

TESTING FOR BIAS IN INITIAL ESTIMATES OF KEY ECONOMIC INDICATORS

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This article continues a series of annual articles which examine revisions made to the key economic indicators published by the CSO. The key economic indicators selected for these annual articles are those designated for "revisions targets" and listed on pages 26 and 27 of the CSO agency framework document.

The first article in this series was published in the May 1992 issue of *Economic Trends*. That article reported the results of the analysis of potential bias, based on 10 years of data up to the end of 1991. This analysis was successively updated and published in May 1993 and in May 1994. The current article updates it again by shifting the 10-year data span to the end of 1994.

The frequency and magnitude of successive revisions are key elements in assessing the reliability of the published economic statistics. For some statistics these revisions have tended to be in the same direction. Sound economic policy requires that the initial estimates of economic indicators should not give a misleading idea of what has happened in the recent past. This means that the initial estimates should not be prone to revision bias. Reflecting this the CSO's agency framework document includes, in addition to targets for the maximum size of acceptable revisions, a requirement to carry out a thorough analysis of revisions and to test for any evidence of bias in the initial estimates of all the variables covered by revisions indicators and publish regularly the results of this analysis.

Revisions become necessary for at least three main reasons: 1) receipts of further more comprehensive data, 2) changes in estimating procedure, and 3) replacement of judgmental adjustments with more source data. The difference between the first and the "final" estimate also gives an indication of the magnitude of error in the first estimates. In order to reduce this error in the first estimates and following the recommendation in the Pickford report the CSO launched in 1989 an extensive programme of improvements to data sources and methodology. The results of these recent improvements would not be fully incorporated in this article because most of the data covered relate to first estimates made before 1989. This is particularly true for the longer term revisions to GDP where the first estimates covered relate to the period q4 1981 to q3 1991.

Methodology

As in the previous articles, we considered an indicator to be biased if in the long run its mean revision is different from zero. However, we have to allow for the fact that the average revision over some finite period may be non-zero simply through random effects. Therefore, we need to test whether an observed mean differs from zero by more than could be expected due to random effects; in statistical terminology, whether the mean revision is significantly different from zero.

We considered that the standard t-test would not be directly applicable to test the significance of mean revisions because the successive values in a revision series are frequently correlated. The t-test requires the conditions of normality and the independence of successive values. While the revision values generally seemed to follow a normal distribution, serial correlation coefficients frequently indicated that successive values were not independent. Therefore, for all series with a positive coefficient the t-values were calculated after allowing for the serial correlation. For series with negative coefficient of correlation, raw t-values were used to test the significance of the means. The formulas used are given in the technical notes.

The revisions series were also tested for the effects of economic cycles. The expansion and contraction phases of the economy have been defined respectively as the period from a trough to a peak and from a peak to a trough. These are identified from the coincident index of the cyclical indicators published in the monthly issues of *Economic Trends*. The individual revision values were then associated with either of the two phases according to the quarter or the month of the initial estimate, thus obtaining two separate revisions series for each variable. Separate means were calculated for the expansion and contraction phases and t-values, corrected for serial correlations, were obtained for each separate series to test for any evidence of bias due to the economic cycles.

The periods covered for the main analysis in this article are 10 years from 1985 to 1994, 5 years from 1990 to 1994 and 3 years from 1992 to 1994 inclusive. The dating here refers to publication of the revised data. For example with the long term revision to GDP, where the revision taken is three years after the first publication, the final value included relates to Q3 1991, the twelfth revision of which appeared in the quarterly GDP First Release (formerly called Press Notice) in December 1994.

It was, however, felt that to test the effects of the economic cycle properly, on the overestimation or the underestimation of the growth rates, a longer series of data was needed. Seventeen years of data were thus obtained for the PPI, IOP, visible trade and GDP at constant prices. Out of about 212 revision values for the monthly series, some 128 values were associated with the expansion and 84 with the contraction phases. For the quarterly series, there were 77 revision values covering the initial estimates from 1974 to 1991 with about 39 in the expansion and 33 in the contraction phase of the economy.

The tests for bias were carried out over the 10 year, 5 year and 3 year periods.

