

# Defining Price Stability in Japan: A View from America

Christian Broda and David E. Weinstein

*Japanese monetary and fiscal policy uses the consumer price index (CPI) as a metric for price stability. Despite a major effort to improve the index, the Japanese methodology of calculating the CPI seems to have a large number of deficiencies. Little attention is paid in Japan to substitution biases and quality upgrading. This implies that important methodological differences have emerged between the United States and Japan since the former started to correct for these biases in 1999. We estimate that using the new corrected U.S. methodology, Japan's deflation averaged 1.2 percent per year since 1999. This is more than twice the deflation suggested by Japanese national statistics. Ignoring these methodological differences is misleading, because it would suggest that U.S. real per capita consumption growth has been growing at a rate that is almost 2 percentage points higher than that of Japan between 1999 and 2006. When a common methodology is used, Japan's growth has been much closer to that of the United States over this period. Moreover, we estimate that the bias of the Japanese CPI relative to a true cost-of-living index is around 2 percent per year. This overstatement in the Japanese CPI in combination with Japan's low inflation rate is likely to cost the government more than ¥69 trillion—or 14 percent of GDP—over the next 10 years in increased Social Security transfers and debt service. For monetary policy, the overstatement of inflation suggests that if the BOJ adopts a formal inflation target without changing the current CPI methodology, a lower band of less than 1.8 percent would not achieve its goal of price stability.*

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Christian Broda: University of Chicago, Graduate School of Business, and National Bureau of Economic Research (E-mail: cbroda@chicagogsb.edu)

David E. Weinstein: Columbia University and National Bureau of Economic Research (E-mail: dew35@columbia.edu)

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## I. Introduction

On March 9, 2006, the Bank of Japan (BOJ) issued a statement clarifying its thinking on price stability: "Price stability is, conceptually, a state where the change in the price index without measurement bias is zero percent. Currently, there seems to be no significant bias in the Japanese consumer price index."<sup>1</sup> This confidence in the lack of bias in the Japanese consumer price index (CPI) is particularly surprising, since the Japanese national statistics office does not correct for even the most basic problems in standard index theory. By contrast, understanding biases in the U.S. CPI has been a major undertaking that has produced many changes in the index in recent years. In this paper, we review how the differences between the Japanese and U.S. way of calculating price indexes makes cross-country comparison based on national statistics highly misleading. We discuss the conceptual issues related to CPI measurement, the recent modifications to the U.S. CPI, and the implications that they have for fiscal and monetary policy in Japan.<sup>2</sup>

We begin by documenting that by using the U.S. methodology of calculating price indexes, Japan's deflation averaged 1.2 percent per year since 1999. This is more than two times the deflation suggested by Japanese official statistics. This comparison is a useful exercise, because the U.S. Bureau of Labor Statistics (BLS) has updated its procedures to correct for widely recognized problems in standard price indexes and devotes substantially more resources to the calculation of prices indexes than Japan's counterpart, the Ministry of Internal Affairs and Communications (MIAC). It also underscores the risks of ignoring methodological differences when comparing cross-country performances. If we ignore the methodological differences between the United States and Japan and compare growth by looking at the official data of each country, we would conclude that U.S. real per capita consumption has been growing at a rate that is around 2 percentage points higher than Japan's real per capita consumption during the 1999–2006 period. However, when we use a common methodology, Japan's growth over this period has been much closer to that of the United States, being only 0.7 percentage point smaller.

The differences between CPI methodologies can be traced to simple improvements in the formulas used in the United States that have not yet been implemented in Japan. As a result of the Boskin Report (Advisory Commission to Study the Consumer Price Index [1996]), it became apparent that two basic corrections were required to improve the measurement of prices. First, the so-called substitution bias had to be corrected. Indexes used to compute prices should recognize the simple fact

1. See Bank of Japan (2006, p. 61).

2. Measurement issues have plagued the Japanese CPI. For example, consider what happened in the first few months after the BOJ's statement. After five consecutive months of positive year-on-year CPI inflation, the BOJ ended its policy of quantitative easing. After four more months of CPI growth of around 0.6 percent per year, the BOJ raised interest rates to 0.25 percent. However, little more than five months after the BOJ noted that there was no bias in the Japanese CPI, the Ministry of Internal Affairs and Communications (MIAC) updated the CPI weights (which was just one of the eight possible sources of bias that the BOJ had dismissed) and revealed that inflation had been consistently negative (year on year) for every month until the BOJ raised rates. While inflation was standing at a positive 0.1 percent annual rate in March 2006, it went negative in April (0.6 percent below the old CPI) following the end of quantitative easing. When the BOJ raised rates to 0.25 percent, inflation was only 0.2 percent. After the rate increases, deflationary pressures intensified. The numbers for March 2007 reveal that year-on-year core inflation (the general index excluding fresh food) stood at -0.1 percent. Deflation had returned.

that when the price of, say, apples relative to oranges rises, the quantity demanded of apples will fall. By ignoring the fall in apples purchased, conventional price indexes that use a fixed weight for apples and oranges over time tend to overweight the importance of price increases.<sup>3</sup> The United States corrected for this problem with two successive modifications of the formulas used in computing the CPI in 1999 and 2002. Japan has not addressed the substitution bias. Second, the Boskin Report concluded that hedonics should be used to capture the growth in quality in some fast-growing products like PCs. By 2002, the BLS had extended the use of hedonic regression to estimate the value of items changing in quality to cellphones, PCs, and refrigerators, among several other durable goods. Today, hedonics are also used in the United States for the pricing of cable television, lodging away from home, and college tuition and fees. Japan only uses hedonics for PCs since 2000 and for digital cameras since 2003. These two differences imply that even if all prices move identically in the United States and Japan in 2007, the measured Japanese inflation will be around 0.8 percentage point *higher* than in the United States.

The rest of the paper highlights the differences and implications between using simple atheoretic procedures of aggregating prices over a fixed basket of goods, like the Japanese CPI, and the so-called cost-of-living indexes (COLIs), which measure the cost of maintaining a certain “standard of living,” without restrictions on what is in the basket. Barring computational errors, atheoretic indexes are not wrong, they are just not informative. For this reason, most economists recognize that the measurement goal of a CPI is a COLI. The stance of Japan’s MIAC on this issue is confusing. On parts of its website, it states that Japan’s index is simply an atheoretic cost of goods index: “[I]t is necessary to pay attention that the CPI intends to measure the price movements themselves, not to measure movements of living expenses with changes of varieties, qualities or quantities of goods and services . . .”<sup>4</sup> This view suggests that the CPI may fluctuate even though these movements may not reflect changes in the cost of living. The absence of a theoretical justification underlying the CPI means that the Japanese CPI may not tell us how these price changes actually are affecting the cost of living. This, of course, raises concerns about what exactly the CPI is measuring.

However, on the same website in which the MIAC explains that the CPI is not a measure of living expenses, it also argues that it *is* a COLI: “The index shows changes in the total amount of expenditure required to purchase the equivalent goods and services purchased by households in the base year . . .” The inconsistency of the two statements reflects the inherent tension between producing an atheoretic index and the desire to have that index mean something.

The absence of a theoretical underpinning for the CPI creates a conundrum for policymakers that is not unique to Japan. For example, if the MIAC produces indexes of prices that are determined only by the formula used, then there is little theoretical justification to define “price stability” following the existing CPI, since the index is not measuring prices in a way that is easily interpretable in terms of economic fundamentals. We survey recent studies which show that new, higher-quality products

3. As expected, this leads to an overstatement of the true cost-of-living index.

4. See the website of the MIAC under “Frequently Asked Questions” (<http://www.stat.go.jp/english/data/cpi/1585.htm>).

are constantly replacing older products and that this process is mostly ignored by statistical offices. Since the overall quality available to consumers is rising, the COLI is falling at a faster pace than that implied by the formulas used by most agencies. Thus, there remains a substantial bias arising from new and higher-quality goods in the CPI. This upward bias is estimated to be around 0.8 percentage point per year. This implies that together with other existing biases, the overall bias in the Japanese CPI relative to a true COLI is around 1.8 percent per year.

The implications of this bias are enormous. Many Japanese government transfers, such as public pensions, are indexed to the CPI. The conventional justification for this indexing is that it is required to keep the “standard of living” of the elderly constant over time. However, if the CPI is biased upward, then this means that the government is spending vastly more than it should to keep the standard of living of the elderly constant over time. If this overstatement in the Japanese CPI is not corrected, it will imply higher government expenses of more than ¥69 trillion—or 14 percent of GDP—over the next 10 years in increased Social Security transfers and debt service. For monetary policy, the overstatement of inflation suggests that if the BOJ adopts a formal inflation target without changing the current CPI methodology, a *lower band* of less than 1.8 percent would not achieve a goal of price stability.

## II. Price Indexes in Japan and the United States: Some Important Differences

Much of the theoretical work for biases in the U.S. CPI has been developed by government and academic economists interested in obtaining better measures of inflation. While the United States has resisted officially using utility-theory based indexes, the BLS has implemented a large number of modifications to the CPI that make it perform more closely to this benchmark. Indeed, much of the Boskin Report explicitly addressed eliminating deviations (biases) between the CPI and the Törnqvist index.<sup>5</sup>

The United States has also benefited enormously from the government’s interest in data collection. Ariga and Matsui (2003) report that in 2002 the U.S. government spent 10 times more than Japan on the collection of statistics. They show that this number actually understated the difference for a number of reasons. First, 68 percent of Japanese statisticians were involved in the collection of agricultural statistics (as opposed to 1.5 percent in the United States). Second, the Statistics Bureau of the MIAC had only 10 people with a masters-level education and no one with a Ph.D. The U.S. government, by contrast, employed 2,000 statisticians and economists. While we could not find information on the training level of the statisticians at the BLS, every economist and statistician opening listed on the BLS website (checked on August 25, 2006) required the applicant to have at least a masters degree. Moreover, every economist and statistician in the BLS over Grade 9, which constitutes the

5. The Törnqvist index has the desirable property that it is superlative, that is, it is a second-order approximation to any arbitrary twice-differentiable linear homogenous utility function.

vast majority of these positions, must hold a masters or higher degree. Taken together, the differences of 30-to-1 in spending and manpower are likely to generate substantial differences in the sophistication that Japanese and U.S. statistical agencies can bring to bear on data collection and processing.

It is therefore not surprising that the Japanese CPI is constructed using different procedures than those in the United States. The Japanese CPI is constructed in accordance with the International Labor Organization (ILO) minimum standards, but this is a low threshold. The typical member of the ILO has a per capita income 1/20th that of Japan and cannot be expected to implement the sophisticated price measurements used in the United States. As a result, the methodologies used by Japan and the United States differ substantially, and one should be very cautious doing cross-country comparisons of aggregate prices. To understand these differences, one needs to delve a bit deeper into the statistics.

The U.S. CPI contains two levels of aggregation. At the *upper* level, 211 strata-level price *indexes* in each of 38 areas (or regions) are combined either using a Laspeyres formula in the case of the standard CPI or a Törnqvist formula when using the chained CPI (C-CPI).<sup>6</sup> This means that there are 8,018 item-area indexes which are aggregated at the upper level. Each of these indexes is in turn based on a *lower*-level sample of approximately 10 price *quotations* per item-area (85,000 price quotes overall). This lower-level price quotation is critical for the BLS's approach to price measurement. Almost all of the deviations from the standard Laspeyres index in the U.S. case—hedonics, geometric averaging of prices, sample rotations, and so on—occur at this lower level. Thus, while the upper level of the U.S. CPI is Laspeyres, the lower level is a complex combination of geometric averages, hedonics, and imputations. Since much of the substitution by consumers is done at the lower level (among, say, different brands of the same good) rather than across different expenditure classes (e.g., cars versus televisions), this two-tiered approach corrects much of the substitution bias.

The Japanese CPI, by contrast, is much closer to a pure Laspeyres index. At the upper level, the Japanese CPI is more disaggregated than the U.S. CPI. Japan uses 598 items in its CPI instead of the 211 strata used in the United States, and surveys these prices in 167 municipalities across Japan, as opposed to the 38 in the United States. Thus, at the upper level, Japan has more than 10 times the number of price series in its CPI calculation. However, there is a big cost to the significantly larger and more geographically dispersed sample: the lower level of the Japanese CPI is much smaller. To the extent that multiple prices are aggregated to form an upper-level index, it is done using a simple average of the prices. Moreover, most of the research on the Japanese CPI, with the notable exception of Ariga and Matsui (2003), has focused on issues at the upper-level biases, leaving most of what the United States has focused on untouched. For example, statisticians in Japan do not use geometric averages or random samples of prices and only started to do hedonic regressions on PCs and digital cameras in recent years.

