

TESTING FOR BIAS IN INITIAL ESTIMATES OF THE COMPONENTS OF GDP

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Introduction

An earlier article published in the May 1992 issue of *Economic Trends* suggested that quarterly estimates of year on year growth rates of gross domestic product (GDP) published in the 10 years ending Q4 1991, showed some evidence of bias in initial estimates produced three years earlier. The present article analyses the revisions to growth rates of the components of GDP, when examined in terms of incomes, expenditures, and output, in order to identify which of the individual components contributed to the bias in the aggregated measure of GDP.

It should, however, be stressed that since this article is looking at long term revisions the latest figures which can be covered relate to estimates of growth rates into 1988. The analysis in this article, therefore, could not take account of some significant recent improvements made particularly to the methodology and in the identification of new data sources, incorporated into the initial estimates of quarterly growths from 1989 onwards.

Estimates of the components of expenditure, income and output are published in a quarterly article on national accounts in *Economic Trends*. The data for the first to the thirteenth estimates of each item and for each of the 40 quarters, analyzed in this article, have been taken from successive quarterly issues. The analysis covers published data for the 10 years from 1982 to end 1991, as in the earlier article. The dates refer to the publication of the thirteenth estimate, as before.

Method of Testing for Bias

The methods used for the present analysis are the same as described in the article published in the May 1992 issue of *Economic Trends*. Revisions series for each item were arrived at by taking the difference between the first and the thirteenth estimates of percentage growth rates over four quarters. The same definition of bias is used here as in the last article; an indicator is considered to be biased if its mean revision is different from zero.

- a) In the first instance a Student's *t*-test was applied to each series. However, this test is applicable only if the revisions follow a normal (Gaussian) distribution. The Wilcoxon signed-rank test, which is a non parametric test and which requires no assumption about the underlying distribution, was also applied to all the series. Strictly speaking this test examines whether the median (rather than the mean) is different from zero.
- b) All series were tested for serial correlation. Where a significant coefficient for correlation was found, a Cochrane-Orcutt transformation was performed before re-applying the *t*-test.
- c) As in the last article, all the series were examined for the effect of business cycles. The series of revisions were

regressed on a dummy variable with 1 denoting the expansion and -1 denoting the contraction phase of the economy. Where a significant phase effect was observed the residuals of those series were tested for the presence of serial correlation. The Cochrane-Orcutt regression procedure was then used to test the effect of business cycles again.

Results and Discussion of individual items

The results are summarised in Tables 1 to 6 in the annex. First the total of the relevant components is examined, e.g. the total of the components of GDP when analyzed into categories of expenditure. Then the components were examined separately. Also included in the annex are separate graphs for each indicator, showing the magnitude of individual revisions over the whole ten year period.

Components of Total Expenditure

Mean revision to the growth rate of **Total Final Expenditure less Imports less Factor Cost Adjustment** in current prices was an increase of 1.1 per cent over the 10 year and 1.30 per cent in the latter 5 year period. The corresponding figures in constant prices were 0.78 and 1.08. The *t*-values for all four means were highly significant. However, the serial correlations were also significant and after Cochrane-Orcutt transformation on the 10 year data the *t*-values were reduced; falling just below the 5% significance level at current prices but remaining significant at constant prices.

A regression on the business cycle variable showed no phase effect for the first 5 year period (publication dates: 1982 to 1986) but a significant downward bias in the initial estimates during the expansion phase of the second 5 year period (publication dates: 1987 to 1991).

The components which contributed most to the revisions to the total expenditure were **Consumers' expenditure** and **Gross Domestic Fixed Capital Formation (GDFCF)**. These two items together account for more than 60% of total final expenditure. The *t*-values for the mean revisions over the 10 year period were highly significant in both current and constant prices. The same results were obtained by the Wilcoxon test. In all cases these revisions increased the initial estimates. The main reason for these significantly upward mean revisions were some very large and consistently positive changes to consumers' expenditure, and higher revisions still to GDFCF during the last three years of the 10 year period.

The mean revision to consumers' expenditure in current prices was an increase of 0.5 percentage points in the first 5 year period compared to 1.06 per cent in the second 5 year span. At constant prices these upward revisions were 0.10 and 0.98 percentage points respectively. The corresponding figures for GDFCF were 1.31 and 3.14 at current prices and 0.70 and 3.43 percentage points at constant prices. The serial correlation was significant for both consumers' expenditure and GDFCF. A Cochrane-Orcutt transformation reduced

the t-values but while the mean revisions to GDFCF became non-significant the mean revisions to consumers' expenditure remained significant in all cases.

