

# Japan's Experience on the Chain-linking Method and on Combining Supply-side and Demand-side Data for Quarterly GDP\*

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## 1. Introduction

In Japan, the preliminary quarterly estimates for GDP (expenditure approach) are published by the Economic and Social Research Institute (ESRI), Cabinet Office. The preliminary quarterly GDP attracts much attention from market players, analysts, media, and policymakers who try to understand developments in the Japanese economy.

Recently, ESRI took two major actions for improvements of quarterly GDP estimates in Japan. One is the introduction of the chain method, and the other is the introduction of a new estimation method for preliminary quarterly GDP.

The purpose of this paper is to present the outline of Japan's experience on the introduction of these two methods. Section 2 concerns the introduction of the chain method, and Section 3 concerns a new estimation method for preliminary quarterly GDP. Each section gives a summary of the new and old methods. Moreover, the background and effect of the introduction of each new method are given. Section 4 briefly concludes.

## 2. Introduction of the Chain-linking Method to the Compilation of Real GDP (Dec. 2004)

### 2.1. Conventional versus New Method for the Compilation of Real GDP (expenditure approach)

The chain-linking method was introduced to the compilation of real GDP (expenditure approach) in December 2004 in Japan. The conventional method was a fixed-base year method, with the base year being 1995 at that time. The adopted chain-linking method is based on previous years. At present, 2000 is the reference year for which the deflators are expressed as equal to 100.

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The basic frame for the compilation of real GDP (expenditure approach) in Japan is outlined below (Figure 1).

- (□) Basic unit deflators for nearly 400 items are compiled from prices and corresponding values for nearly 2200 commodities.
- (□) Nominal quarterly figures for each demand component are subdivided.
- (□) The real subdivided figures are calculated by dividing the nominal subdivided figures by the corresponding basic unit deflators.
- (□) Each real demand component is calculated by aggregating the real subdivided figures.
- (□) Real GDP is calculated by aggregating real demand components.

This basic frame is common to the chain-linking method and the fixed base year method. However, the way of aggregation has been changed by the introduction of the chain-linking method. The way of aggregation was a simple summation under the fixed base year method. On the other hand, the chain-linking method needs more complicated aggregation, of which the formula is displayed in Section 2.3.1.

## **2.2. Background of the Introduction**

The substitution bias included in the Laspeyres index (or Paasche index) tends to increase as the period goes far from the base year under the fixed-base year method. The conventional benchmark revision took place every five years. As a result, the benchmark revision was delayed for 10 years maximum. The year 2004 was almost 10 years behind the base year 1995.

In addition, the bias might be exacerbated by plummeting prices of ICT goods and services with rapid diffusions. One reason for the decreasing prices of ICT goods and services is their increase in quality. Especially, the hedonic approach is applied to each individual price index for some ICT goods such as computers in the CPI or corporate goods price index (CGPI). The bias has probably increased in this ICT-led recovery (Figure2).

Therefore the bias might have been hard to neglect in 2004. To eliminate these biases, the SNA93 recommends the chain-linking method.

### **2.3.1. Basic Formulas of the Adopted Chain Index**

Basic formulas of the adopted chain index are as follows:

1) Volume measures: Annually chain-linking Laspeyres volume index

$$\text{Calendar year real value : } CV_t = \frac{\sum_i P_{t-1}^i \cdot Q_t^i}{\sum_i P_{t-1}^i \cdot Q_{t-1}^i} \times CV_{t-1} \quad (1)$$

$$\text{Quarterly real value : } CV_{t,k} = \frac{\sum_i P_{t-1}^i \cdot Q_{t,k}^i}{\sum_i P_{t-1}^i \cdot Q_{t-1}^i} \times CV_{t-1} \quad (2)$$

2) Deflators : Annually chain-linking Paache price index

$$\text{Calendar year deflator : } CP_t = \frac{\sum_i P_t^i \cdot Q_t^i}{\sum_i P_{t-1}^i \cdot Q_t^i} \times CP_{t-1} \quad (3)$$

$$\text{Quarterly deflator : } CP_{t,k} = \frac{\sum_i P_{t,k}^i \cdot Q_{t,k}^i}{\sum_i P_{t-1}^i \cdot Q_{t,k}^i} \times CP_{t-1} \quad (4)$$

$CV_{t,k}$  : Real value for the quarter k, year t (chain-linking method)

$CP_{t,k}$  : Deflator for the quarter k, year t (chain-linking method)

$Q_{t,k}^i$  : Real value of commodity i for the quarter k, year t

$P_{t,k}^i$  : Price index of commodity i for the quarter k, year t;

It is noted that the actual figures for real value and deflator are obtained after some adjustments such as ‘the fourth quarter overlapping approach’ to the calculation based on the basic formula above<sup>1</sup>.

### 2.3.2. Comparison of Different Chain-type Indexes

There are different indexes in chain-type indexes. Major indexes are as follows.

(A) Annually chain-linked Laspeyres volume index (or Paasche deflator)

(B) Quarterly chain-linked Fisher volume index (or deflator)

(C) Annually chain-linked Fisher volume index (or deflator)

A kind of (B) formula is adopted in the United States. A kind of (A) formula is adopted in the Eurostat.

<sup>1</sup> Detailed information is described in Chapter V of ESRI (2005a).

The formulas of these indexes are shown below:

1) Volume Measures

(A) Annually chain-linked Laspeyres volume index

The formula of this index is same as equation (1).

(B) Quarterly chain-linked Fisher volume index

$$FV_k = \sqrt{\frac{\sum_i P_{k-1}^i \cdot Q_k^i}{\sum_i P_{k-1}^i \cdot Q_{k-1}^i} \times \frac{\sum_i P_k^i \cdot Q_k^i}{\sum_i P_k^i \cdot Q_{k-1}^i}} \times FV_{k-1} \quad (5)$$

(C) Annually chain-linked Fisher volume index

$$FV_{t,k} = \sqrt{\frac{\sum_i P_{t-1}^i \cdot Q_{t,k}^i}{\sum_i P_{t-1}^i \cdot Q_{t-1}^i} \times \frac{\sum_i P_{t,k}^i \cdot Q_{t,k}^i}{\sum_i P_{t,k}^i \cdot Q_{t-1}^i}} \times FV_{t-1} \quad (6)$$

2) Deflators

(A) Annually chain-linked Paasche deflator

The formula of this index is same as equation (3).