6. Some of these strata are comprised of two or more entry-level items (ELIs) to account for different items within a strata. The 305 ELIs are aggregated into the 211 strata in the CPI.

How much do the Japanese gain from the greater geographic dispersion in the index? The answer is, probably not much. Broda and Weinstein (2007b) use ACNielsen Homescan data to examine the prices of goods purchased in 10 cities in the United States. The major advantage of these data is that goods are defined using barcodes and hence the exact same goods can be compared in different cities. The results suggest that, at least for goods, there is very little dispersion in average prices across cities: the standard deviation in average prices of identical goods across cities is only 2 percent. Indeed, there is more dispersion in prices within cities than across cities. Much of the difference in apparent price differentials across cities arises from different samples of goods. This suggests that the law of one price holds reasonably well across cities for the typical good in the United States. It is likely that given Japan's smaller land mass, prices are even more integrated.

This has an important policy implication for thinking about how data are collected in Japan and the United States. If there is not much difference in the price of the average can of soda in two cities, statistical agencies can save significant amounts of money by not collecting regional price information on goods (while maybe continuing to collect it for non-tradables like housing). This information could be used in Japan to increase the sample size of the lower level of the CPI.

#### **A. Lower-Level Substitution Bias**

The Japanese CPI measures the current cost of a fixed basket of goods and services. As a fixed-quantity weight index,<sup>7</sup> the Laspeyres index tends to overstate increases in the cost of living because it ignores the substitutions that consumers make in response to changes in relative prices. For instance, if the price of Kirin beer bottles rises relative to the price of Asahi beer bottles, consumers will partially substitute the purchase of Asahi for that of Kirin. Since a fixed-quantity weight index assigns a relatively higher share to Kirin (the product whose price has risen) than consumers do, the CPI will overestimate the increase in consumers' cost of living.

A simple example can illustrate the extent of the bias. Assume that the typical Japanese consumer buys one bottle of Kirin beer and one bottle of Asahi beer a month at a cost of ¥300 per bottle. If the price of Kirin beer today rises to ¥600 and the price of Asahi falls to ¥150, most consumers would switch their purchases toward Asahi, but a fixed-quantity index like the Japanese CPI would record this set of price changes as inflation. If the Japanese CPI recorded the price of beer as 1 in the first year, the price index in the second year would be a 25 percent increase in the price of beer, that is,  $0.25 = ((600 + 150)/(300 + 300) - 1)$ . In other words, the Japanese CPI methodology assumes that consumers continue to buy the same amount of Kirin and Asahi even after their prices change.

The high degree of geographic dispersion in the Japanese CPI results in a very small sample at the lower level. For example, the MIAC typically uses only one price quotation per item-area, as opposed to 10 in the United States (Ariga and Matsui [2003]), and only several dozen price quotations in the Tokyo metropolitan area. One of the major

7. As the name suggests, a fixed-weight index adds prices of different goods and services using a quantity weight that is fixed over a long period of time, typically over five years.

drawbacks of this procedure is that the Japanese CPI cannot make any adjustments for what the BLS calls “lower-level substitution”: the ability of consumers to switch away from high-priced brands to low-priced brands of a particular item in a particular region.<sup>8</sup>

The United States corrects for this problem by randomly sampling prices and using geometric averaging at the lower level since 1999. The advantage of geometric averaging is that it allows for substitutability among the various goods that make up an item index. Since the United States uses approximately 10 price quotations per item-area, the BLS has more flexibility in terms of how prices are aggregated into the index. In the example discussed above, the BLS would take the geometric average of the prices and produce an estimate of no inflation in the second year ( $0 = (2 \cdot 0.5)^{0.5} - 1$ ).

The U.S. formulation is equivalent to assuming that goods have an elasticity of substitution of unity. Shapiro and Wilcox (1997) document that the geometric mean of prices is a close approximation of the superlative Törnqvist aggregator. This is not that surprising, since the geometric average is a first-order log approximation of an arbitrary utility function while the Törnqvist can be thought of as a second-order approximation.

But how important is this bias in reality? In the United States, the quantitative importance of this adjustment has been estimated to be quite large. Lebow, Roberts, and Stockton (1994) estimate that prior to the implementation of geometric averaging, the lower-level substitution bias ranged from 0.3–0.4 percentage point per year. Moulton and Smedley (1995) estimated that the switch to geometric weighting at the lower level corrects an upward bias in the CPI of around 0.5 percentage point per year.<sup>9</sup> Shapiro and Wilcox (1997) put the bias in the range of 0–0.5 percentage point. Broda and Weinstein (2007a) used ACNielsen Homescan data to compare a pure Laspeyres index with a Törnqvist index and found that lower-level substitution created an upward bias of 0.4 percentage point per year. The similarity of these numbers despite their coming from different datasets and arising from different methodologies suggests that it is reasonable to conjecture a large upward bias in Japan. Based on these estimates, we believe a reasonable estimate of the upward bias due to lower-level substitution to be around 0.4 percentage point per year in Japan as well.

One critique of this approach is offered by Shiratsuka (1999). He uses the methodology of the Boskin Report to estimate the bias, an approach that we mimic in this paper, and argues that the lower-level substitution bias is only 0.1 percentage point per year. He summarizes his reasoning as follows:

Since the Management and Coordination Agency does not release the price index of those lower than the item level, problems in aggregating individual sample prices into item levels have not been estimated. However, taking into

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8. Sato (2007) argues that this avoids a bias in the CPI, because simple averages of prices and geometric averages of prices will yield similar results if the goods sampled are chosen to be homogeneous and therefore do not exhibit large relative price fluctuations. While this point is correct, it reflects the fact that without random sampling, one cannot estimate the lower-level bias in the Japanese case. If the MIAC performed random sampling, the bias would be larger. Thus, the measured low bias in the Japanese case is just an artifact of the non-random sample used in the analysis.

9. Greenlees (1997) argues the lower-level bias in the U.S. CPI prior to the introduction of the geometric average was 0.2 percentage point per year but, as the Boskin Report documents, this lower number reflects the remaining bias after the BLS implemented procedures to reduce the lower-level substitution bias.

account the fact that (1) the increase in the Japanese CPI is now at a low rate, thus biases caused by the index formula are deemed to be almost negligible; and (2) the classification of Japanese CPI items is more detailed than the item strata used in the United States, it can be safely assumed that biases caused in the process of aggregation of individual prices into item level are considerably smaller than the U.S. estimate of 0.25 percent.

In this paper, I will assume the bias stemming from the process of aggregating individual prices to item level to be 0.10 percent, a figure derived as the difference between upper level substitution and lower level substitution, which were both estimated in the Boskin Report.<sup>10</sup>

The argument that low inflation leads to low *relative* price volatility seems problematic, because there is no clear connection between relative price movements and aggregate price movements at these low levels of inflation. Prices could be rising in unison with no relative price changes, or alternatively there can be large relative movements in prices with no overall trend in prices. In the United States, these deviations are enormous. Klenow and Kryvtsov (2005) find that in BLS data the average *monthly* movement in a price quotation is 13.1 percent in a period of low U.S. inflation. Similarly, Broda and Weinstein (2007a) find that in scanner data the typical quarterly movement in the average price of a good with a barcode is 8 percent for a similar period. This suggests that there is vastly more price volatility at the individual good level than we observe at the aggregate level. Since the bias is driven by the high levels of price volatility of price quotations, the fact that aggregate inflation is low probably does not have much of an impact on the magnitude of the bias in low-inflation environments.

Second, although Shiratsuka (1999) argues that the fact that Japanese item strata are more numerous than those in the United States compensates for the lower-level bias, this seems unlikely. The key point to bear in mind is that the lower-level substitution bias is a formula bias arising from the fact that the Laspeyres index does not allow for substitution at the lower level. This formula bias will be present regardless of the level of aggregation. Put simply, a Laspeyres index would exhibit formula bias even if one observed every price in the Japanese economy.

Elsewhere, Shiratsuka has argued that the lower-level substitution is a U.S.-specific problem which arises out of the U.S. decision to conduct random sampling of prices.<sup>11</sup> The MIAC, by contrast, does not conduct random sampling of goods, but rather instructs its agents to select the best-selling brands in the largest-selling stores. Since the MIAC typically instructs agents to select very similar goods at the lower level (for example, the beer index is composed of beer sold in six-packs of particular-sized cans), there is much less price dispersion among items at the lower level. One implication of this is that the problem in the Japanese CPI cannot be corrected by simply geometrically averaging the prices if the prices that the MIAC chooses all move in unison. However, this does not mean that the bias is absent. By contrast, the non-random sampling

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10. See Shiratsuka (1999, p. 82).

11. See Shiratsuka (2007).



of goods means that the index does not correct at all for the very real tendency of consumers to substitute away from high-priced products and toward lower-priced ones. Thus, while simply using geometric averages in the absence of random sampling may not correct the lower-level substitution bias, this does not mean that the index is unbiased. Rather, the implication is that one needs both random sampling and geometric averaging to obtain the correct change in the cost of living. We therefore believe that the gap between the U.S. CPI and the Japanese one is probably about 0.4 percentage point.

### B. Upper-Level Substitution Bias

Upper-level substitution bias arises from the fact that in both the U.S. (non-chained) CPI and the Japanese CPI, strata-level indexes are aggregated using a Laspeyres formula. Thus, if the price of one stratum rises and another falls by the same amount, the index will record inflation because there is no adjustment for the fact that consumers may substitute consumption from the expensive stratum to the cheaper one. Such estimates used to range between 0.1 and 0.2 percentage point per year.

Since the Boskin Report appeared, new data have become available which suggest this bias is significantly larger. Estimates of the magnitude of the bias from ignoring substitutions *across* the CPI's roughly 8,000 item strata<sup>12</sup> are typically made by comparing the CPI with an alternative measure that does take substitution into account.<sup>13</sup> Ever since the BLS began publishing a C-CPI using a Törnqvist formula at the upper level, it has become trivial to compute the bias arising from upper-level substitution—the bias simply is the difference between the chained and unchained CPIs. Lebow and Rudd (2003) find the upper-level substitution bias to be around 0.5 percentage point for 1998–2000 in the United States. Table 1 extends their comparison to 2006 to show that this bias has been roughly 0.5 percentage point for the period since 2000.

**Table 1 The Impact of U.S. Chaining on U.S. CPI Measures**

	CPI	C-CPI	Average inflation difference (percentage points)
1999	100.0	100.0	
2000	103.4	102.0	1.4
01	106.3	104.3	0.6
02	108.0	105.6	0.3
03	110.4	107.8	0.2
04	113.4	110.5	0.2
05	117.2	113.7	0.5
06	121.0	116.9	0.4
Average			0.5

Source: U.S. Bureau of Labor Statistics.

12. Examples of item strata are uncooked ground beef in Dallas and hospital services in Atlanta.

13. In January 1999, the BLS implemented measures to correct for the substitution that occurs *within* strata. It is believed that most of this “within” bias has been corrected.

Shiratsuka (1999) computed the bias for Japan and came up with a much smaller number of 0.1 percent per year between 1970 and 1997. Since the MIAC produces both Paasche and Laspeyres indexes, it is possible to compare the Laspeyres index relative to the Fisher index. Since the Fisher index is a superlative index, the difference is a good approximation of the bias. In Table 2, we compute the upper-level substitution bias for Japan and find that while the bias was on average 0.13 percentage point per year from 1970 to 2000, which is largely in line with Shiratsuka's estimate, between 2000 and 2005 it rose to 0.25 percent per year. We therefore use this more recent number for our estimate.

This number is very close to an estimate of the bias produced by Feldman (2006). He compared a Laspeyres index of inflation with a geometric average of the price indexes that used historic weights. He estimates that between 2003 and 2005 a Laspeyres index would have overstated inflation by 0.3 percent per year relative to a geometric average of prices.

One element of the Japanese method of computing prices which is quite confusing is that while both Japan and the United States now report a C-CPI, the methodology for chaining is completely different in the two countries. The U.S. C-CPI uses a superlative index number formula at the upper level and geometric price averaging at the lower level. This means that the U.S. C-CPI can be thought of as somewhere between a first- and second-order approximation of an arbitrary utility function.

