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Uncertainty of GDP Gap in Real Time: The Case of Japan

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Abstract

GDP gap is the most watched economic statistics after 90th in JAPAN. In fact, the certainty of the government forecast on the economic condition is mainly judged by the preliminary GDP but not by the revised ones. We think that most misleading problems around the GDP were occurred due to the undesirable characteristics of uncertainty of the preliminary GDP. Though almost all observers inspect economic conditions by preliminary GDP, however, few know the statistical property of errors including the estimated GDP.

We have estimated the reliability of the GDP gap based on the Real-Time data. Main conclusions as follow;

1) The difference (the revision width) between the real-time GDP gap and ex post GDP gap is the same order of magnitude as the GDP gap itself.
2) The real-time gap is almost underestimated against final gap until the 1990s, but after the 1990s, the real-time gap is almost overestimated.
3) Assuming that later estimates are more accurate than earlier ones, the revisions reflect improvements in accuracy relative to earlier estimates. But the revisions of GDP are more like measurement error than like efficient forecast. That is, early GDP is quiet different from final GDP.

Our findings have important suggestion for the use of preliminary GDP by policymaker and forecasters. If the policymaker decides budget policy with using the preliminary GDP, it is probable for best selection of policy to be no good. The estimates of the GDP gap have attracted relatively little to the revision of the GDP data. However, actually, the GDP gap which was estimated at real-time is different from the GDP gap on the ex post. We can not ignore the influence of the revision of the GDP data

Key Words: Real-time data, output gap, measurement error
JEL Classification: E19, E61, E32

1. Introduction

GDP gap is a typical macro variable often used by evaluating the economic condition and the policy-making, especially after 90th in JAPAN. After 90th, a lot of studies on the measurement of the GDP gap are examined by the Cabinet Office and Bank of Japan.

However, there are two problems on the GDP gap.

First, GDP is processing statistics that is composed by several source data. Almost observers, policymakers and manager, consider it the primary measure of the macro economy. For almost user, it is very important to watch the preliminary estimate of GDP. In fact, the certainty of the government forecast is judged by the preliminary estimate but the revision. It is most closely to watch the economic condition by the preliminary GDP. Though almost all observers watch economic conditions by preliminary GDP, not all know the property of estimates of GDP.

Secondly, the GDP gap is an un-observed variable. The estimation of GDP gap depends on the methods mainly and it is a big problem that the estimation doesn't have robustness. Most studies concentrate on the methods of the measurement (Kamada, Masuda 2000). Generally, GDP gap is estimated on the available data when we need that. But there are few of notice that GDP data is revised after estimation. There is possibility to be led to incorrect decisions if the actual decision-making was wrong with the GDP gap at the time of the use.

The purpose of this study is to examine the reliability of the measurement of the GDP gap at real time data: We will further discuss the property of the revisions in GDP estimates, especially preliminary estimates. In the second sections, making survey of early literature according to the GDP estimates, we will show the methods of Real-Time Data and the estimating GDP gap. In third sections, we investigate the methods of estimating GDP gap to examine whether the real time estimates of GDP gap are quite different from the final estimate. We examine whether the preliminary estimates of GDP are efficient forecast of the final estimate in the fourth section.

2. Real-Time Data and the Methods of estimating GDP gap

2.1 The releasing schedule of GDP

Estimates of GDP are a series of processing statistics that is composed by several source data or other statistics. In Japan, GDP is revised four times: There is the first preliminary quarterly estimates (first QE), the second preliminary quarterly estimates

(second QE), the annual revision, and the benchmark revision. The first estimate of GDP is made approximately 70 days after the end of the quarter[i]. It is called as “QE (Quarterly Estimate)” and is based on incomplete source data. The next estimate is made approximately 100 days after the end of the quarter. It is referred to as the “the second preliminary estimate”. This estimate is based on more source data than the first estimate. These two estimates are called “preliminary GDP”. Most source data of preliminary GDP is the expenditures side data like Family Income and Expenditure Survey and Financial Statements Statistics of Corporations by Industry.

These preliminary GDP estimates are revised to as the “'Annual Estimation” at every next December. After that, this GDP estimate is further revised at every next year, and is referred to as the “final estimate”. There are apparent differences between the preliminary and final estimates in source date and estimating methodology. The annual GDP figures are estimated by the Commodity-Flow method based on the annually available supply-side statistics that cover economic activity widely and contain the thorough aggregation of the each commodity's items. While the preliminary estimation is mainly made from demand-side statistics, the Commodity-Flow method requires more time, too long time lag after the Preliminary Estimates, but provide more accurate and detailed information.

The final estimate of GDP is reviewed and modified every 5 years in the benchmark year. Though the estimate of GDP depends on the definition of GDP components and the coverage of GDP, the definition of GDP is occasionally changed. On October 2000, GDP based on 93SNA have been released.

