A Statistical Analysis of Revisions to the Irish National Accounts

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Abstract. This paper examines the effects of data revisions on the major expenditure components in the Irish national accounts. The various tests used to establish their extent confirm that revisions affect levels more seriously than growth rates. A strong tendency is found in most series for preliminary estimates to understate the final (true) figures; and while most of the revision occurs in the first period, there is occasionally some over-correction in later periods. The immediate problems such revisions pose for the econometrician and policy maker are discussed.

THE object of this paper is to assess the effects of data revisions on the national accounts from the point of view of the policy maker and the econometrician. In particular, the author is concerned with the statistical aspects of the revisions rather than with the specific problems they pose for econometric model building.

Section 1 of the paper comprises a general introduction to the concept of "data revisions" in the context of national accounts. Section 2 discusses the choice of data and the problems faced in selecting them. Section 3 details the major questions to be posed and hypotheses to be tested, together with the main results of the analysis. Section 4 gives the conclusions of the study. Appendix I outlines the notation to be used in analysing all series.

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1. *Introduction*

Many economic policy decisions are formulated on the basis of estimates of the levels and rates of change of variables in the national accounts. The necessity of using the most recent data available for arriving at important policy decisions means that estimates which are essentially provisional have to be used. So the starting point of any exercise using national accounts data should be an awareness that preliminary estimates may be, and often are, subject to considerable revision. Such revisions are inevitable because the figures are derived from a sample rather than from the enumeration of a complete population. The author's concern in this study is neither with a negative criticism of the Central Statistics Office (CSO) nor with an attempt to explain the manner in which the statistics are collected,[1] but rather with an attempt to analyse statistically the extent of the revisions, and draw out the implications for research workers using the national accounts as a source of data.

Before desc·ibing the methods used to analyse the data, it is essential to define what is meant by "revisions to data" in the present context. Basically, there are two main reasons for revising any series of data: first, to account for changes in definition—"definitional revisions"; and secondly, to make corrections on the basis of new information which becomes available from other sources—"accuracy revisions".

Definitional Revisions

There is an ongoing attempt to improve the quality of economic statistics. In particular, attempts have been made, both to bring the published statistics more into line with the theoretical concepts they seek to measure,[2] and to improve the basis for international comparison by adjusting definitions.[3] For these reasons, changes in the definition of particular series are occasionally made. While such

1For discussion of this topic see, for example, Broderick (1969) and notes accompanying tables in the National Income and Expenditure (NIE).

2. A good example of this form of revision, and of the problems it poses, is provided by the inclusion from 1970 onwards of the foreign trade of Shannon with that of the Republic of Ireland. Previously, because of its special tax situation, the Shannon Airport Area had been treated as a foreign country from the point of view of the Irish foreign trade statistics. This change does mean, of course, that the post-1970 figures are considerably more accurate measures of the true levels of exports and imports for the country as a whole than the pre-1970 figures were. However, as a result of this change in definition and in particular, because, to date, the CSO have only revised the series back as far as 1958, the problem for the econometrician in search of a long continuous series of import and export data is considerable: the two options open to him are to drop the earlier observations or risk introducing bias into his data by estimating the figures prior to 1958.

3. An example of this type of definitional revision is the exclusion of "emigrants' remittances" and of "pensions from abroad" from the national income and national product aggregates in 1972. These flows are now being treated as "current transfers with the rest of the world". This change, which is detailed in Appendix 1 of the NIE (1972), made the Irish national accounts conform to the system adopted in the EEC. At present, this revision has only been backdated to 1965; therefore the new series is extremely short and the continuity of the old constant price series is broken because there is no implicit deflator for "current transfers with the rest of the world".

changes are obviously necessary and desirable, they can present difficulties to the user; for example, while series are usually revised backwards over a number of time periods, this is not done immediately, and in certain cases, the revised series do not go back sufficiently far for some analytical purposes, e.g. time series regression. However, the primary concern of this study is with accuracy rather than definitional revisions. Every attempt was made, therefore, to exclude all definitional revisions from the data.

Accuracy Revisions

Accuracy revisions are those made to data in the interest of improving the provisional estimates but which do *not* involve any changes in definitions or concepts. These occur, in the main, for three reasons:

(1) increased sample size (preliminary estimates may have to be made before the full sample is available);

(2) reconciliation of a series with data which become available from other sources (in particular the five-yearly Census);

(3) rectification of administrative errors incurred in data collection or preparation (loss or omission of data, etc.).