The MIAC "chaining" is actually what the BLS calls "annual weight updating." The BLS now updates the base weights in the CPI every two years. While more frequent weight updating may reduce substitution biases, it is not sufficient to eliminate them. To understand why, think about how the problem arises. One of the problems in the Laspeyres index is that persistence in price movements can cause the base weights to deviate significantly from the current expenditure shares. Earlier versions of the CPI suffered from this problem, as often the weights were updated less than once a decade. If prices in some sectors are trending upward, then the Laspeyres index will overweight those sectors, because it will not adjust for the fact that

**Table 2 Upper-Level Substitution Bias in Japan**

	Laspeyres	Paasche	Fisher	Annual bias (percent)
1970	130.4	126.0	128.2	0.36
75	172.4	171.0	171.7	0.09
80	137.2	134.6	135.9	0.20
85	114.4	113.3	113.8	0.10
90	106.2	105.5	105.8	0.07
95	106.4	106.2	106.3	0.02
2000	101.0	99.9	100.4	0.11
05	97.3	94.9	96.1	0.25

Note: Laspeyres, Paasche, and Fisher indexes are computed using a base year that is five years prior to each entry.

Source: Ministry of Internal Affairs and Communications, "Explanation of the Consumer Price Index," 2005, p. 10, and the authors' calculations.

consumers will buy relatively fewer items if the prices of those goods are rising relative to other goods.

Increasing the frequency of weight updating is conceptually quite different from adopting a superlative index. Regardless of the frequency of the weight updating, one cannot change the fact that the Laspeyres index uses historical weights, and consumption decisions today are going to be reflected in current weights. As long as relative prices have changed, the weights will differ. Thus, while the substitution bias may be mitigated by the fact that the MIAC now updates the CPI's base weights more frequently, it has not corrected for the fact that if prices change, the base weights will not be the same as the current weights. For goods whose prices are changing rapidly (e.g., high-tech goods), the Japanese C-CPI will not correct for the substitution bias.

In fact, it is possible that the higher frequency of base updating has exacerbated the biases in the Japanese CPI. To understand why, consider the following example. Suppose that the prices of a given good have mean-reverting fluctuations. If the price of the good is high in one period, consumers will substitute away from the good. In the next period, when the price falls, the fact that demand for the good was low in the previous period will mean that the price drop will be given a lower weight. This means that more frequent base updating can actually increase an inflationary bias. It is hard to know whether this happens in reality, but as the simple example makes clear, the Japanese form of "chaining" does not necessarily reduce the bias in the CPI.

Cage, Greenlees, and Jackman (2003) show the precise impact of the biennially weight-updated CPI for All Urban Consumers (CPI-U) index series relative to a chained index or C-CPI-U index series over the 1991–2000 period to measure the anticipated difference between the two series.<sup>14</sup> We present their results in Table 3. The average difference between a CPI-U whose weights are updated biennially and

**Table 3 The U.S. and Japanese Way of Chaining**

	Inflation from simulated biennially updated CPI-U	Inflation from simulated final C-CPI-U	Percent difference
1991	4.0	3.9	0.1
92	3.2	2.7	0.5
93	3.0	2.8	0.2
94	2.7	2.4	0.2
95	2.6	2.4	0.2
96	3.0	2.7	0.3
97	2.2	1.8	0.4
98	1.4	0.9	0.5
99	2.2	1.7	0.5
2000	3.3	2.8	0.5
Average annual percent difference			0.3
Average annual percent difference, 1991–95			0.2
Average annual percent difference, 1996–2000			0.4

Source: Cage, Greenlees, and Jackman (2003).

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14. See Cage, Greenlees, and Jackman (2003, table 5.2).

the C-CPI-U was 0.3 percentage point per year over this time period, which suggests that the Japanese method of chaining (i.e., base updating) does little to correct the underlying formula bias.

The gap between the weight-updated CPI-U and C-CPI-U appears to have widened in the later part of the decade. The average annual percent difference between the two indexes rose to 0.4 percent in 1996–2000, double that observed from 1991–95. Analogously, the percent difference in simulated weight-updated CPI-U and C-CPI-U 12-month indexes steadily increased after 1992. A likely contributor to the growing gap is increased dispersion in relative entry-level item (ELI) changes. In general, the CPI-U and the C-CPI-U will diverge to the extent that (1) component ELIs have rates of inflation that differ from each other and (2) expenditure shares reflect a shift in consumer purchases toward those item categories that have fallen in relative price. Consequently, when there is more variation in price movements among ELIs, there is more room for the Laspeyres-based CPI-U and the superlative-based C-CPI-U to diverge. Price changes in CPI elementary indexes varied more widely during the later part of the 1990s. The bottom line from this exercise is that the biennially updated CPI has a bias of the same magnitude that we observed for the general CPI-U, which leads us to conclude that increasing the frequency of weight updating is not effective in reducing the bias of a Laspeyres index.

This is relevant for understanding why some of Shiratsuka's later work may not have identified this bias. Shiratsuka (2005, 2006) estimates the differences between a fixed-weight Laspeyres, a Japanese-style chained Laspeyres index, and the midpoint-weighted Laspeyres (which uses weights between the base year and the current year) and finds that they all produce similar results. Unfortunately, none of the indexes that he examines are superlative indexes, and all of them use historic weights. If we know that the fixed-weight Laspeyres has a significant substitution bias and that all of the MIAC's corrections to this index produce similar results, then the only logical conclusion is that these corrections failed to eliminate the bias. This is probably not that surprising, since none of the indexes used by the Japanese government chain in the U.S. sense.

### **C. Sampling**

One of the problems associated with the measurement of consumer prices in Japan and the United States concerns the treatment of new retailers. Since the point of purchase is fixed in the sample, if new stores open that offer lower prices for the same goods, these price drops will not be captured by either the BLS or the MIAC. Neither country has procedures for adequately capturing changes in consumers' purchasing habits. However, as Hausman and Leibtag (2004) point out, it is very hard to square the assumption that large discounters do not offer lower quality-adjusted prices with the spectacular success that these stores have had in recent years in Japan and the United States.

Wal-Mart and other large retailers have succeeded in building enormous businesses by offering the same goods for lower prices. Prior to 1990, large-scale retailers found it difficult to open new stores in Japan due to restrictions imposed by the Large Scale Retail Law. Starting in 1990 and continuing through 2000, the Japanese government

deregulated the opening of stores in Japan (JETRO [2003]). The net result of this was that mass merchandisers have made rapid progress in the Japanese market. For example, Toys “R” Us opened its first store in Japan in 1991 and had 133 stores by 2002. Costco opened its first store in 1999 and Wal-Mart acquired a 34 percent stake in the Japanese retailer Seiyu in 2002 (JETRO [2003]). Japanese retailing is clearly undergoing a fairly profound change, brought about by foreign and domestic mass merchandisers. Overall, the average sales floor space per retail establishment grew at annual rate of 4.0 percent between 1991 and 2004. By contrast, the rate of floor space per retail establishment growth was only 2.3 percent per year between 1979 and 1988. This rate of growth has, if anything, accelerated in recent years: floor space per retail establishment grew at a rate of 4.1 percent between 1999 and 2004.<sup>15</sup>

Shiratsuka (1999) argues that one can obtain estimates of the bias due to outlet substitution by looking at price movements following the Great Hanshin-Awaji Earthquake (also known as the Kobe Earthquake) of 1995. He obtains an estimate of the upward bias between 0.05 and 0.6 percentage point. In the United States, Hausman and Leibtag (2004) have examined the problem of outlet substitution more directly and find an outlet bias of around 0.3 to 0.4 percentage point per year for food products. This is somewhat larger than the original finding by Reinsdorf (1993) and motivates us to assume that the aggregate upward outlet bias in the Japanese CPI is probably also around 0.2 percentage point per year.

A second problem arises from how goods are chosen to be in the CPI in the two countries. The MIAC uses a far simpler sampling procedure than the BLS in the construction of the lower-level sample (see MIAC [2007b] and BLS [2007]). The Japanese approach to sampling of goods follows a top-down approach. Periodically, the MIAC decides what items to sample and then adds them to the CPI. So, for example, one simply could not have done hedonic regressions on PCs in Japan prior to 2000, because they were not an element of the Japanese CPI. By contrast, the Japanese CPI was still tracking abacus lesson fees as late as 1999. Similarly CD players and MP3 players are not included but phonographs are (Shiratsuka [2006]).<sup>16</sup> To the extent that the prices of PCs, CD players, and MP3 players have fallen faster than the prices of abacus lessons and phonographs, one might suspect an upward bias in the CPI due to the slow rotation of items. Moreover, when new goods are added to the Japanese sample, there is no adjustment made for the fact that the prices of these goods may deviate from the prices of goods they replace. This is equivalent to assuming that none of the price movements associated with the introduction of new goods is due to quality differences. This could be problematic if higher-quality, higher-priced goods replace older varieties.

Another important difference is that the BLS uses much broader definitions of its strata and then samples products based on the products available in stores. For example, the BLS has less specific strata and then uses interviews of store personnel to ascertain what the expenditure shares are for different products. Once it ascertains the sales weights of products, it randomly selects products using market shares as sampling weights.

15. See MIAC (2007a).

16. The iPod was introduced into the Japanese CPI in 2007 (Sato [2007]).

The different procedures produce very different rates of product rotation. The BLS schedules a rotation of 25 percent of its sample every year based on these interviews and achieves full sample rotation every four years. While it is difficult to ascertain the rate of sample rotation in Japan, documents provided by the MIAC indicate that Japan rotated only 10 percent of its sample in 2006.<sup>17</sup> Thus, scheduled rotations in Japan seem to occur at one-half to one-third the rate of that of the United States. Indeed, the rate of product rotation is more comparable to the way the U.S. CPI was constructed prior to 1981. Concerns over failure of the CPI to rotate its sample fast enough (particularly the location of purchases) resulted in a major revision of BLS procedures in 1998 to correct these problems.

It is hard to know exactly how important the rotation of products is for the Japanese CPI. Most papers that have examined the bias in the United States (Lebow, Roberts, and Stockton [1994] and the Boskin Report) put the bias at 0.1 percentage point per year. This seems a conservative estimate for Japan, given the even slower rates of rotation that exist there. However, since we are uncertain of this effect, we will leave it out of our estimate of the overall difference between the U.S. and Japanese CPIs.

#### **D. Quality/New Good Bias**

Since the CPI in both Japan and the United States is defined using a common set of goods, there is no scope for adjusting prices based on the introduction of new goods. This is likely to bias the CPI upward for a simple reason. One can think of the creation of a new good as a price decline from the reservation price of that good to the price that is actually observed in the market. Lebow and Rudd (2003) review the existing research on the quality bias and assess it to be 0.4 percent in the United States in 2003. However, they admit that existing research provides them often with “little guidance” and that their estimates are largely judgmental. Indeed, they only have a high degree of confidence in their estimates for 7 percent of the sample.

The United States phased in a more extensive use of hedonics following the Boskin Report. Although hedonics is only used for a few strata where quality upgrading is likely to be important, the impact has been quite large. The few sectors that are adjusted hedonically have a substantial impact on the overall index. The current usage of hedonics in the United States is estimated by Lebow and Rudd (2003) to lower the measured rate of inflation by CPI by 0.2 percentage point.

It is hard to know what the comparable number for Japan would be. Recently, the importance of hedonic adjustments for PCs has lessened. However, the fact that Japan uses hedonics so sparingly is a cause for concern. We believe that the greater usage of hedonics in the United States probably means that the Japanese CPI inflation deviates by around 0.2 percentage point from the U.S. CPI inflation.

Less is known about the level of bias for goods without a hedonic adjustment. The most comprehensive study of quality upgrading for a wide range of products is Broda and Weinstein (2007a). They examine all barcode data in the United States

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17. The figure of 10 percent was based on the 71 new items included in the 2000 revision of the CPI and 55 items eliminated out of a total of 598 items. Neither set of numbers includes forced rotations arising from the appearance and disappearance of goods. Shiratsuka (2006) reports that the MIAC reviews items and *potentially* changes them every 2.5 years.

and find that the rates of new product creation are enormous. Overall, 40 percent of all purchases of goods in their sample in a year did not exist four years earlier. This implies substantial impacts from product creation on the price index. Using constant elasticity of substitution and translog utility functions, Broda and Weinstein (2007a) find that the upward bias from new goods is 0.8 percentage point per year between 1994 and 2003. To the extent that we think Japanese consumers are at least as quality conscious as U.S. consumers, one should expect comparable upward biases in Japanese data.

