Bank of Japan
Research and Statistics Department
July 2003

Economic Commentary

Number 2003-02

Why is the Rate of Decline in the GDP Deflator So Large?

—Exploring the background against the discrepancy from the Consumer Price Index—

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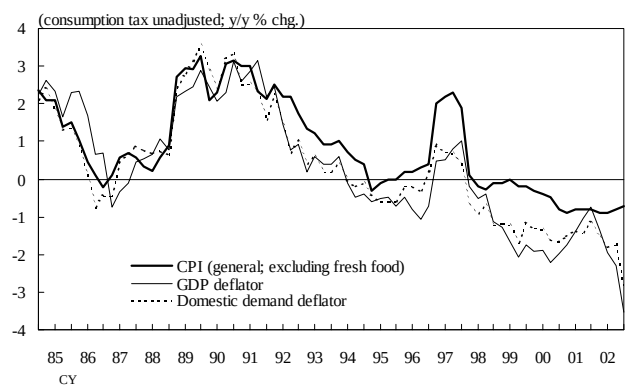
Characteristics of the GDP deflator

The year-on-year rate of decline in the *Consumer Price Index* (CPI)—excluding fresh food, since it fluctuates significantly—narrowed to –0.4 percent in April 2003. Meanwhile, the year-on-year change of the GDP deflator for the first quarter of 2003 dropped to its lowest record of –3.5 percent. The slower rate of decline in the CPI was largely attributable to reforms in the medical insurance system. The sharp drop in the GDP deflator was affected by several temporary factors that are discussed below. From a longer perspective, however, the CPI and GDP deflator show different movements; one's assessment of deflation differs substantially from the other's, depending on which index is being observed. This paper examines how the movements of these two price indices actually differ and what brings about those differences.

A comparison of the CPI and GDP deflator over the years reveals two characteristics (Chart 1). First, the year-on-year changes of the GDP deflator are constantly well below those of the CPI. This pattern has been observed since the first half of the 1990s, and the difference has widened in recent years. Second, the GDP deflator exhibits more short-term fluctuations than does the CPI. What are behind these two characteristics? Let us examine each of them.

Chart 1: Consumer price index and GDP deflator



Sources: Ministry of Public Management, Home Affairs, Posts and Telecommunications, "Consumer Price Index"; Cabinet Office, "National Accounts."

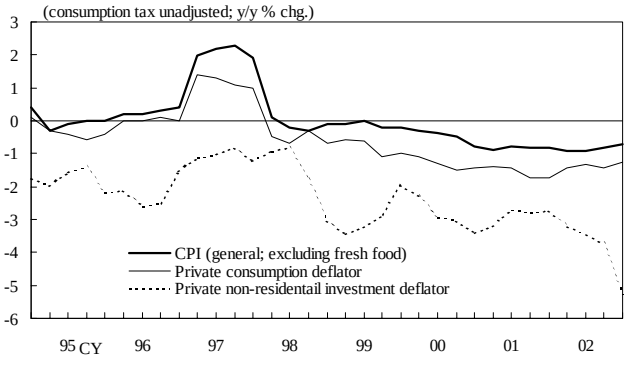
Larger rate of decline of the GDP deflator

The two major reasons why the GDP deflator constantly shows larger rates of decline are: (i) it covers a wider range of goods and services, including investment goods whose prices are falling at a significant pace; and (ii) it is computed using an "index formula" that is known to give an opposite bias from the CPI.

(1) Effects from the coverage

Among the components of the GDP deflator, the difference from the CPI is particularly large in the private non-residential investment deflator (Chart 2). This component of the GDP deflator reflects the movements of the prices of investment goods, which are not covered by the CPI. Along with rapid technological innovation, prices of IT-related goods are falling at a very fast pace, due largely to "quality adjustment." Quality adjustment refers to a part of the index computation process, whereby, for instance, the prices of PCs are judged to have declined to a half when the quality has doubled, even with the selling price unchanged at 200,000 yen. Since the private non-residential investment deflator includes prices of many investment goods with this characteristic, it has been the component that exerts the largest downward pressure on the GDP deflator.

Chart 2: Deflators of private consumption and private non-residential investment



Sources; Ministry of Public Management, Home Affairs, Posts and Telecommunications, "Consumer Price Index"; Cabinet Office, "National Accounts."