In this study, we abstract from ignore for simplicity the definitional changes, our purpose is to characterize the statistical revisions of the estimate. We analyze five estimates of the quarter-to-quarter growth rate of seasonally adjusted series; which we denote Y1, Y2, Y3, Y4, and Y5, respectively, is summarized in the table 1., and we analyze consistent 68SNA definition from the second quarter of 1978 to the first quarter of 1999. Because of strong trend in the level data, use of the growth rates eliminates the strong trend in GDP. For almost user, using the quarter-to-quarter growth rate is very important information **(see Table 1)**.

2.2 Real-Time Data

2.2.1 Structure of Real-Time Data

Real-time GDP gap is calculated from GDP statistics available in each estimation

[i] The methods of estimates of GDP are modified on August 2002. To publish the primary preliminary estimates is earlier by nearly one month.

period. To construct a series of GDP available in each estimation period, we use benchmark revisions first, annual revisions second, final estimates third, first preliminary quarterly estimates (first QE) fourth. Note that we adjust to eliminate data-gap that occurs due to benchmark revision. As it understands even if it sees **Table 2**, it is composed by “Revised Annual Estimation” (Y4), “Annual Estimation” (Y3), “The second preliminary estimate” (Y2) and “The first preliminary estimate” (Y1) and the number of Y2 and Y3 depends on the time of each use .Final output gap is calculated under the assumption that in each estimation period, the whole series of the latest GDP estimates were known. We use 2000:Q2 data as “Final data”.

2.2.2 Quasi-final data

In this study, we evaluate the influence of the data revision. Here, we attempted to think of Quasi-final data. Quasi-final data is calculated under the assumption that in each estimation period, the latest GDP estimates (Yf) were known up to that period. To make a series of GDP for quasi-final data, we use 1990-based benchmark revisions first, 1990-based revised annual estimates second, 1990-based annual estimates third, and 1990-based first preliminary quarterly estimates (first QE) fourth.

2.3 The Methods of estimating GDP gap

GDP gap is defined as the difference of actual GDP and potential GDP. However, because potential GDP is an un-observed variable, we are able to produce many different estimated output gap series with variety methods and the definition of potential GDP. We use some de-trending methods and the macro production function to estimate GDP gap. In our study, because to analyze the influence of the data revision is a main purpose, we ignore a definition in the GDP gap and the propriety of the way of estimating.

We consider four types of methods. They are:

1. The production function method
2. Deterministic Trends: Linear Trend
3. Deterministic Trends: Quadratic Trend
4. The Hedrick and Prescott filter

In appendix 1, we list types of methods used in this study.

3. Result – Effect of data revision

3.1 The difference between real-time gap and final gap

In this section, we compare the GDP gap and Business cycle for the five different methods **(see Figure1)**. As for the level of the GDP gap, there is a large difference among the each method, especially, the spread of gap becomes large in the 90s.The difference of the GDP gap is roughly 5 % until the 90s, after the 90s, about 15 %.

As for the GDP gap in the Final data, we find same situation. Until the mid of 80s, the difference of the GDP gap is roughly 3 %, but the spread is becoming large about 15 % **(see Figure 2)**. In this way, the level of gap depends on the choice of the methods of estimating mainly. Next, we examine the influence of the GDP data revision. Until the 90s, the estimation by the Real-Time data becomes larger than the estimation by the Final data. However, since the 90s, the estimation by the Real-Time data becomes more excessive than the estimation by the Final data **(see Figure 3)**.

In order to understand the difference between the real-time gap and final gap, we examine the reliability of GDP gap in **the Table 3**. Table 3 provides the correlation of the real-time and final estimates in column 1. We find that correlation range is large from a low of 0.07 for the Quadratic Trend to a high of 0.70 for the Linear Trend. In column 2, this indicator indicates the ratio of the standard deviation of the revision and the standard deviation of the final estimates of the gap. The Quadratic Trend is larger variance than the final estimate of the output gap.

In column 3 and 4, these indicate the frequencies with which the real-time gap is worse. Column 3 indicates the frequency with which the real-time and the final gap estimates have opposite signs. The Quadratic Trend (0.73) is worse methods. The next column shows the frequency with which the absolute value of the revision exceeds the absolute value of the final gap. Except production Function (0.08), the range of other methods is from 0.89 for the Quadratic Trend to 0.44 for the Linear Trend. In the GDP gap which was measured by the Real data, even if it is positive, the GDP gap by the Final data shows to become negative.

We find that the revisions are of the same order of magnitude as the estimated output gaps in column 5. Column 5 indicates the ratio of the absolute value of the revision and the absolute value of the final gap. Production Function is 0.52, but other methods are very large. The difference (the revision width) between real-time GDP gap and ex post revision is in the size as much as the gap level in this way. Also, in the same aspect, we may have different judgments between in advance and in ex post, especially in the second half of the 90s, the output gap depended on the data which is gotten by each real-time. As for this thing, a similar result is pointed out in the preceding study (Orphanides, A and Norden S. (1999) in the U.S.).

3.2 Causes of difference between the real-time gap and final gap

As for the difference between the real-time gap and final gap, there are not only the effects of data but also the influence of the recursive estimate. We will determine the cause of the difference by Quasi-final data.

