What Was the UK GDP Then? A Data Study

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I. Introduction

A. Objective of Study

The objective of this study is to describe the generation of the six series listed in **What Was the UK GDP Then?** The two basic series are GDP at current prices and GDP at constant prices. Each series is presented not only in level but also in per-capita form. Also shown are the GDP deflator, construed essentially as the current-price/constant-price GDP ratio, and population, used to transform GDP from level to per-capita form. As is customary in **How Much Is That?** the unit of observation is the calendar year.

The study is noteworthy in several respects. First, the series are provided for a time period of maximum continuous length, ending with the year 2000: they are true long-run series. Second, even though the territory-covered changes over time, each series is made consistent conceptually, and the same applies to the series in relation to each other. Third, the series are extended back in time to incorporate estimates for selected years that are again consistent conceptually with the continuous segment of the series, and the extended series are consistent with each other. Fourth, all existing estimates of GDP (or related measures) are discussed, the better to facilitate selection of components of the desired series. Fifth, the various approaches to estimating GDP and the techniques of dealing with statistical discrepancies are reviewed, to help in the selection process. Sixth, sufficient information is provided so that the interested scholar can alter the series to fit analyses and judgments that are different from those made and applied by the present author.

B. Product Concept

<u>Total versus partial:</u> The product concept is macroeconomic rather than microeconomic, and encompasses all activity rather than some subset (such as individual sectors) of this activity.

<u>Gross versus net:</u> Product is "total" in yet another sense:" gross rather than net of depreciation (capital consumption). The concept of gross rather than net product was developed by the British economist Colin Clark (1937a, pp. 61, 84-90; 1937b, p. 310), who at the same time generated the first empirical estimates of explicit gross product.[1]

<u>Domestic versus national:</u> *Domestic* product is a *territorial* concept, economic activity occurring within the geographic area of the home country (in the present study, the United Kingdom or, as one goes back in time, its predecessor entities).[2] *National* product is a *residential* concept, economic activity performed by factors of production owned by residents of the home country (in this case, the UK).

The relationship between the two concepts is generally considered to be: GDP *equals* GNP *minus* "net factor income from abroad," where "net factor income from abroad" *equals* income receivable by domestic factors from the rest of the world *minus* income payable to nonresident factors by domestic residents.[3] In the UK national accounts, GNP as defined above is now termed "gross national income" (GNI). Also, net factor income from abroad is divided into net property income from abroad *plus* net entrepreneurial income from abroad *plus* net employment income from abroad.

Market prices versus factor cost: The pertinent concept for this study (following UK ongoing national accounts) is GDP at market prices, which *equals* GDP at factor cost *plus* net production taxes (taxes minus subsidies on production). The UK national accounts also distinguish GDP at basic prices, which *equals* GDP at factor cost *plus* net taxes on production other than taxes on products.[4]

The term "national income" is sometimes used generically, to encompass any total-product measure. In the narrow sense, the term denotes "net national product at factor cost."

Current prices versus constant prices: Considered over time, GDP at current prices—also called nominal or money GDP—incorporates both changes in volume and changes in prices. GDP at constant prices of a base year corrects for changes in prices relative to the base year. If the deflator has value unity for the base year, then GDP at current prices is the product of the deflator and GDP at constant prices. It is customary, however, to let the deflator have value 100 for the base year, whence the deflator is defined as 100 *times* the ratio of current-price to constant-price GDP.

Table 1, columns 1-2, show the preference of GDP over GNP and market prices over factor cost adopted in this study (consistent with UK official statistics). In contrast to the selection of the total over partial, gross over net, domestic over national, and market-price over factor-cost (or basic-price) concepts, GDP will be generated here (again as in the official national accounts) *both* at current prices and at constant prices.

Table 1
Dimensions of National-Accounts Preferred Aggregate: Ordering

		Statistical Discrepancies	
Aggregate	Concept	Value	Elimination Technique
1. GDP	1. market prices	zero	1. balanced estimate
2. GNP	2. factor cost[a]	zero	2. compromise estimate
		zero	3. manipulation[b]
		zero	4. residual[c]
		nonzero	5. none
		not applicable	6. single approach

[a]Or basic prices.
[b]Of "least-reliable" components.
[c]One component estimated as residual.

II. Methodology of Estimating GDP

A. Approaches

There are three basic approaches to estimating GDP. The *expenditure approach* sums expenditure on domestically produced final goods and services by households, firms, government, and nonresidents; the *income approach* sums factor incomes (incomes earned in the domestic production of goods and services); the *output approach* sums the value added by domestic producing sectors.[5]

B. Statistical Discrepancies

1. Issue

If more than one approach is used to generate GDP and if the approaches are employed independently, then the resulting estimates of GDP are invariably unequal—in spite of the fact that all approaches are measuring the same entity. As stated both officially and by private scholars:

> For each of the three measures of GDP, based on expenditure, income and output, there are data limitations and measurement difficulties so that, in practice, the estimates never coincide exactly, despite their conceptual equivalence. The data used to measure transactions throughout the accounts are drawn from many administrative and statistical sources, giving rise to errors and omissions, timing differences and sampling errors.—*Blue Book* 1991, p. 9

> Gross domestic product has conventionally been measured using information on expenditure, income, and output. Since the aim of historians has been to use independent information from different sources, measurement errors will inevitably creep in at the various stages of calculation, resulting in significant discrepancies between the three estimates of GDP.—Solomou and Weale (1996, p. 101)

From an empirical standpoint, multiple estimates of GDP are viewed as a boon rather than a problem. As other researchers comment:

> For an entity that is intrinsically and practically so difficult to measure, it is obviously a gain to have more than one approach to the problem of measurement; and it is right that the material should be given from which the results of the three different methods can be calculated. It is better to reveal the extent of the divergencies than to impart a false sense of security by giving a single figure only. The Central Statistical Office has methods which are laid down and ascertainable by which the separate income, expenditure and output estimates are obtained; if it were to conceal the discrepancies by applying arbitrary adjustments in order to

> produce a consistent set of estimates, this might put the integrity of the system under suspicion.—Godley and Gillion (1964a, p. 61)

However, both the official national accountants and many private researchers have taken the view that a single, definitive, "best" estimate of GDP is preferred—although this statement is largely based on revealed preference.[6] There are two rationales for this position. First, data from all three approaches—consequently, all the available data—can be utilized to produce the definitive estimate. Second, the three methodologies can all be employed in the process. As no one approach is conceptually superior to the others, it is only reasonable to encompass all three approaches within a giant framework.

Given that a "best" estimate of GDP has been generated (the means of doing so are the topic of section 3 below), the UK national accounts defines the "statistical discrepancy" for a given approach as the adjustment required to equalize the estimates of the approaches under consideration. Specifically, the statistical discrepancy is the estimate of GDP generated by the given approach *minus* the definitive estimate of GDP. With two approaches used and, as is logical, with the definitive estimate between the two single-approach estimates, the sign of one of the statistical discrepancies is reversed in the official accounts. Then, in official terminology, the "residual error" *equals* the sum of the statistical discrepancies *equals* the higher single-approach estimate *minus* the lower single-approach estimate.

2. Literature on UK Statistical Discrepancies

There are two parts to the literature on statistical discrepancies in the UK national accounts. First, there are studies that analyze the discrepancies empirically. This literature is presented in summary form in Table 2. Second, there are works that generate "reconciled" estimates of UK GDP, shown in Tables 4, 6, and 7. Some literature falls into both categories, namely, the studies listed in parts II, III, and IV of Table 2.

Table 2
Empirical Studies that Analyze UK Statistical Discrepancies

Author	Period	Denomination[a]
I. Statistical Discrepancies Not Eliminated		
Jefferys and Walters (1955, pp. 7-13)	1870-1952	current prices
Maurice (1968, p. 51)	1948-1966	constant prices
Fuller (1970)	1870-1964	current and constant prices
II. Statistical Discrepancies Eliminated Artificially		
Ross (1964)	1952-1962	current and constant prices
III. Statistical Discrepancies Eliminated Via Compromise Estimate[b]		
Godley and Gillon (1964a, pp. 62-65)	1950-1962	constant prices
Godley and Gillion (1964b)[c]	1958-1963	constant prices
Feinstein (1972, pp. 12-20, T12-T13)	1870-1965[d], 1857-1938[e]	current and constant prices

Table 2 Empirical Studies that Analyze UK Statistical Discrepancies		
Author	Period	Denomination[a]
Greasley (1986, pp. 417-419)	1856-1913	constant prices
Matthews, Feinstein, and Odling-Smee (1982, pp. 554-555)	1856-1973	constant prices
IV. Statistical Discrepancies Eliminated Via Balanced Estimate[b]		
Blake and Pain (1991, pp. 66-68)	1980-1990	current and constant prices
Sefton and Weale (1995, pp. 3-4)	1920-1990	current and constant prices
Solomou and Weale (1996, pp. 101-102)	1920-1938	current and constant prices