Accuracy revisions pose problems for both the policy maker and the econometrician. The policy maker who is attempting to analyse the present state of the economy, has to decide whether the data he is using are substantially different in their unrevised state from the revised (true) figures—and how this affects his view of trends in the economy. The type of problem with which he is faced can be seen in comparing the first growth rate[4] of published series with the latest (final) for example, the growth rate in GNP at constant prices for 1968 was revised, from 5·4 per cent to 8·4 per cent. While this particular revision is especially large, it is not unique; indeed comparing the first with the most recent rates for 1969 (which may be revised still further) we note already a revision from 3·8 per cent to 5·3 per cent and for 1970 from 1·5 per cent to 2·6 per cent. Obviously differences of this magnitude between preliminary and final growth rates, by affecting one's assessment of the current state of the economy, have serious implications for policy making.

For econometric model building the problems raised by using data which are not fully revised depend on the properties of the measurement errors and on whether they occur in the dependent or independent variables. In the first place, if the errors are not "well-behaved" (i.e. one or more of the usual assumptions of zero mean, homogeneity or serial independence are violated), then, for estimation to be possible at all, some adaptation must be made to any of the usual

4. In Ireland, it has always been the practice for policy makers to use the mixed preliminary rather than the pure preliminary growth rate. (See Appendix I.)

estimating methods, irrespective of whether they occur in the dependent or independent variables.

Secondly, if errors are well-behaved and occur in the dependent variable, they may be subsumed into the disturbance term in the equation and will not lead to any bias in the estimated coefficients. However, the disturbance term variance will be larger in those periods for which the dependent variable is unrevised, and the resulting heteroscedasticity will lead to inefficiency in parameters estimated by ordinary least squares (OLS). Finally, the consequences of well-behaved measurement errors in the independent variables are even more serious: OLS estimates will be both biased and inconsistent. A number of alternative estimating methods have been suggested for this case, most of which require specific assumptions about the variance and the distribution of the errors. (For a review, see Johnston, 1963 chapter 6.)

The question at issue, therefore, is whether the most recent (and hence unrevised) data should be omitted from the estimation to reduce the risk of introducing bias into the parameter estimates or whether, for the sake of degrees of freedom and in order to incorporate recent changes in trends, they should be included. Obviously one cannot say *a priori* that the problem of bias in particular data sets will be severe—this question is essentially an empirical one and the purpose of this study is to evaluate the extent of this problem in the major components of the Irish national accounts.[5]

This problem creates greater difficulties for short-term economic forecasting. To start with, it introduces a basic ambiguity into the whole concept. Is the forecaster trying to predict the "true" value of the variable of interest, the best estimate of which is, presumably, the final revised estimate? Or, is he trying to predict the first official estimate of this variable, even though this is liable to subsequent revision? Obviously the first alternative is preferable from the standpoint of monitoring the actual progress of the economy. But, on the other hand, to accept it absolutely means that the accuracy of an individual forecaster or forecasting method can only be fully evaluated when the final estimates become available—which may be some years after the original forecasts are made.

Analysis of Accuracy Revisions

In analysing the effects of data revisions the error series is defined as the difference in each case between the preliminary and the final estimate, i.e. the full extent of the revision to the level or growth rate (see definitions in Appendix I). In other words, it is assumed that the fully revised series is sufficiently true for the purposes

5. Burns (1973) illustrated this problem by showing that the use of "mixed" data (most up-to-date data available, i.e. incorporating both revised and unrevised data) can actually yield results which are inferior to those based on unrevised data for all periods (in the sense that the estimates of crucial parameters based on unrevised data may be closer to the estimates based on final data than the estimates derived from a "mixed" sample). Of course, Burns's findings, which are based on the estimation of a consumption function for Australia, cannot be immediately generalised to other data sets.

at hand. Given this error series, one would like to analyse it, establish its properties and attempt to determine its implications for economic analysis. Basically one would hope that the series would have the desirable properties of a variable with zero mean, without trend, cyclical fluctuations or autocorrelation and with a distribution which is approximately normal (or at least symmetric). There is also the question of whether revisions are made to growth rates rather than to levels, i.e. whether growth rates are the object of the statistician's revisions and levels merely adapted to incorporate such revisions.