(2) Effects from the index formula

The differences in the coverage only partially explain the different movements of the GDP deflator and CPI, however. The private consumption deflator basically has the same coverage as the CPI (Chart 2) does. But its year-on-year changes are also persistently lower than those of the CPI, although the difference is not as large as that with the private non-residential investment deflator. To understand why this is the case, a closer look at the "index formula" of price indices is necessary; this is a somewhat technical but an important point for discussion. A simple numerical example is given below.

Numerical example of the price index formula

	Base year	1 year later	2 years later	3 years later
Price of Food	100	100	100	100
Price of PCs	100	50	25	12.5
Quantity of Food	1	1	1	1
(Quantity Weight)	(0.5)	(0.33)	(0.2)	(0.11)
Quantity of PCs	1	2	4	8
(Quantity Weight)	(0.5)	(0.67)	(0.8)	(0.89)
Laspeyres index	100	75	62.5	56.3
(y/y % chg.)		(-25)	(-17)	(-10)
Paasche index	100	66.7	40	22.2
(y/y % chg.)		(-33)	(-40)	(-45)

* "Price" of PCs is quality-adjusted. "Quantity" refers to the real value after quality adjustment, rather than the number of units consumed.

Weight used for the Laspeyres index of each period.

Weight used for the Paasche index of each period.

Let us hypothesize an economy consisting of only two types of goods: food and PCs. Let us also assume that; (i) in the base year, when both types of price indices are defined as "100," one unit each is consumed; (ii) the price and unit consumed of food remain unchanged thereafter; and (iii) the selling price of PCs and the number of PC units consumed continue to be the same as in the base year, but, as the quality doubles each year, quality-adjusted "price" in the price index declines by half every year, and the "quantity" increases by twofold every year.

To aggregate the "prices" of food and PCs into an price index of the overall economy, two major formulas are known—Laspeyres index and Paasche index. The index is called "Laspeyres" when each price is summed using the quantity weight fixed at the base year. On the other hand, the index is "Paasche" if the quantity weight of the current period is respectively applied.

Regarding the Laspeyres index, in this example, the prices of food and PCs are aggregated for each period at the fixed ratio of 1:1.[1] Looking closely at changes in PC prices, although the rate of decline stays constant at 50 percent every year, the absolute price level and, along with that, its difference from the previous period becomes smaller over time. Hence, in the Laspeyres index, whose quantity weight is fixed, changes in PC prices have fewer and fewer effects on the overall index with the lapse of time. This is why the year-on-year rate of decline of the Laspeyres index diminishes each year: 25 percent→17 percent→10 percent.

On the other hand, in the Paasche index, the relative weight of PCs to food increases substantially from 2:1, 4:1, and 8:1. This is because the fall in PC prices arising from the quality adjustment leads correspondingly to an increase in quantity of PCs.[2] Contrary to the previous example, as the effects of the weight increase, the influence from PCs becomes more significant. The year-on-year rate of decline in the Paasche index becomes larger each year, as in the numerical example, due to this factor: 33 percent→40 percent→45 percent. As this example clearly demonstrates, what magnifies the discrepancy between the Laspeyres index and the Paasche index is the combination of (i) the existence of goods such as IT-related goods whose prices and quantities continue to change in the opposite direction and (ii) the lapse of time from the base year. In the above example, looking at the same case of "the economy three years later," the Laspeyres index and the Paasche index show completely different pictures of the degree of deflation, with the former indicating a –10 percent deflation and the latter a –45 percent deflation.

Indeed, the CPI is a Laspeyres index, while the GDP deflator and its demand components are Paasche indices. Therefore, it is basically the difference in the index formula that causes the private consumption deflator to have a larger rate of decline than that of the CPI (Chart 2) . In fact, prices of PC products in the CPI, which was set as 100 in the base year of 2000, dropped sharply to 36.6 in March 2003. This indicates that the same situation as in the previous numerical example is actually taking place and the current CPI is likely to have an upward bias because it is the Laspeyres index. On the other hand, the private consumption deflator may suffer from a downward bias because of the Paasche index. Furthermore, it possibly makes the bias even larger that the deflator is the old 1995-year based.