[a]"Prices" incorporate "factor cost."
[b]Page references refer only to analysis of statistical discrepancies.
[c]Criticism of Ross (1964).
[d]For current prices.
[e]For constant prices

3. Techniques of Reconciliation

a. None

The simplest approach to reconciliation is for the issue not to arise. This is the situation if only a single approach is used to estimate GDP. Deane (1968), listed as the second entry in Table 5 below, and the entries in Table 8 excluding those that adopt "hybrid" approaches (see section b.ii below), are in this category. When more than one approach is employed, the simplest way to address the issue of statistical discrepancies becomes not to reconcile them at all. The discrepancies may be computed, noted, compared, and even analyzed—but in the end merely accepted. Jefferys and Walters (1955), Maurice (1968), and Fuller (1970), the entries in part I of Table 2, are of this nature. Jefferys and Walters develop expenditure-based and income-based GDP series, but do not reconcile their discrepancies. Fuller does not generate his own series, whether single-approach or reconciled; but he provides empirical evidence regarding the substantive "compromise" technique. At one time the official national accounts simply presented the various estimates of GDP with no attempt at reconciliation, as listed, for example, in Maurice (1968, p. 51).

b. Artificial

i. Select One Approach

One approach may be selected as the "best," so that GDP estimates of other approaches are ignored. This is the judgment of Ross (1964), who opts for the output approach; but his underlying empirical justification is contradicted by Godley and Gillion (1964b). These studies are placed in the appropriate parts of Table 2.

ii. Use Hybrid Approach

There may be insufficient data for any one approach to generate an estimate of GDP, but two (or, in principle, also three) may be used together to produce a single GDP estimate. Thus a combined, or hybrid, approach is employed, and statistical discrepancies do not exist. Four entries (identified by note h) in Table 8 are of this ilk.

c. Substantive

i. Manipulation of Least-Reliable Estimate

An entry in one of the estimates (for example, "gross capital formation," within the expenditure-approach estimate) may be viewed as "least reliable." The entirety of the residual error is assigned to that, "least-reliable" entry and thereby allocated to the approach to which the entry belongs. Formally, there is zero statistical discrepancy; but in fact the residual error has simply been distributed in this extreme way. Early on, this technique was employed in the UK national accounts (see section III.C.1).

ii. Compromise

The compromise technique obtains a unique estimate of GDP by averaging the GDP estimates of the single approaches. Let Y denote true GDP and Y_i the GDP estimate of approach i. Of course, i runs over two or three of expenditure, income, output; and a given year is understood. Usually, the arithmetic mean of Y_i is taken; but the geometric mean is occasionally used. For many years, the compromise (arithmetic-average) estimate of GDP was presented in the UK official accounts (see sections III.C.2 and III.C.3). Private studies that generate compromise series of GDP are listed in Tables 2 (part III) and 6.

Justification of the compromise technique is provided by several advocates of the procedure. Feinstein (1972, pp. 16, 18, 20) observes that, with two alternative estimates, it is likely that true GDP is between the estimates, suggestive of the average as a compromise. He also states that with no basis for selection of the "best" estimate, all available information is utilized by taking the average. Godley and Gillion (1964a, p. 67) note that the compromise estimate follows from the following facts: (1) There is no reason to suppose that one approach is more or less reliable than the others. (2) The estimates of the various single approaches are substantially independent. (3) Information should not be wasted. Matthews, Feinstein, and Odling-Smee (1982, pp. 554-555) argue that the mean is the best estimate, because (1) all available information is thereby incorporated, and (2) it is possible that all three single-approach estimates are biased to the same extent. Greasley and Oxley (1995, pp. 262, 266) take the position that, with uncertainty as to which single-approach estimate is most reliable, the average should be taken as a compromise.

The compromise technique has a statistical basis as follows. Let Y denote true GDP and Y_i the GDP estimate emanating from approach i (expenditure, income, output).

An additional subscript for time is understood. Then, assuming additive error terms, $Y_i = Y + e_i$, where e_i is the measurement error associated with Y_i.[7] Assume that (i) each Y_i is an unbiased estimate of Y, that is, $E(e_i) = 0$, and (2) the variance-covariance matrix of the e_i is diagonal with $var(e_i) = v$ (a constant) for all i. The deviation of Y_i from Y is subject to a quadratic loss (customary in econometric theory); that is, this deviation is measured as $(Y_i - Y)^2$. Then the objective function $\sum(Y_i - \ddot{Y})^2$ is to be minimized with respect to $\ddot{Y}$, where $\ddot{Y}$ is the estimator of Y. This is a simple exercise in least-square estimation. The result obviously is that $\ddot{Y}$ equals the arithmetic mean of the Y_i.[8] Under the assumptions specified, this estimator has the statistically desirable best-linear-unbiased property.[9]

As Solomou and Weale (1996, p. 101) state: "If the measurement errors were assumed to be randomly distributed and the three estimates of GDP were of equal reliability, the averaging procedure used to construct the compromise estimate of GDP would provide a practical and simple solution to measurement error problems."

There are two specific statistical objections to the compromise technique. (1) The assumption $E(e_i) = 0$ does not hold: the measurement errors are not randomly distributed, the single-approach estimates, Y_i, are biased. (2) The assumption $var(e_i) = v$ for all i, is also invalid. The latter objection manifests the fact that the single-approach estimates (and their component entries) are not equally reliable.[10]

Objection (1) could be countered by compromise-technique advocates via the argument that, as long as the biases of the single-approach estimates are not all in the same direction, the averaging process involves cancellation of part of the bias in any given estimate. Indeed, that property of averaging is one of the arguments in favor of the technique. On the one hand, it is hard to envisage any technique—including the most-sophisticated "balancing" (see section iii below) that, at the extreme, could cope with a systematic *equal* bias on the part of the single approaches, that is, the structure $Y_i = A_i + Y + e_i$, all i, where an *unknown* $A_i = A$ for all i. The same statement applies for A_i of the same sign and "close" in magnitude to one another. On the other hand, the compromise advocates would claim that the compromise approach is ideal for the situation in which A_i differs in sign among the approaches.

Objection (2) is, in effect, addressed by those authors who advocate what may be termed a "weighted-compromise" estimate. The deviation $(Y_i - \ddot{Y})^2$ should be weighted by the inverse of $var(e_i)$. Essentially on this basis, Ross (1964, p. 17) suggests that the expenditure estimate could be given a weight of about one-sixth the output estimate. Similarly, Reid (1968, p. 441) would have a weighting pattern of .15-.20 for the income estimate, .40-.60 for output, and the balance for expenditure.

Though these authors do not state this explicitly, leaving it for proponents of the "balancing" technique to do so, the objective function for best-linear-unbiasedness becomes $\sum(Y_i - \ddot{Y})^2/var(e_i)$.[11] The $\ddot{Y}$ resulting from the minimization process is then closer to the Y_i with smaller $var(e_i)$, that is, with greater reliability. Looked at another way, more of the implicit "statistical discrepancy" or "adjustment" is borne by the Y_i with greater $var(e_i)$, that is, with less reliability.

iii. Balancing

It would be pleasing to the historian of national accounting to report that the balancing technique was developed as a reaction to the limitations of the compromise estimate. However, that statement would be only partially true, because the essentials of the balancing procedure were presented in a classic paper years before the compromise estimate appeared.[12] Nevertheless, it is fair to say that balancing estimates of GDP began to be generated in large part to override the weaknesses of compromise estimates. The objective function $\Sigma(Y_i - \ddot{Y})^2/var(e_i)$ was presented in section ii as an extended compromise technique; it can also be construed as the most elemental balancing technique.

The balancing technique goes further than that objective function in two respects. First, at least in principle, the technique incorporates the entire variance-covariance matrix of measurement errors. Some off-diagonal terms in the form of $cov(e_i, e_j)$ are not zero: the estimates of the single approaches are not independent. Further, some balancing estimates allow for correlation in the measurement errors e_i over time ("serial correlation") and, in principle, even for cross-correlation in the measurement errors e_i and e_j where each is in a different year ("serial cross-correlation"). The objective function is expanded to include suitably weighted cross-product terms. It would appear that the ideal best-linear-unbiased estimator is thereby achieved.

However, that conclusion is premature, because there is an additional criticism of the compromise technique, one that is inherently addressed by the balancing procedure. Solomou and Weale (1996, p. 102) state the issue well: "A more important problem of using the compromise estimate to describe the behavior of the economy is that the simple averaging procedure does not indicate what adjustments should be made to the component series. Thus, although there is an attempt to deal with measurement errors at the aggregate level, all the national accounting inconsistencies remain in the disaggregate series."

A balancing estimator, therefore, involves a predetermined level of disaggregation. Any disaggregation (below the level of GDP itself) implies that there are accounting constraints to be satisfied in the least-squares minimization process. Least-squares is applied subject to a set of accounting constraints. For example, if the level of disaggregation is just below GDP, one such constraint could be that the sum of the GDP components of approach i—the expenditure approach, for example, whence final consumption expenditure (of households, nonprofit institutions serving households, and government), gross capital formation, and net exports of goods and services—equals the GDP total of approach j (say, the income approach).[13] At the level of maximum feasible disaggregation, detailed input-output supply-and-use tables are used to set the constraints. This high level of disaggregation is utilized in the official national accounts, summarized in Table 4, while private scholars—the “balanced” series of which are listed in Tables 2 [part IV] and 7—typically work with less disaggregation.