(B) Quarterly chain-linked Fisher deflator

$$FP_k = \sqrt{\frac{\sum_i P_k^i \cdot Q_{k-1}^i}{\sum_i P_{k-1}^i \cdot Q_{k-1}^i} \times \frac{\sum_i P_k^i \cdot Q_k^i}{\sum_i P_{k-1}^i \cdot Q_k^i}} \times FP_{k-1} \quad (7)$$

(C) Annually chain-linked Fisher deflator

$$FP_{t,k} = \sqrt{\frac{\sum_i P_{t,k}^i \cdot Q_{t-1}^i}{\sum_i P_{t-1}^i \cdot Q_{t-1}^i} \times \frac{\sum_i P_{t,k}^i \cdot Q_{t,k}^i}{\sum_i P_{t-1}^i \cdot Q_{t,k}^i}} \times FP_{t-1} \quad (8)$$

Several discussions took place over which formula should be adopted. Theoretically, the Fisher index has less bias than the Laspeyres volume index (or Paasche deflator). On the other hand, the Laspeyres volume index (or Paasche deflator) has some advantages in calculating. One advantage of the Laspeyres

volume index (or Paasche deflator) is that it's easier and quicker to calculate than the Fisher index. Also the advantage on the additivity is pointed out. Under the Laspeyres volume index the additivity holds for the reference year and the next year exceptionally, while it does not hold generally (real GDP is not equal to the sum of real demand components generally).

To judge the degree of bias in the formula (A), a comparison of these indexes was made. Figure 3 shows the differences in growth rates of real GDP (or change rates of GDP Deflator) between (B) and (A), and between (C) and (A). These differences are not so large. These results suggest that the bias of formula (A) is actually not so large. Therefore the final decision of ESRI was that formula (A) should be adopted.

#### **2.4. Effects of the Introduction**

The effects of introducing the chain-linking method can be found by looking at the difference between this method and the fixed-base-year method in growth rates for real GDP. Figure 4(1) shows this difference. Most of the time, the growth rates by fixed-base-year method are higher than those by the chain-linking method. This fact suggested that growth rates for real GDP for most of the time were overestimated under the fixed-base-year method. The overestimation of growth rates for real GDP might be reflected in the bias stated above. It can be said that growth rates for real GDP have been corrected downward most of the time by the introduction of the chain-linking method.

Figure 4(2)-(4) shows the difference in GDP deflator, private non-residential investment deflator, and household consumption deflator, respectively. Most of the time, change rates of the deflators by the fixed-base-year method are lower than those by the chain-linking method. It is thought that the change rates of these deflators have been corrected upward most of the time by the introduction of the chain-linking method. The differences are remarkably large in the non-residential investment deflator. It implies that the impact of falling prices in ICT goods has been very large on non-residential investment.

#### **2.5. Other Points on the Chain-linking Method**

There are some other points to be mentioned on the chain-linking method. The first is that the fixed-based real GDE figures are released as "reference series" nearly two weeks after the release of the official 2<sup>nd</sup> preliminary estimates. The second point is that introduction of the chain-linking method to GDP from the production approach is now under preparation. Third, the chain-linking method has not yet been adapted to GDP from the expenditure approach before Oct.–Dec. 1993.

### **3. Introduction of New Estimation Method of Preliminary Quarterly GDP (Aug.2002)**

#### **3.1. Old and New Methods for Preliminary Quarterly GDP**

ESRI introduced a new estimation method of preliminary quarterly GDP in August 2002. It was a

major change in the structure of the quarterly estimation method. In summary, the feature of the old method was to use *only the demand-side statistics* in extrapolating. On the other hand, the feature of the new method is to combine the figures estimated using *the demand-side statistics* and those estimated using *the supply-side statistics*.

### **3.2. Basic Estimation Method for Preliminary Quarterly GDP in Japan**

Preliminary Quarterly GDP is estimated only from the expenditure approach in Japan. The estimation method is basically as follows:

- (□) Components of the annual GDP (expenditure approach) are estimated mainly by the commodity-flow method using supply-side statistics.
- (□) The quarterly series are calculated by distributing the annual estimates (□) into quarters using quarterly indicators.
- (□) The quarterly components of *preliminary* GDP are estimated by extrapolating the latest values of series (□) using the latest quarterly indicators.

This basic frame is almost common to the old and the new estimation methods. The main difference is demand-side statistics or supply-side statistics are used in extrapolating.

### **3.3. Features and Problems of the Old Estimation Method**

As stated above, the feature of the old method was to use the demand-side statistics in extrapolating. Examples are the “Family Income and Expenditure Survey” (Household Survey) and the “Quarterly Financial Statements Statistics of Corporations,” among others.

The following problems should be pointed out regarding the old estimation method. The first point is that there is some bias due to the sampling nature of the demand-side statistics. The second point is that there was inconsistency between the old method for preliminary quarterly estimates and the annual estimation method. In the annual estimation, the commodity flow method is adopted and supply-side statistics such as manufacture census are used. On the other hand, the old method for preliminary quarterly estimates was based on demand-side statistics. The third point is that the release of the preliminary quarterly estimates was late. Under the old estimation method, the 1st preliminary GDP estimates were released two months and 1 week after the end of the quarter. The date was just after the release of the Quarterly Financial Statements Statistics of Corporations. Analysts had requested ESRI to release preliminary GDP estimates earlier, from the viewpoint of timely evaluation of economic trends.

### **3.4. Features of the New Estimation Method**

One feature of the new estimation method is to combine the figures estimated using demand-side statistics and those estimated using supply-side statistics. Each demand component is calculated as the weighted average of the two estimates<sup>2</sup>. The weights are calculated based on the variances of the demand-side and supply-side statistics<sup>3</sup>. More precisely, this combining method is applied to the estimates of household consumption and the second preliminary estimates of private non-residential investment. Demand-side statistics were used for estimating private non-residential investment in the Quarterly Financial Statements Statistics of Corporations, which is available at the second preliminary estimation.