Additionally, the rate of decline of the private non-residential investment deflator seems to be expanding (Chart 2). Weak demand is partly the reason. But, the increased weight of IT-related goods, whose price-decline is particularly large among machinery,[3] may have intensified the downward bias on the deflator.[4]

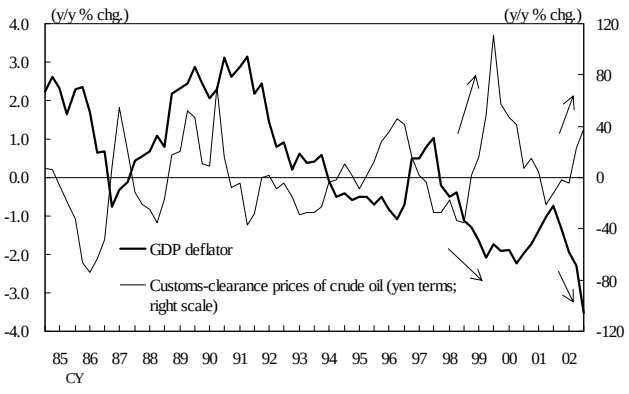
Short-term fluctuations of the GDP deflator

The following three factors are important contributors to large short-term fluctuations of the GDP deflator: (i) fluctuations of the terms of trade such as changes in crude oil prices; (ii) changes in the relative weights of demand components within the GDP (especially the share of private non-residential investment); and (iii) large fluctuations due to irregularities.

(1) Effects from the terms of trade

In line with the basic concept of the overall GDP, the GDP deflator is compiled such that it equals "domestic prices + α∗export prices – β∗import prices." Thus, the GDP deflator is directly influenced by the relative relationships of export and import prices—that is, the terms of trade. A typical factor causing short-term fluctuations in the terms of trade is the changes in crude oil prices. Here, close attention should be paid to the fact that when import prices increase due to the "rise" in crude oil prices, the GDP deflator "falls," which is obvious in the above formula, when, as is the case of Japan, the rise of oil prices is not immediately passed on to domestic prices (Chart 3).

Chart 3: GDP deflator and customs-clearance prices of crude oil (yen basis)

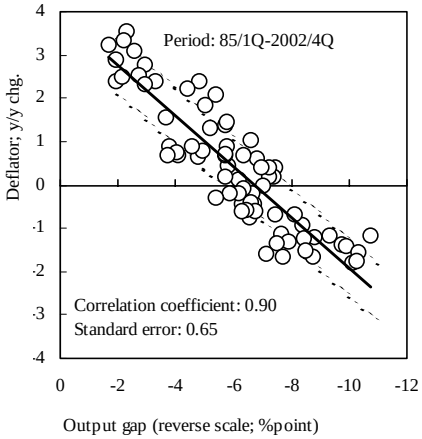


Sources: Cabinet Office, "National Accounts"; Ministry of Finance, "The Summary Report on Trade of Japan."

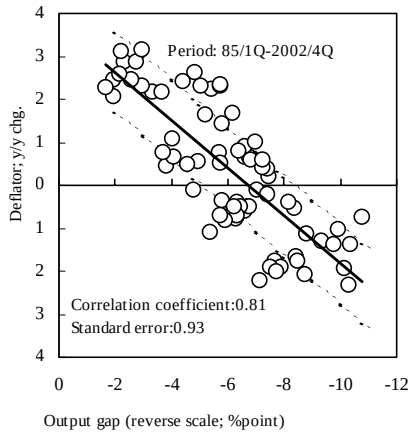
The GDP deflator is based on the notion that both the output price decreases and the input price increases cause the deflator to decline, because both of them lower corporate profits. This is natural since the GDP deflator is a part of the GDP statistics, which try to capture the value-added. Hence, it is in line with this principle that the rise in crude oil prices leads to the decline in the GDP deflator. However, when using the deflator as an indicator of the underlying price movements, the domestic demand deflator is more appropriate, since it excludes the effects of export and import price fluctuations—in other words, the effects of the fluctuations of the terms of trade (dotted line in Chart 1). Also, in terms of the relationship with the output gap, the domestic demand deflator has a better fit than does the GDP deflator (Chart 4).