The technique of balancing is well exposited verbally in Anonymous (1989, p. 83), Crafts (1995, p. 19), and Sefton and Weale (1995, pp. 6-11). Mathematical expositions are more numerous.[14] Table 1, columns 3-4, ranks estimation techniques regarding treatment of statistical discrepancies or residual error. Because of its internal consistency, the balancing technique (that generates a “balanced estimate” of GDP) is most preferred. Next is the compromise technique, because it makes use of the estimates of two or (ideally) three approaches in an effective way. Four other “techniques” of addressing discrepancies are ranked as 3-6, but on an “other things being equal” basis. For example, though ranked sixth, a single approach that provides a consistent series over a long time period could be preferred over techniques 3-5 in a given situation. In general, the ranking 3-6 is by no means definitive.

III. Official Series

A. Early History

Official national accounting in the UK had an early false start with the *Inland Revenue Report on National Income 1929* (1977), where national income was estimated for 1923-1924. The report was confidential and not published until almost a half-century had elapsed. Ongoing official national accounting in the UK began in early 1940, when an estimate of national income was prepared for internal use. Later, in early December 1940, working in what became the Central Statistical Office (now the Office for National Statistics) in that very month, the notable economists James Meade and Richard Stone completed the first draft of what became the “White Paper” *Analysis of the Sources of War Finance and Estimate of the National Income and Expenditure in 1938 and 1940*. This White Paper became public on April 7, 1941, as a document accompanying the annual budget. Subsequently, through 1951, a White Paper on national income and expenditure was published annually in conjunction with the budget. Beginning in 1952, a *Blue Book* (so called because of the color of its cover) entitled *National Income and Expenditure* became the annual publication for the national accounts. In 1984 the name of the *Blue Book* was changed to *United Kingdom National Accounts*.[15]

The earliest year for which official national accounts exist is 1938, and GDP at current market prices, and at current factor cost or at current basic prices (all popularly called “nominal” or “money” GDP) exists annually from that year.[16] An innovative year was 1954, when the *Blue Book* displayed constant-price estimates of GDP for the first time. Constant-price or constant-factor-cost (each popularly called “real” or “volume”) GDP is available in official statistics since 1946, and systematically only from 1948. Traditionally, constant-price GDP has the schemata shown in Table 3. The time span 1948-2000 is divided into periods. Each period has a “base year,” the price structure of which revalues the components of GDP—and therefore GDP itself—for each year in the period. The procedure of adopting a new base year is called “rebasing.”[17] Each period, except the latest, also has a “link year,” the year for which figures for the given period are linked to those for the immediately later period. This technique is called "chain-linking." Proceeding sequentially, as Table 3 represents, the GDP for all years is expressed in prices of the latest base year, 1995 (although, of course, the relative-price structure remains period-specific).[18]

Table 3
Official Constant-Price GDP, 1948-2000

Period[a]	Base Year	Link Year
1994-2000	1995	____
1986-1994	1990	1994
1983-1986	1985	1986
1978-1983	1980	1983
1973-1977	1975	1978
1963[b]-1972	1970	1973
1958-1962[b]	1963	1963[c]
1948-1957	1958	1958

[a]For both expenditure and output estimates, except where otherwise noted.
[b]For expenditure estimate; 1968 for output estimate.
[c]For expenditure estimate, and output estimate 1958-1962; 1968 for output estimate 1963-1968.

Sources: *United Kingdom National Accounts: Concepts, Sources and Methods,* p. 221; Maurice (1968, p. 39); *Blue Book 2002*, p. 37.

The ratio of nominal to real GDP is called the GDP deflator, sometimes the "implicit" GDP deflator ("implicit" because of its ratio derivation). Of course, the numerator and denominator of the ratio must be defined consistently. Acceptable pairs of the GDP measures are {current-market-price, constant-market-price}, {current-factor-cost, constant-factor-cost}, {current-basic-price, constant-basic-price}.

B. Approaches

Traditionally, the UK official national accounts have provided GDP estimates for all three approaches. Considering *nominal* GDP, directly generated (independent) estimates have been computed for the both the expenditure and income approaches for all years since 1938. However, nominal GDP using the output approach is available only from 1989.[19] Input-output balancing (see section C.4 below) is required for this estimation, and the requisite input-output information is available only from that year.

Turning to single-approach *real* GDP estimates, expenditure-approach GDP has been calculated since 1946. Prices of goods and services are all that is needed to divide expenditure-approach nominal GDP into real GDP and a price deflator. As, traditionally, both nominal and real expenditure-approach GDP were computed alternatively at market prices and at factor cost, both an expenditure market-price and an expenditure factor-cost deflator were readily calculable.[20]

The income approach provides no *direct* estimate of real GDP, because this would involve the Herculean task of separating income components, such as wages and salaries ("compensation of employees" in the UK accounts) and profits ("gross operating surplus") into volume and price segments. In contrast, the output approach has generated a GDP estimate at constant factor cost (basic prices, since the 1998 *Blue Book*) from 1946 onward.

C. Reconciliation Techniques

With the exception of selecting one approach as "the best," every reconciliation technique mentioned in section II.B.3 above has been employed in the UK national accounts. Table 4 summarizes the latest published revised official GDP data (as of December 31, 2002), with electronic publishing (the National Statistics website) considered to incorporate the most recent revisions. The reconciliation techniques for these data are stated in the last column of the table. Entries in the table are in reverse time order (latest first), because of the presumption that more-recent series are superior to earlier series and therefore are more likely to be selected as components of the GDP series constructed for **What Was the UK GDP Then?** The discussion that follows considers the reconciliation techniques not only of the "latest-revised" data (entries in the table), but also of data that have been superseded. So a full history of official reconciliation techniques is presented.

Table 4
Official GDP Series, United Kingdom, 1938-2000[a]

Source[b]	Period	Concept[c]	Denom.[d]	Approach[e]	Statistical Discrepancies	
					Value	Technique[f]
website[g,h]	1989-2000	MP	C, K	C: E, I K: E, O	zero	BAL[i]
website[g,j]	1986-1988	MP	C, K	same	zero	BAL,[k] COM[l]
website[g]	1948-1985	MP	C, K	same	zero	COM[m]
ET (1981)	1946-1947	FC	C	E, I	zero	MAN
NIE (1956)	1938, 1946-1947	FC, MP[n]	C	E, I	zero	MAN
NIE (1956)	1946-1947	MP	K	E	_____	_____
NIE (1956)	1946-1947	FC	K	E, O	nonzero[o]	_____
SW (1951)	1938-1945	MP[p]	C	E, I	zero	NI

[a]Latest revised data as of December 31, 2002.
[b]website = National Statistics website, ET = *Economic Trends, Annual Supplement*, NIE = *National Income and Expenditure*, SW = *Statistical Digest of the War*.
[c]MP = market prices, FC = factor cost.

[d]Denomination: C = current prices or factor cost, K = constant prices or factor cost.
[e]E= expenditure, I = income, O = output.
[f]BAL = balanced estimate, COM = compromise estimate, MAN = manipulation of "least-reliable" components, NI = estimates not independent.
[g]nationalstatistics.gov.uk
[h]Also in *Blue Book* 2002, pp. 46-49.
[i]Via input-output supply-and-use tables for current-price GDP. See text for details.
[j]Also in *Blue Book* 2002, pp. 46, 48.
[k]Via 1989 and 1990 input-output supply-and-use tables. See text for details.
[l]Via equal income/expenditure allocation of residual remaining after balancing.
[m]For 1958, 1963, 1970, 1975, 1980, 1985, which are "base years" (see Table 4), the compromise estimate is the average of the expenditure and income estimates, and the expenditure and income adjustments are equalized. For intervening years (that is, for movements of GDP between base years) and for 1948-1957, all three GDP estimates—expenditure, income, and output (reflated by the expenditure factor-cost deflator)—are given equal weight in determination of GDP at current factor cost; so the compromise estimate is essentially the average of all three estimates, leading to non-equal expenditure and income adjustments. Factor-cost adjustments (net production taxes) are applied to yield GDP at market prices.
[n]Computable as "gross domestic product at factor cost" *plus* "taxes on expenditure" *minus* "subsidies."
[o]But not computed.
[p]Computable as "income arising in the United Kingdom" *plus* "provision for depreciation" *plus* "indirect taxes" *minus* "subsidies."

Sources: Anonymous (1988, pp. 79-89); Brueton (1998, p. 41); *United Kingdom National Accounts: Concepts, Sources and Methods*, pp. 200, 205-209, 215-220; *Blue Book* 1992, pp. 8-9; *Blue Book* 1997, pp. 16-18, 32, 195-196; *Blue Book* 2002, pp. 31-34.