Figure 5 shows an image of the new estimation method for preliminary quarterly GDP. The upper half of the figure represents the estimation using supply-side statistics described in Section 3.5.1. The lower half represents the estimation using demand-side statistics, mentioned in Section 3.5.2. These two estimates are now combined, as stated above.

#### **3.5.1 Outline of the New Estimation Method Using Supply-side Statistics**

The new estimation method using supply-side statistics is a kind of simplified commodity flow method. Figure 6 shows the outline of this method<sup>4</sup>. At the first stage, quarterly domestic shipments (A) based on 90 commodity classifications are estimated. Next, net imports (B-C) are added, trade and transport margins (D) are added, and changes in inventory (E) are subtracted from shipments (A). Next, quarterly domestic aggregate supplies (F) are estimated. Allocation ratios (r-H, r-I) are multiplied by the quarterly domestic aggregate supplies (F). Lastly, household consumption (H) and gross fixed capital formation (I) are estimated for each commodity classification. Allocation ratios (r-H, r-I) are calculated from the latest annual estimates by the commodity flow method.

Examples of the supply-side statistics are “Current Survey of Production”, “Current Survey of Selected Service industries” and so on. Number of ‘selected’ industries has increased recently.

#### **3.5.2 The Present Method Using Demand-side Statistics**

As for the present estimation method using the demand-side statistics, it is basically the same as the old estimation method. But some modifications are applied. For example, rate of change from the previous quarter is adopted in extrapolating, while rate of change from the same quarter of the previous year was used formerly.

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<sup>2</sup> The value of each weight is shown in reference #3 of ESRI (2005a).

<sup>3</sup> The concept of combining methods is described in reference #6 of ESRI (2005a).

<sup>4</sup> Detailed information is described in Chapter III of ESRI (2005a).

### **3.6. Effects of the Introduction**

Three effects of the introduction of the new method are pointed out. The first is that preliminary GDP estimates have been released earlier. The 1<sup>st</sup> preliminary GDP estimates have been released almost one month earlier than before. The release date is approximately one month and two weeks after the end of the quarter, which is basically the average of the other major developed countries. The release date of the 2<sup>nd</sup> preliminary GDP estimates is approximately two months and 10 days after the end of the quarter. The second effect is that the preliminary quarterly estimates have improved consistency with the annual estimates. Supply-side statistics are used in the new method for quarterly estimates, as in the annual estimation. The third point is that the preliminary GDP estimates have been more accurate. This is suggested by figure 7, which shows that preliminary GDP estimates by the new method are smoother than the old ones.

### **3.7. Remaining Challenges to the Estimation for Quarterly GDP**

There are some remaining challenges to the estimation for quarterly GDP in Japan. Here two points are mentioned. First, the new quarterly estimation method is now applied to GDP from the expenditure approach after Jan.-Mar. 1994. Adoption of the new method to the series before Oct.-Dec. 1993 is needed. Second, at present preliminary quarterly estimates are published only for GDP from the expenditure approach and compensation of employees. It is necessary to publish preliminary quarterly estimates for GDP from the production approach and other income components.

## **4. Conclusion**

The chain-linking method and new preliminary estimation method have recently been introduced to Japan's quarterly GDP. It is thought that the accuracy of Japan's quarterly GDP has improved after the introduction of these methods. Furthermore, preliminary quarterly GDP is now released earlier than before. These changes have been welcomed by users. Challenges, however, remain. It is necessary to adopt new methods to the past series of quarterly GDP before 1993. It is desirable to produce preliminary quarterly GDP also from the production approach and the income approach, in addition to the expenditure approach. More generally, some argue that, to improve the figures of quarterly GDP, it is necessary to make efforts such as calculating the figures more accurately, releasing the figures more promptly and more transparently, and adapting the estimation methods to the structural changes in the economy. ESRI will continue to make such efforts toward better figures of quarterly GDP in Japan.

## References

ESRI (2004). Application of the Chain-Linking Method to the Compilation of Japan's SNA, November.

<http://www.esri.cao.go.jp/en/sna/041118/egizisokuho.html>

ESRI (2005a). The Japanese System of National Accounts (JSNA) and Related Challenges (For ESRI meeting on the JSA, Mar. 24, 2005), March..

<http://www.esri.go.jp/en/workshop/050325/050325main-e.html>

ESRI (2005b). Estimation Method of Preliminary Quarterly GDP (QE) (The 4th edition), July.

<http://www.esri.cao.go.jp/en/sna/050721/method.html>

Fig. 1: Outline of compilation of deflators and real figures for GDP (expenditure approach)