In addition to providing quantitative information on the difficulties of using unrevised data, this analysis can also be used to indicate the reliability and accuracy of the Irish national accounts. It has been a practice in most countries to analyse the Statistical Discrepancy[6] series, in a manner quite similar to that described above, in attempting to evaluate the quality of national accounting—the major references can be found in Smyth (1964) and McDonald (1972). This Statistical Discrepancy, considered by most authors to be the best overall measure of the quality of national accounts data cannot, however, be so regarded for Ireland, because the "discrepancy" published only represents the difference obtained by using separate expenditure and output price deflators.[7]

2. *Choice of Data*

The choice of data was a particularly difficult problem—the rule of thumb was to confine the analysis to those data most frequently used in macro-economic model building. (For detailed reference to data sources see Appendix I.) However, another major restriction on the choice of data was the impossibility of examining meaningfully the output side of the national accounts at constant prices, as the preliminary observations are not published in *Review and Outlook* (R & O) and in the NIE these data were only introduced in 1966. Consequently in effect, the expenditure side of the accounts was the major source of data.

Using a prime to indicate a series at constant (1968) prices, the series analysed are as follows:

Gross national product (expenditure)	Y Y'
Personal expenditure on consumers' goods and services	C C'
Gross domestic fixed capital formation	I I'
Net expenditure by public authorities on current goods and services	G G'
Exports of goods and services	X
Imports of goods and services	M

6. This discrepancy is the difference between the estimates of Gross National Product from the income, expenditure and output sides of the national accounts, (which difference in a world of perfect statistics would of course be zero).

7. The difference which arises between the expenditure and output side of the Irish national accounts at current prices, is redistributed to constrain, for publication purposes, the two figures to be identical. At constant prices, the output and expenditure sides are not constrained to be equal (except in the case of the base year); the difference arises solely from the use of different price deflators.

Time Periods

The inclusion of R & O first estimates, which form the basis for many policy decisions, severely restricted the time period for analysis. While current price series from the NIE are available from 1947, and constant price series from 1956, both are only available from the R & O[8] from 1958. Data from the post 1968 period are still likely to be subject to revision and they have been excluded to avoid introducing bias into the later estimates (see Appendix I). Thus the time period for analysis is 1958 to 1968 (eleven observations).[9]

In the case of "Net expenditure by public authorities" at current and constant prices a further restriction on observations was introduced by a major change in definition in 1963, which made the calculation of preliminary figures prior to that year impossible. In addition, analysis of "Exports of goods and services" and "Imports of goods and services" at constant prices had to be completely omitted, because of the major change in definition in 1965—"Net factor income flows" were excluded from both—and, due to the absence of a substitute price deflator, it was impossible to obtain preliminary figures prior to that year.

3. *Analysis and Results*

In the course of the analysis in this section, we will attempt to answer the following five key questions:

(i) How large is the average revision made to a particular series (i.e. average error in a particular series) and what is its relative size? Is there a tendency for the preliminary figures to underestimate or overestimate the final (true) figures?

(ii) How do revisions affect growth rates? How does the average revision to the growth rate compare with the average growth rate i.e. how large is the average error in the growth rate? Is there a tendency for preliminary estimates of the growth rate to underestimate or overestimate the final (true) figures?

(iii) To what extent do revisions always bring preliminary and partially revised growth rates closer to the final (true) growth rates, i.e. are mixed growth rates closer to the true growth rate than pure growth rates?

(iv) How long is it before figures are fully revised, i.e. before all the error has been corrected? At what stage can one be sure that most of the revision has taken place?

8. While some earlier figures are available in the budgets for 1957 and 1958, they are not readily comparable: thus in order to maintain comparability in all series these earlier observations were omitted.

9. All constant price figures were converted, where necessary, to base 1968.

(v) What are the major statistical properties of the error series (variously defined) in the major national accounts aggregates?

Most of the statistics presented below to answer these questions are those typically used in studies of this kind, cf. Denton and Oksanen (1963) for a complete set of references; others were devised by the present author.