1. Hybrid Approach and Manipulation of Least-Reliable Estimate

At the beginning of UK official national accounting, a combined (hybrid) approach involving income and expenditure estimates was the practice. However, it is officially stated (Maurice, 1968, p. 39) that until 1953 the procedure rather was to manipulate the least-reliable estimates (that is, components of the expenditure or income GDP estimates). It is difficult to distinguish the two techniques, and in fact "manipulation of least-reliable estimate" may be interpreted as a special case of the "hybrid approach." Further, computing one component of expenditure or income GDP as a residual can be construed as an application of "manipulation of the least-reliable estimate." In fact, in at least one early document this "residual" method is specifically acknowledged.[21] The fourth, fifth, seventh and eighth entries in Table 4 involve these types of reconciliation, while the sixth entry shows the only market-price real GDP estimate for 1946-1947.

2. Former Compromise Technique

Only with the 1992 *Blue Book* was all reference to the various GDP estimates dropped in favor of a single estimate. Nevertheless, in earlier *Blue Books* this single "best" estimate was identified, and was denoted as GDP(A), for "average GDP." Similar nomenclature applied to the single-approach estimates (shown until the 1992 *Blue Book*): GDP(E), GDP(I), GDP(O) for the expenditure, income, output estimate. Prior to the 1988 *Blue Book*, GDP(A) was computed as the arithmetic average of GDP(E), GDP(I), and GDP(O), after GDP(O) was converted from constant to current factor cost via multiplication by the expenditure factor-cost deflator. The same technique was applied to obtain GDP(A) at constant factor cost, with GDP(I) transformed to real form by division by the expenditure factor-cost deflator.[22]

Thus application of the compromise technique *symmetrically* to both nominal and real GDP is noted. GDP estimates derived from this, former, compromise procedure are obsolete, so do not enter Table 4.

3. Compromise Technique: 1948-1985

With the 1988 *Blue Book*, the official compromise estimate becomes more complex. For the base years 1958, 1963, 1970, 1975, 1980, 1985 (and originally 1948, as well), GDP in current prices was computed as the arithmetic average of the income and expenditure estimates. Thus statistical discrepancies for expenditure and income were made equal in these base years. In the intervening years (and it appears also eventually 1948-1957—see below), the movement of nominal GDP was determined as the arithmetic average of the expenditure, income, and output estimates, with the last converted from constant to current factor cost by means of the expenditure factor-cost deflator. For these years, the statistical discrepancies for expenditure and income are therefore unequal.

The year 1948 is a base year, and originally expenditure and income adjustments were made equal for this year as well as the later base years.[23] However, subsequent revised estimates for this year (as shown in the National Statistics website) involve non-equal statistical discrepancies.

Finally, at constant factor cost, GDP is simply current factor-cost GDP divided by the expenditure factor-cost deflator. Thus the compromise technique is a device used to reconcile only *nominal* GDP. Real GDP is obtained as if the resultant nominal GDP was, in effect, derived from the expenditure approach alone.

The third entry of Table 4 reflects these compromise techniques for the 1948-1985 time period.[24]

4. Balancing Technique: 1989-2000

Beginning for the year 1989, the official national accounts use input-output balancing to provide a single, definitive reconciled estimate of current-price GDP. The initial year of this balancing is 1989, because only then did the requisite annual input-output information become available. The framework of balancing is described as follows:

> Because the income, output and expenditure measures of GDP can all be calculated from the I-O [input-output] supply and use balances, a single estimate of GDP can be derived by balancing the supply and demand for goods and services and reconciling them with the corresponding value added estimates. For the years 1989 [onward]...the balancing process has been used to set the level of current price GDP and has disposed of the need for any statistical discrepancies....
>
> The I-O balance is based on a framework which incorporates estimates of industry outputs, inputs and value added. The balance is composed of two matrices: the 'Supply' matrix and the 'Combined use' matrix, each of which breaks down and balances one hundred and twenty-three different industries and products at purchasers' prices....The I-O balance is effectively achieved...when the data from the income, expenditure and output approaches used to fill the matrices all produce the same estimate of current price GDP.—*United Kingdom National Accounts: Concepts, Sources and Methods*, pp. 216, 217

Two features of the official balancing technique are immediately apparent: the central use of input-output information (in fact, *two* input-output tables) and the high level of disaggregation (123 industries). Neither of these characteristics is inherent in the methodology of balancing (see section II.B.3.c.iii above). Another interesting feature of the official balancing procedure is that it is as much an exercise in data *generation* as it is in data *reconciliation*. As officially stated:

> To obtain the revised estimates an iterative process begins to reconcile the income and output-based estimates of industry value added and the supply and demand for each product. These estimates are scrutinized and validated and checked for their plausibility and coherence across all industries and products. Consistency and coherence over time are also important and the impact of revisions to earlier years and the quality of the relative data sources are also taken into account. In addition when necessary other sources, for example ONS [Office for National Statistics] survey data and company reports and accounts, are used to inform the investigation of particular areas. *Discussions follow between the I-O team and data compilers and any issues are resolved.*

> As final estimates are received from data compilers the steps of assessment and scrutiny, comparison and reconciliation continue. For the time series under consideration the quality of source data, revisions performance and any specific estimation problems are taken into account. *Any changes to estimates are agreed* and the inconsistencies between supply and demand, and between output and income-based value added, are continually reduced. This process continues until convergence between the aggregate totals is achieved.—*United Kingdom National Accounts: Concepts, Sources and Methods*, p. 218 (italics added)

Thus negotiation between data compilers and input-output specialists is central to the process. Consider further description of the procedure:

> The single best estimate of GDP which emerges will reflect the relative merits of the output, income and expenditure estimates at the aggregate level. It will also have been assessed after consideration of the effect on current and constant price expenditure growth rates, the impact on the expenditure deflator, and the relation between current and constant price value added.
>
> Once this GDP estimate has been fine tuned and agreed by all concerned, the industry value added and the value added weights are fixed after a full reconciliation of the income-based components with the output-based estimate. Product supply and demand will still differ at this stage because of the lack of detailed source data on, for example, distributors trading margins and the allocation of other services provided by manufacturers, but adjustments are made until a balance is achieved.—*United Kingdom National Accounts: Concepts, Sources and Methods*, p. 219

Hence full balancing at the aggregate level is achieved, and *statistical* balancing theory (discussed in section II.B.3.c.iii) has not been applied! Indeed, it is only at the final stage of the process and for the purpose of reconciling intermediate flows that resort is had to this theory:

> The Combined use matrix is then fully balanced by adjusting the intermediate purchases within the predetermined column and row totals.
>
> The final step in the balancing process is to apply the r.A.s. method to the intermediate section of the Combined Use matrix. This process will adjust the intermediate purchases in line with predetermined row and column totals, resulting in a fully balanced table. The term r.A.s. refers to an iterative mathematical process....The end result of this process is that supply equals demand for each product.
>
> The end result is a full I-O balance where input equals output and supply equals demand for all one hundred and twenty-three product and industry

> groups.—*United Kingdom National Accounts: Concepts, Sources and Methods*, p. 219

Sefton and Weale (1995, pp. 27-28) observe that in the official procedure "the residuals are allocated on a basis which may correspond approximately to least-squares balancing, with the residuals being allocated to those components which are believed to be least reliable." They note that basing the approach on input-output tables "relies on a great deal of disaggregate data and allows consideration of commodity balances as well as discrepancies between income and expenditure" (Sefton and Weale, 1995, p. 6). These elements might compensate for the neglect of statistical balancing: "In practice it [official balancing] may be similar to an application of the techniques [statistical balancing] described in this book, carried out in finer detail."

However, Sefton and Weale criticize official balancing, because (1) the technique is applied not to a long time series but rather essentially one year at a time, (2) "the mechanics of the adjustment process remain obscure." One might add that (3) the negotiations between data compilers and input-output specialists could introduce elements of subjectivity and arbitrariness, that would be absent from a formal statistical procedure.

Just as with the compromise technique discussed in section 3, there is a lack of symmetry in the treatment of nominal and real GDP. Current-price GDP receives the full balancing treatment, whereas constant-price GDP is obtained by deflation via the expenditure approach.

The first entry in Table 4 summarizes official balancing for 1989-2000.

5. Combined Balancing-Compromise Technique: 1986-1988

For 1986-1988, the UK national accounts use a combined balancing-compromise technique. As input-output tables do not exist for these years, information from the 1989 and 1990 tables is used to achieve a partial reconciliation, followed by compromise treatment of the remaining residual error:

> For the years 1985 to 1988, a better reconciliation has been achieved between the broadly independent estimates of income and expenditure components at current prices than hitherto, reflecting better understanding of the basic sources and the use of information from the 1989 and 1990 input-output tables. The discrepancies remaining between the sums of income and expenditure components at the initial reconciliation were comparatively small and well within the margins of error of the aggregates. It was therefore decided to distributed the discrepancy, or residual error as it is conventionally known, equally between the income and expenditure aggregates.—*Blue Book* 1997, p. 195

Sefton and Weale (1995, p. 6) criticize this procedure: "These residuals were themselves derived after substantial use had been made of the 1989 and 1990 input-output tables...to reconcile disparate sources. They have been allocated equally between income and expenditure, but no clues are given as to the components of income/expenditure to which the adjustments have been made. Thus this is, in aggregate, similar to averaging, with the errors allocated across the data in an undisclosed manner."

