	0.038	0.962	0.025	0.975
60	0.035	0.965	0.022	0.978
70	0.033	0.967	0.020	0.980
80	0.032	0.968	0.018	0.982
90	0.031	0.969	0.017	0.983
100	0.031	0.969	0.016	0.984
∞	0.029	0.971	0.010	0.990

From the viewpoint of supporting the DEPI, it must be reasonable that the DEPI allocates the very large (small) weight for the asset prices (the current prices), based on the intertemporal optimization behavior of economic agents. However, such an argument misses the critical point that reliability of asset price statistics is very low. While the current price indices are also affected by measurement errors, their reliability is by far higher than asset price statistics.[18]

Therefore, it seems quite difficult to construct a reliable price index that includes asset price information. Putting large weight on the asset prices cannot be rationalized without considering the large difference in the reliability of statistics. This point will be examined in more detail below.

B. Reliability of Asset Price Statistics

1. Coverage of statistics

The ICLI measures changes in the current and future prices of consumption flows implied in the asset price fluctuations, while keeping the lifetime utility level

18. See Chapter V for more a detailed discussion on the reliability of the DEPI.

constant. In this case, it is crucial to emphasize that the ICLI must cover all assets, which are sources of present and future consumption, such as tangible and intangible, financial and nonfinancial, and human and nonhuman assets. Nevertheless, even the National Wealth Statistics, which have the broadest coverage among the asset price statistics and are used in compiling the DEPI, do not include human capital.[19]

The reasons why no comprehensive asset price statistics, which cover human capital, exist are as follows. First, human capital is never traded in the markets, and it is quite difficult to estimate its market value. Second, human capital investment has a long development period, and opportunity cost is an important factor for human capital investment decisions. Third, it is not possible to make a bank loan contract with collateral of human capital because of an imperfection in capital markets.

Now we try to make some rough estimates on the human capital value, in order to examine the coverage of currently available asset price statistics. The calculation is based on the assumption that the value of human capital (W_H) is equivalent to the present discounted value of labor income (Y_L) under the following conditions:[20] (1) growth rate of future labor income (g), depreciation rate of human capital (d), and discount rate of future income (r) are all constant over time; (2) gross growth rate of labor income is equal to the product of gross depreciation rate of human capital and gross discount rate; and (3) population composition and human capital investment pattern are constant over time.

In this case, value of human capital, which is calculated as the present discounted value of labor income with average expected job tenure of n-year, is

$$W_H = Y_L \frac{1+g}{(1+d)(1+r)} + Y_L\left(\frac{1+g}{(1+d)(1+r)}\right)^2 + \cdots\ Y_L\left(\frac{1+g}{(1+d)(1+r)}\right)^n. \qquad (2)$$
$$= nY_L$$

According to the System of National Accounts in Japan, the compensation of employees was ¥286 trillion in 1997. If we assume that average expected job tenure is 25 years, the value of human capital is calculated as ¥7,157 trillion in 1997 from equation (2).[21]

19. Ishikawa (1991) provides an extensive survey of the issues related with human capital.
20. The following estimation methodology is taken from Iwata (1992). In addition, there exist other types of estimation methods such as summation of human capital investment, and using an estimated consumption function based permanent income hypothesis.
21. Takayama (1992) applies individual data of *National Survey of Family Income and Expenditure* to estimate the value of households' human capital in 1984 at ¥4,406 trillion. It corresponds to ¥5,146 trillion on a 1994-year basis after adjusting for inflation between 1984 and 1994. This figure is judged as approximately equivalent to the estimates in this paper, because the estimates in Takayama (1992) do not cover the one-person family.

When we sum up the above estimated value of human capital and the value of nonhuman capital assets in the System of National Accounts, total net asset value of households reached ¥8,854 trillion in 1997 (Table 3). The table also shows that the ratio of nonhuman and human capital is about one to three, and the relative importance of human capital is high. This indicates that the coverage of the National Wealth Statistics is just 25 percent of the total assets in the household sector.

Table 3 Balance Sheet for Households in 1997

¥ trillions, percent

Nonhuman capital	2,654 (28.4)
Net fixed assets	303 (3.2)
Land	1,068 (11.4)
Financial assets	1,222 (13.1)
Others	61 (0.6)
Debt	401 (4.3)
Net worth	2,187 (23.4)
Human capital	7,157 (76.6)
Net total assets	9,344 (100.0)
National wealth	3,241

Notes: 1. Figures on human capital are the author's estimation.
2. Net total assets are sum of net worth and human capital.
3. National wealth covers nonfinancial incorporated enterprises, financial institutions, and general government, in addition to households.

Source: Economic Planning Agency, *Annual Report on National Accounts*.

2. Accuracy of price information

Another problem of asset price statistics is that their accuracy is insufficient for quantitative analysis. For example, land, which is a typical tangible asset, is characterized by its diversity and variety. In practice, there are various evaluations of land prices, ranging from actual traded prices to the Officially Published Land Prices, and it is quite difficult to say which price indicates fair prices. In this case, although it may be possible to apply a hedonic approach to estimate quality-adjusted price changes, limited data availability would make such research quite difficult.[22]

3. Changes in composition of asset holdings

In constructing an aggregated asset price indicator, it is also difficult to adjust the changes in asset composition over time. Table 4 shows an asset and debt composition in the consolidated balance sheet for Japan over time, and two points should be noted. First, both the asset and debt sides of the national balance sheet for Japan expanded more rapidly than the national wealth (deducted debt and equity from total assets). The ratio of total assets (equal to the sum of total debt and net worth) to the nominal GDP increased to 16.6 in 1990 from 8.1 in 1970, and declined to 14.6 in 1997. During the same time period, net worth rose from 4.0 in 1970 to 8.2 in 1990 and declined to 6.4 in 1997. Second, looking at the composition of assets and debt, the weight of financial assets, and debt excluding equity increased.