Extrapolating between the set of goods in the Broda and Weinstein (2007a) sample and that of the whole CPI is difficult to do, because we do not know rates of innovation in other sectors. However, there are good reasons to believe that their estimate is plausible for the entire CPI. First, the sample of goods they examine is quite broad, comprising 40 percent of all goods categories in the CPI. Second, the set of goods they examine—food and beverages, groceries, and mass merchandising goods—are goods in which new product innovation is likely to be relatively small. These are not the sectors that one typically thinks of as the most innovative ones in the economy. Indeed, the Boskin Report had assumed that the bias in food and beverages was only 0.1 percentage point per year—a fraction of the actual bias. As a result, there are good reasons to believe that these estimates, if anything, understate the aggregate bias.

### III. Summing Up the Biases

Table 4 summarizes the biases in the United States prior to the modifications that occurred after the Boskin Report and shows the estimated differences with the Japanese current methodology of computing the CPI. In a very careful and controversial paper, Shiratsuka (1999) estimated that there was an upward bias of 0.9 percent per year in the Japanese CPI.

To the extent that we can apply U.S. estimates of these biases to Japanese data, it appears that there are substantial biases still to be corrected. Table 4 summarizes the biases that we have been discussing. Upper- and lower-level substitution biases are likely to amount to around 0.2 and 0.4 percentage point per year, respectively.

**Table 4 Estimates of CPI Bias**

Country	United States		Japan	Japan–United States
Category of bias	Pre-1999 bias	Post-1999 bias	2006 bias	Post-1999 difference
Upper-level substitution	0.4	0.0	0.2	0.2
Lower-level substitution	0.4	0.0	0.4	0.4
Outlet substitution	0.2	0.2	0.2	0.0
Outlet bias excluding selected goods	0.8	0.8	0.8	0.0
Hedonics on selected goods	0.2	0.0	0.2	0.2
<b>Total bias</b>	<b>2.0</b>	<b>1.0</b>	<b>1.8</b>	<b>0.8</b>

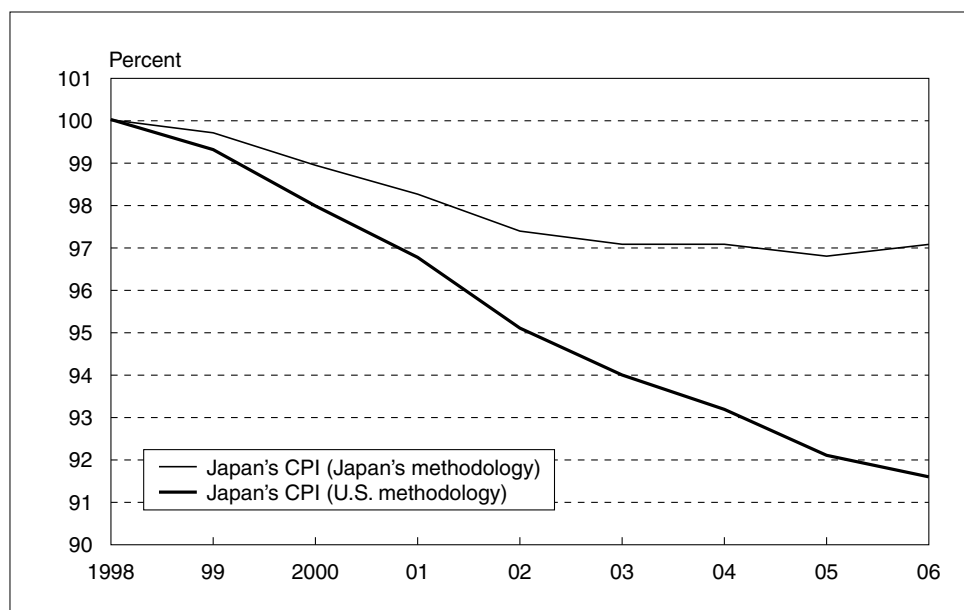
Note: For the United States, “selected goods” includes PCs, cellphones, refrigerators, cable television, lodging away from home, and college tuition and fees. For Japan, “selected goods” comprises PCs and digital cameras.

Outlet rotation biases are likely to stand at 0.2 percentage point. New goods and quality upgrading are likely to add another 0.8 percentage point per year to this in both Japan and the United States. Hedonic adjustments are likely to reduce the U.S. CPI relative to the Japanese CPI by 0.2 percent per year. This suggests a total bias of 1.8 percent in Japan and 1.0 percent per year in the United States. This suggests that the level of bias in Japan is approximately the same as the upward bias in the U.S. CPI prior to the Boskin Report revisions.

These estimates based on U.S. data are not out of line with estimates of the bias based on Japanese data. Ariga and Matsui (2003) examined the difference between point-of-sale price data and the prices reported in the CPI. They consistently found that the CPI overstated inflation by 1.5 percent to 2 percent per year in the sample of goods he examined. Thus, there seem to be substantial amounts of evidence in both the United States and Japan that the methodology used by the MIAC to measure biases substantially overstates inflation.

In Figure 1, we conduct a counterfactual exercise of assessing what the Japanese price level would be if MIAC had changed the methodology for computing the Japanese CPI along the same timetable as the BLS. Here we assume that lower-level substitution bias was eliminated in the United States in 1999, the upper-level substitution bias was eliminated in 2002, and the quality bias was reduced by 0.15 percent in 2000 and 2001 and 0.2 percent thereafter. As one can see from the figure, between 1998 and 2006, the official index fell by 2.9 percentage points. However, if the BLS had received the same data over the same time period, they would have produced an 8.4 percentage point drop in the price level. In other words, while the Japanese CPI was registering an average rate of deflation of 0.5 percent per year, had the MIAC been keeping up with advances in CPI being implemented by the BLS,

**Figure 1 Japanese Prices Computed with U.S. and Japanese CPI Methodologies**





they would have been recording deflation of 1.2 percent per year. This suggests that methodological differences are potentially important in understanding the low rate of deflation in Japan. These numbers are all the more striking if one realizes that if one adjusted for quality in the manner suggested by Broda and Weinstein (2007a) and the outlet bias as suggested by Hausman and Leibtag (2004) the Japanese rate of deflation would have been greater by another 1.0 percentage point or 2.2 percentage points per year!

## IV. The Impact of CPI Biases on Policy

### A. Comparing Real Per Capita GDP across Countries

Table 5 presents evidence on the implications of the bias in the CPI for understanding Japan's economic performance since 1998. We computed real per capita household consumption growth using Japanese and U.S. national accounts and CPI data in the first and third columns of the table. For Japan we used the usual CPI, and for the United States we used the C-CPI. As one can see from the final row, if one simply looked at the official data, U.S. real per capita private consumption growth averaged 2.1 percent per year over this time period, while in Japan it was an anemic 0.4 percent. However, if one adjusts for the biases in the Japanese data suggested by Table 4, then the Japanese growth rate rises to 1.2 percent per year. This is still well below that of the United States, but considerably higher than what the official numbers suggest.

**Table 5 Cross-Country Growth Comparisons**

	Real per capita household consumption growth (annual percent), Japan Official statistics	Japan, using U.S. methodology	United States, using U.S. methodology
1999	0.5	1.3	3.5
2000	0.3	1.1	2.7
01	1.1	1.9	0.8
02	0.3	1.1	1.6
03	-0.5	0.3	1.5
04	0.7	1.5	2.8
05	0.8	1.6	2.0
06	0.1	0.9	1.7
Cumulative	3.1	8.7	14.9
Average	0.4	1.2	2.1

Note: Real per capita household consumption growth in Japan was computed using the Economic and Social Research Institute's data on nominal household consumption deflated by the Japanese CPI and population data taken from the International Monetary Fund's *International Financial Statistics*. For the U.S. numbers, we used nominal personal consumption data from the Bureau of Economic Analysis and deflated it by the C-CPI-U for 1999–2006. We used Lebow and Rudd's (2003) estimate of the difference between the C-CPI-U and the CPI-U in conjunction with the CPI-U numbers to compute the movement in the price index between 1998 and 1999.

Sources: International Monetary Fund, *International Financial Statistics*; U.S. Bureau of Labor Statistics; and the Ministry of Internal Affairs and Communications.

## B. Fiscal Policy

Many policy implications arise from the better measurement of prices. One of the most important concerns the role of the CPI on the fiscal situation. Eliminating biases in the Japanese CPI is likely to have a major positive impact on Japan's fiscal situation. Although Japanese tax brackets are not indexed to inflation, many Japanese government transfers, such as public pensions, are indexed to the CPI. If the CPI is biased, then this means that the government is spending vastly more than it should. Correcting the biases in the CPI would mean that inflation adjustments to government benefits and taxes would more accurately reflect changes in the cost of living. It would also reduce future federal deficits and the national debt. As the U.S. Congressional Budget Office (1994) stated, "If the change in the CPI overstates the change in the cost of living, this means that some federal programs would overcompensate for the effect of price changes in living standards, and wealth would be transferred from younger and future generations to current recipients of federal programs—an effect that legislators may not have intended."

The same logic applies to Japan. A correction of the CPI bias would work to reduce outlays that are automatically linked to the CPI. Currently, not only Social Security spending is linked to the CPI. Japanese non-medical pension and welfare benefits totaled ¥58 trillion in 2004, or 12 percent of GDP. If the Japanese CPI is rising by more than the true cost of living, these benefits are likely to be rising too rapidly. Unlike the United States, the elimination of the CPI bias would not raise government revenues, since tax brackets are not indexed to inflation.

Figure 2 shows the overall reductions in deficits in the next 10 years that would result from correcting an overstatement of 1.8 percentage points in the CPI if conventionally measured inflation stood at 2.7 percent per year or more.<sup>18</sup> Here, we use the forecasts by Morgan (2004) of pension expenditures following the 2004 pension reforms and assume that non-health-related welfare expenses continue to be 29 percent as large as pension expenses. If we assume that the real cost of government debt is 2 percent per year, then this implies that in 2017 alone correcting the biases in the CPI would reduce the Japanese government deficit by ¥14 trillion, or 3 percent of GDP! The accumulated reductions in deficits after 10 years amounts to more than ¥69 trillion, or almost 14 percent of GDP. To put this number into perspective, it is more than total central government tax receipts in fiscal 2006. Clearly, correctly measuring inflation can have important fiscal consequences for the government.

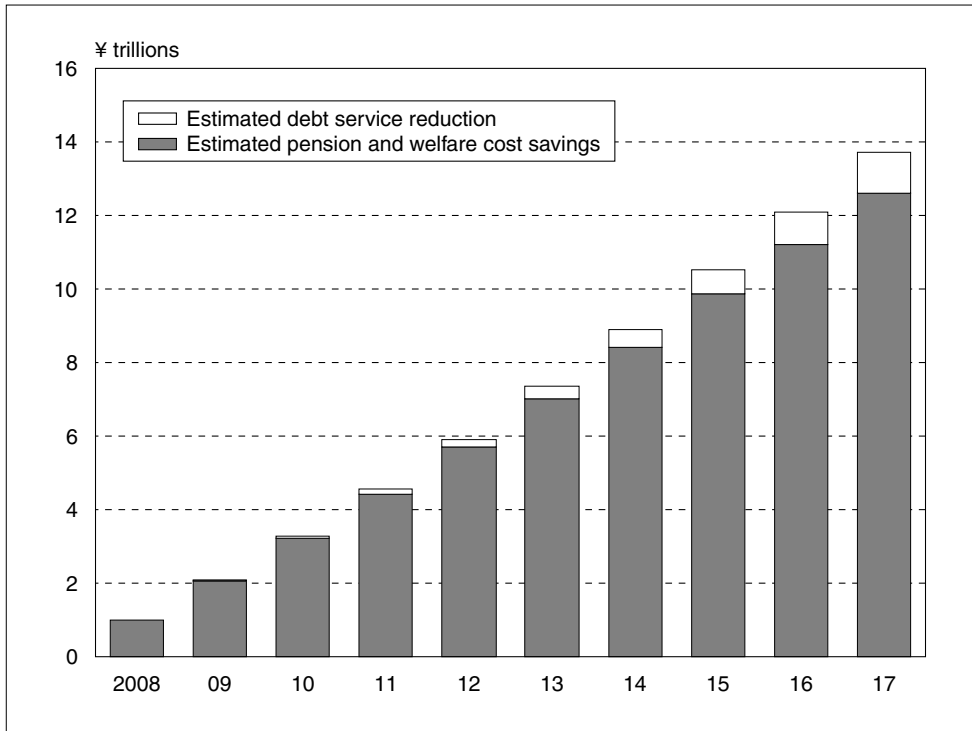
## C. Monetary Policy

A second important policy implication concerns monetary policy. If the Japanese CPI is biased upward by 1.8 percent, then this suggests that unless current measured inflation is at least 1.8 percent per year, the central bank would not be achieving a target of price stability. However, there is a good reason to believe that inflation

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18. Given the fact that the growth of nominal expenditures on pensions is legally bound below by zero or CPI inflation less approximately 0.9 percent, the amount of savings is dependent on the rate of inflation. This implies that full savings from re-indexing would not be achievable without an inflation rate of 2.7 percent per year. We are indebted to R. Anton Braun for pointing this out.