In defense of the official procedure, it could be argued that the years 1986-1988 are a transition between the compromise GDP estimates of 1948-1985 and the balanced estimates of 1989 onward; and, as such, the advantages of balancing and disadvantages of compromise are inherently present.

As stated in the above *Blue Book* quotation, originally the combined approach was applied also to the year 1985.[25] The existence of income and expenditure statistical discrepancies in the latest revised data, and the fact that these discrepancies are equal in magnitude, imply that definitive GDP for 1985 remains that generated by the compromise technique described in section 3 above.[26]

GDP at constant prices for the 1986-1988 period is obtained via the expenditure deflator, as has been described for 1948-1985 and 1989 onward. The second entry in Table 4 shows that the combined balancing-compromise estimate is definitive GDP for 1986-1988.[27]

IV. Private Single-Approach Series

A. Predecessor Series

"Predecessor series" are defined here as series that are long-run and continuous, but that pertain to net rather than gross product. As observed by Mitchell and Deane (1962, p. 364), Prest (1948, pp. 58-59) developed "the first long and continuous series of national income estimates." The series runs from 1870 to 1946; but the original segment is 1870-1914.[28] Southern Ireland is included to 1919, excluded thereafter; and, to his credit, Prest is concerned with the non-comparability associated with the change in territory. He employs an income approach for his own segment, and the aggregate concept is net national product (income) at factor cost.[29]

Prest deserve praise for generating an estimate of not only nominal but also real net national product. He deflates the nominal series by a retail price index (1870-1914), cost-of-living index (1914-1938), and the implicit national-accounts consumption price index adjusted for quality change (1938-1946). Adjustment for quality is certainly a praiseworthy procedure. Also to his credit, Prest adjusts depreciation allowances from original to replacement cost as part of the deflation procedure.

Feinstein (1961, p. 384), in a harbinger of his great work to come, revises the original (1870-1914) segment of the Prest series and extends the series back to 1855. The

Feinstein series is reprinted in Mitchell and Deane (1962, pp. 367-368), who also deflate the series using the cost-of-living index employed by Prest.

B. GDP or GNP Series

Private GDP or GNP long-run series emanating from a single (expenditure, income, or output) approach that run between 1830 and 1920 are summarized in Table 5—1830 because that is the earliest year for which any such series has an observation, 1920 because the most recently published private "balancing" series begins on that date (see Table 7) and that series overlaps with official "balancing" figures to cover the rest of the twentieth century and beyond.

Table 5
Private Single-Approach GDP/GNP Series, United Kingdom, 1830-1920

Author	Period	Aggregate, Denom.[a]	Concept[b]	Base Year[c]	Data Source	Approach
Jefferys and Walters (1955, pp. 8-9, 36-37)	1870-1920	GNP[d], C	FC, MP	_____	various[e]	expenditure, income
Deane (1968, pp. 104-107)	1830-1914	GNP, C, K	FC, MP[f]	1900	various[g]	expenditure
Feinstein (1972, pp. T4-T5, T12, T18-T19)[h]	1855-1920[i]	GDP, C, K[j]	FC	1900[k], 1938[l]	various[m,n]	income
Feinstein (1972, pp. T10-T12, T14-T15)	1870-1920[i]	GDP, C, K	FC, MP	1900[k], 1938[l]	various[m,o]	expenditure
Feinstein (1972, pp. T12-T13, T18-T19)	1870-1920[i]	GDP[p] C, K	FC	1900[k], 1938[l]	various[m,o]	expenditure
Feinstein (1972, pp. T18-T19, T24-T25)[q]	1855-1913, 1920[i]	GDP, K	FC	1913[r]	various[m,s]	output
Greasley (1986, pp. 438-439)	1856-1913	GDP, C, K[t]	FC	1900	Feinstein (1972), other[u]	income

Table 5 Private Single-Approach GDP/GNP Series, United Kingdom, 1830-1920						
Author	Period	Aggregate, Denom.[a]	Concept[b]	Base Year[c]	Data Source	Approach
Greasley (1989, pp. 258-259)	1856-1913	GDP, C, K[t]	FC	1900	Feinstein (1972, 1986), Greasley (1986)	income
Mitchell (1988, pp. 828-829)	1855-1920[i]	GDP, C	FC	____	Feinstein (1972) revised[v]	income
Mitchell (1988, pp. 831-833, 837-839)	1830-1920[i]	GDP, C, K	FC, MP	1900[w], 1938[l]	Deane (1968), Feinstein (1972) revised[v]	expenditure
Solomou and Weale (1991, p. 60)	1870- 1913	GDP C, K	FC	1900	Feinstein (1972)[x]	expenditure
Solomou and Weale (1991, p. 60)	1870-1913	GDP, K	FC	1900	Feinstein (1972)	output

[a]Denomination: C = current prices or factor cost, K = constant prices or factor cost.
[b]MP = market prices, FC = factor cost.
[c]For constant-price GDP or GNP.
[d]Computable as follows. For income approach: "Net national income at factor cost" *plus* "Depreciation" *equals* GNP at factor cost, *plus* "Rates and taxes on expenditure net of subsidies" *equals* GNP at market prices. For expenditure approach: "Consumers' expenditure on goods and services" *plus* "Public authorities' current expenditure on goods and services" *plus* "Gross domestic capital formation" *plus* "Value of physical increase in stocks and work in progress" *equals* GNP at market prices, *minus* "Rates and taxes on expenditure net of subsidies" *equals* GNP at factor cost.
[e]See Jefferys and Walters (1955, pp. 2-7, 23-38).
[f]Computable as "Gross national product at factor cost" *plus* "Indirect taxes net of subsidies."
[g]See Deane (1968, pp. 103, 108-112).
[h]Current-price series reprinted 1870-1913 in Solomou and Weale (1991, p. 60).
[i]1920 both including and excluding Southern Ireland.
[j]Current-price series deflated by expenditure deflator. Feinstein (1972, pp. T132-T133) shows the deflator only from 1870. He does not identify the deflator for 1855-1869, for which the expenditure series are not available. However, the only logical inputs to the deflator for that period are current-price income and constant-price output.

[k]For 1870-1913.
[l]For 1913-1920.
[m]For 1946-1965, *National Income and Expenditure*, especially 1968 volume. For 1855-1945, various sources; Feinstein (1972, p. 2) summarizes: "For earlier periods existing estimates were adopted wherever possible, with only such adjustment as was necessary to obtain consistency....Where no previous estimate was available or where it was thought possible to produce substantially improved results, new estimates were prepared."
[n]Details for the income approach are in Feinstein (1972, pp. 30-205 scattered).
[o]Details for the expenditure approach are in Feinstein (1972, pp. 44-52, 77-79, 101-103, 105-108, 110-122, 182-204).
[p]Adjusted for changes in inventories 1873-1874, 1879-1880, 1882-1883, 1889-1893, 1900-1901, and for trend 1870-1887. See Feinstein (1972, pp. 17-18).
[q]Reprinted in Mitchell (1988, pp. 845-846).
[r]Base years for weighting pattern for overall GDP are 1907 for 1855-1913 and 1924 for 1913-1920. At the sectoral level, base years can vary both by sector (agriculture, industrial production, services) and time period (1855-1913, 1913-1920). For details, see Feinstein (1972, p. 207).
[s]Details on the output approach are in Feinstein (1972, pp. 206-214).
[t]Current-price series deflated by "Feinstein's GDP deflator" (Greasley, 1986, p. 439). See note j.
[u]See Greasley (1986, pp. 420-428, 431-439).
[v]"Extensions and revisions thereto kindly provided by Professor Feinstein" (Mitchell, 1988, p. 828, note 1).
[w]For 1830-1913.
[x]"Adjusted to reflect Feinstein's revised investment figures for the period 1870-1914" (Solomou and Weale, 1991, p. 58).

Jefferys and Walters (1955), the earliest (and first) entry in Table 5 to construct a gross-product (GNP) series, antedate Feinstein (1961), whose series is net national product. However, the GNP series of Jefferys and Walters are not presented as such by the authors, but rather must be computed from component series (see note d of Table 5). The honor of developing the first explicitly gross product series of any length belongs to Clark (1937a, p. 88), who generates GNP annually for 1924-1933. This is not a long-term series, and so is excluded from Table 5. The distinction of creating the first long-run series of this nature was earned by Deane (1968), the second entry in the table.