(i) *Errors in Levels*

The mean and standard deviation of the arithmetic and absolute errors were calculated. To estimate the extent of the revision to the level Students t test was used to test whether the means of the arithmetic error series were statistically different from zero; this statistical test is obviously inappropriate for either of the absolute series. A simple measure of whether or not preliminary estimates (X^P) of the different series tend to be conservative, was calculated by counting the number of times X^F (the final estimate) was greater than X^P and using the binomial distribution to test whether this number was significantly different from the expected number obtained from a random population. From the results of this analysis, detailed in Table 1, we note that the average percentage revision varied from 0·79 per cent (imports at current prices) to 5·11 per cent (investment at current prices). With the exception of expenditure by public authorities at constant prices, (G') the revisions on average occurred in an upward direction, ranging from 0·42 per cent (imports at current prices) to 4·93 per cent (investment at current prices). In both income series, both investment series and the export series, the average revision was statistically greater than zero. Only in the two income series and in the current price investment series was the actual number of upward revisions statistically greater than the number which would be expected from a random population.

(ii) *Errors in Growth Rates*

Both pure preliminary (x^P) and mixed preliminary ($x^{P,R1}$) growth rate series[10] were calculated for to see whether the general use of mixed rather than pure growth rates for policy purposes has empirical support. (The mean and standard deviation of the final (true) growth rate are presented in Table 2 to give some perspective to the relative size of the revision.) Again, the significance of the means of both arithmetic series was tested and the number of times x^F exceeds x^P and $x^{P,R1}$ respectively was calculated as a measure of the tendency of the preliminary estimates to over- or under-estimate.

Revisions do not affect growth rates to the same degree as levels, although their effects on pure preliminary growth rates are in general greater than those on mixed preliminary series. The average revision to the former (Table 2, column 4)

10. For definitions, see Appendix I.

TABLE 1: *Difference between preliminary* (X^P) *and final levels* (X^F) *mean and standard deviation*†

Series	X^P-X^F £ million	$\lvert X^P-X^F \rvert$ £ million	$\frac{X^P-X^F}{X^F} \times 100$	$\frac{\lvert X^P-X^F \rvert}{X^F} \times 100$	*Number of Positive Revisions* X^P *to* X^F
Y	−20·664*** (18·215)	20·664 (18·215)	−2·249*** (1·502)	2·249 (1·502)	11***
Y′	−17·118** (20·191)	17·336 (19·985)	−1·539** (1·678)	1·564 (1·653)	10***
C	−8·573 (18·011)	11·336 (16·245)	−1·095 (2·105)	1·561 (1·752)	7
C′	−4·718 (17·071)	10·809 (13·689)	−0·555 (2·042)	1·349 (1·582)	4
I	−6·618*** (5·450)	6·782 (5·224)	−4·927*** (4·697)	5·106 (4·481)	10***
I′	−5·955** (8·109)	8·391 (5·226)	−3·729** (5·260)	5·090 (3·804)	8
G	−0·867 (2·717)	2·167 (1·628)	−0·852 (2·251)	1·814 (1·411)	5
G′	2·217 (5·227)	4·650 (2·697)	1·629 (3·592)	3·190 (1·968)	3
X	−1·682* (2·621)	2·573 (1·643)	−0·614** (0·803)	0·878 (0·460)	8
M	−1·891 (5·175)	3·036 (4·535)	−0·420 (1·096)	0·789 (0·842)	7

*10 per cent significance. **5 per cent significance. ***1 per cent significance.
†Standard deviation in brackets.

varied from 6·5 percentage points down to 0·96 percentage points. The average revision to the latter (Table 2, column 6) varied from 2·05 percentage points down to 0·67 percentage points. In most series, the majority of revisions to both growth rates occurred in an upward direction—although only to the mixed preliminary estimates in the two income series was the average revision statistically greater than zero.

TABLE 2: *Difference between preliminary and final growth rates: mean and standard deviation?*