22. See Suzuki and Ohta (1994) for an application of the hedonic approach to land price analysis. In addition, there are estimates such as Ito and Hirono (1993) and Kasuga (1996) for housing prices and rents.

Table 4 Consolidated Accounts for Japan

¥ trillions, percent

	1970	80	90	97
Reproducible tangible assets	121 (20.5)	592 (22.4)	1,053 (14.8)	1,387 (18.7)
Non-reproducible tangible assets	174 (29.4)	745 (28.2)	2,420 (33.9)	1,729 (23.3)
Financial assets	296 (50.1)	1,305 (49.4)	3,663 (51.3)	4,306 (58.0)
Total assets	591 (100.0)	2,642 (100.0)	7,137 (100.0)	7,422 (100.0)
Debt (excluding equity)	266 (45.1)	1,177 (44.6)	3,008 (42.1)	3,810 (51.3)
Equity	28 (4.7)	125 (4.7)	607 (8.5)	371 (5.0)
Net wealth	296 (50.2)	1,340 (50.7)	3,522 (49.4)	3,241 (43.7)
Ratio to nominal GDP	4.0	5.6	8.2	6.4
Total debt and national wealth	591 (100.0)	2,642 (100.0)	7,137 (100.0)	7,422 (100.0)
Ratio to nominal GDP	8.1	11.0	16.6	14.6

Source: Economic Planning Agency, *Annual Report on National Accounts*.

The DEPI focuses on the changes in net national wealth to trace the fluctuations in the aggregated asset value as the sources of future consumption expenditure. However, it should be noted that changes in the net national wealth might reflect the impact of changes in the composition of assets and debt.

C. Policy Implications and Sources of Asset Price Fluctuation

1. Dispersion from fundamentals

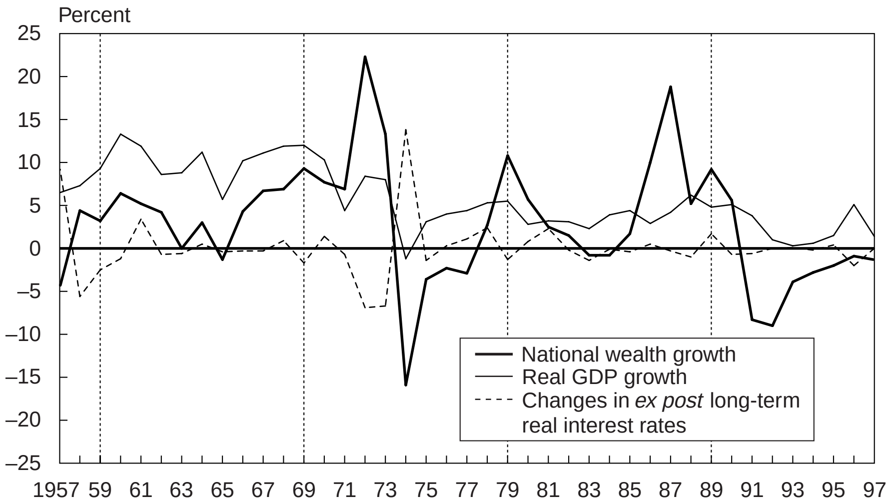
Based on the discounted present value formula, which is the basic theoretical framework for asset pricing, asset price is equal to the present discounted value of future flow of its income. Profit maximization of the firm indicates that its marginal revenue corresponds to its marginal productivity of assets. Therefore, if we assume that marginal productivity of capital (MPK), nominal interest rate (r), and expected rate of inflation (π) are all constant over time, real asset price (q/p) is determined as

$$q/p = MPK/(r - \pi). \qquad (3)$$

This equation implies that expected return on assets and expected nominal rate determine the fluctuation of real asset price.

Figure 3 plots the time series of changes in real price of net national wealth, real GDP growth,[23] and changes in expected real interest to examine the relationship between asset price and fundamentals. It shows that real asset price changes almost correspond to the movements in fundamentals. The changes in real asset price have a positive correlation with real GDP growth, and a negative correlation with expected changes in the real interest rate.

Figure 3 Asset Price Fluctuation and Fundamentals



Note: *Ex post* long-term real interest rates correspond to the long-term prime lending rate deducted by the changes of the GDP deflator.
Sources: Economic Planning Agency, *Annual Report on National Accounts*; Bank of Japan, *Financial and Economic Statistics Monthly*.

However, it is also true that the degree of correlation between the real asset price and fundamentals varies over time. For example, from the late 1980s, Japan experienced tremendous fluctuation of asset prices, which is much larger than the fluctuation implied by the fundamental variables such as real GDP growth and expected changes in the real interest rate.

Prolonged deviation of asset price from its fundamental value is often called a bubble. Even if investors are perfectly rational, the actual stock price may contain a bubble element and, therefore, there can be a divergence between the asset price and its fundamental value.[24] In general, asset prices reflect investors' expectations about the future, and such expectations seem to have played an important role in sustainability of bubbles. In this case, it is impossible to extract information on future inflation rates of goods and services from the asset prices.