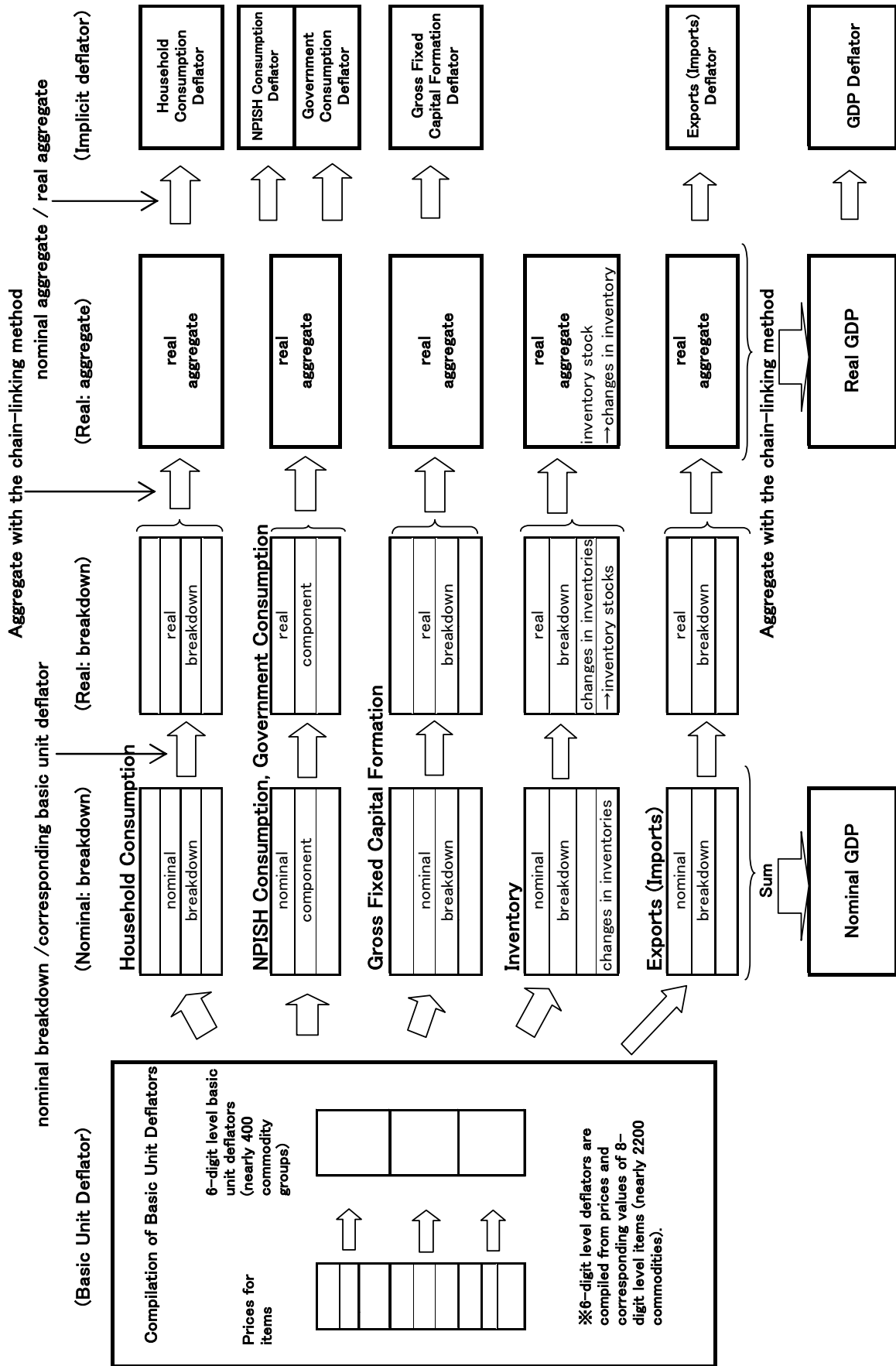
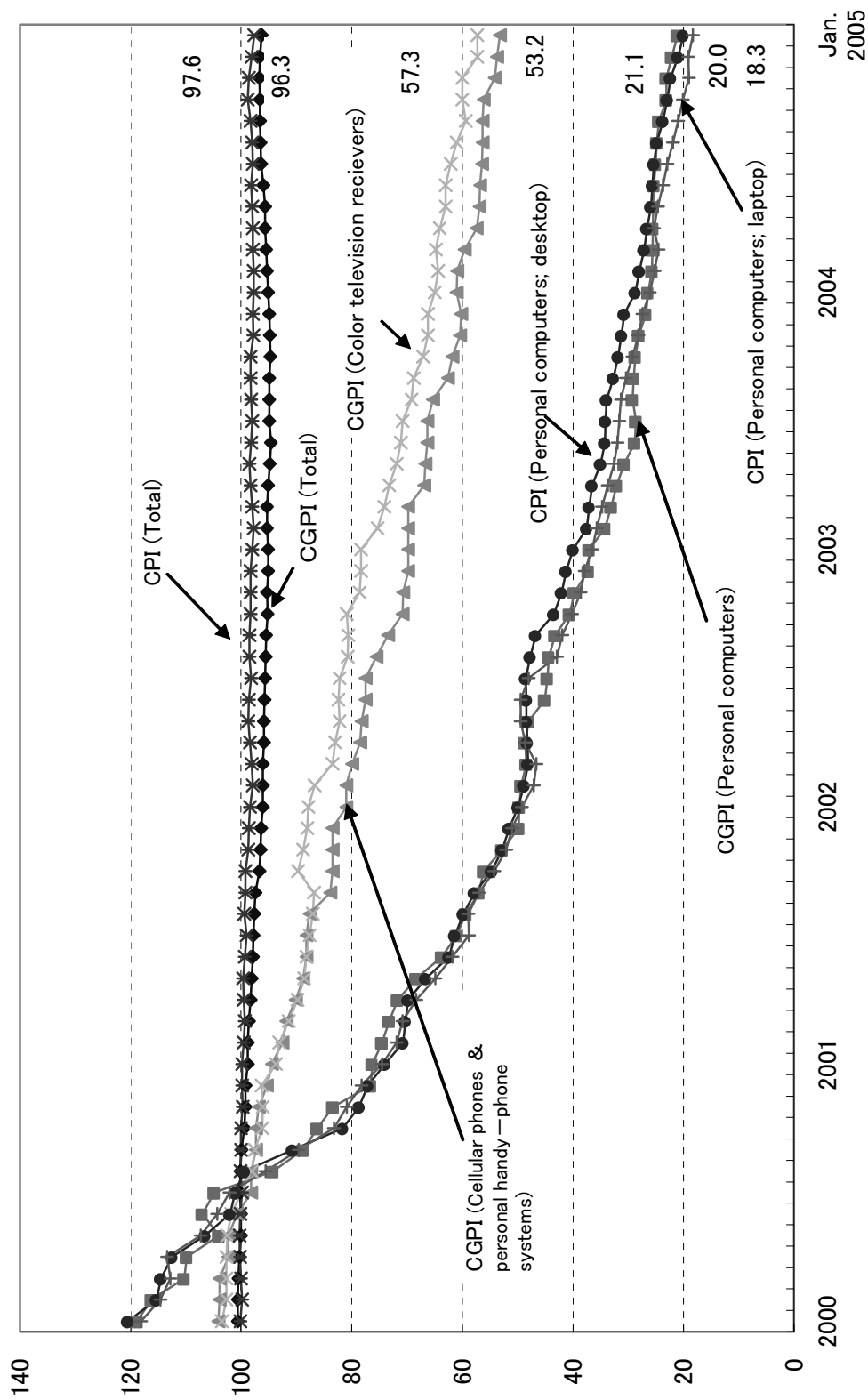