Series	x^F	$x^P - X^F$	$\|x^P - x^F\|$	$x^{P,RI} - x^F$	$\|x^{P,RI} - x^F\|$	Number of Positive Revisions	
						x^P to x^F	$x^{P,RI}$ to x^F
Y	8·300 (2·883)	−0·526 (1·590)	1·330 (0·932)	−1·071*** (0·937)	1·090 (0·911)	5	10***
Y′	4·351 (1·881)	−0·544 (1·974)	1·500 (1·246)	−0·831** (0·910)	0·885 (0·851)	6	8*
C	7·096 (3·419)	−0·653 (2·366)	1·862 (1·490)	−0·841 (1·603)	1·395 (1·092)	6	7
C′	3·667 (2·234)	−0·591 (2·562)	1·899 (1·716)	−0·678 (1·353)	1·228 (0·815)	6	7
I	12·621 (6·641)	1·452 (6·926)	5·541 (4·025)	−0·680 (2·369)	1·927 (1·415)	4	7
I′	9·259 (5·826)	1·487 (7·712)	6·513 (3·847)	−0·530 (2·667)	2·051 (1·658)	3	6
G	10·671 (5·936)	0·780 (3·016)	2·036 (2·163)	−1·210 (1·944)	1·958 (0·906)	1	4
G′	3·463 (1·827)	−1·100 (2·902)	2·031 (3·186)	−0·696 (1·898)	1·631 (0·942)	3	3
X	10·207 (5·764)	0·032 (1·354)	0·957 (0·905)	0·080 (0·834)	0·670 (0·452)	4	3
M	10·108 (7·267)	−0·249 (1·704)	0·995 (1·369)	−0·019 (1·100)	0·715 (0·801)	5	4

*For definitions see Appendix I.

(iii) *Correlation between Growth Rates*

The Theil inequality coefficient (for details, see Theil 1966) was used to test for correlation between different series of growth rate estimates. This statistic is preferred to a simple correlation coefficient because it measures conformity to the linear relationship implying perfect agreement between the two series rather than just to any linear relation.[11] It should clarify the degree to which revisions bring growth rates closer to the final (true) growth rate, i.e. it should determine whether, using Irish data, growth rates should be estimated from data revised to a similar degree or whether it is better to use growth rates estimated from mixed data, which incorporate more up-to-date information.

TABLE 3: *Correlation between preliminary, partially revised and final series*

Series	x^{P} *and* x^{F}	$x^{P,R1}$ *and* x^{F}	$x^{R1,R2}$ *and* x^{F}	$x^{R2,R3}$ *and* x^{F}
Y	0·181	0·158	0·141	0·083
Y'	0·413	0·252	0·194	0·100
C	0·298	0·221	0·176	0·089
C'	0·589	0·333	0·266	0·181
I	0·477	0·164	0·137	0·100
I'	0·690	0·238	0·189	0·134
G	0·234	0·176	0·114	0·031
G'	0·735	0·637	0·528	0·776
X	0·109	0·063	0·044	0·031
M	0·130	0·083	0·054	0·000

The Theil inequality coefficient confirms that each revision to the preliminary growth rate in every series, with the exception of expenditure by public authorities at constant prices (G'), brings the growth rate closer to the final (true) rate, i.e. the coefficient converges towards zero (perfect conformity). The implication of this for using Irish data is that it is better to use mixed growth rates which incorporate most recent information than to use pure growth rates—the Irish policy maker is vindicated!

11. The simple (Pearsonian) correlation coefficient is defined as

$$r = \frac{\Sigma(x^{P}-\bar{x}^{P})(x^{F}-\bar{x}^{F})}{\sqrt{\{\Sigma(x^{P}-\bar{x}^{P})^2\}\{\Sigma(x^{F}-\bar{x}^{F})^2\}}}$$

This statistic measures the degree of association between x^{P} and x^{F}, etc., with no restriction placed on the form of association in question, i.e. the higher r is, the greater the degree of association, The Theil inequality coefficient, defined as:

$$U = \sqrt{\frac{\Sigma(x^{P}-x^{F})^2}{\Sigma(x^{F})^2}}$$

measures the deviation from *absolute* conformity, i.e. perfect agreement between x^{P} and x^{F}, etc., which is represented graphically as a 45° line through the origin. Thus if the preliminary figures were identical U would equal zero, i.e. the lower is U, the greater is conformity between x^{P} and x^{F}, etc.