Technical Notes:

The Cochrane-Orcutt procedure allows for serial correlation when fitting a regression model

$$Y_t = \mu + \beta X_t + \varepsilon_t$$

where the errors $\{\varepsilon_t\}$ are thought to be serially correlated and follow an autoregressive model of order one (AR1) namely

$$\varepsilon_t = \alpha \varepsilon_{t-1} + u_t$$

where the $\{u_t\}$ are independent and the constant α is such that $|\alpha| < 1$ for stationarity.

However, in our problem there is no explanatory variable and, therefore, CO regression will not really apply.

There is another procedure where for an (AR1) process it can be shown (Priestley, 1981, p.320) that the variance of the sample mean is given (approximately) by

$\sigma^2(1 + \alpha)/n(1 - \alpha)$; σ^2 denotes variance of the usual process. When α is zero (no serial correlation) this formula reduces to the usual formula, namely σ^2/n . The equivalent number of independent observations will be $n(1 - \alpha) / (1 + \alpha)$.

The variance is estimated (Box and Jenkins, 1976, p.195) by

$$s^2 = s^2(1 + \alpha) / n(1 - \alpha)$$

where s^2 denotes the usual estimate of variance and α equals first order serial correlation of revisions.

A corrected t-statistic, therefore, would be calculated directly (without needing to use the CO procedure) by

$$t = \text{mean revision}/s_x$$

with $n^* = n(1 - \alpha^2) / (1 + \alpha^2)$ degrees of freedom which also gives the equivalent number of independent observations for estimating variance (Priestley, 1981, p.327).

Main Results

- After correcting for serial correlation two indicators - long term revisions to GDP at both constant and current prices showed any evidence of significant bias over the whole 10 year period. The revisions to PPI also showed evidence of bias over the 10 year period. However, for the latest 3 year period, three indicators - index of production, retail sales and current balance - showed significant t-values. This suggests bias in the initial estimates. At least in part, the bias could be due to improvements in the methodology for collecting the data.
- The absolute mean revisions were generally down for all three periods ending in December 1994 when compared to the same periods ending in December 1993. However these revisions were slightly higher for current balance and the index of production in the latest 5 and 3 year periods.
- The initial estimates of longer term GDP growth at both constant and current prices showed evidence of significant bias in the expansion phase of the economic cycles. PPI and IOP were the other two indicators where initial estimates showed evidence of bias in the expansion phase.

The detailed results are shown in table 1 and 2 and in the charts in the annex. Additional charts for GDP and PPI also show the association of revision values with the coincident index of the economic cycles. Owing to the introduction of a new statistical system (INTRASTAT), measuring trade with the European Single Market, monthly statistics on the overall balance were not produced in the first half of 1993. The revisions analysis for **visible trade**, therefore, excludes this period.

The results are discussed below in the sections relating to each indicator.

Index of production (IOP)

The index of production covers total manufacturing plus energy and water supply (SIC Divisions 1-4). The monthly index is published in table 7.1 of Monthly Digest. Revisions to the three months on three months growth rate are taken as the difference between the fourth and the first estimate. The figure published in the December 1994 issue, consequently, relates to the third revised estimate for July 1994.

The mean revisions in all three periods ending in December 1994 were higher compared to the same periods ending in 1993. Revisions in the last year were predominantly positive, as a result of improve-

ments in the methods for collecting the relevant output data. Consequently the t-value, for the last three year period became significant and indicative of bias. The t-values for the five and ten year periods remained non-significant.

Producer price index (PPI)

The revisions relate to the index numbers of producer prices for the output of manufactured products (SIC Division 2-4). The index is published in Table 18.6 of Monthly Digest. Revisions over two months of percentage annual growth is taken and the figures published in December 1994 refer to the revisions for growth in September 1994.

The mean revision for the 10 year period ending December 1994 was slightly higher than for the 10 year period ending in December 1993. The t-value was also significant. The average revision in the 5 and 3 years to December 1994 were slightly lower and the t-values for these two periods remained non-significant.

Retail sales

The index of retail sales volume is published in Table 14.1 of Monthly Digest. The revision analysis is based on three months on three months percentage growth as revised three months after the first publication. The reading for December 1994 refers to the revision between the first and fourth estimate of three month on three month percentage growth for August 1994.