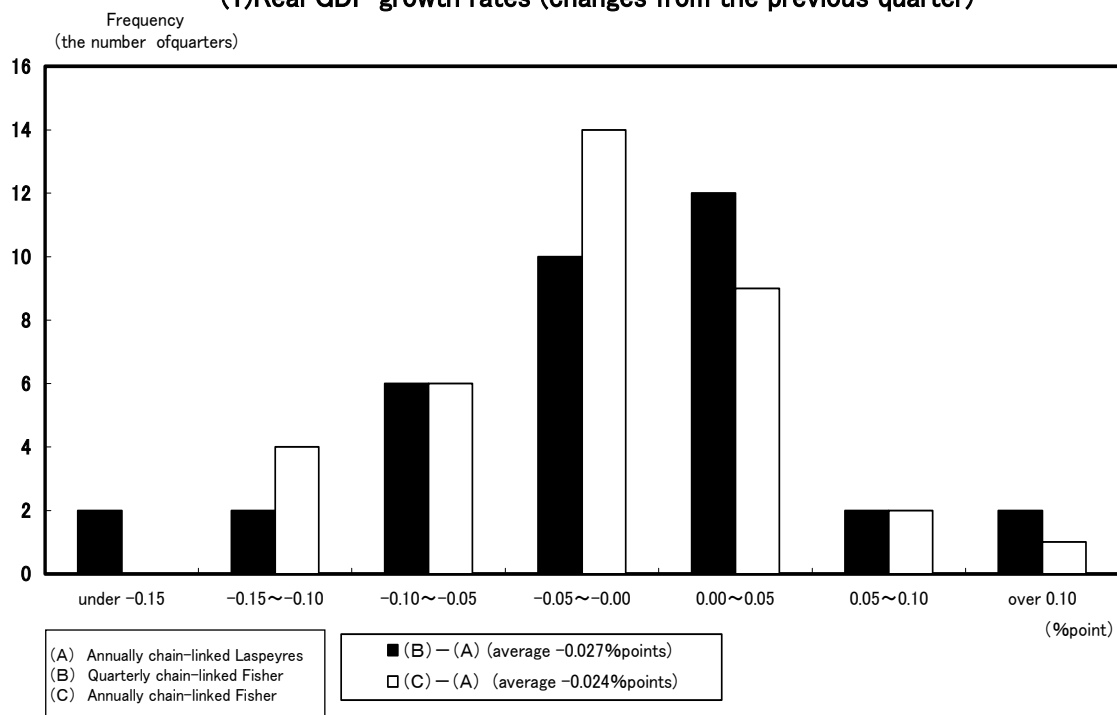


Fig. 2: Recent movement in price of IT-related goods

Corporate Goods Price Index and Consumer Price Index (Monthly)

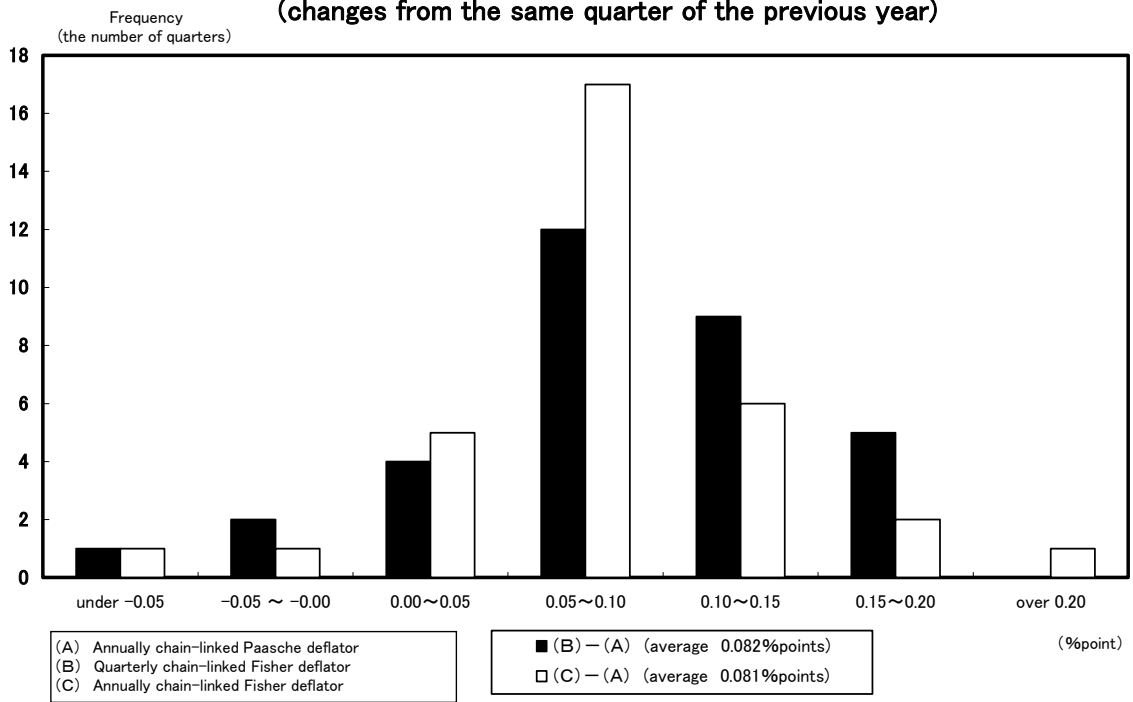


**Fig.3:Comparison of different chain-type indexes  
(1)Real GDP growth rates (changes from the previous quarter)**



(note: Above chart is calculated using 36 quarters, from 2nd quarter of 1997 to 1st quarter of 2004)

**Fig.3(2) Changes in GDP deflator  
(changes from the same quarter of the previous year)**



(note) Above chart is calculated using 33 quarters, from 1st quarter of 1996 to 1st quarter of 2004