(iv) *Stage by Stage Correction*

For the purpose of this study it was necessary to make some assumption about the time span over which revisions are made—in particular, it was assumed that (for the 1968 figures) the fifth CSO estimate was final (see Appendix I). It is interesting to compare for different series how much of the "correction" occurs in the first, second and third revision; one would expect substantial variation between series because of differences in the methods of collecting the data. We make this comparison by calculating the *average* absolute revision at the first, second and third stage of revision as a percentage of the average absolute (total) revision.

$$\frac{|X^P - X^{R1}|}{|X^P - X^F|} \times 100; \quad \frac{|X^P - X^{R2}|}{|X^P - X^F|} \times 100; \quad \frac{|X^P - X^{R3}|}{|X^P - X^F|} \times 100$$

TABLE 4: *Proportion of the average absolute final error accounted for at different stages of revision*

Series	*First revision*	*Second revision*	*Third revision*
Y	39·2%	66·3%	83·8%
Y′	75·3%	104·1%	100·2%
C	56·9%	104·7%	112·1%
C′	106·9%	140·3%	89·5%
I	60·3%	83·5%	80·8%
I′	73·7%	98·8%	92·7%
G	161·5%	133·8%	123·1%
G′	105·0%	107·5%	167·0%
X	35·3%	102·8%	79·9%
M	63·8%	81·2%	88·6%

While revisions always bring preliminary growth rates closer to the final (true) growth rate, as evidenced by the Theil inequality coefficients in Table 3, the effects of revisions on levels are somewhat different. The adjustment process of preliminary through to final levels is not monotonic[12]—the average intermediate revision to the preliminary estimate is often considerably greater than the average total revision, indicating the tendency for intermediate revisions to over-correct. The statistics in Table 4 seem to imply that in Irish national accounting, levels are manipulated to take account of revisions to the growth rates. In the cases where it can be measured meaningfully, much of the error in the preliminary levels has been accounted for after the first revision (CSO first estimate) and virtually all the correction has taken place after the third revision.

12. Stekler (1967) found similar results for US quarterly national accounts.

(v) *Tests for Randomness*

Because of the shortage of observations, eleven in the case of levels, ten in the case of growth rates,[13] it is not possible to test formally for the presence of normality in the error series. Instead non-parametric methods were used to test each of the major error series for trend, cyclical fluctuations and autocorrelation. These tests were carried out independently, although a fuller analysis would require the specification of how the different properties are inter-related.

(*a*) *Trend*

The Mann-Kendall[14] test for trend was applied—it involves ranking the observations by increasing size and testing the hypothesis that the ranking is random. The Kendall rank correlation coefficient r is calculated: lying between $+1$ and -1, its positive and negative values indicate positive and negative trend respectively.

TABLE 5: *Mann-Kendall test for trend*

Series	$X^P - X^F$	$\frac{X^P - X^F}{X^F} \times 100$	$x^P - x^F$	$x^{PR,1} - x^F$
Y	−0·127	+0·055	−0·111	+0·066
Y'	−0·127	−0·127	−0·111	−0·155
C	−0·273	−0·273	−0·333*	−0·377*
C'	−0·091	−0·091	+0·022	−0·600***
I	−0·018	+0·200	−0·067	+0·022
I'	+0·091	+0·164	−0·156	−0·011
G	+0·733*	+0·733*	−0·400	+0·200
G'	−0·300**	−0·300**	−0·200	−0·800***
X	−0·273	+0·055	−0·333*	−0·333*
M	−0·164	−0·255	−0·244	−0·467**

The Mann-Kendall, test indicates some trend in six out of the ten series analysed. The two expenditures by public authorities series (G, G') suffered most severely from trend—in the case of the current price series, positive trend and in the constant price series, negative trend. Overall there is greater evidence of negative rather than positive trend, indicating that there is little tendency for the error (variously defined) to grow over time.

13. In the two *expenditure by public authorities* series, G and G', there are only six and five observations respectively (see below).

14. See Kendall (1948). Details of the simple application of the test can be found in Tintner (1952), pp. 211–215, and Siegel (1956), pp. 213–223.

(*b*) *Cyclical Fluctuations*

Cyclical patterns in measurement errors, though usually associated with quarterly rather than annual data, may also be found in the latter. For example, there may be a systematic tendency to over- or underestimate different stages in the business cycle. To test for cyclical fluctuations, the Wallis-Moore[15] X_p^2 test was used. It tests for the randomness of a series with respect to a phase duration by comparing the *observed* number of runs of length one, two and greater than two in the signs of the first differences of the error series, with the *expected* number on the assumption of randomness in the series.