A difference between real-time data and quasi-final data reflects an effect of data revision. While the differences are basically attributed to revision of GDP statistics, a preliminary-final-estimate discrepancy has a greater effect than a benchmark-revision effect. This is because source data used for preliminary estimates of GDP are substantially different from those used for final estimates of GDP. A difference between quasi-final data and final data reflects an effect of recursive estimate of GDP gap, not data revision. In the **Table 4**, “Total Revision” shows the difference of the GDP gap by Real-Time and the Final data. “Data Revision” shows the difference of the GDP gap by Real-Time and Quasi-final data.

In the production function, we can distinguish between the effects of data revision and the recursive estimate. We will arrange other Real-Time data on the private company gross capital stock and rate of the capacity utilization. In appendix 2, we list source data in this study

We can explain that the difference of the GDP gap caused by about 50% on the revision of the GDP data in production function. In addition, there is about 70-80% because of the data revision when we use other Real-Time data on the private company gross capital stock and rate of the capacity utilization. Except production function, there is large effect in the recursive estimate. However, it is understood that the effect of the data revision has expanded after 1990's.

Why is the effect of data revision so large? We estimate the statistical property of each revision of GDP. We examine whether the preliminary estimates of GDP are efficient forecast of the final estimate in the next section.

4. A characterization of the revisions – Forecast errors or Measurement errors?

4.1 Measurement errors or Forecast errors: GDP revisions

According to Mankiw and Shapiro (1986), they distinguish and examine two alternative hypotheses about why GDP revisions arise in US. Their first hypothesis is that revisions arise because of measurement error in the early GDP. Such error result from the early estimates based on unrepresentative data or on too small sample. If an early estimate contains measurement errors, then the revision is uncorrelated with the revised value, but correlated with the provisional estimate. In other word the revised

estimate is quite different from the early estimate. The second hypothesis is that the revisions arise because of imperfect forecasts of the subsequent revised estimates. If the early estimates contain the forecast error, the forecasts don't systematically overstate or understate the actual value, then the revision should become uncorrelated with the provisional estimate, but correlated with the revised value. Whether the revisions are characterized as measurement error or as forecast error depend on the methods of estimation of Statistical Agency. If the GDP were estimated by the source data without taking accounts of the relations between the source data as time-series correlation or cross-sectional correlation, we would expect the revisions to reflect the measurement error. If agency uses optimal statistical procedures to construct the GDP, we would expect the revisions to behave as efficient forecast.

They examine by the correlation matrix; correlation between the revision and the provisional estimate. If the correlation of the revisions with earlier provisional estimate is not significantly different from zero, there is measurement error in GDP. If the correlation of the revisions with the current and subsequent estimate is not significantly different from zero, there is forecast error in GDP.

Mankiw and Shapiro conclude that the revision of GDP (they used GNP) growth, both nominal and real, has like forecast error than like measurement error. After there study, this conclusion is supported by Kennedy (1990) and others.

4.2 The relations between revisions and each of the estimates

I assess whether the preliminary GDP are rational forecasts of the final figure. If the GDP is successively revised, each of the estimates regards as a revision of previous estimates and as a provisional estimate for subsequent revisions. As described by figure 1, for example, Y2 is the revision of Y1, but a provisional estimate of Y3 and Y4. If these GDP estimates are efficient forecasts, each of the estimates should be positively correlated with all of the revisions announced previously, but uncorrelated with data available at the time of the provisional estimate **(see Figure 4)**.

Assuming that the preliminary GDP is equal to the true value plus a random measurement error, we could think that there is no correlation between measurement error and the true value and measurement error would be small with the revision. Then, there is negative correlation between the revision and the estimation before the revision, because the preliminary GDP which was overestimated tend to be revised downward. Conversely, if the preliminary GDP is combined with taking account of the time-series correlations of GDP and other data, it occur equally whether the preliminary GDP is revised upward or downward, then, there is no correlation between the revision and the

estimation before the revision. There is positive correlation between the revision and the provisional estimate.

By examining the correlations of the revisions with data available before and after the provisional, we use the annualized quarter-to-quarter growth rate of seasonal adjusted real GDP on the “Seasonal National Accounts”. We expect that the trend in the series will be eliminated by using of the growth rate rather than the level.

We use following five estimates as introduced in section 2: The First Preliminary, The Second Preliminary, Annual Estimation, The Second Annual Estimation and Final estimation denoted as Y1, Y2, Y3, Y4 and Y5, respectively. These estimates are summarized in table 1.

When the preliminary GDP of July-September is revised annually every December, ‘Annual Estimation' and The Second Annual Estimation are released. As Y3 and Y4 are calculated again every December, the growth rate of the seasonal adjusted real GDP is not fixed. So we use Y3 as four quarter before end of quarter, Y4 as five to eight quarter before end of quarter. Y5 is the estimate that is released on April-June 2000. The revision “Y1-Y2” means the change from Y1 to Y2 estimates.

Table 5 shows correlations between each estimate and the revisions. The four incremental revisions are described in the rows of the tables and each of estimates is listed in the columns. The t-values under the hypothesis of no correlation are given in parentheses.