**Figure 2 Budgetary Impact of CPI Revision in Japan**



would need to be substantially higher to instill confidence that the economy was still not suffering from deflation.

Given the high degree of underlying price volatility of individual price quotations, one can do a back-of-the-envelope calculation about the standard error of the Japanese CPI due to the fact that inflation is measured from a sample of goods. If we assume that the typical monthly movement in an underlying price is around 20 percent, then this implies that with 95,000 price quotes in the Japanese data, the standard error of a monthly CPI release should be equal to 20 percent divided by the square root of 95,000 or about 0.06 percent at a monthly frequency or about 0.7 percent at an annual frequency. Ignoring the bias, this means that the inherent measurement error associated with the CPI implies that one cannot reject that a monthly CPI number is not zero at the 95 percent confidence band unless inflation is over 1.4 percent per year.

How good is this back-of-the-envelope calculation? Broda and Weinstein (2007a) bootstrap the measurement error of the U.S. CPI by drawing on their sample of 700,000 barcodes to see how much sample selection matters. In their estimation, the standard error of the CPI at a quarterly frequency is approximately 0.6 percent at the quarterly frequency, which is very close to the intuition one gets from the simple exercise that we just considered. Moreover, for inflation innovations, they find that the standard deviation of the measurement error is close to 0.9 percent. This suggests that the measurement error is likely to be sufficiently large that it is unlikely much information is contained in high-frequency movements in the Japanese CPI.

The standard deviation falls to 0.1 percent at a four-quarter frequency in the U.S. data, which suggests that much of the measurement error reflects sales and other high-frequency price fluctuations. However, even so, if the numbers for Japan are comparable to the U.S. numbers, then this suggests that the 95 percent confidence bands on even annual fluctuations in the CPI are probably close to  $\pm 0.2$  percent per year. This suggests that a central bank wishing to be confident that the economy was not in deflation should not let inflation fall below 2.0 percent. Interestingly, this number is larger than the definition of price stability used by any members of the BOJ's Policy Board.

## V. Conclusion

Japan has not invested as heavily as the United States in the production of statistics. In this paper, we have discussed a few of the many ways in which an upward bias can creep into the CPI. These biases seem to lead to an upward bias in the official number of around 1 percent relative to the U.S. methodology. Moreover, the standard error of mismeasurement implies that a central bank interested in preventing deflation should target inflation of closer to 2.0 percent.

The decision not to invest in better statistics is largely motivated by inertia and an attempt to hold down the cost of government. In this paper, we suggest that this strategy may be “pennywise but pound foolish.” There is good reason to believe that the resulting upward bias in the CPI has had and will continue to have a large negative impact on the Japanese government deficit. Over the next 10 years, the inflationary bias in the Japanese CPI is likely to cost Japan ¥69 trillion. This amount is far more than the cost of revising the index. Moreover, Japanese policymaking is hampered by inadequate statistical resources. Even in 2006, measurement errors resulted in the central bank thinking that there was inflation when in fact there was deflation. This can have potentially serious consequences for monetary policy.

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## Comment

R. ANTON BRAUN<sup>19</sup>

University of Tokyo and Bank of Japan

I want to start by saying a few words about the relationship between the consumer price index (CPI) and a cost-of-living index (COLI). It is widely accepted in the United States that the CPI is a measure of the cost of living, and that measuring the

19. Views expressed in this comment are those of the author and not necessarily those of the University of Tokyo or of the Bank of Japan.

cost of living is the objective of CPI measurement. What is a COLI? It starts basically from a notion of an expenditure function for a household. An expenditure function specifies the expenditures required to achieve a given utility level at a particular set of prices. Given an expenditure function, one can measure changes in the cost of living by altering the prices. From this, we see that measuring the cost of living requires two things: a utility level you want to guarantee, and prices from a reference year. Then you take the ratio of the expenditure function evaluated at current prices relative to its value using the reference year prices, and that gives you your COLI.

The expenditure function is based on household optimization, or more accurately household expenditure minimization, and as we have seen the expenditure function requires us to specify a level of utility. This raises the question of whose utility level? One common way to deal with this problem is to assume Cobb-Douglas utility. Under Cobb-Douglas utility, the utility level factors out of the expenditure function in a multiplicative way, and then it disappears when calculating the COLI. What that means is we do not have to worry about household heterogeneity. The second characteristic of Cobb-Douglas preferences is that it implies the appropriate way to average prices is to take a geometric average.

The idea that the CPI is a COLI and measures the cost of living is not universally accepted among policymakers or statisticians. So, to put it briefly, why do economists in the United States take it for granted that the CPI should try and measure the cost of living?

One reason is that most economists agree that demand curves are downward sloping. If the price of Asahi beer goes up relative to the price of Kirin beer, I will buy more Kirin and less Asahi. The second reason relates to the objective of the government. Most economists agree that its objective is to enhance welfare and a COLI is based on household optimization.

Does the Japanese CPI overstate the Japanese cost of living by 1.8 percent? I think Shigenori Shiratsuka is in a much better position than I am to answer this question, and I am looking forward to his discussion. Instead, I am going to talk about the implications of the 1.8 percent bias, documented by the authors of today's paper, for government policy in Japan.

Their first claim is that better measurement of the CPI is going to save the government a lot of money—almost 14 percent of GDP if you sum these benefits over 10 years. The original Boskin Report (Advisory Commission to Study the Consumer Price Index [1996]) had a big impact in the United States. Interestingly, the report estimated the size of the bias to be 2 percent. Clearly, biases of this size have potentially large implications for government policy. Unfortunately, in Japan the 2004 Pension Reform Act that Weinstein was referring to has some particular characteristics that affect the size and direction of any potential savings from better measurement. This act changed the nature of the guarantee offered by the public pension system from one that guaranteed benefits to one that places a cap on contributions. The previous idea was “Let us keep benefits fixed, and let contributions be what they have to be to deliver guaranteed benefits of a particular level.” With the aging of Japan, this policy has changed, and contributions are now capped. However, this also means that real benefits are going to have to fall over time. So the act sets up a particular strategy for reducing

benefits. In fact, the strategy is one proposed in the Boskin Report: “CPI minus  $X$ .” Take the measured CPI inflation rate in Japan: subtract  $X$ , and adjust benefits up by this smaller amount. The size of the adjustment happens to be Shiratsuka’s previous estimate of the bias in the Japanese CPI: 0.90 percent.

But there is a nonlinear characteristic to this adjustment scheme. This scheme only kicks in if you have got positive CPI growth. In situations where there is negative CPI growth, there is a floor, so nominal benefits do not fall. That nonlinearity creates some problems when you are in a situation where deflation might occur. Current measured CPI growth in Japan is 0 percent. If we take the estimate by the authors of today’s paper, then the true cost of the index is growing at  $-2$  percent; this implies that Japan currently finds itself in a situation where it is bleeding to the tune of almost 14 percent of GDP over 10 years. Thanks to the floor, real benefits are rising rather than declining.

A bias of 1.8 percent in the Japanese COLI raises another issue, too. That is, right now prices are virtually stable using the current measure; the authors’ analysis implies that the inflation rate will have to rise by more than 1.8 percent before the government’s plan for reducing real benefits kicks in. What this means is that none of the savings described by the authors can be achieved unless the floor is removed and nominal benefits are allowed to fall. If such a policy change is not made, then more accurate measurement of the CPI actually makes the funding problem for the public pension problem more severe, because it puts off the date when real benefits start to fall.

What about monetary policy? If people agreed that consumer prices and the cost of living were falling at the rate of 2 percent per year in Japan, I think most central bankers and academic economists who work in monetary policy would also agree that the call rate should be immediately reduced to zero. Moreover, with deflation at 2 percent a year, many would argue that unorthodox policies like “helicopter drops” should also be adopted. As an aside, policies along this line were tried in Japan during the 1990s.

Unfortunately, there is a big gap between the authors’ measurements and reality. Rather than lowering the call rate, the Bank of Japan (BOJ) recently *increased* the call rate to 0.5 percent. Moreover, I think it is safe to say that markets are factoring in further increases in the call rate in 2007. So rebasing the CPI has not really changed market expectations about the future course of the call rate.

So what is going on? What is the source of the discrepancy between measurement and reality? Why are markets expecting higher interest rates?

GDP growth is at about trend, but given the experience we have had over the past 10 years, trend growth for one year does not look so bad. As for prices, both the CPI and the GDP price deflator are down from last year. So we have a situation where deflationary pressures have picked up a bit and we are at trend in terms of real growth. So why is the market factoring in the possibility of a higher nominal interest rate?

One answer can be found by reading the BOJ’s webpage. On April 27, 2007, for example, it mentioned a number of risk factors, but I think the risk factor that is most important here is the risk of a new financial bubble. Equity prices have doubled since 2003, and land prices have picked up too. Commercial prices in urban areas were up 1 percent in 2005, and 8.9 percent in 2006. This year, commercial real estate prices in

some cases are up as much as 40 percent. Japan is experiencing sudden rises in asset prices, and given the experiences from the late 1980s, you can see there might be some reason for concern.

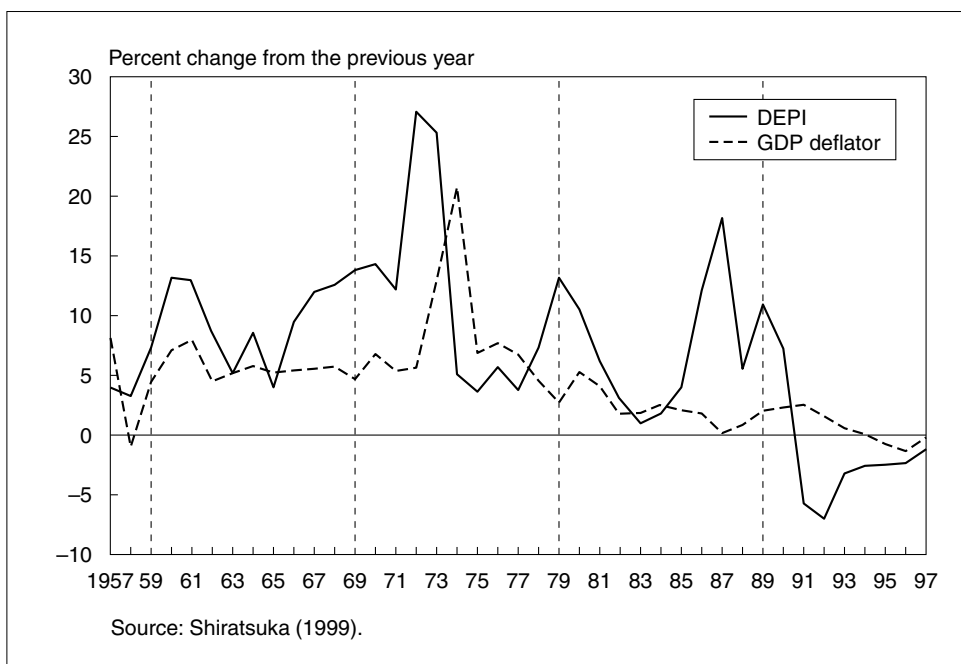
That raises the following question: how do you reflect these concerns in the conduct of monetary policy? I am going to argue: CPI measurement. Individuals provision for tomorrow by accumulating wealth. The return on wealth determines the relative price of today's consumption to tomorrow's consumption, in both the United States and Japan. The CPI, however, is measured as if there is no tomorrow. The measurement of CPI in both countries is static.

The BOJ has been aware of this issue since at least 1992, and maybe even longer. Shibuya (1992), for example, describes a way to construct a dynamic equilibrium price index (DEPI).