Chart 4: Deflators and output gap

(a) Domestic demand deflator



(b) GDP deflator

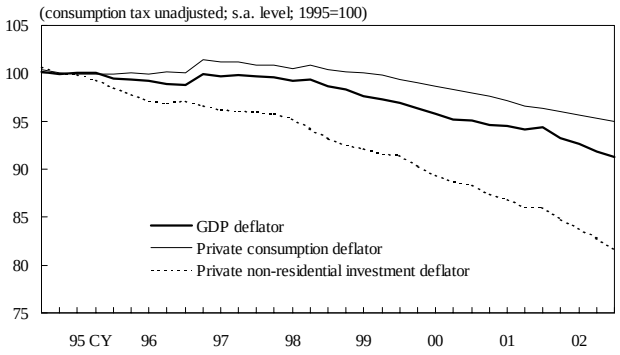


Sources: Ministry of Public Management, Home Affairs, Posts and Telecommunications, "Labour Force Survey"; Cabinet Office, "National Accounts," "Gross Capital Stock of Private Enterprises"; Ministry of Economy, Trade and Industry, "Indices of Industrial Production"; Ministry of Health, Labour and Welfare, "Monthly Labour Survey," etc.

(2) Effects from the relative share changes of demand components

As already discussed, the rate of decline in the private non-residential investment deflator has been significant and the index level has recently become very low (Chart 5). The GDP deflator is compiled as a weighted average of each demand component deflator, using their current relative shares in the GDP as weights. Therefore, the mere increase in the relative share of private non-residential investment whose deflator levels are very low would exert downward pressure on the overall GDP deflator. In simpler terms, "the average price would fall with an increase of low-priced goods."

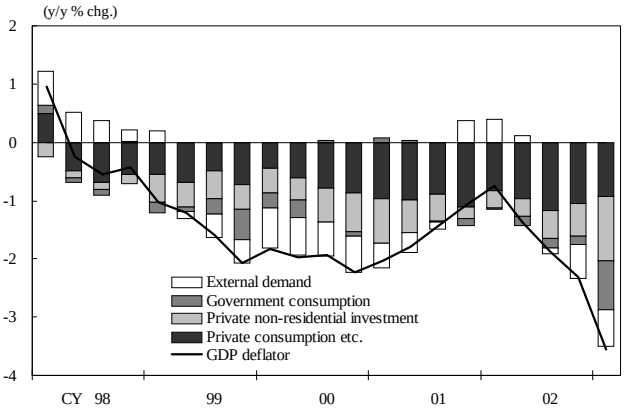
Chart 5: Index level of deflators



Source: Cabinet Office, "National Accounts."

The share of private non-residential investment generally increases when the economy is heading for recovery. Thus, attention should be paid to the fact that the GDP deflator tends to decline during recovery. For example, to look at the cyclical variation of the private non-residential investment deflator, its negative contributions diminished in 2001, but expanded in 2002 (Chart 6). This is related to the fact that private non-residential investment declined during 2001, but stopped declining and moved toward recovery in 2002. Furthermore, the rate of decline in the private non-residential investment deflator itself may have the following cyclical movement: it contracted with the decrease in the weight of IT-related goods and expanded with the increase.

Chart 6: Contribution of each component to GDP deflator



Note: Private consumption etc. consists of private consumption, private residential investment, private inventory, public investment, and public inventory.

Source: Cabinet Office, "National Accounts."

(3) Effects from irregular factors

The GDP deflator is also affected by various irregular factors. As mentioned in the introductory part, the most recent GDP deflator for the first quarter of 2003 marked an extremely large drop of –3.5 percent on a year-on-year basis. A breakdown of the deflator (Chart 6) reveals that, above all, the sudden sharp decline of the government consumption deflator is most striking. This was largely due to the temporary factor that (i) the wages and salaries of central and local government employees—a basic and major statistic of the government consumption deflator—were largely cut.[5] In addition, the following two factors contributed to the decline: (ii) the decrease in the external demand deflator due to a rise in crude oil prices; and (iii) the faster pace of decline in the private non-residential investment deflator due to an increase in computers, whose prices decline substantially.[6] These three factors contributing to the fluctuations in the GDP deflator all happened at the same time to exert strong downward pressure in the first quarter of 2003.

Conclusion: Increasing role of the chain index

The CPI, which is the most well-known price index; (i) has an upward bias since it is a Laspeyres index,[7] and (ii) only covers private consumption expenditures. Hence, in judging the developments of prices, it is indispensable to use the GDP deflator together, as it covers the overall economy. Nevertheless, the following three factors should be taken into consideration when using the GDP deflator: (i) since the base year is old, the downward bias of the Paasche index may possibly be large; (ii) the large short-term fluctuations make it difficult to gauge the underlying trend of price movements; and (iii) the effect of "quality adjustment" on its decline rather than changes in nominal prices is larger compared to CPI. Under these circumstances, a degree of caution is warranted when using the GDP deflator as an indicator for the underlying trend of price movements, and also as a proxy for the expected rate of deflation.