The average revisions over the 10 and 5 year periods ending December 1994 remained the same when compared to the corresponding periods ending December 1993, but for the 3 year period it is slightly higher. The t-values for the 10 year period remained non-significant but became slightly significant for the 5 and the 3 year periods. This is due to a predominance of positive revisions in 1993 and, to a lesser extent, 1992. The main reasons were methodological improvements and some late receipts of data.

GDP (total output)

The revision taken for this analysis is the difference between 10 week estimates and 6 week estimates, published in CSO's First Release, for the quarterly changes in total output. The last figure for Q4 1994 relates to the 10 week estimate for Q3 1994 published in the quarterly First Release in December 1994.

The t-values for all three periods ending in December 1994 remained non-significant as before. However, while the mean revisions over the 10 year and 5 year periods have virtually remained the same, the average revision over 3 year period ending in December 1994 was nearly twice as much as it was for the same period ending in December 1993.

GDP (short term, constant prices)

Quarterly estimates are published in quarterly GDP First Release and in Economic Trends. Revisions for quarter on quarter growth in GDP is taken from the first estimate and the estimate six months later. Consequently the figure for Q4 1994 relates to the second revision to Q1 1994 published in the quarterly GDP First Release in December 1994.

The t-values for all three periods remained non-significant. However the mean revision for the 3 year period was slightly higher than in the same period before. The average revision over the 5 and 10 year periods remained virtually the same.

GDP (longer term, constant prices)

Revisions to the four quarter growth of GDP are taken from initial estimate and three years later. The last revision included in analysis relates therefore, to the twelfth revision to Q3 1994 published in the quarterly GDP First Release in December 1994.

The mean revisions over the recent 5 and 3 year periods continued to decline. These were 0.3 and 0.2 percentage points respectively for the two periods ending in December 1994. The t-value for the 3 year period was significant but it remained not significant for the other two periods ending in December 1994.

GDP (longer term, current prices)

Revisions are taken over twelve quarters for the four quarter percentage growth rate. The last figure relates to the 12th revision to Q3 1991 published in the quarterly GDP First Release in December 1994.

The new figures for mean revisions showed remarkable improvement in limiting the size of revisions to the annual growth rate of GDP. The mean revisions continued to decline for all three periods, particularly for the latest 3 year period where it was first reduced from 1.0 percentage points to 0.6 between the periods ending in December 1992 and 1993. The mean revision for the 3 year period ending in December 1994 was reduced to only 0.2 percentage points. However, the t-values for the 10 year period remained significant after allowing for serial correlation.

Current balance (short term)

The current balance is the difference between exports and import visible trade and invisible (services, transfers and investment income). The figures are published in the balance of payments First Release. For the bias, revisions over six months are taken for the current balance as a percentage of GDP at factor cost. The last reading for Q4 1994 relates to the second revision to Q1 1994 published in December 1994.

The average revisions for all three periods ending 1994 were lower than for the same periods ending in 1993. The t-values for all three periods remained not significant.

Current balance (longer term)

Longer term revisions to the current balance are taken as a percentage of GDP over three years. The last figure for Q4 1994 therefore, relates to the revisions to Q3 1991.

The average revision for all three periods increased from the previous levels. The t-values, while remaining not significant in the 10 year period, became significant for both the 5 and the 3 year periods.

Public sector borrowing requirement (PSBR)

Monthly estimates of PSBR are published in the CSO's First Release and Financial Statistics. Revisions over three months are taken for PSBR (not seasonally adjusted) as a percentage of 1/3rd of GDP market prices. The last figure published in December 1994, therefore, relates to the third revision to August 1994.

There has been no change to the average revision in the 10 year period but the average revisions for the 5 and the 3 year periods ending December 1994 were lower compared to the same periods ending in December 1993. The t-values for all three periods remained non-significant.