It is a tribute to the majestic work of Feinstein (1972) that all the remaining entries in Table 5 either are, or build on, Feinstein's series. It should be noted that the two series in Mitchell (1988) are authored by Feinstein in revision of his earlier work. Mitchell is listed as the "author," but provides only the venue. A second indication of Feinstein's scholarship is that Feinstein (1972) is the only study that develops estimates of GDP based on all three approaches (expenditure, income, output). A caveat is that any *constant* factor-cost income series—listed in Feinstein (1972) in the third entry, and in

Greasley (1986, 1989) as the seventh and eighth entries—is not directly computed but rather is *current* factor-cost income divided by the expenditure factor-cost deflator.

Yet a third manifestation of Feinstein's greatness is that there is only one author, Greasley (1986, 1989), who provides a substantially new series, and that for only one of the approaches (income). Solomou and Weale (1991), the penultimate entry in the table, use Feinstein's own later data to revise Feinstein's expenditure series. Solomou and Weale (1991), the final entry, simply change the form of Feinstein's output series.[30]

To understand the contribution of Greasley, one begins with the fact that Feinstein (1972) provides not one but two expenditure GDP series: the original series (fourth entry in Table 5) and an adjusted series (fifth entry in the table). To obtain the latter series, two adjustments are involved and they are applied sequentially. The first adjustment corrects for inconsistencies in timing with reference to "general trade conditions" and "the movement of the income estimate" (Feinstein, 1972, p. 17). In particular, the original expenditure series is altered for 13 years over 1873-1901, such that (i) six changes are positive, (ii) seven negative, and (iii) the algebraic sum of the changes is zero. This imposed pattern suggests that these adjustments correct for timing errors in inventory changes (as stated in note p in Table 5). That is the view of Feinstein (1972, p. 18), though he states that the corrections also apply "to components of consumers' expenditure and fixed capital formation not properly adjusted for stock [inventory] changes."

The second adjustment emanates from Feinstein's view that this expenditure series (given the first adjustment) has an inappropriate trend relative to the income estimate. Therefore "the expenditure estimate (after correction in the 13 specified years) was further adjusted for trend by subtraction of an amount declining linearly from .5% of G.D.P. in 1870 to zero in 1887" (Feinstein, 1972, p. 18).

Greasley (1986, p. 418) observes that "the modified expenditure data [are] preferred by Feinstein" and that the purpose of both adjustments is "to produce some conformity with the income data....Feinstein argues that the income data are more reliable, and modifies the expenditure data to produce a greater conformity in the two series." Greasley (1986, p. 428) takes another position: it is Feinstein's *income* series that is defective. He develops "revised data for wage income and profits and nonfarm income from self employment," and combines them with "Feinstein's series for rent, salaries, and intermediate incomes" to generate a new income series. This series is the seventh entry in Table 5. Greasley concludes: "The revised nominal income estimates are more compatible with Feinstein's unadjusted expenditure data than are Feinstein's income series....Feinstein's adjustments to the expenditure series no longer appear warranted."

Feinstein (1989) makes a number of criticisms of Greasley's income series, and Greasley (1989) modifies his series in response to those criticisms that he accepts as valid. This revised series is the eighth entry in Table 5. The Greasley modified income series is judged here as superior to that of Feinstein, and Greasley's (1986, p. 428) judgment that "the revised nominal income estimates are more compatible with

Feinstein's unadjusted expenditure data than are Feinstein's income series" is also accepted.

V. Private Compromise Series

A. Pre-Feinstein Series

Private compromise series are summarized in Table 6. Those generated prior to the work of Feinstein (1972) are distinguished by the use purely of official data and therefore embody short time periods. Godley and Gillion (1964a), and Reid (1968) are the studies in this category. They began the practice, emulated by all later authors, of including income in the compromise series, by converting it to real terms via the expenditure deflator. They also employ the arithmetic mean to obtain the compromise estimate, a usage followed by some—but not all—subsequent authors.

Table 6
Private Compromise GDP[a] Series, United Kingdom, 1855-1965

Author	Period	Data Source	Denomination[b]:Approach[c]
Godley and Gillion (1964a, p. 63)	1950-1962	*National Income and Expenditure*, 1963[d]	K: AM (E, I^e, O)
Reid (1968, p. 443)	1950-1965	*National Income and Expenditure*, 1965[d]	K: AM (E, I^e, O)
Feinstein (1972, pp. T12-T13, T18-T19)	1870-1965[f]	See Table 5.	C: AM (E^g, I) K: AM (E^g, I^h, O)[i]
Mitchell (1988, p. 836)	1855-1948[f]	Feinstein (1972)[j], *National Income and Expenditure*[k]	C: AM (E^g, I) K: AM (E^g, I^h)
Greasley (1986, pp. 438-439)	1856-1913	Feinstein (1972), Greasley income series[l]	K: GM (E^m, O, I^h)[n]
Greasley (1989, pp. 258-259)	1856-1913	Feinstein (1972), Greasley revised income series	K: GM (E^m, O, I^h)[n]
Greasley (1992, pp. 208-209)	1856-1913	Greasley (1989), with "minor amendments"[o]	K: GM (E^m, O, I^h)[n]

[a]At factor cost. Base years for constant-price GDP are as follows. For expenditure series, 1900 (for 1870-1913), 1938 (for 1913-1948), 1959 (for 1948-1965). For output series, base-year pattern is complex; see Feinstein (1972, p. 207).
[b]C = current factor cost, K = constant factor cost.
[c]AM = arithmetic mean, GM = geometric mean. E = expenditure, I = income, O = output.
[d]Computation also made using earlier issues, for correspondingly shorter time periods.
[e]Current-price series deflated by expenditure deflator.
[f]1920 both including and excluding Southern Ireland.

[g]Adjusted for changes in inventories 1873-1874, 1879-1880, 1882-1883, 1889-1893, 1900-1901, and for trend 1870-1887. See Feinstein (1972, pp. 17-18).
[h] Current-price series deflated by (Feinstein) expenditure deflator; but see note j of Table 5.
[i]Expenditure excluded 1855-1869; output excluded 1914-1919 and 1939-1945.
[j]With "extensions and revisions" provided by Feinstein.
[k]Various issues.
[l]See note t of Table 5.
[m]Unadjusted Feinstein series.
[n]Expenditure excluded 1856-1869.
[o]Nature of amendments not specified; see Greasley (1992, p. 206).

B. Feinstein and Later Series

Mitchell (1988, p. 819) describes his series (fourth entry in Table 6) as "Feinstein's own 'compromise' between the two alternative estimates of Gross Domestic Product." This description is likely inappropriate, because, while Mitchell uses purely Feinstein data, exclusion of the output estimate as an ingredient in the real (as distinct from nominal) compromise series is contrary to the practice of Feinstein, and in fact of all other adopters of the compromise technique.

Matthews, Feinstein, and Odling-Smee (1982, p. 554) are not included in Table 6, because these authors present only growth rates (for various phases and cycles over the time period 1856-1973) for the compromise series that they construct, without listing the series. Their data are the same as Feinstein (1972), except for slightly different base years and link year.

One difference between the Feinstein-Mitchell and Greasley compromise series is the fact that Feinstein and Mitchell (along with Godley-Gillion and Reid) employ the arithmetic mean, whereas Greasley (along with Matthews, Feinstein, and Odling-Smee) uses the geometric mean. As the discussion in section II.B.3.c.ii suggests, the arithmetic or geometric mean is applicable according as measurement errors are additive or multiplicative. Interestingly, no author justifies the choice, either theoretically or empirically—though the issue is certainly amenable to econometric investigation.

A second difference between Feinstein-Mitchell and Greasley is the component series. Both Feinstein and Mitchell combine Feinstein's income and *adjusted* expenditure series; only, the component series in Mitchell are revised (by Feinstein himself) from Feinstein (1972).[31] Greasley uses *his own* income series and Feinstein's *unadjusted* expenditure series. From the discussion in section IV.B, it is the judgment of the present author that Greasley's data combination is the best.

A similarity between Feinstein-Mitchell and Greasley is *including* income in the real compromise series via deflation by the expenditure deflator. Feinstein exhibits an asymmetry in *excluding* output from the nominal compromise series, though output is readily convertible to current factor cost via "inflation" by the expenditure deflator. Any case for the first inclusion surely warrants the second inclusion; yet the issue is not even discussed in the literature, in spite of the fact that output inflated in this way has been used in the official-accounts compromise estimates.[32] The issue does not arise in Mitchell, as output is excluded from both the nominal and real compromise series.