TABLE 6: *Wallis-Moore test for cyclical fluctuations*

Series	X^P-X^F	$\frac{X^P-X^F}{X^F}\times 100$	x^P-x^F	$x^{P,R1}-x^F$
Y	5·610*	5·610*	3·970	0·616
Y'	0·579	0·579	2·904	1·815
C	1·317	1·317	2·974	7·131**
C'	2·500	2·500	7·132**	2·973
I	5·433*	5·433*	4·398	0·329
I'	2·689	2·689	4·398	3·970
G	0·467	0·467	1·835	0·233
G'	1·192	1·192	0·233	0·233
X	1·317	1·317	1·851	1·851
M	2·310	2·310	0·614	0·614

There is little evidence of cyclical fluctuations in the data. Both the current price income (Y) and the investment (I) series have cyclical fluctuations, at the 10 per cent level in the two level series while in the two consumption series (C, C') cyclical fluctuations are detected in the ($x^{P,R1}-x^F$) and (x^P-x^F) series respectively.

(*c*) *Autocorrelation*

The von Neumann[16] ratio was used to test for autocorrelation in the error series. To test for positive autocorrelation, the calculated value obtained for the von Neumann ratio (ratio of the mean square successive differences to the variance) is compared with the tabulated critical values. Von Neumann's table for small samples was used (see Johnston 1972, Table A-6, page 432).

15. See Wallis and Moore (1941). Tintner (1952), pp. 234–8 and Siegel (1956), pp. 52–53 provide summary descriptions of the test.

16. See von Neumann (1941). Description of test is found in Johnston (1972), pp. 250–251. This test was used in preference to the Durbin Watson because the problem of interdependence in the series, which occurs in a regression context, does not arise here.

TABLE 7: *Von Neumann test for autocorrelation*

Series	$X^P - X^F$	$\frac{X^P - X^F}{X^F} \times 100$	$x^P - x^F$	$x^{P,R1} - x^F$
Y	0·877***	0·980**	0·705***	0·933***
Y'	1·139**	1·263*	1·840	0·899***
C	0·896***	1·104**	2·050	2·099
C'	1·297*	1·480	2·915	1·611
I	1·720	1·516	1·580	1·577
I'	1·868	1·716	1·587	1·506
G	1·935	1·603	3·620	2·871
G'	0·780***	0·776***	2·269	1·604
X	2·607	1·998	2·524	2·403
M	1·649	1·615	1·684	1·662

There is considerable evidence of significant autocorrelation in the two income series—particularly in the current price series (Y). Both the current price consumption series (C) and the constant price expenditure by public authorities series (G') have marked autocorrelation in the two levels series though no significant autocorrelation at all in either growth rate series.

In the case of all four series for which analysis could be undertaken at both current and constant prices, with the exception of expenditure by public authorities, the error in the current prices series is more serious than in the constant price series. This result is broadly similar to that obtained by Durkan and Kelleher (1974), where the method of analysis used was OLS regression.

4. *Conclusions*

The results of the analysis outlined in Section 3 have the following implications for the policy maker and the econometrician.

(*a*) *Implications for Policy Decisions*

From the results of the analysis summarised in Section 3, the problems of using Department of Finance first estimates for formulating policies seem at first sight considerable. Fortunately, however, policy decisions are usually based on growth rate rather than level estimates, because the problem of downward bias in the preliminary estimates of the former is considerably less serious. Nonetheless, the tendency for early estimates to be persistently conservative should be taken account of in analysis because, otherwise, comparisons with previous years may be highly misleading. In the case of (Y, Y'), the only series in which the error in the mixed preliminary growth rate is significantly greater than zero, it is possible to adjust the initial estimate and allow for probable revisions (e.g. the growth in income at constant prices (Y') for 1973 of 7·9 per cent (old definition) is likely to be revised upwards by 0·83 percentage points); in the case of the remaining series it is possible, using the absolute value averages, to place confidence intervals around preliminary estimates (e.g. confidence intervals of 1·4 percentage points could be placed around the estimate of the growth rate in consumption at current prices (*C*) for 1973 of 18·4 per cent). The author is aware that some allowance for possible revisions is probably made consciously or sub-consciously by policy makers; use of the results outlined in Section 3 will hopefully be of assistance to those interested in quantifying the extent of the likely revision.

(*b*) *Implications for Econometric Work*

The problem of errors in independent variables was referred to in Section 2. Maximum likelihood methods can be used to obtain consistent estimates, if the error series are approximately normal. As much economic theory is formulated in terms of levels rather than growth rates, we will be concerned in particular with the distribution of $(X^P - X^F)$.