23. Real GDP growth can be thought of as a proxy for profitability of assets on a real basis.
24. In order to exclude the bubble path, it is assumed that asset prices will not diverge to infinity. See, for example, Blanchard and Watson (1982) for the discussion on the asset price bubble.

However, in the case of the collapse of the bubble, the negative impact on the economy will increase, as the overvaluation of asset prices continues, thus resulting in larger swings in business conditions. In this sense, the rise in the DEPI due to the overvaluation of asset prices may be viewed as a signal for monetary tightening.

2. Adjustment for changes in marginal productivity of assets

The above discussion assumes a static expectation on the marginal return on assets. That is, it assumes that constant rates of economic growth or marginal return on assets continue over time. Indeed, Shibuya (1992) assumes that marginal return on assets is constant over time in order to compute the DEPI with readily available data.

However, the increases in land prices do not necessarily imply the increase in the future prices of services that will be produced by land. The increases in land prices may reflect the higher productivity of land in the future, which is the consequence of technological innovations, such as advances in construction technology of the higher skyscrapers and smart buildings.

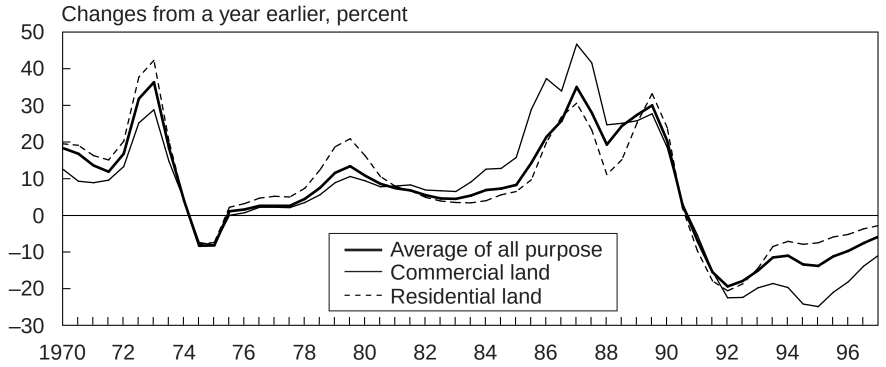
Now suppose that the changes in the marginal productivity of assets occur between the economic conditions A and B. Then the DEPI defined equation (1) is modified as follows:

$$DEPI = \left(\frac{p_0^B}{p_0^A}\right)^{\alpha_0} \times \left(\frac{q_0^B/MPK^B}{q_0^A/MPK^A}\right)^{1-\alpha_0}. \qquad (4)$$

This equation implies that asset prices must be deflated by their marginal productivity to convert them into the asset prices in efficiency unit when we try to extract information on the future prices of products and services. For example, the changes in the marginal productivity must be deducted from the changes in the unit price of land.

Figure 4 plots the year-to-year changes of land prices in Japan by usage. In general, land prices show a similar trend across usage, and no significant changes in the relative prices are observed. In this case, as mentioned above, it is necessary to

Figure 4 Land Prices by Use



Source: Japan Real Estate Institute, *Urban Land Price Index.*

detect the asset price changes measured in the efficiency unit to extract meaningful information. However, such changes in marginal productivity of assets are not directly observable, nor does a readily available proxy exist. Therefore, it is necessary to estimate an aggregate production function to compute the marginal productivity in a rigorous way. Still, it is difficult to estimate the marginal productivity for different assets, and accumulation of time-series data is required to deduct the structural breaks with econometric methodology.

In addition, even though the current marginal productivity can be traced properly, it might be the case that deviation from the proxy for the fundamentals occurs under the expectations on the higher marginal return on assets, reflecting the future innovations. In this case, the difficult question arises to judge in advance whether such asset price increases are phenomena of euphoria.

In summary of the above discussion, when we employ the DEPI as one of the core economic indicators for monetary policy judgment, it is necessary for monetary policy makers to access the possibility of unobserved structural breaks that provoke the substantial changes in the marginal productivity of the economy.

In the monetary policy regime of inflation targeting, which most clearly defines the policy objectives in terms of inflation measures, escape clauses are introduced to permit central banks to temporarily deviate from the targeted range of inflation rates in the case of significant supply shocks, such as remarkable rises in oil prices and natural disasters.[25] In this context, the shift in the marginal productivity of assets, which is interpreted as the structural change in the supply-side of the economy, should be included in the escape clauses, if a central bank adopts an inflation target for the DEPI for its monetary policy framework. In addition, the validity of market expectations, such as the possibility of bubble and euphoria, should be examined to extract the policy implication from the changes in the DEPI properly.

Considering these limitations, it is inappropriate for monetary policy makers to employ the DEPI as one of the core indicators for monetary policy judgment.

25. See Bank of Japan (1995), Bernanke *et al.* (1999), and Leiderman and Svensson (1995) for the details of inflation targeting.

V. Optimal Inflation Measure in Practice

In this chapter, based on the above discussion, I will explore the question of what the optimal inflation measure for monetary policy is in practice.

A. Reliability of DEPI

In order to discuss the optimal inflation measures, it is important to obtain the feasible combinations between the weight for asset prices and the observation errors in the inflation measures. To this end, I perform a simulation on the observation errors in the DEPI to analyze its reliability under the following conditions.

(1) I assume the distributions of changes in price index and asset price follow the normal distribution. This implies that price index and asset price levels follow the lognormal distribution. As a result, the DEPI follows the lognormal distribution, since the DEPI is defined as the geometric mean of price index and asset price.