A regression on the business cycle variable showed a non-significant effect of the phase of the cycle for consumers' expenditure for the 10 year and the first 5 year periods in both price measures. However, there were highly significant phase effects for consumers' expenditure in the second 5 year period and for all periods and in both prices for GDFCF. The main contributing factor to the significant effects in the later 5 years is the high positive revisions to both consumers' expenditure and GDFCF in this period. Of the 20 observations of the revisions to consumers' expenditure in this 5 year period, which contains 8 contraction and 12 expansion quarters of the economic cycles, only 1 revision in current prices and 2 in constant prices were negative and the other 19 and 18 respectively were positive. For GDFCF, which was prone to very high revisions, the range of revisions in this period was -4.24 to 9.73 per cent (5 negative and 15 positive) in current prices and -3.69 to 8.88 per cent (4 negative and 16 positive) in constant prices.

General Government Final Consumption (GGFC) represents the total of Local Authority and Central Government current expenditure on goods and services. The mean revisions to the year on year growth of GGFC were increases of 0.65 and 0.53 percentage points for the 10 year and the latter 5 year periods respectively. The corresponding revisions in constant prices were -0.11 and 0.11. The t-values in all four cases were not significant. A regression on the business cycle variable showed a non-significant effect of the phase of the cycle in each case.

Exports are added to the total domestic expenditure to get total final expenditure, while **Imports** are subtracted from the final expenditure to arrive at the GDP estimate at market prices. The t-values for the mean revisions to the growth rates of both exports and imports were not significant for the current and the constant price measures. However, a regression on the business cycle variable showed a slightly significant phase effect for the current price measure of exports in the first 5 years of the 10 year period.

Components of Factor Incomes

The mean revision to the year on year growth rate of **total domestic income (less stock appreciation)** was an increase of .35 percentage points over the 10 year period and an increase of 0.36 per cent in the latter 5 year period. The t-values were not significant in either period. There was no business cycle effect in any period.

The components which contribute most to the overall mean revision were **Other Income (sum of income from self employment and rent)** and **Gross Trading Profits of Companies**. However, the t-values were significant only for the revisions to other incomes and not for company profits. The non-significant t-value in the latter case was due to a high standard deviation which was in turn the result of a very wide range of revisions, most made in the latter 5 years of the ten year period. The 80% range of revisions in this second 5 year period was between -5.18 and 9.27 (7 negative and 9 positive).

Both components showed high serial correlation. A Cochrane-Orcutt analysis reduced the t-value for other income to a non-significant level.

A regression on the business cycle variable over the 10 year data showed a significant phase effect for other income but not for company profits.

The mean revision to **Income from Employment** over the 10 year period was only just below the 5% significance level. The Wilcoxon signed-rank test made it just significant at 5%. However, the mean revision in the latter 5 years was very small and non-significant. There was an economic cycle effect over the first 5 year period when the mean revision to the annual growth rate was an increase of 0.88 (s.e. 0.22) percentage points.

The other components of factor incomes are **gross trading surpluses of public corporations and general government and non trading capital consumption** along with **stock appreciation** which is a negative item. These components have not been included in this study.

Components of Output

Output by industry is measured and published only as index numbers, at constant prices. The mean revision over the 10 years to the annual growth rates of the **aggregate output** of all industries was an increase of 0.63 percentage points. The t-value was highly significant and this was confirmed by the Wilcoxon test.

The t-value for the mean over the latter 5 year period was not significant. Serial correlation was just above the 5% significance level over the 10 year period and not significant for the latter 5 years. A Cochrane-Orcutt analysis reduced the 10 year t-value to a non-significant level.

There was no phase effect for the business cycles in any period.

The components of output which contributed most to the overall mean revision were **Agriculture, Forestry and Fishing, Manufacturing and Other Services (including Finance)**. Taking account of their weights these industries contributed 80% and 40% to the overall mean in the 10 year and the second 5 year period respectively. The t-values for these components were highly significant and so were the serial correlation coefficients. A Cochrane-Orcutt analysis reduced the t-values for all three components; the t-value for manufacturing still remained significant but became non-significant for the other two components.

A regression of all 10 years of data on the business cycle variable showed a non significant effect of the phase of the cycle for all the components of output. However, when the 10 year period is split into its two halves, the figures showed a significant phase effect for the output of **Distribution, Hotels and Catering** in both the first as well as in the second span of 5 years, but in the opposite direction to each other. However, the t-values for the mean revisions for distribution hotel and catering were non-significant for all periods. There was also a small phase effect in the first 5 year span for the output of other services.

The other components of output, **Construction and Transport** showed small mean revisions for all periods. The t-values in all cases were non-significant and there were no serial correlation found. There was no phase effect of the economic cycles in either case for any period.

Conclusion

This study has shown that the items which contributed most to the bias in the estimates of four quarter growth rate of GDP were consumers' expenditure and gross domestic fixed capital formation (GDFCF) among the expenditure components, other income (self employment income and rent) among the factor incomes and the output for manufacturing and other services (including finance) for the output measure.