Figure 1 is a time-series plot of the DEPI and the Japanese GDP deflator. Consider the late 1980s and early 1990s. The plot is provocative. On the one hand, the GDP deflator is showing lower price pressure in the late 1980s. Interestingly, the DEPI suggests that there is lot of upward pressure on prices! Similarly, even though the GDP deflator continues to rise into 1991, the DEPI falls sharply after 1990. It is provocative to imagine how the late 1980s and early 1990s would have evolved if the BOJ had responded to this measure of inflation.

On the other hand, there are problems with the DEPI—and you can probably see one of them in the plot. This index exhibits lots of volatility. What is the source of this volatility? Asset price variations. Unfortunately, it is quite possible that some of the asset price fluctuations are not being driven by economic fundamentals.

**Figure 1 The DEPI and the Japanese GDP Deflator**





Should a central bank consider asset price movements when setting policy, given that it is still a challenge for economics to produce a theory which attributes all asset price variations to fundamentals? A second issue is that in constructing the DEPI you need a measure of total wealth, and the measure I have shown only uses national wealth. National wealth according to our best estimates is only 10 percent to 25 percent of total wealth, and it is much harder to measure total wealth. I will explain why in a moment.

Monetary policies that assign weight to financial market prices also have another potential problem. Taylor rules which include asset prices have the property that they act to hedge market risk. As prices fall, interest rates drop, and that looks great if you are in the market; you get some free insurance courtesy of the central bank. Do we want central banks to take actions that insure against downside market risk?

Let me return to the issue of how to measure total wealth. There is considerable evidence that between 75 percent and 90 percent of total wealth is human wealth. Equity, interestingly enough, is only about 3 percent to 5 percent of total wealth.

As for volatility of total wealth, there is new research in finance that attempts to measure total wealth. Lustig, Van Nieuwerburg, and Verdellhan (2007), for instance, find that the excess return on total wealth is only about a third as variable as the equity premium. This suggests that a DEPI which uses total wealth may be significantly less volatile than the DEPI measure in Figure 1. Moreover, because human wealth constitutes such a big share of total wealth, you have much stronger links to economic fundamentals. To the best of my knowledge, there is no evidence that variation in wages is driven by speculative bubbles.

As for monetary policy and hedging, Braun and Shioji (2003) discuss the hedging role of monetary policy. Their paper does not ask, “Should central banks take actions that hedge market risk?” Instead it asks, “Historically in Japanese data, has monetary policy taken actions that add to and/or hedge market risk?” Braun and Shioji (2003) find that the answer is “Yes.” They consider how monetary policy affects the *ex ante* risk premium of holding different assets for a hypothetical investor. They solve this investor’s asset allocation problem. He buys assets to smooth consumption over time. When making a decision to invest in any risky asset, he asks, “How correlated are these risks going to be with my personal risks?” and then assigns an *ex ante* risk premium to it. Table 1 reports his overall *ex ante* risk premium for holding Japanese equity and also the *ex post* risk premium on equity using Japanese data for different

**Table 1 Risk Premiums Assigned by a Hypothetical Investor**

Percent

Period	Japanese data	Model: <i>Ex ante</i> expected equity premium		
	Equity premium	Overall risk premium	Financial market risk premium	Monetary policy risk premium
1976–83	0.62	0.78	1.80	0.06
1984–89	1.90	1.10	2.20	2.00
1990–92	-2.30	-7.10	6.90	-15.00
1993–99	-0.15	1.60	5.00	-3.80
2000–02	-0.67	-0.75	3.40	-4.90

sub-periods. We can see that, generally speaking, his *ex ante* risk premiums forecast the actual *ex post* risk premium well. He makes some mistakes as the economic bubble collapsed, but basically is pretty good at forecasting time variation in the overall risk premium on equity.

Braun and Shioji (2003) also use a structural vector autoregression (VAR) to decompose the overall risk premium into five risk factors. The two biggest factors are financial market risk and monetary policy risk. (My allotted time does not allow me to discuss the other three, which are smaller in any case.) Between 1984 and 1989, what was monetary policy doing? Well, it was adding 2 percentage points to the risk premium on holding equity in that period. What was our hypothetical investor thinking? Maybe he was expecting that the central bank would prick the economic bubble at some point and duly assigned an extra 2 percentage points to the risk premiums of holding equity during that period. What happens after 1990? The sign on the monetary policy risk factor turns negative. So, what is the investor thinking now? He is thinking, “Whenever there is bad news for my consumption growth, the BOJ is going to help out by hedging it.” What are the implications of that for market risks? You can see that this action on the part of the monetary authority is acting to hedge the overall risk of holding equity during this period. The same actions that are good for the investor act to hedge risk of holding equity for everybody else in the market more generally.

Let me summarize my discussion. Will a better measure of CPI save the government ¥14 trillion? Not right now. The presence of a floor on cost-of-living adjustments prevents any savings, and better measurement takes you further away from the day when the government can realize any savings. What is the single biggest issue in CPI measurement? I am going to argue that it is not substitution bias or the other biases emphasized in today’s paper. My view is that the single biggest bias is due to the omission of wealth.

Have prices stabilized? We see that stock prices and land prices are up in Japan. Their share in total wealth is small. What is going on with human wealth? This is a question that we do not know the answer to! However, given that human wealth is as much as 90 percent of total wealth, it certainly makes sense to invest resources in measuring this key component in total wealth.

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## Comment

SHIGENORI SHIRATSUKA<sup>20</sup>

Bank of Japan

### I. Introduction

David Weinstein and his co-author, Christian Broda (Broda and Weinstein [2007]), offer very provocative but misleading arguments on the measurement issues of the Japanese consumer price index (CPI).

The authors' approach is misleading in two respects. First, they carry out poor "guesstimations" of measurement biases in the Japanese CPI. They naively apply U.S. empirical results to Japan, without considering the various differences between the two countries, such as economic and price developments and CPI compilation methods. This is in critical contrast to many previous studies in this field, which try to make the best "guesstimations" with due consideration to the details of the CPI compilation methods used in each country.<sup>21</sup>

Second, despite the ambitious title of the paper, the authors fall short of delivering sufficient arguments that discuss the definition of price stability in Japan from a U.S. viewpoint. They focus solely on CPI measurement issues, which are merely very limited issues regarding the numerical definitions of price stability. They should have covered the safety margin against a deflationary spiral as well, to discuss the numerical definition of price stability. They also need to consider how such numerical definition is incorporated into the monetary policy framework in pursuit of price stability in the long term.

Even after reviewing the revised version of the paper, I regret to say that the authors still fail to contribute to enhancing our understanding of the definition of price stability, or the measurement problems in the Japanese CPI. I will elaborate on these points in my comments below.

### II. The Definition of Price Stability

The first question I should ask is whether the authors contribute to our understanding of the definition of price stability. I remain skeptical.

There seems to be consensus among policymakers and academia around the globe that price stability is defined as a situation where general price fluctuations are neutral to economic decision making.<sup>22</sup> In discussing the definition of price stability, I always emphasize the importance of distinguishing two points: one is "measured price stability," and the other is "sustainable price stability" (Shiratsuka [2001]). The

20. The views expressed here are mine and do not necessarily reflect the official position of the Bank of Japan.

21. The Boskin Report (Advisory Commission to Study the Consumer Price Index [1996]) established the starting point for the recent discussion on measurement problems in the CPI in many countries.

22. See, for example, Bank of Japan (2006).

first point corresponds to discussing a tolerable range of inflation rates or a numerical definition of price stability. The second point covers conceptual arguments that price stability should be an important base for sustainable growth. In formulating a monetary policy framework, it is important to discuss how to make the two aspects of price stability consistent in the medium to long term, given the economic and social environment in each country.

The authors simply ignore the second aspect of price stability and focus solely on the first. Nevertheless, they still fail to cover an important issue regarding the first aspect, which is the safety margin against a deflationary spiral. In theory, there is consensus in academic circles, as well as in central bank circles, that a small but positive rate of inflation should be the numerical definition. In practice, this number is considered to depend crucially on the assessment of two things: one is upward bias in price indexes, and the other is the safety margin against a deflationary spiral.<sup>23</sup> The size of the necessary safety margin varies, depending on various factors in addition to upward biases in the CPI, such as the downward rigidity of nominal wages, adverse effects on financial systems and the zero lower bound of nominal interest rates, and so on. All of these points should be covered when discussing the numerical definition of price stability.

Let me elaborate on the implications that upward biases in the CPI have on the numerical definition of price stability. Upward biases in the price indexes imply that overestimation exists regarding the rates of inflation, but at the same time, underestimation also exists regarding the rates of economic growth and real interest. Better price measurements are most likely to correct both the overestimation of inflation and the underestimation of economic growth and real interest rates. If this is the case, we should be content with a much lower numerical target of inflation, because a higher real interest rate implies that we need much smaller safety margins against a deflationary spiral. Thus, upward biases in the CPI do not have relevant implications for the numerical definition of price stability.

### III. The Reality of Measurement Errors in the Japanese CPI

The next question I should ask is whether the authors contribute to our understanding of measurement problems in the Japanese CPI. Unfortunately, I again remain skeptical.

In assessing the magnitude of measurement errors, it is important to account carefully for country-specific factors, such as CPI compilation methods and economic conditions. Such country-specific factors influence the magnitude of measurement error in the CPI. Therefore, the magnitude varies from country to country, and from time to time. In this sense, a simple application of U.S. empirical results might not be appropriate and might be misleading, resulting in a poor “guesstimation.”

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23. See, for example, Bernanke *et al.* (1999).

### A. Previous Studies on Upward Biases in the Japanese and U.S. CPIs

Table 1 summarizes the estimates of upward biases in the CPI, in both Japan and the United States. Regarding the Japanese CPI, the only comprehensive quantitative assessment currently available is my point estimate of 0.90 percent (Shiratsuka [1998, 1999]). Unfortunately, there have been no follow-up studies regarding the magnitude of overall upward biases in Japan after my initial study. It is thus difficult to derive point estimates of the upward biases in the current Japanese CPI.

My point estimate, however, provided two starting points for the assessment of measurement errors in the current Japanese CPI. First, upper-level substitution bias was negligible because of the small relative price variability under low inflation.<sup>24</sup> Second, quality changes/new products bias was the largest source of upward bias, which was the main target in the base-year revision to 2000.

In contrast to Japan, many economists have carried out comprehensive assessments on the upward biases in the U.S. CPI. The Boskin Report (Advisory Commission to Study the Consumer Price Index [1996]) showed a point estimate of 1.10 percent. Thereafter, many economists have done follow-up studies on the Boskin Report by considering revisions to the compilation methods in the U.S. CPI. Lebow and Rudd (2003), the latest study in the United States, showed the point estimate to be 0.87 percent.

### B. Recent Revisions in the Japanese CPI

The current Japanese CPI reflects many improvements in price measurement, particularly at the time of base-year revision to 2000 in the summer of 2001 (Table 2). Important improvements include the following: (1) PCs are included by applying the hedonic method in quality adjustment; (2) the items surveyed are reviewed and potentially changed at mid-year to the next base-year revision (interim review);<sup>25</sup> and (3) the outlets for the price survey are set more flexibly to cover large suburban stores.

**Table 1 Point Estimates of the Upward Bias in Japan and the United States**

Percent

	Japan			United States		
	Shiratsuka (1998, 1999)	Shiratsuka (2005, 2006)	Broda and Weinstein (2007)	Boskin Report (1996)	Lebow and Rudd (2003)	Broda and Weinstein (2007)
Upper-level substitution	0.00	→	0.2	0.15	0.30	0.0
Lower-level substitution	0.10	→	0.4	0.25	0.05	0.0
Quality changes/ new products	0.70	↓	0.8 + 0.2	0.60	0.37	0.8
Outlet substitution	0.10	↘	0.2	0.10	0.05	0.2
Weighting	—	—	—	—	0.10	—
Total	0.90	↓	1.8	1.10	0.87	1.0

24. Upper-level substitution bias arises when aggregating prices surveyed into item levels. This corresponds to the problems of the index formula.

25. A base-year revision of the Japanese CPI is done every five years: the last digit of the year is equal to one or six. An interim review is done at the mid-year between adjacent base-year revisions: the last digit of the year is equal to three or eight.