(2) I assume that observation errors in the GDP deflator are equal to those for the CPI, estimated in Appendix 2 at the level of 0.1 percent annually. In addition, I also assume three levels of observation errors in asset prices, that is, 10, 100, and 1,000 times that for the CPI.[26]

(3) I assume five levels of correlation between the GDP deflator and asset price fluctuations. The coefficient of correlation is 0.00, 0.10, 0.25, 0.50, and 1.00, respectively.[27]

(4) I assume six combinations of the weights for the GDP deflator and asset price: 0.01 : 0.99, 0.03 : 0.097, 0.10 : 0.90, 0.25 : 0.75, 0.50 : 0.50, and 0.75 : 0.25, respectively.

(5) Simulation results are compared with the benchmark of the estimated observation errors in the CPI of the lowest aggregation level at 0.1 percent per annum.[28]

26. According to the estimated observation errors of the CPI in Appendix 2, the observation errors increase as the aggregation levels in data become high. The estimate of the highest aggregation data reaches 1.1 percent per annum, while that of the lowest aggregation data remains just 0.1 percent per annum. Therefore, estimated observation errors vary in accordance with the data aggregation level, by as much as 10 times between the lowest and highest cases. This suggests that estimations with highly aggregated data enlarge the observation errors because of the deterioration in the accuracy of price information. Since asset prices are characterized by the diversity, their accuracy is far lower than that of the CPI price survey. Based on the above consideration, the simulation in this paper assumes the three different levels of observation errors in the asset prices: 10, 100, and 1,000 times the observation errors in the CPI.
27. Coefficients of correlation between the GDP deflator and asset price are 0.27 in 1970 to 1994, and 0.11 in 1980 to 1994.
28. This criterion means that the 95 percent confidence range for the observed inflation rate is 0.2 percent in both the upper and lower sides, when changes in the CPI follow the normal distribution process. For example, when the year-to-year inflation rate is 2.0 percent, there will be a true value between 1.8 and 2.2 percent with the probability of 95 percent.

Table 5 reports the simulation results, and shows the large observation errors, close to that of asset prices, when the weights for asset prices exceed 0.9. Minimum value among the simulated observation errors in the DEPI is 0.5 percent per annum, and it is 10 times larger than that of the GDP deflator. Considering the above examination on the accuracy of the National Wealth Statistics, actual observation errors in the DEPI are expected to be far larger than this minimum result. In addition, suppose that the achievement of the monetary policy objective is measured by the divergence from the targeted inflation rate, and the required confidence range is 0.5 percent on both the upper and lower sides.[29] All the simulation results exceed the allowance.

Table 5 Simulation Results for Observation Errors in the DEPI

Weights		Assumption on correlation				
Current price	Asset price	0.00	0.10	0.25	0.50	1.00
Case 1: Observation errors in asset price = 10 times the current price						
0.01	0.99	0.995	0.995	0.995	0.996	0.996
0.03	0.97	0.985	0.985	0.986	0.987	0.988
0.10	0.90	0.949	0.950	0.952	0.954	0.959
0.25	0.75	0.867	0.870	0.873	0.878	0.889
0.50	0.50	0.711	0.714	0.719	0.728	0.745
0.75	0.25	0.507	0.511	0.517	0.526	0.543
Case 2: Observation errors in asset price = 100 times the current price						
0.01	0.99	9.950	9.950	9.950	9.950	9.951
0.03	0.97	9.849	9.849	9.850	9.850	9.852
0.10	0.90	9.487	9.488	9.489	9.492	9.496
0.25	0.75	8.660	8.663	8.666	8.671	8.682
0.50	0.50	7.071	7.075	7.080	7.089	7.107
0.75	0.25	5.001	5.004	5.010	5.019	5.038
Case 3: Observation errors in asset price = 1,000 times the current price						
0.01	0.99	99.499	99.499	99.499	99.499	99.500
0.03	0.97	98.489	98.489	98.489	98.490	98.492
0.10	0.90	94.868	94.869	94.871	94.873	94.878
0.25	0.75	86.603	86.605	86.608	86.613	86.624
0.50	0.50	70.711	70.714	70.720	70.728	70.746
0.75	0.25	50.000	50.004	50.009	50.019	50.038