The errors in both income series (Y, Y'), and particularly in the current prices series, have significant non-zero means and evidence of non-random distribution. This is quite serious, in so far as GNP is used extensively as an independent variable in macro models and it is to be expected that other income variables will have similar problems. Both investment series (I, I') suffer from the same problems but to a lesser extent, e.g., they have significant non-zero means.

The extent of the errors in the consumption series (C, C') is small—there is slight evidence of autocorrelation. Consumption, however, is less likely to create serious problems in econometric work in the macro-economic area as it is more often used as a regressand rather than a regressor.

The problems in using the remaining series are small: there is evidence of some trend and autocorrelation in the expenditure by public authorities series (G, G') while the revisions to export and import series are slight—in most cases, the preliminary figures are revised only twice.

The main conclusion for the users of these aggregates in econometric work is that there is a problem of non-randomness in the error component of most series, which is particularly serious in the two income series because the errors, continually in the same direction, are compounded in these aggregates. It appears to this author that some consideration might be given to the possibility of omitting the last and perhaps second last observations, where the objective of the model permits it. This might well be possible in a structural model, where the intention is simulation rather than forecasting. For forecasters the problem remains enormous: given that the preliminary growth rates for some major aggregates, and (Y, Y') in particular, are understated by the R & O preliminary estimates, the forecaster can only be correct initially or correct eventually (that is, if he is correct at all!). Table 3 in Section 3 indicates that the R & O first estimates are often considerably off the mark, while the CSO first estimates are much closer to the final figures, i.e. a large amount of the total error in the level series is accounted for by the first revision. Thus, whether sophisticated or naïve methods are being used for forecasting, strong consideration might be given to either dropping recent observations of aggregates which are seriously underestimated or using the results of the above analysis to adjust preliminary estimates to account for likely revisions. In the author's opinion, many of the results obtained in this analysis could be used effectively to adjust recent estimates, and this might go some way towards avoiding the serious type of underestimation in forecasting found also by Durkan and Kelleher (1974) to be prevalent in Irish forecasts to date.

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APPENDIX I

The following notation has been used throughout the text. For any national accounts series X in either value or volume terms—

X^P = Preliminary estimates for a series X, i.e. the first estimate of a series as published in the *Review and Outlook* (R & O) by the Department of Finance.

X^{R1} = First preliminary figure issued in the National Income and Expenditure (NIE) by the CSO. It is in effect the first revision of the Preliminary figure published by the Department of Finance.

X^{R2} = Estimates of a series X revised twice, i.e. a series X^{R2} is a series of estimates which have gone through two stages of revision, e.g. estimate of personal expenditure on consumers' goods and services (C) in 1971 taken from NIE 1972, i.e. preliminary would have been published in R & O 1971–72 and first revision in NIE 1971.

X^{R3} = Estimates of a series X after a third revision (see X^{R2}), e.g. estimate of C in 1970 taken from NIE 1972.

X^F = Final estimates for series X. Theoretically this series should comprise a fully revised set of estimates, which are thereby assumed to be "the most correct"—i.e. any error which can feasibly be removed, has been. For more recent years it was necessary to decide on whether a figure was finally revised or not, as one does not know whether such a figure may yet be revised in the NIE 1973.* From inspection of the data it was decided that the analysis need not go beyond 1968—i.e. the assumption was made that only figures for 1969, 1970, 1971, 1972 may yet be subject to revision. However, this is not a definite statement but rather a testable hypothesis (see below). In addition it should be noted that different series are revised to a different degree, e.g. imports (M) and exports (X) are rarely revised more than once while net expenditure by public authorities (G) for a particular year is revised at least four, and often more than four times.

x^{P} = Preliminary growth rate. This is the growth rate obtained from using preliminary estimates of levels only.

$x^{P,R1}$
$x^{R1,R2}$ = Mixed growth rates.
$x^{R2,R3}$

These are growth rates obtained using data at different stages of revision, e.g. x^{PR1} for 1966–67 is the growth rate obtained using the preliminary figure for 1967 (R & O 1967–68) and the first revised figure for 1966 (NIE 1966). The reader will notice that this is how one usually calculates growth rates; i.e. by taking all figures from the most recent R & O and NIE.

x^{F} = Final growth rate. This is the growth rate obtained from using final figures only to obtain the growth rate.

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*The most recent NIE available is that for 1972 which was published in December 1973.

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