In the upper-right portion of the Table 5, if these correlations are statistically significant, the estimates of GDP are efficient forecast. Conversely, if the correlations in the lower-left portion are significantly different from zero, there is the evidence for the measurement error. The result in table 5 generally supports the hypothesis that the estimates of GDP are involved measurement errors. In the upper-right panel are not significantly different from zero, while most of these in the lower-left are greater than zero at the critical level of 0.05.

This suggestion is opposite result, which was described by Mankiw and Shapiro (1986) or Kennedy (1990) in a study of GDP revisions. We conclude that Japanese GDP is not the efficient forecast of the true value of the GDP.

4.3 Model

In this section, we will show statistical models to assess whether the preliminary GDP estimates are effective forecast of the final figure or measurement error. In case of the

measurement error in the early estimates of the GDP, the provisional estimate differs from the final estimate by a random measurement error. In order to evaluate this hypothesis, suggested by Mankiw and Shapiro [10], each estimates of GDP is considering the following equation,

$$Yi_t = \alpha_0 + \alpha_1 Y4_t + \varepsilon_t \qquad i = 1,2,3. \qquad (1)$$

Where Yi denotes the revision of GDP growth rate in the i estimate of GDP. Failure to reject the joint null $\alpha_0 = 0$ and $\alpha_1 = 1$ is a necessary condition for the error in variables interpretation.

If the final GDP is estimated by the past GDP and other available information, each estimates of GDP can be represented as the following equation. This equation is corresponding to the forecast error model,

$$Y4_t = \beta_0 + \beta_1 Yi_t + \varepsilon_t \qquad i = 1,2,3. \qquad (2)$$

If the preliminary GDP is an efficient forecast of the final GDP, Failure to reject the joint null $\beta_0 = 0$ and $\beta_1 = 1$ is a necessary condition for the error in variables interpretation in (2).

In this estimates, we use each revision (Y1-Y2, Y2-Y3, Y3-Y4) and each GDP growth rate. The regressions are estimated on the 1980:1 to 1999:1 period.

Table 6 shows the result of regressions by the models (1) and (2). Measurement error model is accepted. A necessary condition for measurement error model is and. Tests of this joint null, shown in the upper panel of table 6, are failed to reject for each of the Wald test.

On the other hand, the result of forecast error model is rejected in the lower panel of table 6. Form 6.5 equations to 6.8 equations, these equations suggest forecast error model.6.1-6.4 equations suggest measurements error model. The intercepts of almost regressions are positive, so indicating that the provisional estimates of GDP growth are biased downward.

5. Conclusion

We have estimated the reliability of the GDP gap based on the Real-Time data. Main conclusions as follow;

1) The difference (the revision width) between the real-time GDP gap and ex post

GDP gap is the same order of magnitude as the GDP gap itself.

2) The real-time gap is almost underestimated against final gap until the 1990s, but after the 1990s, the real-time gap is almost overestimated.
3) Assuming that later estimates are more accurate than earlier ones, the revisions reflect improvements in accuracy relative to earlier estimates. But the revisions of GDP are more like measurement error than like efficient forecast. That is, early GDP is quiet different from final GDP.

Our findings have important suggestion for the use of preliminary GDP by policymaker and forecasters. If the policymaker decides budget policy with using the preliminary GDP, it is probable for best selection of policy to be no good. The estimates of the GDP gap have attracted relatively little to the revision of the GDP data. However, actually, the GDP gap which was estimated at real-time is different from the GDP gap on the ex post. We can not ignore the influence of the revision of the GDP data.

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Appendix 1 The Methods of estimating GDP gap

1. The production function method

The macro production function is generally used because it is easy to understand the construction of the economy. In this paper, we assume a Cobb-Douglas production function that uses capital and labor as production factors. That is,

$$Y = A \cdot L^{\alpha} \cdot (\gamma \cdot K)^{1-\alpha} \qquad (1)$$

Where Y is real GDP, A is TFP, L is labor inputs, K is capital stock, γ is capacity utilization, and α is labor elasticity of production. Taking the logarithm of both sides of the equation, we obtain

$$\ln Y = \ln A + \alpha \ln L + (1-\alpha)\ln(\gamma \cdot K) \quad (2)$$

The first term of the equation on the right-hand side is the contribution of TFP, the second is that of labor, and the third is that of capital. The remainder after the second and third terms are subtracted from the left-hand side of the equation is called the "Solow residual", which coincides with TFP if Y, L , K, γ, and α are measured accurately. Potential output "Y^*" obtains by replacing L with its maximum level "L^*"and γ with its maximum level (100%), while TFP is taken as given. That is,

$$\ln Y^* = \ln A + \alpha \ln L^* + (1-\alpha)\ln K \qquad (3)$$

But we can't estimate accurate Output gap. Specifically, in case of Japan, there is not data about capacity utilization of non-manufacturing sectors. For this reason, there is possibility that this distorts the estimation of the GDP gap. In the actual analysis, non-manufacturing capacity utilization is often assumed to be 100%. Also, in the second half of the 90s, because of rapid depreciation of capital stock in the technical innovation like the IT revolution, the "Solow residual" may have declined. The mistake match of the labor supply and demand was expanded with the structure adjustment changed. As a result, in the macro production function, there is generally possibility to have rather been smaller than accurate GDP gap.