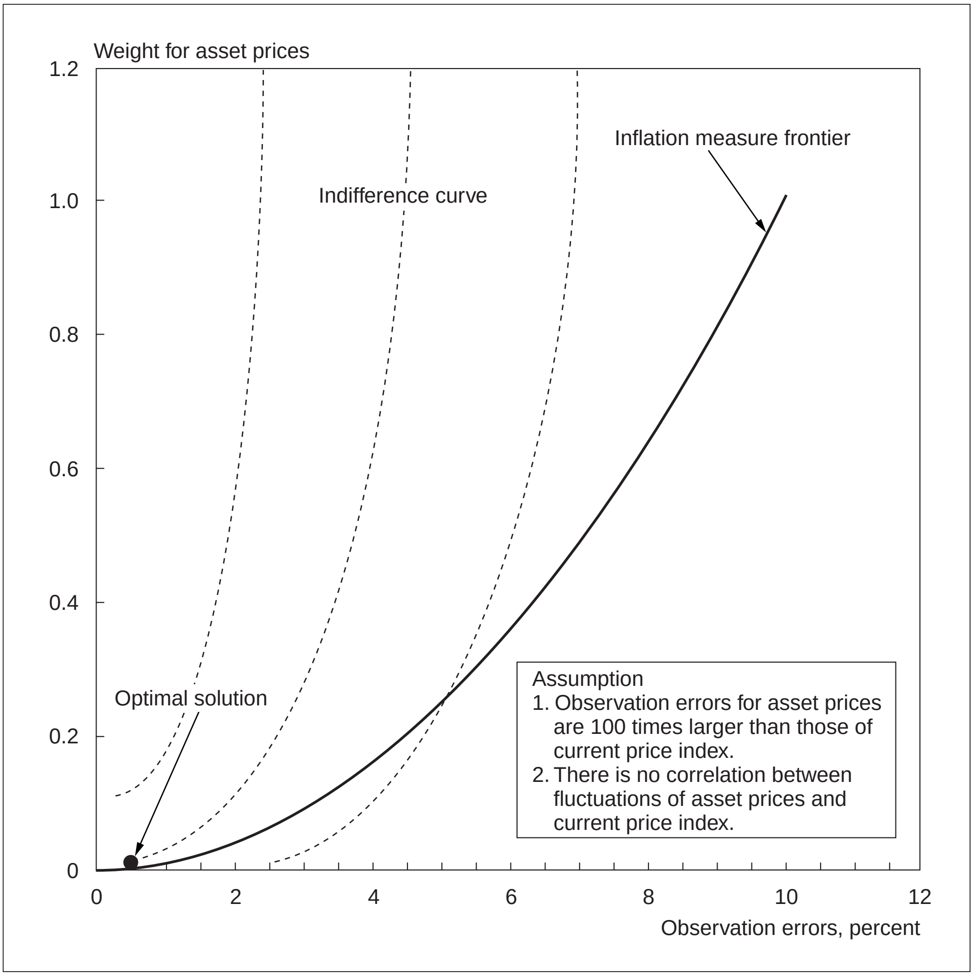
29. Those countries that adopt inflation targeting as the monetary policy framework set an allowance range of 1 percent around the targeted inflation rates. In general, the reason why such targeting ranges are set is that there is a limitation in the controllability of inflation by monetary policy against the business cycle fluctuation and external shocks. Therefore, we assume the maximum allowance level of the observation errors is half that of the ordinary targeting ranges.

B. Optimal Weight Allocation to Asset Prices in Practice

Now I will investigate the optimal combination between the weight for asset prices and the observation errors in the DEPI.

Figure 5 plots the changes in the estimated observation errors in the DEPI in response to varying the weights between asset prices and the current price index.[30] In this figure, the vertical and horizontal axes correspond to the weight assigned to the asset prices and the estimates of the observation errors in the DEPI, respectively.

Figure 5 DEPI Weight and Observation Errors



As the weight for asset prices increases, the observation errors in the DEPI continuously rise. Therefore, their feasible combinations, "the inflation measure frontier," are downward sloping and convex to the lower right. In addition, the indifference

30. In Figure 5, the simulation is conducted under the assumptions that (1) observation errors in the asset price are 100 times more than those for the price index; and (2) there is no correlation between the fluctuation of asset prices and the price index. It should be noted that simulation results shown in Table 5 suggest that simulation results will not be influenced if there exists correlation between the fluctuation of asset prices and price index.

curve for the desirable inflation measures in terms of the weight for the asset prices and the observation errors is also downward sloping and convex to the lower right, since there exists a trade-off between the weight for the asset prices and the observation errors (dashed curve in the figure). On the one hand, increased weight for the asset prices is desirable because the DEPI will reflect much more information on future inflation expectations. On the other hand, increased observation errors will reduce the credibility of inflation measures.

Both the indifference curve and the inflation measure frontier are downward sloping and convex to the lower right. Thus, if the indifference curve is tangent to the inflation measure frontier from the inside, the tangency point will be the desirable combination of weight for the asset price and observation errors. However, if the DEPI is employed as a target indicator for monetary policy, the cost for the increase in the observation errors will rise, as the weight for the asset prices increases. This implies that the slope of the indifference curve is steeper than that of the inflation measure frontier, thus producing the corner solution shown in Figure 5. In this case, the desirable target indicator for the monetary policy will be the conventional price index, which allocates the zero-weight for asset prices in the DEPI. In other words, although there is a reasonable theoretical foundation for supposing that the DEPI allocates a large weight for asset prices, it is difficult to employ it as a core indicator for the monetary policy judgment due to the extremely low accuracy of the readily available data.

VI. Conclusion

In this paper, I examined the possibility of constructing a reliable inflation measure that reflects both the current inflation and asset prices from the theoretical and practical viewpoints. Such an inflation measure, the dynamic equilibrium price index (DEPI), is the extension of the conventional price index concept into the dynamic framework. Although the concept of the DEPI is highly evaluated from the viewpoint of theoretical consistency, it is difficult for monetary policy makers to expect the DEPI to be more than a supplementary indicator for inflation pressures. This is because such modification of the conventional price indices is hardly operational.

The first problem inherent in the DEPI is that asset price changes do not necessarily predict future price changes because there are a lot of sources for asset price fluctuations besides the private-sector expectations for the future course of inflation, such as bubble elements of private-sector expectations and structural changes in the economy. Therefore, if the DEPI is employed as one of the core indicators for monetary policy judgment, monetary policy makers will be faced with the difficulty that it is very hard to extract from the DEPI an appropriate policy implication in practice.