Fig.4 Effects of the introduction of chain-linking method (1) Real GDP growth

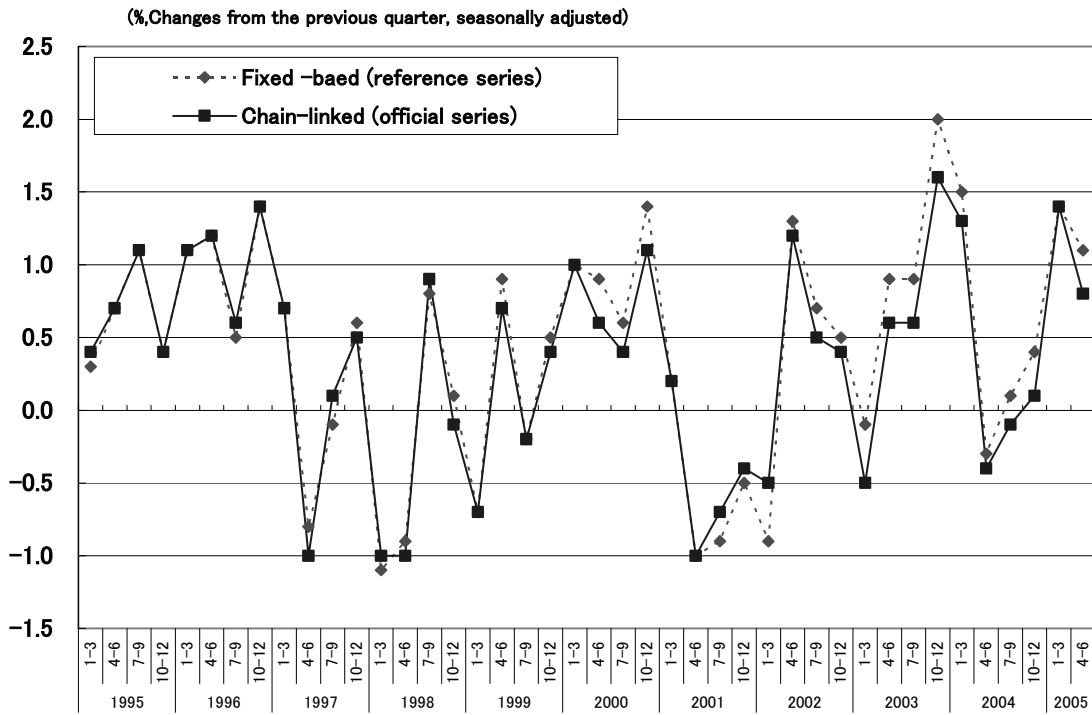
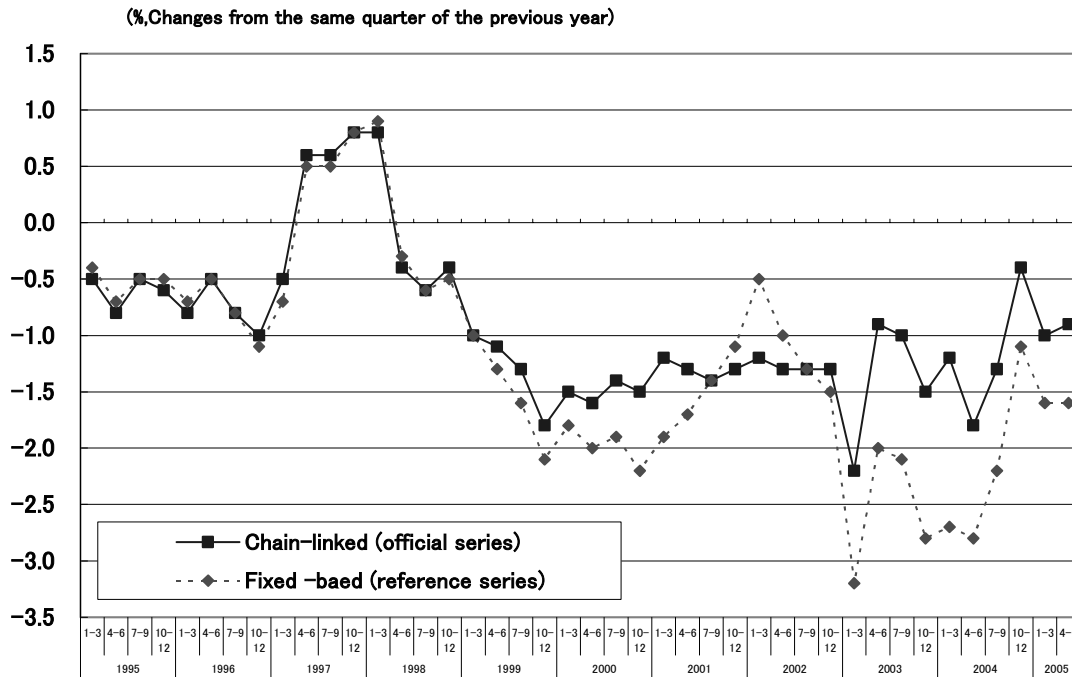
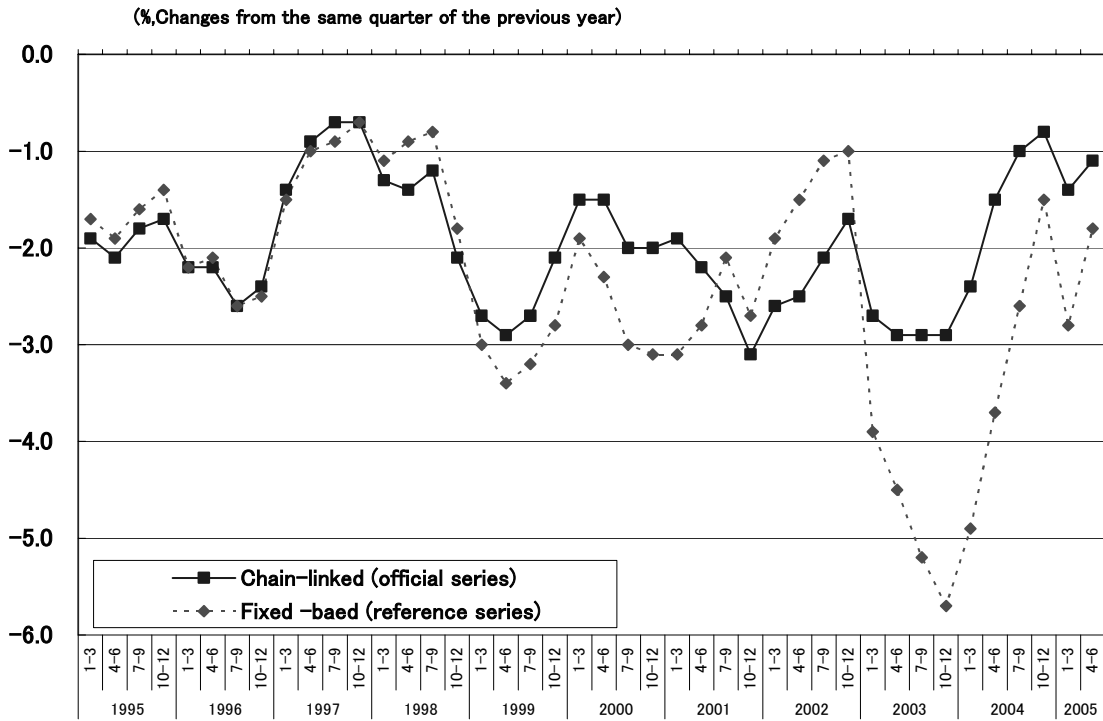