VI. Private Balanced Series

A. Series

Table 7 summarizes the balanced series of UK GDP that have been produced by private authors. Just as Table 4 is arranged for the official series, so entries in Table 7 are in reverse time order (latest first), because of the presumption that more-recent balanced series are superior to earlier series and therefore are more likely to be selected as components of the GDP series constructed for **What Was the UK GDP Then?**

Table 7
Private Balanced[a] GDP[b] Series, United Kingdom, 1870-1990

Author	Period	Concept[c]	Base Year[d]	Data Source
Sefton and Weale (1995, pp. 184-187 or 192-194, 188-191)[e]	1920-1990	MP	1920-1948: 1938 1948-1990: 1985[f]	1920-1945: Feinstein (1972), 1946-1990: official series[g]
Solomou and Weale (1993, p. 100)	1920-1938	MP[h]	1938	Feinstein (1972)
Solomou and Weale (1991, p. 60)	1870-1913	FC	1900	Feinstein (1972), Feinstein and Pollard (1988)
Weale (1988, p. 219)	1974-1984	MP[h]	1980	*National Income and Expenditure* (1985)
Stone (1984, p. 205)	1969-1979	MP	____	*National Income and Expenditure* (1980)

[a]Via least-squares technique with accounting constraints. Approaches are expenditure and income for current-price GDP, expenditure and output for constant-price GDP.
[b]Both current-price and constant-price, except only current-price where "Base Year" column has no entry.
[c]MP = market prices, FC = factor cost.
[d]For constant-price GDP.
[e]Identical series for 1920-1938 in Solomou and Weale (1996, pp. 100-113), where GDP at market prices computable as "GDP [at factor cost]" *plus* "taxes on expenditure" *minus* "subsidies" (current prices), or *plus* "factor-cost adjustment" (constant prices).
[f]Linking of years as in Table 3, except (i) 1985 base applies to 1983-1990, (ii) scaling of components so sum equals appropriate aggregate (Sefton and Weale, 1995, pp. 94-95).
[g]Except, for 1946-1947, where only Feinstein series available.

[h]Computable as "GDP [at factor cost]" *plus* "factor-cost adjustment."

There is an important difference between these series as a group (excluding Stone) and the compromise series (both official and private) discussed in sections III.C.2, III.C.3, and V. The issue of deflating current-price income and (in logic, if not practice) inflating constant-price output to achieve three measures of both nominal and real GDP does not arise. Only the *independent* measures of GDP—current-price expenditure and income, constant-price expenditure and output—need be considered in the balancing process.[33] As Solomou and Weale (1991, pp. 62-63) explain: "The balanced estimates are derived by constraining the current price expenditure and income estimates, and the constant price expenditure and output estimates to be equal. It should be noted that the constant price income estimate is an artifact constructed from these other estimates. It does not contain separate information and is therefore not used in the balancing process."

Almost every characteristic of the official balancing technique (see section III.C.4) does not pertain to private balancing studies:

1. The official technique centers on input-output tables, absent from private balancing.

2. Official balancing is at a high level of product disaggregation: 123 industries. In contrast, Solomou and Weale (1991, 1993) and Sefton and Weale (1995) have only 12 industries, while Weale (1988) and Stone (1984) use no industry breakdown of output.

3. The combination of data generation and data reconciliation inherent in the official process is absent from private balancing, for which the data input is predetermined.

4. Ignoring statistical balancing except at the final stage of the process and after balancing at the level of aggregate GDP has been accomplished, is purely an official phenomenon. In private studies, *all* balancing is statistical in nature.

5. The official technique applies balancing only to nominal GDP, whereas private balancing (again excluding Stone) considers real GDP in conjunction with nominal GDP.

6. Official balanced GDP has been accomplished only from 1989 onward. All the private balanced series go back further in time, and two (Solomou and Weale, 1991; Sefton and Weale, 1995) are truly long-run in nature.

Some data issues warrant discussion. While the Solomou-Weale (1991, 1993) and Sefton-Weale (1995) studies all make use of Feinstein data, two of these studies adjust the data. Sefton and Weale (1995, pp. 68-69) make three modifications to Feinstein's data regarding industry allocation of certain national-accounts flows. Also, they use an updated Standard Industrial Classification for 1948-1990. Solomou and Weale (1991, p.

58, note 3) adjust Feinstein's expenditure series "to reflect Feinstein's revised investment figures for the period 1870-1914."

In a critique of Solomou and Weale (1991), Greasley and Oxley (1995) make two important observations regarding data. First, balanced estimates diverge from compromise estimates mainly to the extent that component series have divergent variances of their measurement errors—divergent "reliabilities," as termed by Greasley-Oxley and others. As Greasley and Oxley (1995, pp. 266-267) write:

> Feinstein, believing there was no reason to favor the reliability of the output-, expenditure-, or income-side measures simply took the average as a compromise. In principle, Solomou and Weale's procedures represent a useful advance since they assign relative reliabilities to the component series. In practice, the balanced estimates ascribe identical reliabilities to the output and income measures of GDP and to consumer spending, which constitutes over 80% of expenditure-side GDP. The scope for divergence between the balanced and compromise estimates looks decidedly modest, though the treating of investment and trade data as respectively relatively uncertain and reliable should produce some disparity.

Greasley and Oxley are correctly interpreting the "Data Reliability" table in Solomou and Weale (1991, p. 58). A lesson here, though unstated by Greasley and Oxley, is that given the data, superior measures of relative error variances should be developed.

Greasley and Oxley go on to state that Solomou and Weale use Feinstein's *unadjusted* expenditure series (albeit incorporating Feinstein's revised estimates of gross domestic fixed capital formation) together with Feinstein's income series. In contrast, Feinstein combined *adjusted* expenditure with income to derive his compromise estimate. As Greasley and Oxley (1995, p. 267) write: "The expenditure estimates used in Feinstein's compromise contain adjustments to produce greater conformity with domestic income....Feinstein considered the expenditure [that is, Feinstein's unadjusted expenditure] data used by Solomou and Weale to be less reliable than the income data."[34] Greasely and Oxley (1995, pp. 267-268) conclude: "That Solomou and Weale do not make similar adjustments to the expenditure estimates, but assign the same reliability to income and consumer spending in their balanced estimates, looks contrary to the spirit of Feinstein, despite the latter being the inspiration for their reliabilities, and substantially accounts for the differences between the [Solomou-Weale] balanced and [Feinstein] compromise estimates."

Yet Greasley and Oxley (1995, p. 269) acknowledge that "Solomou and Weale...use the expenditure data most appropriate for the balanced estimates. Adopting Feinstein's expenditure adjustments to yield greater conformity with income would undermine their accounting identity between nominal and real expenditure, and prices, and perhaps also defeat the purpose of the balancing procedures." The lesson that Greasley and Oxley draw is the need for better data across the board: "the divergence between the estimates of nominal income and expenditure are substantial and even greater without Feinstein's expenditure adjustments...the balancing process should not be allowed to disguise the inherent weaknesses in the underlying data."

In the end, any estimation or reconciliation technique is at the mercy of the available data, which, for the generation of historical series, emanate essentially from three sources: official national accounts, Feinstein (1972), and Greasley (1989), the latter only for income-approach GDP 1856-1913. Perhaps the aforementioned Grealey-Oxley analysis—culminating, as it does, in a plea for superior data—provides a justification for the official balancing characteristic of combining data generation with data reconciliation!

B. Other Studies

Not included in Table 7 is Blake and Pain (1991), who exhibit a quarterly forecast balancing exercise for 1987-1990. They have a balancing *model* but not a balancing *technique*, with the elimination of statistical discrepancies accomplished via "manipulation of the least reliable estimate." They view the output estimate of GDP as the most reliable, and allocate residual error entirely to specific components of income or expenditure, specifically, the current-price residual error to income from self-employment (a component of income-approach GDP) and the constant-price residual error to business investment (a component of expenditure-approach GDP).

Also excluded from the table are balancing studies (always for the UK alone) that deal only with one year: der Ploeg (1981); Barker, der Ploeg, and Weale (1984); and Stone (1987), who produce balanced GDP for the years 1978, 1975, and 1969. These works are discussed in Stone (1988, pp. 28-29).

VII. Estimates of Total Product, Pre-1830

A. Differences between Pre-1830 and Later Estimates

There are four principal differences between the official and private GDP or GNP series, as listed in Tables 4-7, and pre-1830 estimates of total product.

1. Every entry in Tables 4-7 is a *continuous* series. In contrast, all the estimates of total product prior to 1830 are either for (i) single years, (ii) a set of non-contiguous years, or (iii, and rarely) a group of contiguous years for which only one figure is provided to apply to all these years jointly.

2. In Tables 4-7 there are ample *overlaps* of individual series, so that a continuous annual series for the UK can be constructed from 1830 to the present. The disjoint nature of pre-1830 estimates prevents extending this (to-be-developed) series for 1830-2000 backward in a continuous way.

3. The existence of *residual errors* and the associated issue of dealing with *statistical discrepancies* is all-important in the 1830-2000 series, as both the official accounts and many private scholars utilize more than one approach (among expenditure, income, output) in their work. In contrast, those that generate pre-1830 estimates of total product use only one approach or combine two approaches in a hybrid fashion—whence there is no residual error and therefore no statistical discrepancies to be eliminated.

4. With the exceptions of series for output (only at *constant* factor cost) and income (only at *current* factor cost), almost all authors in Tables 4-7 provide *both nominal and real* GDP or GNP as corresponding denominations.[35] Conversion of nominal to real data occurs at a disaggregative level; so the, higher, GDP-level (or GNP-level) deflator is truly "implicit." In contrast, estimates for the pre-1830 era estimate either nominal or real product in a disaggregative fashion, never both. So deflation or inflation (depending on whether conversion is from nominal to real, or real to nominal) is purely at the total-product level. The deflator is an aggregate price index rather than an implicit deflator.