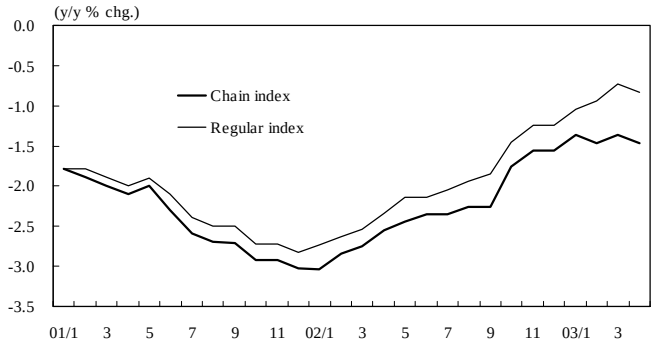
The problem of an increase in bias of the GDP deflator or any other indices caused by the passage of time from the base year can be improved to a certain degree by adopting the "chain index," in which the base year is constantly renewed. In the previous example of PCs and food, if the base year is revised annually or, in other words, the price index level of each good is reset to 100 every year, the bias of the Laspeyres index, for instance, will no longer exist. This is because the impact of PC prices will not diminish over the years.[8]

Taking these advantages into account, the United States has switched its GDP deflator to a chain-type index from the 1992-year base. Furthermore, the chain index of the CPI is released on a monthly basis as a reference series from the July 2002 data.

In Japan, the 2000-year base *Corporate Goods Price Index* (CGPI), compiled by the Bank of Japan, releases the chain index every month as a reference. As to the actual movements of the index, there seems to be a substantial upward bias on the regular Laspeyres CGPI from around 2002 (Chart 7). This type of chain index is not available for the GDP deflator at present. As for the

CPI, the chain index is not released on a monthly basis, only for a calendar year.

Chart 7: Chain index of the Corporate Goods Price Index



Source: Bank of Japan, "Corporate Goods Price Index."

Reference: For details, see "*Rensa houshiki ni yoru kokunai kigyou bukka shisuu no kouhyou—'rensa shisu' dounyu no igi to sono tokuchouten* (release of the corporate goods price index in the chain index—significance and characteristics of introducing the "chain index"; available in Japanese only)."

There are still many technical and other problems associated with the chain index. However, the discrepancy between the CPI and GDP deflator indicates that with the IT sector having more weight in the economy, the biases of price indices are likely to have become more serious when the base year is fixed for a long time. The introduction of the chain index is one possible direction that the price indices can take in this IT era.

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[1] For example, as to the Laspeyres index of three years later, the price index of PCs is 12.5 and that of food 100. Combining these two with a 1:1 weight leads to the sum of 56.3. ((12.5*1+100*1)/2=56.3)

[2] For example, as with the Paasche index of three years later, the price index of PC is 12.5 and that of food 100. Combining these two with a weight of 8:1 leads to the sum of 22.2. ((12.5*8+100*1)/9=22.2).

[3] With respect to *the Indices of Industrial Production*, the weight of IT-related goods among shipments of capital goods (nominal value basis) increased from 46 percent for the 1995-year base to 53 percent for the 2000-year base.

[4] The *Corporate Goods Price Index*, compiled by the Bank of Japan, is used for basic statistics for the private non-residential investment deflator. From the 2000-year base, a sophisticated quality adjustment called the Hedonic approach is applied for servers, in addition to PCs. Thus, the year-on-year declines of the private non-residential deflator tend to be larger from 2001 onward, when the effects of this new index appear.

[5] In fiscal 2002, salaries of central and local government employees were cut by 2 percent, mainly by reducing the end-of-fiscal-year allowances.

[6] In the *Indices of Industrial Production*, shipments of general-purpose computers surged by about 30 percent in the first quarter on a quarter-on-quarter basis.

[7] Although the sources of the upward bias are not confined to this point, this is important when comparing the CPI with the private consumption deflator.

[8] The formula of the Laspeyres index from the second year onward will be all the same as that of the first year ((50*1+100*1/2)=75). The year-on-year rate of decline will always remain at 25 percent.

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