In this study, we assume to apply a linear trend. Because non-manufacturing capacity utilization is assumed to be 100%, this implies that TFP is underestimated. That is why we remove the effects of capacity utilization from the Solow residual by regressing it linearly.

$$Y_t = \overline{A_t} \cdot \left(\gamma_t \cdot K_{t-1}^{1-\alpha}\right) \cdot L_t^{\alpha} \qquad (4)$$

$$\ln \overline{A_t} = \ln Y_t - (1-\alpha)\cdot \ln(\gamma_t \cdot K_{t-1}) - \alpha \cdot L_t \qquad (5)$$

We assume a linear trend in TFP of (5).

$$\ln \overline{A_t} = b_0 + b_1 \cdot t + \varepsilon_t \qquad (6)$$

$$\ln A_t = b_0 + b_1 \cdot t \qquad (7)$$

2. Deterministic Trends

In this study, we use linear and quadratic linear functions. The linear trend is the oldest and simplest of these models. We assume that output may be decomposed into a cyclical factor and a linear function of time.

$$y_t = \alpha + \beta \cdot t + c_t \qquad (8)$$

where c_t is business cycle and y_t is output gap. The quadratic trend adds a second term in the deterministic component:

$$y_t = \alpha + \beta \cdot t + \gamma \cdot t^2 + c_t \qquad (9)$$

It depends on the trend models mainly in the direction of the change with estimation value and so on. This method will incorporate the assumption that the location of the break is fixed and known. But due to their simplicity, deterministic trends remain appealing. Some authors use this method; for example, Taylor (1993).

3. The Hodrick and Prescott Filter

This is a Time series analysis methods. Hodrick and Prescott [1980], is commonly called the HP filter, showed with the filter for the decomposition from trend part while keeping “constant smoothness ". The HP filter decomposes a time series X_t into an additive cyclical component c_t, and a growth component g_t,

$$X_t = g_t + c_t \qquad (10)$$

After that, we choose the series g_t to minimize the variance of the cyclical component c_t subject to a penalty for the variation in the second difference of the growth component g_t. HP filter trend is given by

$$\underset{\{g_t\}_{t=-1}^{T}}{MIN}\left\{\sum_{t=1}^{T} c_t^2 + \lambda \sum_{t=1}^{T}\left[(g_t - g_{t-1}) - (g_{t-1} - g_{t-2})\right]^2\right\} \qquad (11)$$

where λ is called the smoothness parameter, setting λ equal to 1600 by Hodrick and Prescott. In the HP filter, it depends on the value of λ.The larger the value of λ becomes the smoother. As λ approaches infinity, it becomes nearly the straight line trend. On the other hand, the smaller the value of λ becomes X_t.

Appendix 2 Data Description

1. GDP

Source: Economic and Social Research Institute, National Accounts

2. Private Gross Capital Stock

Source: Economic and Social Research Institute, Gross Capital Stock of Private Enterprises

Notes: With the privatization of NTT and JR, the fault of the data has occurred. As for this, we revise previous year at the year of year ratio.

3. Capacity utilization

Source: Ministry of economic and International Trade and Industry, Indices of Industrial Production

Notes: Because the computer, the semiconductor and so on are composed of operation cost, there is possibility that we see underestimate for that production. Also, there is no data about capacity utilization of the non- manufacturing. Therefore, in this study, we remake the capacity utilization of manufacturing and non-manufacturing.

4. Labour Force

Source: Ministry of Labour, Monthly Labour Survey

Table 1: Schedule of GDP estimates

Name of Estimates	Timing of estimates	Variable name
the first preliminary estimates	approximately 70 days after the end of the quarter	Y1
the second preliminary estimates	approximately 100 days after the end of the quarter	Y2
the annual estimation	every next December	Y3
the second annual estimation	every next December after the annual revision	Y4
the benchmark revision	approximately once every 5 years	
Final	Available Data of April-June 2000	Y5

Table 2: Real-Time Data

Available Date / The end of sample	Dec-97	Mar-98	Jun-98	Sep-98	Dec-98	Mar-99	Jun-99	Sep-99	Dec-99	Mar-00	Jun-00	Sep-00
2000:1												
1999:4												Y1
1999:3											Y1	Y2
1999:2										Y1	Y2	Y2
1999:1									Y1	Y2	Y2	Y2
1998:4								Y1	Y2	Y2	Y2	Y2
1998:3							Y1	Y2	Y3	Y3	Y3	Y3
1998:4						Y1	Y2	Y2	Y3	Y3	Y3	Y3
1998:3					Y1	Y2	Y2	Y2	Y3	Y3	Y3	Y3
1998:2				Y1	Y2	Y2	Y2	Y2	Y3	Y3	Y3	Y3
1998:1			Y1	Y2	Y3	Y3	Y3	Y3	Y4	Y4	Y4	Y4
1997:4		Y1	Y2	Y2	Y3	Y3	Y3	Y3	Y4	Y4	Y4	Y4
1997:3	Y1	Y2	Y2	Y2	Y3	Y3	Y3	Y3	Y4	Y4	Y4	Y4
1997:2	Y2	Y2	Y2	Y2	Y3	Y3	Y3	Y3	Y4	Y4	Y4	Y4
1997:1	Y3	Y3	Y3	Y3	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4
1996:4	Y3	Y3	Y3	Y3	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4
1996:3	Y3	Y3	Y3	Y3	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4
1996:2	Y3	Y3	Y3	Y3	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4
1996:1	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4
1995:4	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4
1995:3	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4
1995:2	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4	Y4