TABLE 1: REVISIONS ANALYSIS (1985 - 1994)

Key Targets No.	Indicator	Revision reference	No. of yrs	No. of obs.	Mean rev ignoring sign	Mean rev	Std dev.	Coeff. of serial corr.	SE of Mean	t-value ¹	% of + rev	% of - rev	Range of revision values	
2	Visible trade monthly balance as % of total trade	Three months after the first publication	10	113	0.43	-0.05	0.62	0.08	0.06	0.81	45	55	from -1.72 to 1.93	
		5	53	0.42	-0.05	0.64	0.03	0.09	0.59	43	57	-1.72 1.93		
		3	29	0.42	-0.06	0.66	0.31	0.17	0.38	45	55	-1.72 1.93		
3	Index of production 3-month on 3-month % growth	Three months after the first publication	10	120	0.25	0.04	0.34	0.38	0.05	0.78	48	52	-0.91 1.06	
		5	60	0.19	0.05	0.25	0.29	0.04	1.12	58	42	-0.62 0.92		
		3	36	0.17	0.13	0.16	0.41	0.04	3.02	**	75	25	-0.29 0.46	
4	Producer Price Index percentage annual growth rate	Two months after the first publication	10	120	0.07	0.03	0.09	0.37	0.01	2.28	*	72	28	-0.19 0.26
		5	60	0.07	0.03	0.10	0.40	0.02	0.41	68	32	-0.19 0.26		
		3	36	0.06	0.01	0.08	0.45	0.02	0.46	64	36	-0.19 0.18		
5	Retail sales 3-month on 3-month % growth	Three months after the first publication	10	120	0.15	0.03	0.20	0.24	0.02	1.44		67	33	-0.60 0.60
		5	60	0.12	0.05	0.15	0.19	0.02	2.01	*	63	37	-0.44 0.40	
		3	36	0.13	0.07	0.14	0.38	0.03	2.17	*	64	36	-0.16 0.39	
6(a)i	GDP (total output): quarter on quarter quarterly growth %	Ten weeks est. from six weeks estimates	10	40	0.17	0.06	0.22	0.03	0.04	1.76		65	35	-0.44 0.52
		5	20	0.11	0.02	0.15	-0.13	0.03	0.7	60	40	-0.43 0.26		
		3	12	0.07	0.05	0.08	-0.21	0.02	1.86		67	33	-0.10 0.20	
6(a)ii	GDP at constant prices quarter on quarter quarterly growth %	Six months after the first publication	10	40	0.29	0.08	0.38	-0.11	0.06	1.25		60	40	-1.13 1.17
		5	20	0.19	0.07	0.21	-0.07	0.05	1.39		65	35	-0.30 0.40	
		3	12	0.17	0.10	0.16	0.12	0.05	2.01		75	25	-0.20 0.40	
6b	GDP at constant prices year on year growth annual growth %	Three years after the first publication	10	40	0.62	0.46	0.64	0.27	0.13	3.48	**	80	20	-0.85 1.67
		5	20	0.52	0.30	0.65	0.20	0.18	1.66		75	25	-0.85 1.67	
		3	12	0.50	0.20	0.68	0.25	0.25	0.78		67	33	-0.85 1.64	
6c	GDP at current prices year on year growth annual growth %	Three years after the first publication	10	39	0.75	0.52	0.78	0.27	0.17	3.16	**	77	23	-1.20 2.00
		5	20	0.86	0.55	0.90	0.41	0.31	1.77		70	30	-1.15 2.00	
		3	12	0.60	0.20	0.76	0.01	0.22	0.89		50	50	-1.15 1.97	
7(a)	Current balance quarterly balance as % of GDP at factor cost	Six months after the first publication	10	40	0.37	0.01	0.50	0.17	0.09	0.12		53	47	-0.87 1.30
		5	20	0.49	0.13	0.62	-0.01	0.14	0.92		55	45	-0.87 1.30	
		3	12	0.45	0.02	0.56	0.13	0.19	0.09		42	48	-0.85 1.01	
7(b)	Current balance quarterly balance as % of GDP at factor cost	Three years after the first publication	10	40	0.46	-0.06	0.64	0.11	0.11	0.49		43	57	-1.85 1.76
		5	20	0.47	-0.38	0.53	-0.24	0.12	3.11	**	25	75	-1.85 0.32	
		3	12	0.48	-0.39	0.59	-0.32	0.17	2.2	*	25	75	-1.85 0.32	
8	PSBR monthly PSBR as 1/3rd of GDP at mkt prices	Three months after the first publication	10	120	0.20	-0.02	0.30	0.11	0.03	0.57		48	52	-1.02 1.37
		5	60	0.16	0.01	0.21	0.22	0.03	0.16		55	45	-0.60 0.50	
		3	36	0.14	0.02	0.18	0.29	0.04	0.46		48	42	-1.20 2.00	