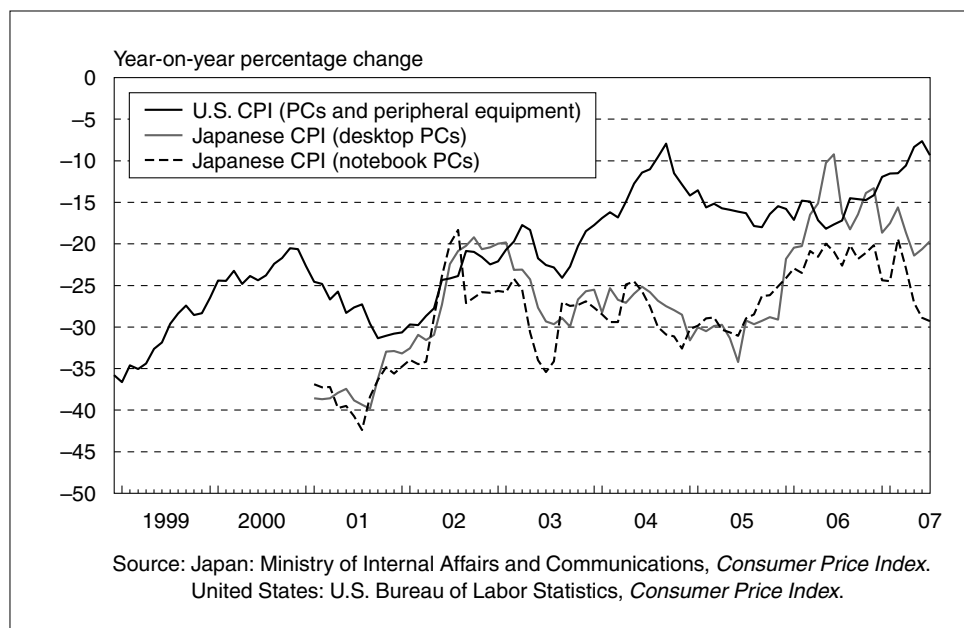
As a result, upward bias in the Japanese CPI becomes substantially smaller, compared with my estimate of the 1990-base index, mainly due to considerable improvements in quality adjustments and new products bias.

For example, the CPIs for both desktop and notebook PCs continually decline at an annual rate of 20–30 percent, as shown in Figure 1. The sum of the weights for the two types of PCs is 0.54 percent, thus inducing a decline in the overall CPI of 0.1–0.2 percentage point. The figure also shows that such declines in the CPI for PCs in Japan are significantly larger than those in the United States.<sup>26</sup>

**Table 2 Recent Major Revisions in the Japanese CPI**

Category	Measures
Quality adjustment	<ul style="list-style-type: none"> <li>● Application of the hedonic method to               <ul style="list-style-type: none"> <li>— PCs (at the revision of the base year to 2000)</li> <li>— Digital cameras (at the interim review in 2003)</li> </ul> </li> </ul>
Frequency of review on the items surveyed	<ul style="list-style-type: none"> <li>● Introduction of interim review (decided at the revision of the base year to 2000)               <ul style="list-style-type: none"> <li>— Introduction of PC printers and Internet connection charges (at the first interim review in January 2003)</li> </ul> </li> </ul>
Index formula	<ul style="list-style-type: none"> <li>● Monthly publication of the chained Laspeyres index and midpoint-year basket index (starting from the revision of the base year to 2005 [scheduled in August 2006])</li> </ul>
Range of outlets surveyed	<ul style="list-style-type: none"> <li>● Inclusion of more large suburban outlets (at the revision of the base year to 2000)</li> </ul>
Weighting	<ul style="list-style-type: none"> <li>● Publication of a reference index for all households, including one-person households (starting from the revision of the base year to 2005 [scheduled in August 2006])</li> </ul>

**Figure 1 CPI for PCs in Japan and the United States**



26. As discussed later, the U.S. statistical agency stopped using the hedonic method in computing the PC price index in 2003.

In addition, the introduction of an interim review of the items surveyed also makes it possible to include new products in a timelier manner. At the interim review conducted in 2003, for example, PC printers and Internet connection charges were included. In the past, new products and services were not brought into the CPI basket immediately, but only after a substantial time lag following their appearance in the market, as shown in Figure 2.

### C. The Magnitude of Measurement Errors in the Japanese CPI

Now let me go into the details of three sources of measurement errors, which are the authors' focus: upper-level substitution, lower-level substitution, and quality adjustment.

#### 1. Upper-level substitution

Upper-level substitution arises from the aggregation formula from the item-strata level to the overall level. More precisely, the CPI assumes that households purchase the same representative consumption basket over time, although in fact they substitute some goods and services for others when relative prices change.

The authors focus on the Paasche check results for the Japanese CPI in the past base-year revisions as quantitative evidence of upper-level substitutions. They compute the differences between annualized changes in the Laspeyres and Fisher indexes between base-year revisions, and then take the latest figure, 0.25 percentage point, as the magnitude of upward bias from upper-level substitution.

**Figure 2 Penetration of Major Durables**

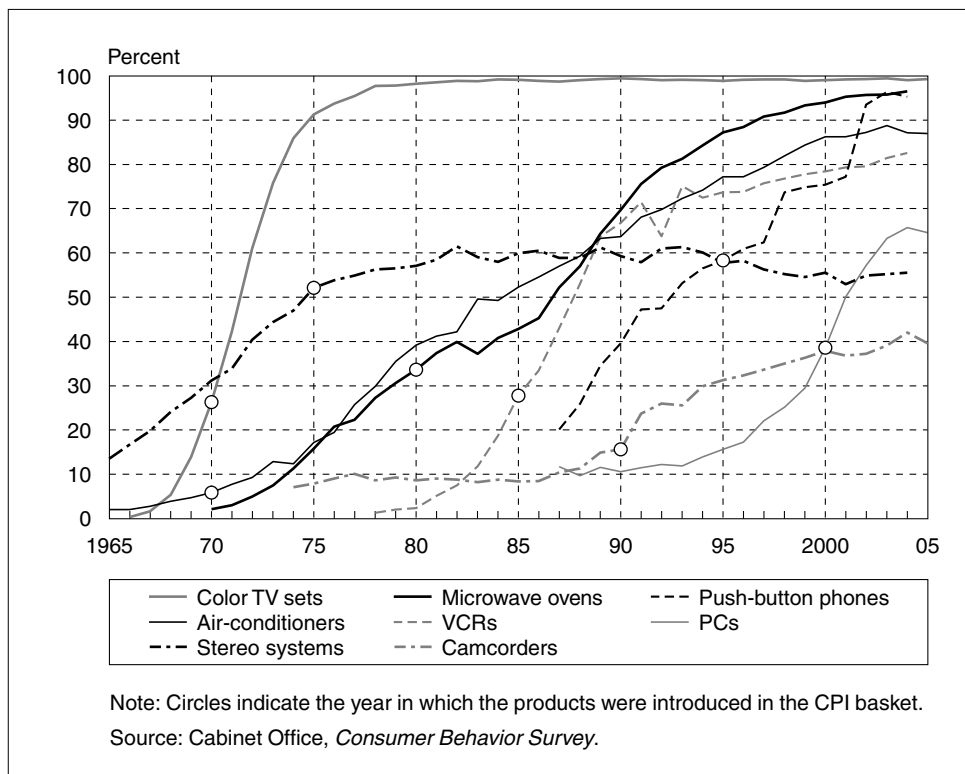


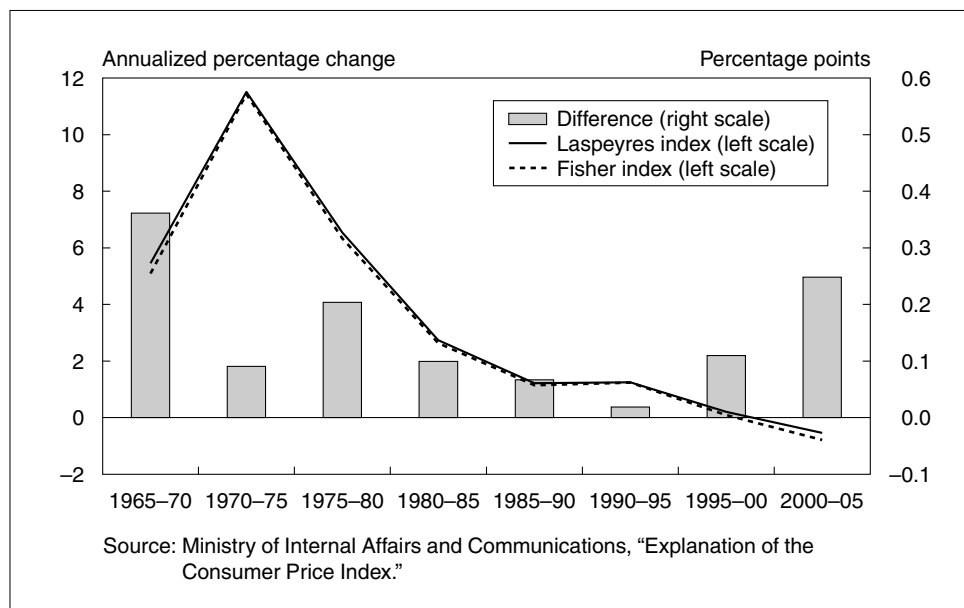
Figure 3 plots the annualized changes in the Paasche and Fisher indexes for base years from 1965 to 2000. The figure confirms that both indexes show very similar movements over time. The figure also suggests that the differences between the two indexes became slightly larger in recent base-year revisions, although the differences are almost zero in the 1990 base. In this respect, I pointed out in recent short notes (Shiratsuka [2005, 2006]) that the effects of upper-level substitution are generally limited compared to the United States, but such effects became slightly larger in recent years. This is because the relative price variability is generally small under a low inflation rate and aggregation formulas in upper levels do not matter much. The relative price variability, however, increases because the 2000-base CPI reflects increases in the share of items with rapid price declines, including PCs.

In fact, Figure 4 shows the relative price variability over time by plotting the distribution of year-on-year changes in item price indexes in the Japanese CPI. The figure plots 10th, 20th, 50th, 80th, and 90th percentile points, which is the rate of change of an item with a cumulative weight equal to 10, 20, 50, 80, and 90 percent. This shows very narrow bounds from the 10th to the 90th percentile point of individual price distribution for the Japanese CPI.

At the same time, the recent increases in the differences between the Laspeyres and Fisher indexes suggest that better measurement of individual prices is likely to expand the variability of relative prices, thus requiring an aggregation formula that is more robust to upper-level substitution. In other words, the effects of improvements to individual price measurement need to be assessed from the viewpoint of the CPI system as a whole.

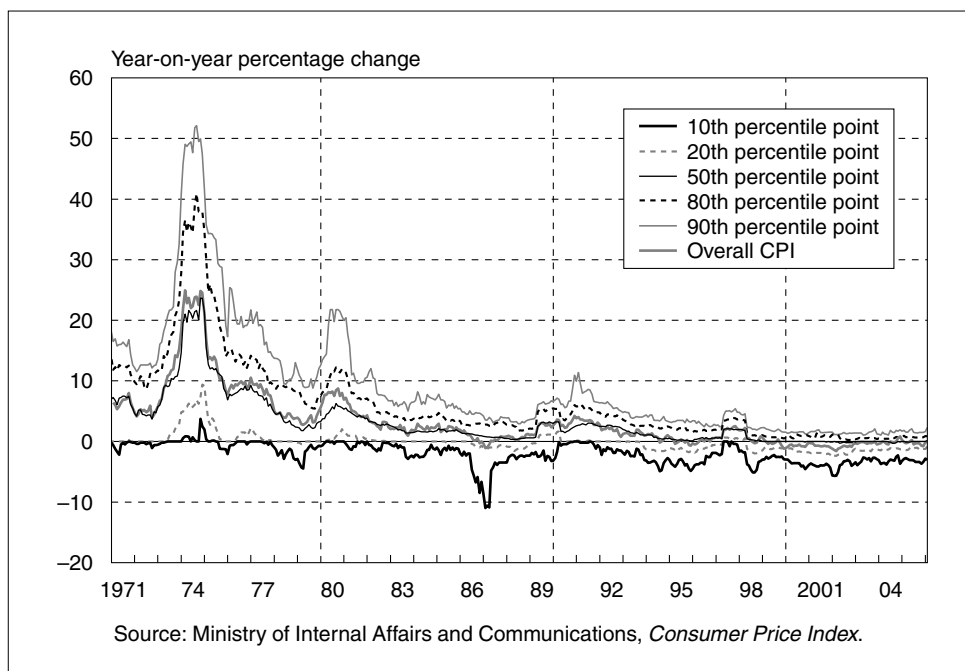
To resolve the upper-level substitution bias examined here, the authors emphasize the importance of introducing the Törnqvist index, one of the superlative indexes, as a

**Figure 3 Paasche Check for the CPI**





**Figure 4 Distribution of Individual Prices in the CPI**



headline indicator for the CPI. Their proposal, however, does not seem effective in minimizing upper-level substitution bias on a real-time basis, because any forms of the superlative indexes can only be computed retroactively. The U.S. CPI is not exceptional, although the authors consider it as the genuine superlative index. More precisely, the U.S. CPI is not the superlative index on a real-time basis, but converges to the superlative index over time, as weight data become available.