Table 3: Summary Reliability Indicators of GDP gap

Table 3 Summary Reliability Indicators of GDP gap

Method	COR	Fig 1	Fig 2	Fig 3	Fig 4
(1)Production Function	0.52	0.97	0.04	0.08	0.52
(2)Linear Trend	0.70	0.77	0.34	0.44	0.81
(3)Quadratic Trend	0.07	1.27	0.73	0.89	1.28
(4)Hodrick-Prescott	0.45	1.09	0.37	0.57	1.20

Note: This table shows measures evaluating between the Final and the Real-Time estimates for alternative methods.
1)COR indicates the correlation of the real-time and final estimates.
2)Fig1 indicates the ratio of the standard deviation of the revision and the standard deviation of the final estimates of the gap.
3)Fig2 indicates the frequency with which the real-time and the final gap estimates have opposite signs.
4)Fig3 indicates the frequency with which the absolute value of the revision exceeds the absolute value of the final gap.
5)Fig4 indicates the ratio of the absolute value of the revision and the absolute value of the final gap.

Table 4: Summary GDP Gap property

	Periods：1980/10-12～2000/4-6				Periods：1990/1-3～2000/4-6			
Method	MEAN	SD	MAX	MIN	MEAN	SD	MAX	MIN
(1)Production Function								
RealTime	▲5.4%	3.5%	1.6%	▲11.0%	▲5.0%	3.8%	1.6%	▲11.0%
Final	▲4.5%	2.9%	1.3%	▲0.8%	▲3.9%	3.2%	1.2%	▲0.8%
Total Revision	1.3%	0.9%	3.6%	0.0%	1.4%	1.0%	3.6%	0.0%
Data Revision	0.9%	0.7%	3.1%	0.0%	1.1%	0.8%	3.1%	0.0%
for GDP Data	0.6%	0.6%	2.4%	0.0%	0.8%	0.6%	2.4%	0.0%
(2)Linear Trend								
RealTime	0.2%	3.6%	7.1%	▲7.7%	▲1.0%	4.3%	7.1%	▲7.7%
Final	▲0.0%	3.5%	6.9%	▲7.6%	1.1%	4.0%	6.9%	▲7.6%
Total Revision	2.6%	1.4%	6.1%	0.0%	2.3%	1.3%	4.7%	0.0%
Data Revision	0.8%	0.6%	2.8%	0.0%	0.8%	0.7%	2.6%	0.0%
(3)Quadratic Trend								
RealTime	▲1.9%	2.6%	1.6%	▲11.0%	▲3.2%	2.8%	1.6%	▲11.0%
Final	▲0.4%	3.4%	6.2%	▲6.4%	1.3%	3.4%	6.2%	▲6.4%
Total Revision	3.4%	2.1%	6.8%	0.0%	4.5%	1.9%	6.8%	0.0%
Data Revision	0.6%	0.5%	2.1%	0.0%	0.6%	0.5%	2.1%	0.0%
(4)Hodrick-Prescott								
RealTime	▲0.3%	1.4%	2.4%	▲3.0%	▲0.8%	1.5%	2.4%	▲3.0%
Final	▲0.0%	1.3%	3.9%	▲3.3%	0.2%	1.7%	3.9%	▲3.3%
Total Revision	1.3%	0.8%	2.9%	0.0%	1.3%	0.9%	2.9%	0.0%
Data Revision	0.5%	0.4%	1.5%	0.0%	0.4%	0.4%	1.4%	0.0%

Notes:
1) The figure is calculated in the absolute value.
2) The statistics shown for the each variable are : MEAN, the mean; SD, the standard deviation; MAX, the maximum vales; and MIN, the minimum values. COR indicates the correlation with the real-time and final estimates of the gap.