The second problem is the appropriateness of large weight for asset prices in the DEPI. The DEPI is defined as the geometric weighted mean of the current price index and asset price, and its weight for asset price is almost equal to one, while that for the current price index is almost zero. From the theoretical viewpoint, it is reasonable to assign the large (small) weight for the asset prices (the current price index), reflecting the dynamic optimization of economic agents. However, such discussion misses the practical viewpoint that reliability of asset price statistics is quite low. Although the conventional price indices are also affected by measurement problems, their reliability is much higher than asset price statistics, implying a difficulty in constructing a reliable price index that includes asset prices.

The DEPI will be quite a similar indicator to asset prices, as far as one accepts the theoretical weights for the current price index and asset prices. If asset prices are judged to be inappropriate as a policy target indicator, and are limited as information variables for monetary policy judgment, it is enough to monitor both the current price indices and the asset prices separately.

In this context, it should be noted that, as Kindleberger (1995) pointed out, there are no cookbook rules for policy judgment, and it is inevitable for monetary policy authorities to make a discretional judgment.[31]

The above conclusion implies that the argument by Bernanke and Woodford (1997) is not a serious problem for monetary policy makers in practice. They point out that it is not the case that monetary policy makers can respond mechanically to private-sector inflation forecasts, since it leads to indeterminacy of rational expectation equilibria. In this case, the asset prices are one of the most likely indicators for monetary policy makers to extract the information on the future course of inflation developments.

However, considering the limitation in asset prices discussed in this paper, it is necessary to make a discretionary judgment to extract an appropriate policy implication from the asset price fluctuations. Therefore, it is not practically feasible to assume a mechanical rule to respond to the asset price fluctuations.[32]

31. Kindleberger (1995) comments on this point as follows:

> When speculation threatens substantial rises in asset prices, with a possible collapse in asset markets later, and harm to the financial system, or if domestic conditions call for one sort of policy, and international goals another, monetary authorities confront a dilemma calling for judgment, not cookbook rules of the game.

32. A similar argument will hold if monetary policy makers employ survey data on the private-sector forecast for inflation as a targeted variable. This is because such survey data are likely to reflect the private sector's belief of unseen structural changes in the economy. In this case, it does not seem to be practically feasible for monetary policy makers to mechanically react to the private-sector forecasts for inflation.

APPENDIX 1: FORMULATION OF DYNAMICALLY EXPANDED PRICE INDEX

As an inflation measure for incorporating the dynamic elements of price fluctuation, Alchian and Klein (1973) proposed the idea of an intertemporal cost of living index (ICLI) that traces "the intertemporal changes in the cost of living that is required to achieve a given level of intertemporal utility."

Assuming that consumer preference depends on both the current and future consumption expenditure as the following utility function:

$$U = U(x_{11}^A, \ldots x_{n1}^A, \ldots, x_{it}^A, \ldots) \quad \text{for } i = 1, \ldots, n;\ t = 1, \ldots \infty, \qquad \text{(A.1)}$$

where x_{it}^A represents the consumption expenditure for good i at time t with economic condition of A.

The budget constraint of the consumer corresponds to the total assets (W^A) that cover the tangible and intangible assets as follows:

$$W^A = \sum_{t=1}^{\infty}\sum_{i=1}^{n} p_{it}^A x_{it}^A = \sum_{j=1}^{m} q_j^A y_j^A, \qquad \text{(A.2)}$$

where p_{it}^A, q_j^A, y_j^A represent the current price of good i at time t under economic condition A,[33] and price and quantity of asset j at time t under economic condition A.

Suppose that the current price of the current or future goods change, and the new economic condition B is realized. As a result, suppose also that the required asset value for the consumer to achieve the same utility level under the economic condition A becomes W^B. The ICLI between the economic conditions A and B is defined as

$$ICLI^{AB} = \frac{W^B}{W^A} = \frac{\sum_{t=1}^{\infty}\sum_{i=1}^{n} p_{it}^B x_{it}^B}{\sum_{t=1}^{\infty}\sum_{i=1}^{n} p_{it}^A x_{it}^A} = \frac{\sum_{j=1}^{m} q_j^B y_j^B}{\sum_{j=1}^{m} q_j^A y_j^A}. \qquad \text{(A.3)}$$

Shibuya (1992) formulates the DEPI as a geometric mean of the current price index and asset prices by assuming a time-separable utility function in one good model and constant marginal productivity of assets.

33. This is the present value of the future product and service prices discounted by the discounted factor.

APPENDIX 2: APPLICATION OF OLS METHOD TO ESTIMATE OBSERVATION ERRORS IN PRICE INDEX

Appendix 2 shows the estimation procedure and results for the observation errors in the price index, which are the basic data for the simulation on the observation errors in the DEPI. First, following Selvanathan and Prasada Rao (1994), I summarize the methodology to estimate the Laspeyres price index and its observation errors from the disaggregated data. Then, I estimate the observation errors with four data sets with different aggregation level of the CPI: 10 major group index, subgroup index, item class index, and item index.

Now let $p_{0t}x_{i0}$ and $p_{it}x_{i0}$ be consumption expenditure to good i at the base period 0 and the current period t, respectively, and consider the regression equation as follows:

$$p_{it}x_{i0} = \gamma_t p_{0t}x_{i0} + \varepsilon_{it}, \quad i = 1, 2, \ldots, n \tag{A.4}$$

where γ_t is identical to all good, and ε_{it} is a random component. In addition, assuming

$$E[\varepsilon_{it}] = 0, \quad \mathrm{cov}[\varepsilon_{it}, \varepsilon_{jt}] = \sigma_t^2 p_{i0}x_{i0}\delta_{ij}, \tag{A.5}$$

where δ_{ij} is Kronecker's delta.