Note: All periods end in Dec (for monthly data) or in Q4 (for quarterly figures) of 1994. Therefore 10 year period starts in Jan '85, 5 year in Jan '90 and 3 year in Jan '92. These dates relate to the publication dates; e.g. revision published in Q4 1994 for GDP would relate to Q3 1994.

- 1 = t-value and Std Error are corrected for the effects of correlation except for the cases where the coefficient of correlation is negative.
 * = significant at the 5% level
 ** = significant at the 1% level

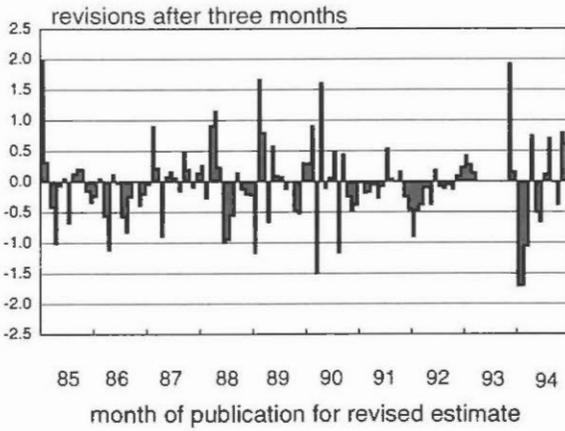
TABLE 2: TESTS OF THE EFFECTS OF ECONOMIC CYCLES ON THE FIRST ESTIMATES
(growth rates per cent)

Key Item targets no.	Item	Period Covered	Overall Mean	t-value	Expansion Phase		Contraction Phase	
					Mean	t-value	Mean	t-value
2	Visible Trade	1977 - 94	-0.05	0.78	-0.03	0.25	0.09	0.00
3	I O P	1977 - 94	0.07	2.13	0.11	2.68	0.00	0.00
4	P P I	1977 - 94	0.03	4.98	0.03	4.57	0.04	0.04
5	Retail Sales	1977 - 94	0.00	0.12	-0.01	-0.36	0.03	0.03
GDP (constant prices)								
6ai	short term 10 weeks	1982 - 94	0.07	2.16	0.10	1.90	0.02	0.02
6aii	short term 6 months	1977 - 94	0.10	2.24	0.08	1.37	0.14	0.14
GDP (longer term)								
6b	constant prices	1977 - 94	0.52	2.74	0.83	4.26	0.16	0.16
6c	current prices	1985 - 94	0.52	3.20	0.74	4.50	0.21	0.21
Current Balance								
7a	short term 6 months	1983 - 94	0.05	0.66	0.04	0.41	0.06	0.06
7b	longer term 3 years	1983 - 94	0.01	0.05	0.09	0.63	-0.11	-0.11
8	P S B R	1984 - 94	0.01	0.21	0.00	0.08	-0.03	-0.03