Table 5: Correlation between each estimate of GDP

	Estimates of each GDP Growth				
Revisions	Y1	Y2	Y3	Y4	Y5
in constant					
Y1-Y2	0.12	-0.06	-0.04	0.00	-0.06
	(1.03)	(-0.51)	(-0.35)	(-0.04)	(-0.49)
Y2-Y3	0.44	0.46	0.11	0.12	0.10
	(4.07)	(4.52)	(0.92)	(1.02)	(0.87)
Y3-Y4	0.46	0.47	0.52	0.11	0.09
	(4.49)	(4.57)	(5.25)	(0.94)	(0.75)
Y4-Y5	0.15	0.13	0.14	0.14	-0.33
	(1.18)	(1.15)	(1.21)	(1.26)	(-3.05)
in current					
Y1-Y2	0.13	-0.10	-0.13	-0.06	-0.03
	(1.36)	(-0.34)	(-0.79)	(-0.40)	(-0.08)
Y2-Y3	0.49	0.46	0.09	0.02	0.15
	(4.69)	(4.47)	(0.74)	(0.48)	(0.99)
Y3-Y4	0.49	0.52	0.53	0.15	0.20
	(4.19)	(4.49)	(4.70)	(0.80)	(1.11)
Y4-Y5	-0.13	-0.11	-0.05	0.01	-0.41
	(-0.97)	(-0.81)	(-0.34)	(0.02)	(-3.91)

Note:
1) Estimation period : 1980:1-3～1999:1-3
2) The figures in parentheses are marginal significance levels of tests of the null hypothesis that the correlation is zero.

Table 6: Tests for Efficient Forecast and measurement error in GDP

Measurement Error Model : $Yi_t = \alpha_0 + \alpha_1 Y5_t + \varepsilon_t, i = 1,2,3$

	Dependent Variable	Intercept	Slope	R-squared	SE	Wald Test
6.1	Y1	5.02E-04 (0.00)	0.918 (0.10)	0.534	7.32E-03	0.761 (0.68)
6.2	Y2	9.06E-04 (0.00)	0.931 (0.09)	0.555	7.10E-03	1.057 (0.59)
6.3	Y3	9.93E-04 (0.00)	0.885 (0.08)	0.633	5.75E-03	2.211 (0.33)
6.4	Y4	1.69E-03 (0.00)	0.844 (0.06)	0.782	3.82E-03	9.024 (0.01)

Forecast Error Model : $Y5_t = \beta_0 + \beta_1 Yi_t + \varepsilon_t, i = 1,2,3$

	Regressor	Intercept	Slope	R-squared	SE	Wald Test
6.5	Y1	2.87E-03 (0.00)	0.588 (0.07)	0.534	5.85E-03	38.440 (0.00)
6.6	Y2	2.47E-03 (0.00)	0.603 (0.07)	0.555	5.72E-03	39.042 (0.00)
6.7	Y3	1.77E-03 (0.00)	0.721 (0.06)	0.638	5.19E-03	21.235 (0.00)
6.8	Y4	-8.30E-05 (0.00)	0.929 (0.05)	0.782	4.01E-03	3.765 (0.15)

Note:
1) Estimation period : 1980:1-3～1999:1-3
2) Wald Tests in the upper panel refer to the joint null $\alpha_0=0$, $\alpha_1=1$; those in the lower panel are tests of the null $\beta_0=0$, $\beta_1=1$.
3) Marginal significance levels of Wald test and standard deviations of coefficient estimates are shown in parentheses.
4) The First Preliminary, The Second Preliminary, Annual Estimation, The Second Annual Estimation and Final estimation denoted as Y1, Y2, Y3, Y4 and Y5.