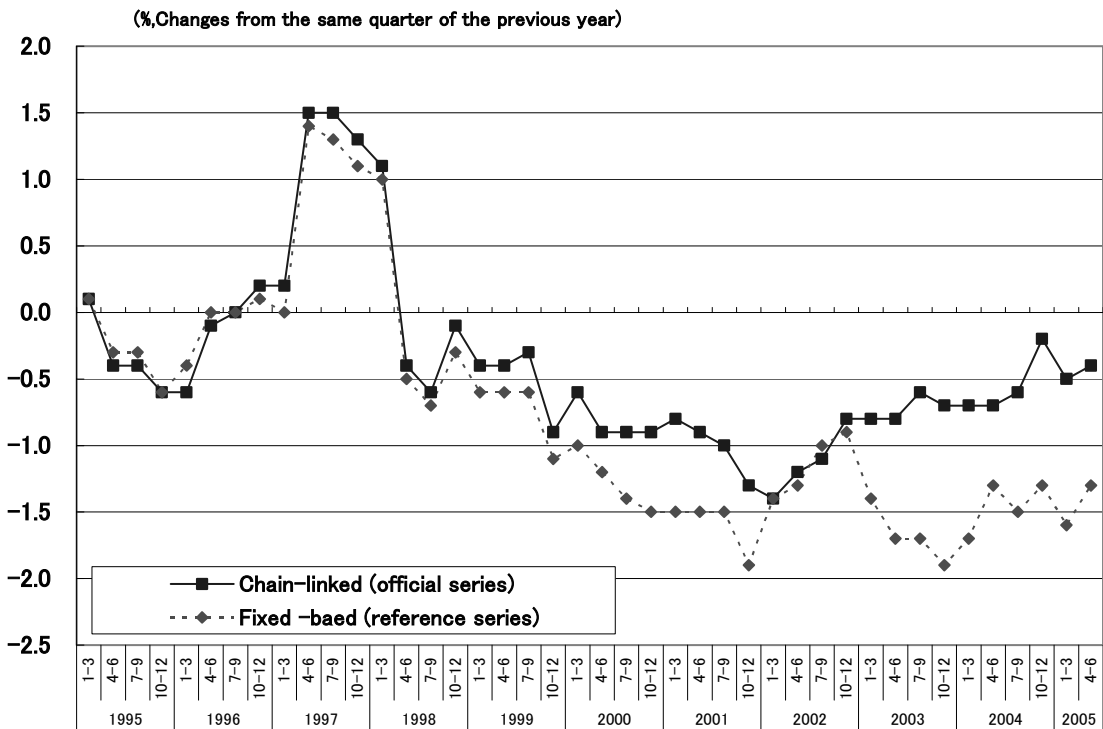
Fig.4 (2) GDP deflator



**Fig.4 Effects of the introduction of chain-linking method  
(3) Private non-residential investment deflator**



**Fig.4 (4) Household Consumption deflator**



**Fig5. Image of new estimation method of preliminary quarterly