NOTE: t-values have been calculated allowing for positive serial correlation

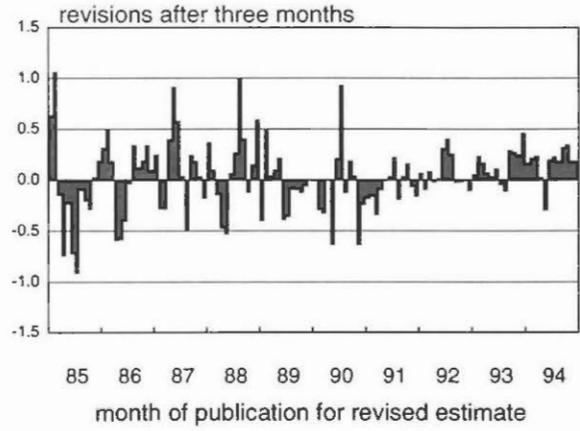
Visible trade balance

revision as percent of total trade



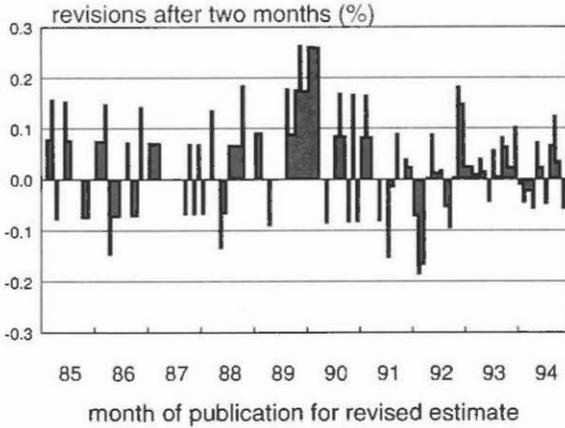
Index of production

three month on three month per cent change



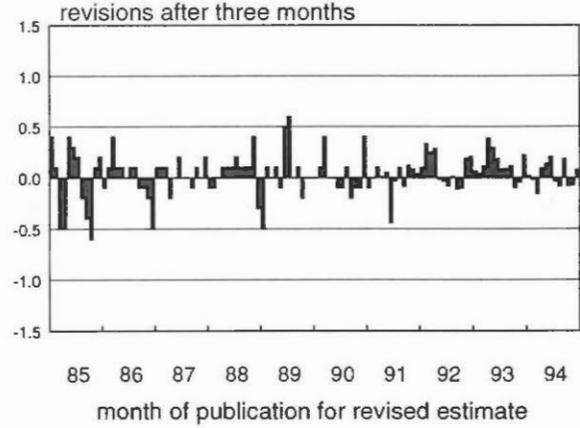
Producer price index

annual growth rates



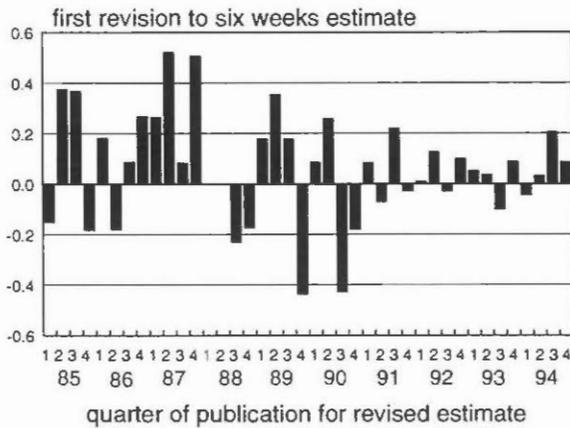
Retail sales

three month on three month per cent change



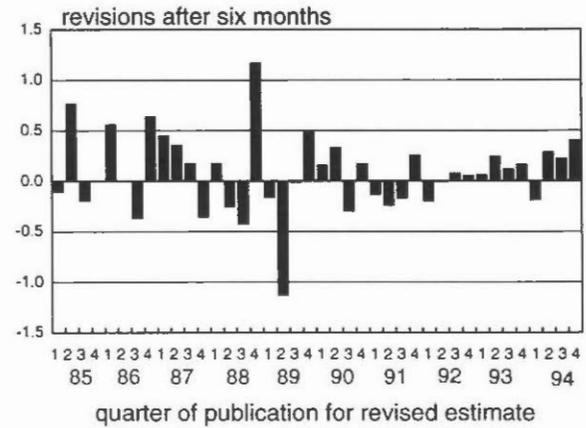
GDP (Total output)