The average revisions to consumers' expenditure and GDFCF were high and consistently positive during recent years both in current and constant prices. The average revision to the four quarter growth rate of consumers' expenditure in constant prices in the recent 5 years (1987-1991) was more than eight times as much as in the first 5 year span. Similarly the average revision to the four-quarter growth rate of GDFCF at constant prices was nearly five times as much in the recent 5 years compared to the first 5 year span of the 10 year period.

Of the components of factor incomes, other income (self employment income and rent) showed the highest average revision over the 10 year period. There were large revisions to gross company profits over the 10 year period and also in the two halves of 5 years. But there were equal numbers and of similar magnitude of both negative and positive revisions (21 negative and 19 positive) and therefore, the mean revision for company profit was small and its t-value insignificant.

The mean revision to the four-quarter growth rate of the output of manufacturing showed a slight decline in the magnitude of the bias in the recent years. The picture for the revisions to the growth rate of the output of other services also changed from a highly significant t-value for the mean over the 10 year period to a non-significant t-value and a small average revision in the most recent years.

When tested for the effect of the phase of the economic cycle, the study found no phase effect on the initial estimates of consumers' expenditure, but a strong phase effect for GDFCF over the 10 year period and in the first 5 year period in both current and constant prices. The second 5 year period contains two expansion phases - one before Q3 1984 and the second, a very strong one, from Q1 86 to Q3 1988. Spanned by these two expansion phases was a contraction phase which was too weak to have any significant influence on the estimates of any of the GDP items. It may not, therefore, be proper to draw any conclusion about the effect of the economic cycle on revisions for this period. The only two income components where phase effects were found over the 10 year period were income from employment and other income.

The average revision to the growth rate of the output of agriculture, food and fisheries over the 10 year period was also significant but only slightly. However, the contribution of its mean revision to the overall mean for the total output was negligible.

Apart from these components, all other items tested showed no indication of bias.

The analysis covered historical data up to 1988. The recent improvements made to the methodology of compiling the national accounts should reduce these biases. Further monitoring to verify this will be reported in due course in an update to this article. In addition an analysis which will update the results of the article published in May 1992 will be published in the May 1993 issue of *Economic Trends*.

I. TABLE: REVISIONS ANALYSIS: EXPENDITURE COMPONENTS AT CURRENT MARKET PRICES

Indicator	Revision reference	No. of yrs	No. of obs.	Mean rev.	Std dev.	SE of Mean	t-value	Wilcoxon Z	% of + rev	% of - rev	Coeff. of serial corr.	Range of revision values
Total GDP Expenditure	Three years after the first publication	10	40	1.07	1.85	0.29	3.61 **	3.37 **	75.0	25.0	0.64 **	5.00 to -2.86
Components												
Current Factor Cost	Three years after the first publication	5	20	1.29	1.60	0.36	3.51 **		90.0	10.0	0.53 **	4.76 to -2.86
Year on Year growth Annual growth %												
Consumer Expenditure	Three years after the first publication	10	40	0.84	1.12	0.18	4.64 **	3.89 **	70.0	30.0	0.50 **	3.47 to -0.83
Year on Year growth Annual growth %												
	Three years after the first publication	5	20	1.17	0.95	0.21	5.39 **		85.0	15.0	0.38	2.98 to -0.44
General Govmnt Final Consumption	Three years after the first publication	10	40	0.44	1.50	0.24	1.85	1.94	57.5	42.5	0.28	3.01 to -3.84
Year on Year growth Annual growth %												
	Three years after the first publication	5	20	0.53	1.34	0.30	1.74		60.0	40.0	0.29	3.01 to -1.85
Gross Domestic Fixed Capital Formation	Three years after the first publication	10	40	2.23	3.88	0.61	3.59 **	3.08 **	67.5	32.5	0.63 **	9.73 to -4.24
Year on Year growth Annual growth %												
	Three years after the first publication	5	20	3.14	3.86	0.86	3.55 **		75.0	25.0	0.48 *	9.73 to -4.24
Imports	Three years after the first publication	10	40	0.25	1.34	0.21	1.15	1.10	55.0	45.0	-0.10	3.95 to -3.42
Year on Year growth Annual growth %												
	Three years after the first publication	5	20	0.18	1.04	0.23	0.74		60.0	40.0	0.01	2.08 to -2.56
Exports	Three years after the first publication	10	40	0.10	1.00	0.16	0.63	0.17	47.5	52.5	0.25	3.13 to -1.54
Year on Year growth Annual growth %												
	Three years after the first publication	5	20	-0.26	0.83	0.19	-1.38		35.0	65.0	-0.10	1.51 to -1.54

NOTE: Ten year period runs from April '82 to Jan '92.
Five year period runs from April '87 to Jan '92.
These dates relate to the publication dates; e.g. revision published in Q4 1991 for GDP(E) would relate to Q3 1991.

Wilcoxon Z is the equivalent normal score of the Wilcoxon test.

* = significant at the 5% level; ** = significant at the 1% level.