By dividing equation (A.4) by $\sqrt{p_{i0}x_{i0}}$, the following equation is derived:

$$p_{it}^* = \gamma_t p_{i0}^* + u_{it}, \tag{A.6}$$

where $p_{it}^* = p_{it}\sqrt{x_{i0}/p_{i0}}$, $u_{it} = \varepsilon_{it}/\sqrt{p_{i0}x_{i0}}$. From equation (A.5),

$$\mathrm{cov}[u_{it}, u_{jt}] = \mathrm{cov}[u_{it}, u_{jt}]/(p_{i0}x_{i0}) = \sigma_t^2\delta_{ij}. \tag{A.7}$$

Therefore, the ordinary least square (OLS) estimation can be applied. The estimated coefficient is

$$\hat{\gamma}_t = \sum_{i=1}^{n} p_{it}^* p_{i0}^* \Big/ \sum_{i=1}^{n} (p_{i0}^*)^2 = \sum_{i=1}^{n} p_{it}x_{i0} \Big/ \sum_{i=1}^{n} p_{i0}x_{i0}, \tag{A.8}$$

and coincides with the Laspeyres index formula. Thus, the standard error for the estimated coefficient corresponds to the observation error for the price index.

Appendix Table 1 shows the estimation results for the item index, item class index, subgroup index, and 10 major group index in the Japanese CPI.[34] The estimated observation error for the CPI is just 0.1 percent per year for the item index, which has the lowest aggregation level. However, the estimates become larger as the aggregation level gets higher: 0.6, 0.8, and 1.1 percent per year for the item class index, subgroup index, and 10 major group index, respectively. This implies that the observation errors expand as the accuracy of price survey decreases.

Appendix Table 1 Estimation of Observation Errors in the CPI

	1991	92	93	94	95	Average
Estimation by item index						
Coeff.	1.033	1.050	1.064	1.071	1.070	—
S.E.	0.002	0.002	0.003	0.004	0.005	0.001
R^2	0.996	0.992	0.987	0.978	0.971	—
Estimation by item class index						
Coeff.	1.032	1.050	1.063	1.071	1.070	—
S.E.	0.003	0.005	0.006	0.007	0.009	0.006
R^2	0.997	0.994	0.992	0.986	0.981	—
Estimation by subgroup index						
Coeff.	1.032	1.050	1.064	1.071	1.070	—
S.E.	0.005	0.006	0.008	0.011	0.013	0.008
R^2	0.995	0.994	0.990	0.981	0.975	—
Estimation by 10 major group index						
Coeff.	1.033	1.050	1.063	1.071	1.070	—
S.E.	0.005	0.007	0.010	0.014	0.017	0.011
R^2	0.998	0.997	0.994	0.988	0.982	—

34. Estimation is conducted with the 1990-base CPI.

References

Alchian, Armen A., and Benjamin Klein, "On a Correct Measure of Inflation," *Journal of Money, Credit, and Banking*, 5 (1), 1973, pp. 173–191.

Ball, Laurence, and N. Gregory Mankiw, "Relative-Price Changes as Aggregate Supply Shocks," *Quarterly Journal of Economics*, 110 (1), 1995, pp. 161–193.

Bank of Japan, "Inflation Targeting in Selected Countries," *Bank of Japan Quarterly Bulletin*, 3 (2), 1995, pp. 39–52.

Barro, Robert J., and Xavier Sala-i-Martin, *Economic Growth*, McGraw-Hill, Inc., 1995.

Bernanke, Ben S., and Michael Woodford, "Inflation Forecasts and Monetary Policy," *Journal of Money, Credit and Banking*, 29 (4), 1997, pp. 654–684.

———, Thomas Laubach, Fredric S. Mishkin, and Adam S. Posen, *Inflation Targeting: Lessons from the International Evidence*, Princeton University Press, 1999.

Blanchard, Olivier J., and Mark W. Watson, "Bubbles, Rational Expectations, and Financial Markets," in Paul Wachtel, ed. *Crises in the Economic and Financial Structure*, Lexington Books, 1982, pp. 295–315.

Bockelmann, Horst, "Comments," in Kuniho Sawamoto, Zenta Nakajima, and Hiroo Taguchi, eds. *Financial Stability in a Changing Environment*, Macmillan Press, 1995, pp. 498–500.

Borio, C. E. V., N. Kennedy, and S. D. Prowse, "Exploring Aggregate Asset Price Fluctuations across Countries: Measurement, Determinants and Monetary Policy Implications," *BIS Economic Papers* No. 40, 1994.

Bruni, Franco, "Comments" in Kuniho Sawamoto, Zenta Nakajima, and Hiroo Taguchi, eds. *Financial Stability in a Changing Environment*, Macmillan Press, 1995, pp. 501–505.

Carlson, Keith M., "Do Price Indices Tell Us about Inflation? A Review of the Issues," *Federal Reserve Bank of St. Louis Review*, 71 (6), 1989, pp. 12–30.

Goodhart, Charles A. E., "Price Stability and Financial Fragility," in Kuniho Sawamoto, Zenta Nakajima, and Hiroo Taguchi, eds. *Financial Stability in a Changing Environment*, Macmillan Press, 1995, pp. 439–497.

Hamori, Shigeyuki, *Shouhisha Koudou to Nihon no Shisan Shijo* (Consumer Behavior and Japanese Asset Markets), Toyo Keizai Shimposha, 1996 (in Japanese).