In this regard, I should emphasize that upper-level substitution bias is more likely to cause problems from a longer-term perspective, rather than a short-term perspective. Monthly publication of the Japanese CPI includes an indicator based on a midpoint-year weight formula that uses time-varying weight, but is less influenced by the drift problem.<sup>27</sup> This provides preliminary but real-time information regarding the magnitude of upper-level substitution bias. Such assessments are cross-checked afterward with the Paasche test, which becomes available at the time of a base-year revision. This information provides sufficient basis for assessing the effects of upper-level substitution in the long term.

## 2. Lower-level substitution

Turning to lower-level substitutions: it is highly misleading to simply apply U.S. estimates to Japan, because fundamental differences exist in their price surveying methods.

27. The drift problem for a price index with time-varying weight indicates a situation in which the overall index will not return to the initial level, even after the individual index returns to the initial level, when price levels fluctuate in a volatile manner. This problem occurs because the same magnitude of upward and downward changes in the level of price index results in different rates of change: the rate of upward changes exceeds that of the downward changes. Such effects become serious when relative prices fluctuate in a highly volatile manner.

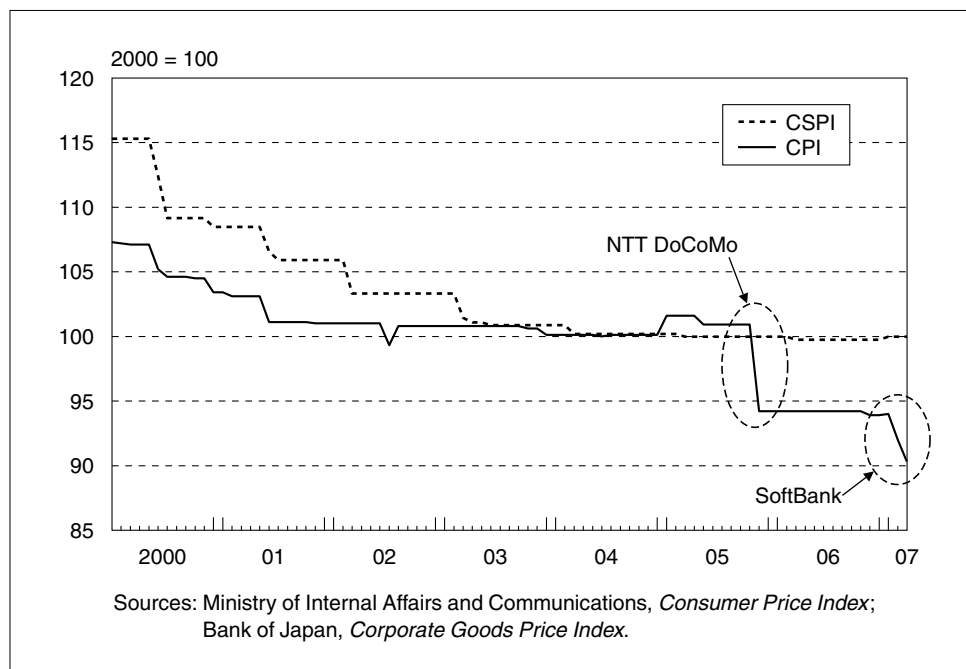
The Japanese CPI employs a one-specification-for-one-item method in surveying individual prices. This method specifies a few popular specifications for each item, and continually surveys its price. As a result, the dispersion of prices surveyed is restrained to a low level, thereby limiting the impact of the differences in lower-level aggregation formulas. The representativeness of the prices surveyed, however, becomes difficult to maintain for highly differentiated products and services.

In contrast, the U.S. CPI employs random sampling of a large number of prices surveyed, within broadly defined item strata. This sampling method becomes a source of lower-level substitution bias when using an arithmetic mean of prices surveyed as an aggregation formula at the lower level.<sup>28</sup> This is because dispersion of the price surveyed generally becomes high within broadly defined item strata. Nevertheless, the random sampling method is deemed effective in maintaining the representativeness of prices surveyed.

It should be noted that lower-level substitution bias is a problem unique to the United States, because of the use of random sampling of a large number of prices surveyed. At least, this problem is less relevant to Japan. Instead, I should emphasize that Japan's problem is that the one-specification-for-one-item method potentially produces both upward and downward biases.

Figure 5 plots the CPI and the corporate service price index (CSPI) for cellular phone service charges in Japan, which provide a good example of downward bias. The

**Figure 5 Cellular Phone Service Charges**



28. The U.S. CPI employs the geometric mean of prices surveyed in lower-level aggregation in response to the suggestion of this point in the Boskin Report.

figure shows a general downward trend for cellular phone service charges. This is very consistent with our general impression, but the figure also shows two sharp declines due to the introduction of new price plans by NTT DoCoMo in the second half of 2005 and SoftBank at the beginning of 2007. These sharp declines occur because the price index formula for cellular phone service charges in Japan implicitly assumes that there will be an instantaneous shift of carrier users to the cheapest price plan. In practice, however, adjustment and switching costs exist when changing price plans as well as carriers, thus making the shift to the cheapest price plan gradual.

### 3. Quality adjustment methods

Regarding quality adjustment issues, the hedonic method is considered an effective way of performing quality adjustment, especially in durable goods. The hedonic method assumes that the quality of a product is determined by its quantitative characteristics and is thus measured as an aggregation of such quantitative characteristics. In practice, the hedonic method analyzes the price-quality relationship by regressing prices on numerous product characteristics.

The hedonic method is now applied to PCs and digital cameras in Japan. This method, however, is not necessarily a panacea, as is obvious from the fact that the U.S. statistical agency no longer uses it in compiling the CPI for PCs, but rather uses the attribute cost adjustment method instead.<sup>29</sup> Whether to expand its application to other goods and services should be examined carefully in terms of the cost efficiency of the hedonic method for individual goods and services.

Figure 1, shown earlier, plots the CPI for PCs, both in Japan and the United States. The figure shows a significant decline in the CPI for PCs in both countries, but also shows that the tempo of decline is higher in Japan, especially in the recent period since the second half of 2003, when the U.S. statistical agency stopped using the hedonic method for PCs.

This apparently shows that the simple application of U.S. results to Japan is very misleading. There have been significant improvements in the measurement of consumer prices in Japan, especially since the time of the base-year revision to 2000 in the summer of 2001, so it is important to consider the Japanese situation after 2000.

## IV. Conclusions

In conclusion, I remain skeptical of the authors' contribution to improving our understanding of the definition of price stability and the measurement problems in the Japanese CPI.

The authors need to make better "guesstimations" by carefully accounting for the various differences between Japan and the United States, such as economic and price developments and the compilation methods of their respective CPIs. They might also wish to reconsider the title of their paper.

29. The attribute cost adjustment method assesses the quality of PCs based on the market prices of components for seven attribute categories, such as the CPU, memory, and hard disk drive. This is because the hedonic quality adjustments regarding CPU speed are deemed unreliable. In addition, the attribute value of components for PCs has become more easily available on the Internet.

In discussing CPI measurement errors, it should be noted that measurement errors are unavoidable to some extent, despite the efforts of statistical agencies to construct accurate statistics. This is because the economy is constantly changing. Statistical agencies are thus required to regularly assess whether their data properly reflect dynamic changes in the economy, thereby allocating their limited resources efficiently to create better statistics.

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## General Discussion

As a rejoinder to the comments of Shigenori Shiratsuka (Bank of Japan), David Weinstein insisted that there was still upward bias in the Japanese consumer price index (CPI). Regarding the authors' methodology applying measurement in the United States to Japan to calculate the upward bias, Weinstein acknowledged that the magnitude of the measurement varied by country and that it was one of the problems with the methodology. In terms of upper-level substitution bias, he agreed that it was possible for him to misread Shiratsuka (1999)<sup>30</sup> but disagreed that upper-level substitution bias was zero because the Japanese CPI continued to use historical weights. With respect to the comment that a large lower-level substitution bias was specific to the United States because of the random sampling of price surveys, Weinstein insisted that there was no particular reason why random sampling in the

30. See Shigenori Shiratsuka, "Measurement Errors in the Japanese Consumer Price Index," *Monetary and Economic Studies*, 17 (3), Institute for Monetary and Economic Studies, Bank of Japan, 1999, pp. 69–102.

United States should produce more volatility in individual prices than one specification for one item policy in Japan, and that there would be a lower-level substitution bias in Japan. As for any upward bias from quality adjustments, Weinstein reemphasized that the very limited use of hedonics in Japan was likely to produce bias.

Weinstein also responded to the comments of Anton Braun (University of Tokyo and Bank of Japan) on the policy implications. Regarding the floor on nominal benefits in situations of CPI deflation, he acknowledged that he would have to redo some calculations concerning the benefit growth rate. Regarding the construction of the dynamic equilibrium price index (DEPI), Weinstein agreed that the point about DEPI versus CPI was interesting but there was considerable difficulty in measuring the index at this point.

In the general discussions, there were comments and questions on the CPI measurement methodology. Kiyohiko G. Nishimura (Bank of Japan)<sup>31</sup> commented that the authors might not have good access to information regarding the way the Japanese CPI was compiled following the base-year revisions in 2000 and 2005 and the direction in which it was changing<sup>32</sup> and that their paper would be greatly improved if they consulted experts at the Statistical Council. Takatoshi Ito (University of Tokyo) asked Weinstein and Shiratsuka whether the chained index in Japan was effective and how the base-year revisions affected the measurement of the CPI. Weinstein responded to Ito that it was important for the upper-level substitution bias that the Japanese CPI was not conceptually a Törnqvist index. In contrast, Shiratsuka argued that there was not much difference among different aggregation formulas in Japan at the moment, due to small relative price variability across items surveyed. Shiratsuka also stated that the base-year revisions seem to introduce a significant downward bias, since the price substitution method for cell phone charges, for example, assumes that all customers shift immediately to the cheapest price contract, as mentioned in his comment. Bennett T. McCallum (Carnegie Mellon University) gave examples where the CPI understates inflation. Having stated that technological change found ways in which services that used to be provided with goods were no longer provided, he asked whether the CPI took these into account in the measurement methodology in the United States. Weinstein responded that services prices are, in general, very difficult to measure. Regarding Weinstein's claim that the Japanese CPI compilation does not gain from the greater geographic dispersion given Japan's smaller land mass, Nishimura gave the example that the price of a pair of men's shoes in the same specification was found to differ markedly in different cities. Weinstein responded to Nishimura that there was enormous heterogeneity in a category, even with the same specification, and that we should refer to identical goods to see the gain from geographic dispersion.

Miyako Suda (Bank of Japan) stated that, according to opinion survey data, the general public perceived prices to be stable. She then argued that the bias in the CPI was insignificant in the sense that movement in the CPI was consistent with the

31. Owing to his absence, Nishimura contributed written comments to the conference and had a staff member read them.

32. According to Nishimura's comments, the direction is consistent with the recommendation of the Panel on Conceptual, Measurement, and Other Statistical Issues in Developing Cost-of-Living Indexes, in Charles L. Schultze and Christopher Mackie, eds. *At What Price?: Conceptualizing and Measuring Cost-of-Living and Price Indexes*, Washington, D.C.: National Academies Press, 2002.

survey data. Weinstein responded that the survey may not actually pick up price movements under low inflation.

There were follow-up comments on the DEPI that Braun discussed. Maurice Obstfeld (University of California at Berkeley) stated that the DEPI was an interesting construct and that the incorporation of human capital into the index appeared essential. He also commented that the implementation seemed very hard to do in practice, but as a matter of principle one could advance a theoretical justification for including asset prices in the indicator of inflation for monetary policy. Ito pointed out that CPI and the GDP deflator already had a significant portion of rents and imputed rents which theoretically represent future asset prices, and stated that we should look at these as important price variables.