Figure 1: Real-Time estimates of the Business Cycle

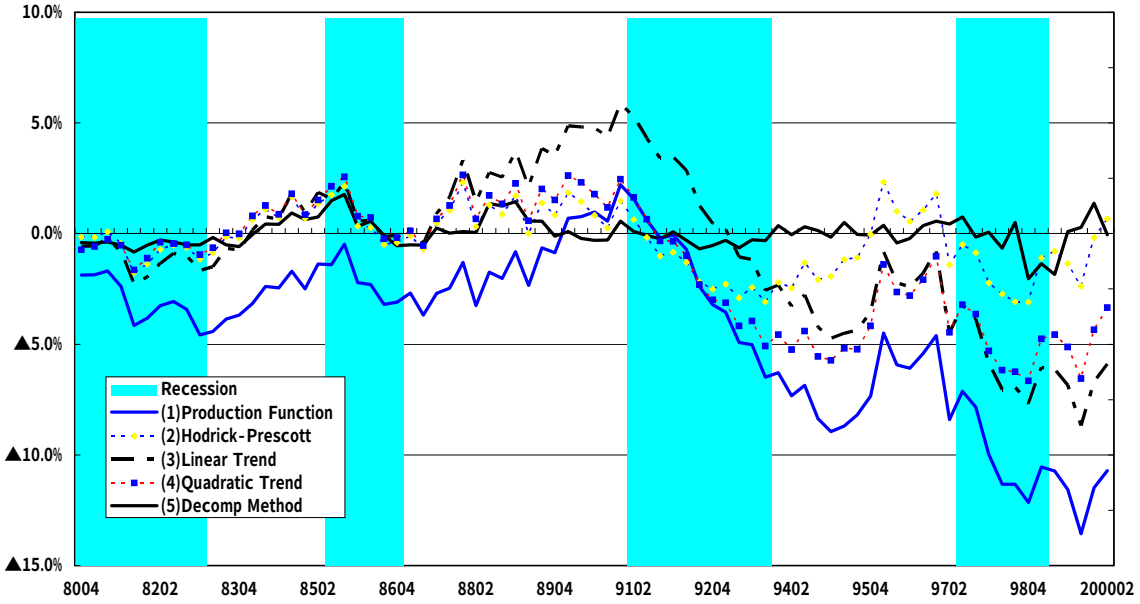

Figure 2: Final Estimates of the Business Cycle

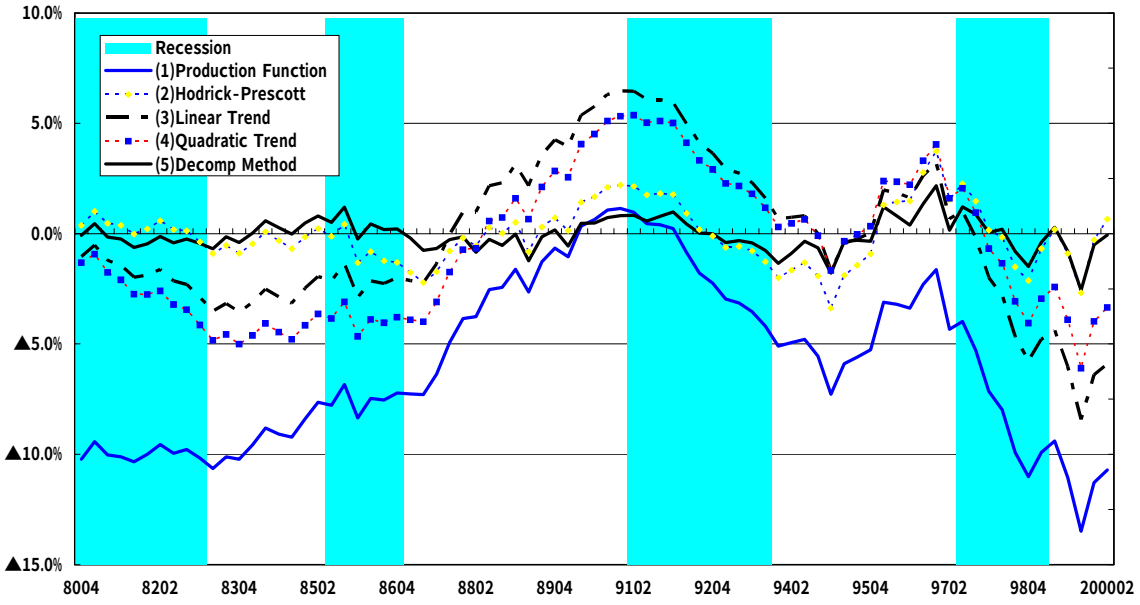

Figure 3: The revision in Business Cycle Estimates

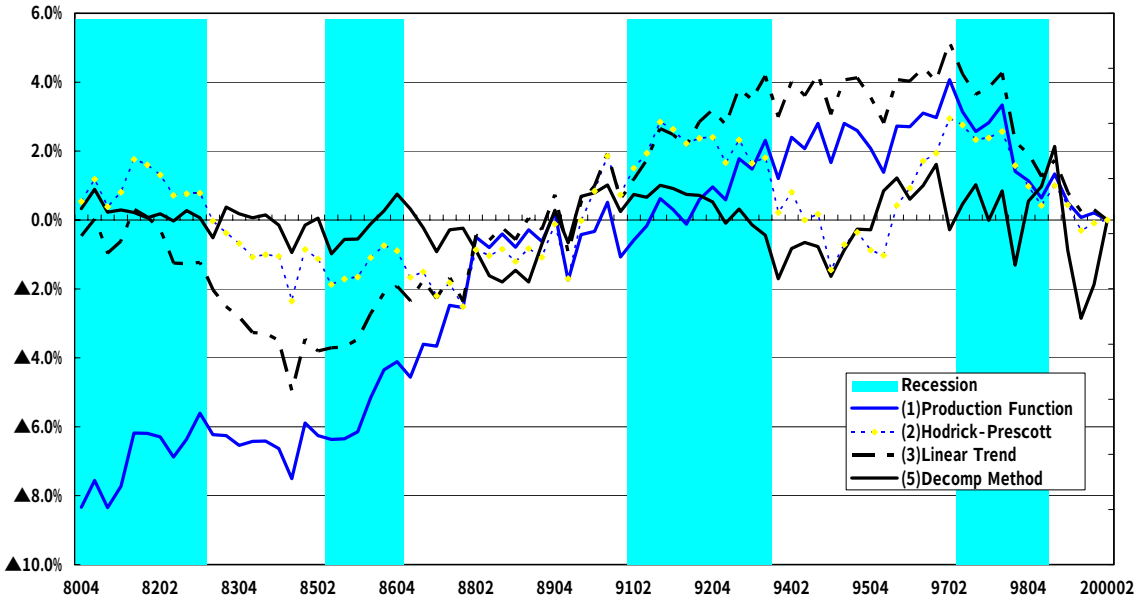

Figure 4: The relations between each estimates of GDP and revisions