Hoshi, Takeo, "Shihon Shijo no Hukanzen Sei to Kin'yu Seisaku no Hakyu Keiro: Saikin no Kenkyu Seika no Tenbo (Imperfection in Capital Markets and Transmission Mechanism of Monetary Policy: Review of Recent Studies)," *Kin'yu Kenkyu* (Monetary and Economic Studies), 16 (1), Institute for Monetary and Economic Studies, Bank of Japan, 1996, pp. 105–136 (in Japanese).

Ishikawa, Tsuneo, *Shotoku to Tomi* (Income and Wealth), Iwanami Shoten, 1991 (in Japanese).

Ito, Takatoshi, and Keiko Nosse Hirono, "Efficiency of the Housing Market," *Monetary and Economic Studies*, 11 (1), Institute for Monetary and Economic Studies, Bank of Japan, 1993, pp. 1–32.

Iwata, Kazumasa, "Sutokku Keizai to Zeisei (Stock Economy and Tax System)," Takatoshi Ito and Yukio Noguchi, eds. *Bunseki Nihon Keizai no Suttoku Ka* (Analysis on Advance in Stock Economy), Nihon Keizai Shimbunsha, 1992 (in Japanese).

Kasuga, Yoshiyuki, "Shutoken ni Okeru Jutaku no Kousatsu: Mikuro Deita ni Yoru Jutaku Shijou no Kenshou (Housing Problems in Metropolitan Area: Examination of Housing Market by Micro Data)," *Chousa* No. 211, Japan Development Bank, 1996 (in Japanese).

Kindleberger, Charles P., "Asset Inflation and Monetary Policy," *BNL Quarterly Review*, No. 192, 1995, pp. 17–37.

Leiderman, Leonard, and Lars E. O. Svensson, eds. *Inflation Targets*, CEPR, 1995.

Matsushita, Yasuo, "Role of Capital Market and Its Confronting Problems," *Bank of Japan Quarterly Bulletin*, Bank of Japan, 1995, pp. 15–23.

Noguchi, Yukio, *Baburu no Keizaigaku* (Economics on Bubbles), Nihon Keizai Shimbunsha, 1992 (in Japanese).

Okina, Kunio, *Kitai to Touki no Keizai Bunseki—'Baburu' Genshou to Kawase Reito* (Economic Analysis of Expectations and Speculations—'Bubble' Phenomena and Exchange Rates), Toyo Keizai Shimposha, 1985 (in Japanese).

———, *Kin'yu Seisaku* (Monetary Policy), Toyo Keizai Shimposha, 1993 (in Japanese).
Pollak, Robert A., *The Theory of the Cost-of-Living Index*, Oxford University Press, 1989.
Santoni, G. J., and H. Brian Moehring, "Asset Return and Measured Inflation," *Journal of Money, Credit, and Banking*, 26 (2), 1994, pp. 232–248.
Selvanathan, E. A., and D. S. Prasada Rao, *Index Numbers: A Stochastic Approach*, Macmillan Press, 1994.
Shibuya, Hiroshi, "Dynamic Equilibrium Price Index: Asset Price and Inflation," *Monetary and Economic Studies*, 10 (1), Institute for Monetary and Economic Studies, Bank of Japan, 1992, pp. 95–109.
———, "Monetary Policy, Banking Crisis, and Disequilibrium Dynamics: Business Cycles with Capital Price Overshooting," mimeo, 1995.
Shigehara, Kumiharu, "Shisan Kakaku no Hendo to Infureishon ni Tsuite (Asset Price Fluctuation and Inflation)," *Kin'yu Kenkyu* (Monetary and Economic Studies), 9 (2), Institute for Monetary and Economic Studies, Bank of Japan, 1990, pp. 1–5 (in Japanese).
Shiller, Robert J., *Macro Markets*, Oxford University Press, 1993.
Shiratsuka, Shigenori, "Shisan Kakaku Hendo to Bukka Shisu (Asset Price Fluctuation and Price Indices)," *Kin'yu Kenkyu* (Monetary and Economic Studies), 14 (4), Institute for Monetary and Economic Studies, Bank of Japan, 1996, pp. 45–72 (in Japanese).
———, "Inflation Measures for Monetary Policy: Measuring the Underlying Inflation Trend and Its Implication for Monetary Policy Implementation," *Monetary and Economic Studies*, 15 (2), Institute for Monetary and Economic Studies, Bank of Japan, 1997, pp. 1–26.
———, *Bukka no Keizai Bunseki* (Economic Analysis of Inflation Measures), University of Tokyo Press, 1998 (in Japanese).
———, "Measurement Errors in the Japanese Consumer Price Index," *Monetary and Economic Studies*, Institute for Monetary and Economic Studies, Bank of Japan, 17 (3), 1999, pp. 69–102 (this issue).
Suzuki, Kenji, and Makoto Ohta, "A Hedonic Analysis of Land Prices and Rents in the Bubble: Kanagawa Prefecture in Japan for 1986–1988," *Economic Studies Quarterly*, 45 (1), 1994, pp. 73–94.
Suzuki, Yoshio, *En Defure to Doru Infure* (Yen Deflation and Dollar Inflation), Toyo Keizai Shimposha, 1995 (in Japanese).
Takayama, Noriyuki, *Sutokku Ekonomi* (Stock Economy), Toyo Keizai Shimposha, 1992 (in Japanese).