GDP**

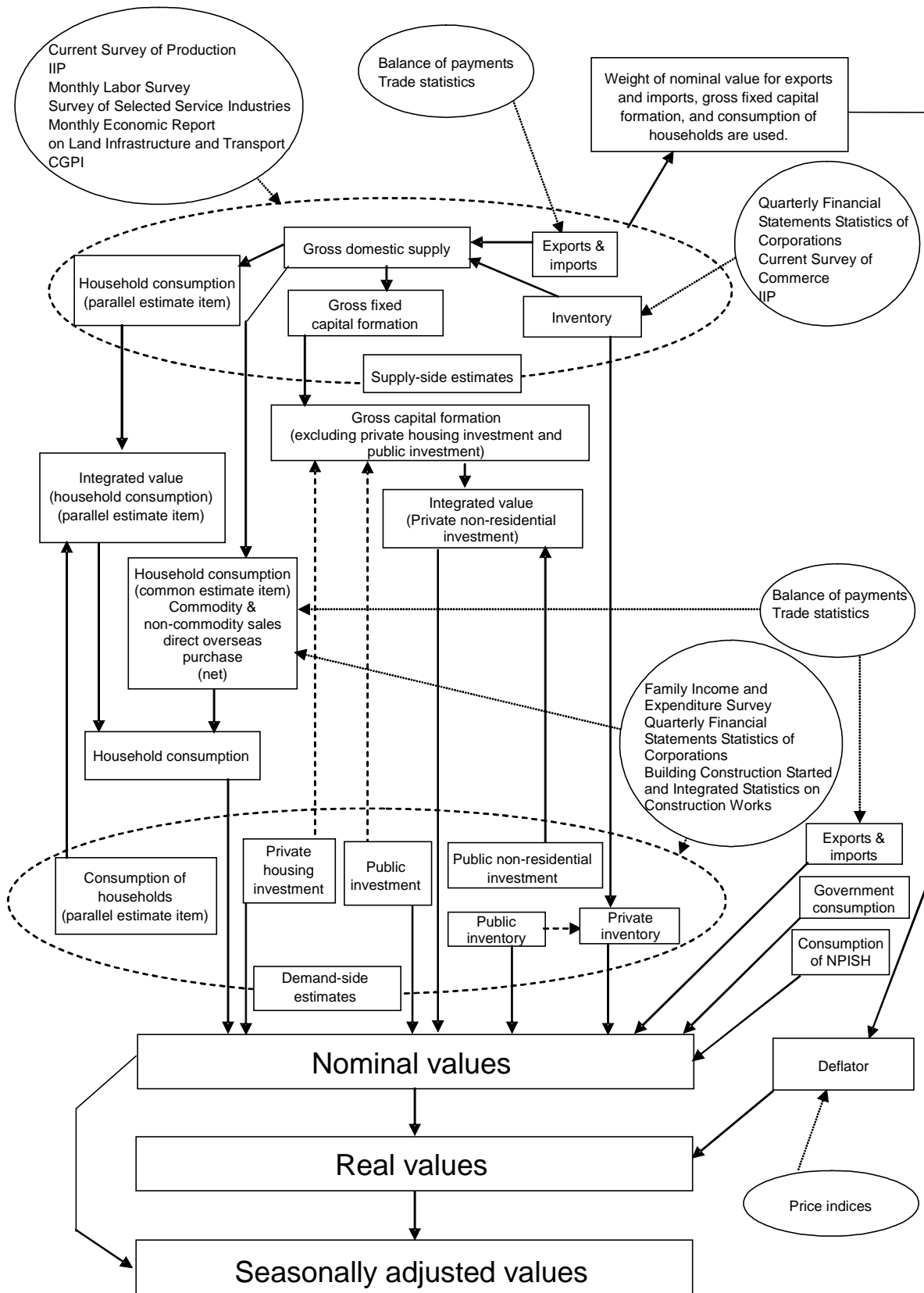


Fig.6 Outline of the new method using the supply-side statistics

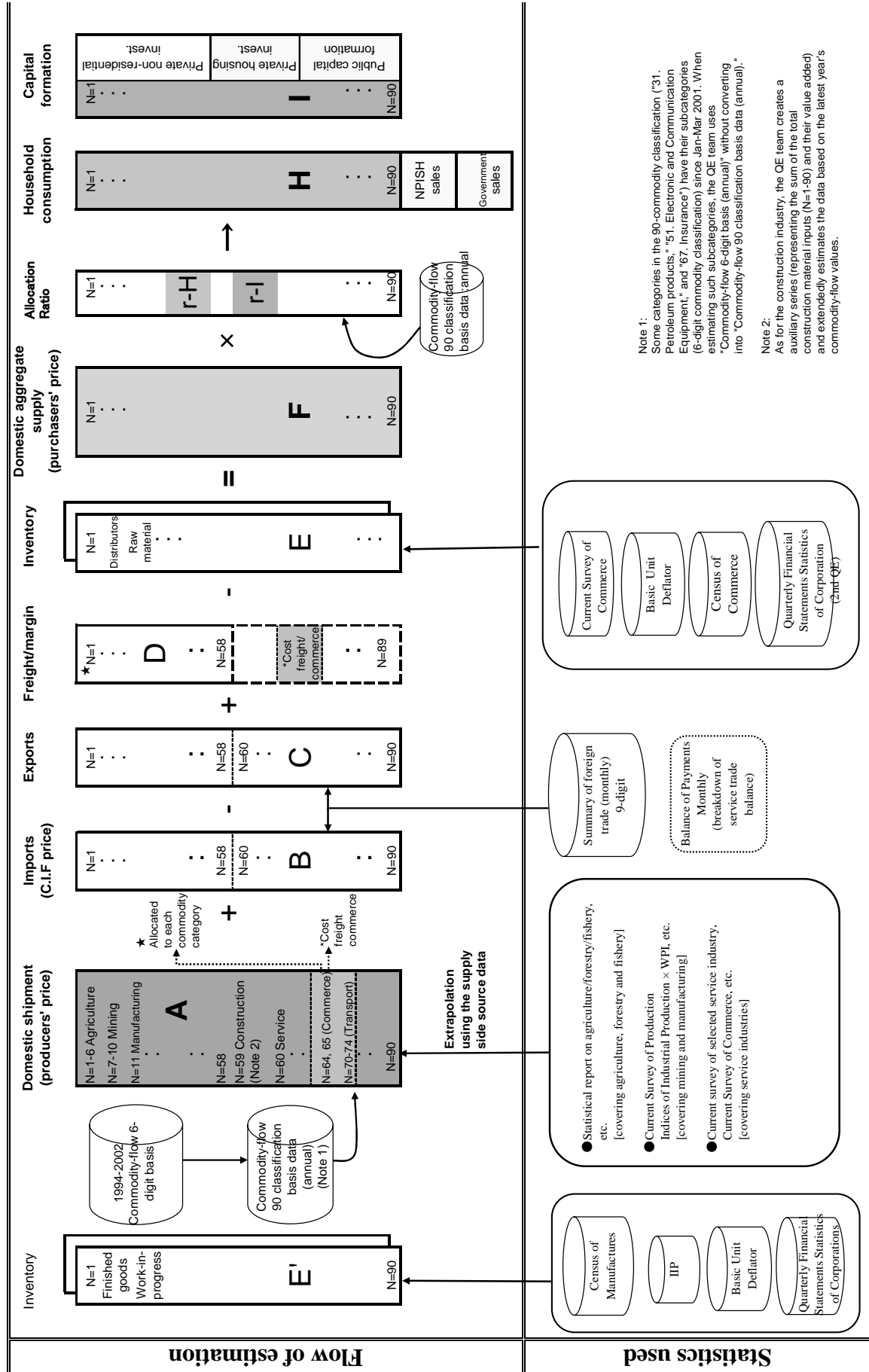


Fig.7: Comparison the new estimates with the Old estimates for real GDP  
 <trillion Yen (Fixed-based; Base year=1995),seasonally adjusted>