quarter on quarter per cent change

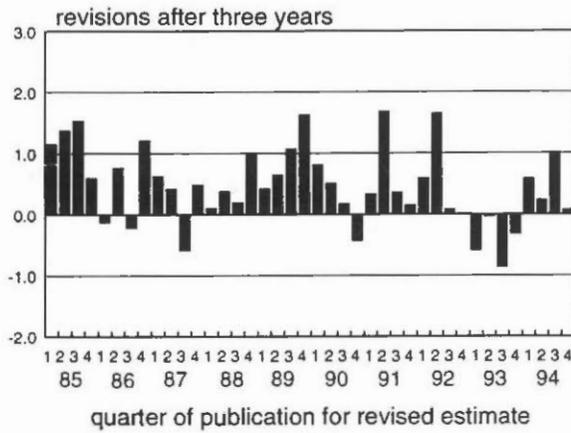


GDP at constant prices

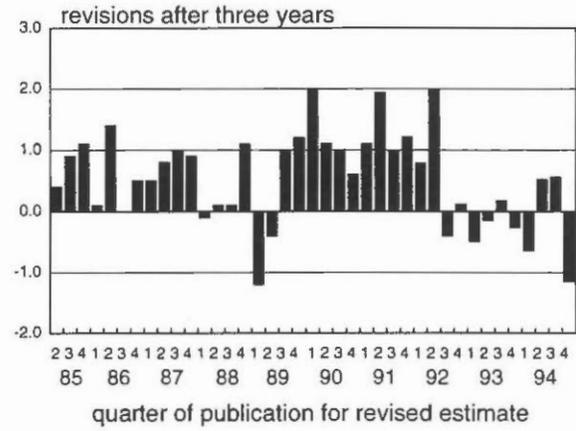
quarter on quarter per cent change



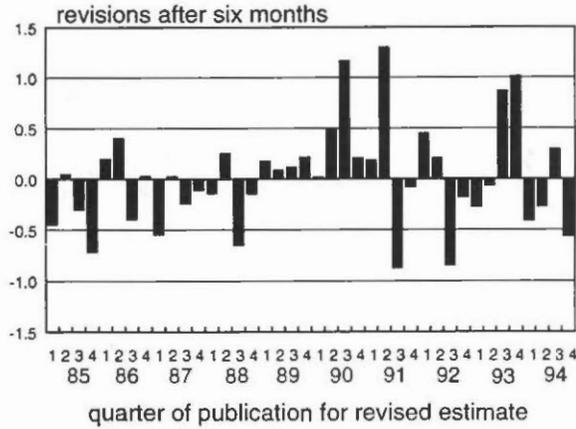
GDP at constant prices
four quarter per cent change



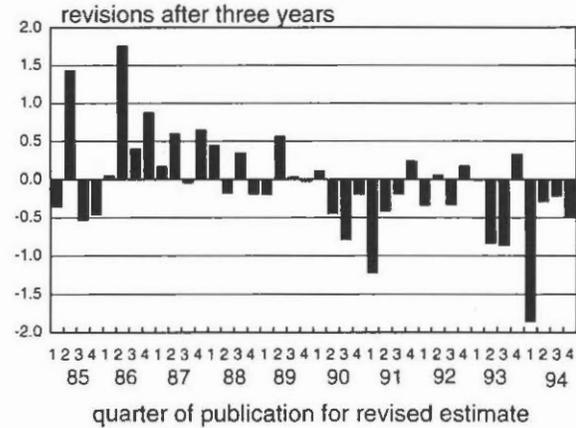
GDP at current prices
four quarter per cent change



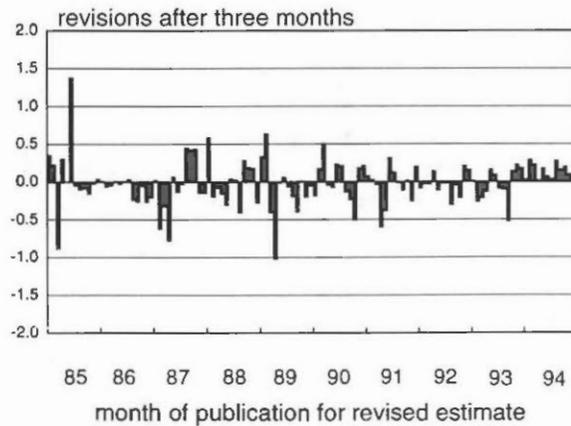
Current balance (short term)
as percent of GDP at factor cost



Current balance (long term)
as percent of GDP at factor cost



Public sector borrowing requirement
as percent of 1/3 GDP at market prices



Producer price index
(also showing the economic cycles)
annual growth rates