Point 4 permits separate consideration of existing pre-1830 nominal and real estimates (in sections B and C below), and also treatment of the associated deflator (or inflator) measures in later sections (XI.B.1.b, XI.B.2).

B. Estimates of Nominal Product

1. Contemporary Estimates

Estimates of total income or product of a country were initially made in only nominal terms. William Petty was the first person to estimate the total product of any country. He did so in his *Verbum Sapienti* in 1665, where he applied a hybrid expenditure-income approach to calculate the consumption component of GNP for England and Wales as £40 million.[36] Later, in 1676, in his famous *Political Arithmetick*, Petty revised the figure upward to £42 million. Studenski (1958, p. 26) calls Petty "the originator of national income estimates," while Mitchell and Deane (1962, p. 364) observe that Petty "produced the first known national income estimate for this country [Britain]." However, Deane (1955, p. 5) cautions that "his [Petty's] figures are far from reliable."

A number of contemporary observers followed Petty in developing estimates of national income for various British territory—England and Wales, Great Britain (England, Wales, and Scotland), or the United Kingdom (England, Wales, Scotland, and Ireland). These estimates, for the period starting from the work of Gregory King in 1688 to the early 1830s, are discussed in Deane (1955; 1956, pp. 339-349), Studenski (1958, pp. 30-51, 101-110, 117-118), Lindert and Williamson (1982). Unlike Deane and Lindert-Williamson, Studenski presents the contemporary estimates without revision to improve or extend the original figures. This characteristic may not be a disadvantage to historians of national-income accounting, but limits the work relative to Deane and Lindert-Williamson for development of the series for **What Was the UK GDP Then?**

2. 1688-1830

Points 1-2 in section A above imply that extension of the (to-be-constructed) 1830-2000 series backward in time can be done feasibly only for isolated years. Yet it is desired to perform this exercise such that the pre-1830 observations are conceptually consistent with the continuous segment of the series. Therefore, to be identified as potential extensions of the series, pre-1830 estimates must satisfy the following criteria: They must be part of a group of estimates for (i) at least two years (not necessarily consecutive—indeed, such observations do not exist), with (ii) at least one year prior to 1830 and (iii) all estimates in the group deemed consistent by the responsible author.

Criterion (iii) is a necessary condition for an internally consistent set of new observations; criterion (ii) is required for an extended series; and criterion (i) is necessary to create an overlap between consistent sets of new observations (and ultimately between these sets and the 1830-2000 segment). Table 8 lists and summarizes eight groupings of series with these characteristics. Fulfillment of the criteria is shown in the table as follows: (i) and (ii) via column 2 ("Year"), and (iii) in notes c, o, q, r, s, u, v, y.

Table 8
Groupings[a] of Current-Factor-Cost GNP[b] Estimates, 1688 to 1831

Author	Year	Amount (£ m.)	Data Source	Approach
I. Deane (1955) Estimates for England and Wales[c]				
p. 8[d]	1688	48.0[e]	Barnett (1936)[f], Whitworth (1771)[g]	expenditure-income[h,i]
pp. 21-22	1770[j]	130[k]	Young (1770, 1771, 1774-1779)	output
p. 29	1798[j]	200.2[l]	Beeke (1800)[m], Bell (1802)	income[n]
pp. 33-36	1812	248	Colquhoun (1815)	output
II. Deane (1956) Estimates for Great Britain[o]				
p. 340	1800[j]	228	Beeke (1800)[m], Bell (1802)	income[n]
p. 342	1812	329.914	Colquhoun (1815)	output
p. 344	1822	288	Lowe (1822)	expenditure-output[h]
pp. 348, 353	1831[j]	424[p]	Pebrer (1833)	output
III. Deane (1956) Estimates Derived from Lowe, for Great Britain[q]				
p. 345	1792	157	Lowe (1822)	income[n]
p. 345	1806	277	Lowe (1822)	income[n]
p. 345	1813-1814	382	Lowe (1822)	income[n]
p. 345	1822	288	Lowe (1822)	income[n]
IV. Deane (1957) Estimates Derived from Mulhall, for United Kingdom[r]				
p. 458	1812	404	Mulhall (1896, 1899)	output
p. 458	1820	429	Mulhall (1896, 1899)	output
V. Veverka (1961) Estimates for United Kingdom[s]				

Table 8 Groupings[a] of Current-Factor-Cost GNP[b] Estimates, 1688 to 1831				
Author	Year	Amount (£ m.)	Data Source	Approach
p. 37	1792	200	Deane (1956)[t]	unstated
p. 37	1800	300	Deane (1956)[t]	unstated
p. 37	1814	418	Deane (1956)[t]	unstated
p. 37	1822	360	Deane (1956)[t]	unstated
p. 37	1831	403	Deane (1956)[t]	unstated
VI. Veverka (1963) Estimates for United Kingdom[u]				
p. 114	1790	186	"forthcoming study"	unstated
p. 114	1800	308	"forthcoming study"	unstated
p. 114	1810	407	"forthcoming study"	unstated
p. 114	1820	403	"forthcoming study"	unstated
p. 114	1830	438	"forthcoming study"	unstated
VII. Deane and Cole (1967) Estimates for Great Britain[v]				
p. 166	1801	232.0	Tax-assessment data, wages-and-salaries data[w]	income
p. 166	1811	301.1	Tax-assessment data, wages-and-salaries data[w]	income
p. 166	1821	291.0	Lowe (1822)	expenditure-output[h]
p. 166	1831	340.0	various[x]	income-output[h]
VIII. Lindert and Willliamson (1982, 1983b) Estimates for England and Wales[y]				
(1982, p. 393)	1688	54.440248	Barnett (1936)[f], Holmes (1977), Lindert (1980)	income[n]
1982, pp 396-397; 1983b (p. 329)	1759	66.838441	Massie (1760), Williamson (1982)	income[n]
1982, pp. 400-401	1801-1803	199.062194[z]	Colquhoun (1806, 1815), Davis (1956), House of Commons (1863-1869)	income[n]

[a]Groupings of estimates (i) for at least two years, (ii) at least one of which is prior to 1830, and (iii) all of which are deemed consistent by the responsible author.
[b]It happens that the aggregate measured by all estimates of nominal GDP or GNP prior to 1830 is effectively GNP at factor cost. However, see notes e and v.
[c]Estimates listed together as "approximate total national income" in table "Summary of Indicators of Economic Growth in England and Wales, 1688-1812" (Deane, 1955, p. 36). Aggregate measured is clearly GNP, as Deane (1955, p. 36, note 2) writes: "It is likely that they [the estimates] are gross of depreciation." "Incomes from abroad" is a separate entry for 1798, but is not separated from domestic-derived income for the other dates. Because "incomes from abroad" is gross rather than net of income paid abroad, gross *domestic* product cannot be calculated even for 1798.
[d]Reprinted in Deane and Cole (1967, p. 2).

[e]Retained earnings of firms assumed zero, whence personal income equals national income (national product at factor cost). GNP at market prices = 50.8, via Deane's addition of "indirect taxes (central government and local government)."
[f]Reprint of works of Gregory King.
[g]Reprint of works of Charles Davenant.
[h]Hybrid approach.
[i]Output by sector in Deane and Cole (1967, p. 156).
[j]Around that year.
[k]"About" that figure. Derived as 130.1 in Deane and Cole (1967, p. 156).
[l]Stated as "a little under £200 million" in Deane (1956, p. 340).
[m]Includes ("the Younger") William Pitt's estimates of assessable income.
[n]Personal income equated to national income. As stated by Lindert and Williamson (1983a, p. 105, note 2), "total personal income virtually equaled national income at factor cost before the mid-19th century, since retained earnings of nonhousehold enterprises were negligible."
[o]Estimates listed together as "national income" in table "Rates of change in the national income of Great Britain, 1800-1846" (Deane, 1956, p. 353). [Income from] "property abroad" is an individual entry for 1800, and "Banking and incomes from abroad' a separate item for 1812. However, because these flows are gross rather than net of income paid abroad (and in any event, for 1812, because "incomes from abroad" are included with "banking" income), gross *domestic* product cannot be calculated.
[p]Original estimate is for United Kingdom. Deane derives estimate for Great Britain by assuming per-capita income of Ireland 2/3 that of United Kingdom (Deane, 1956, p. 353, note 2 to Table 9).
[q]Estimates listed together as "derived national income at current prices" in table "Lowe's Estimates of Economic Trends in Great Britain, 1792-1822" (Deane, 1956, p. 345).
[r]Estimates listed together as "total national income" in table "National income of the United Kingdom, 1812-95" (Deane, 1957, p. 458).
[s]Estimates listed together as "total GNP at current prices" in table "Total Government Expenditure and Gross National Product, at Current and 1900 Prices, Selected Years, 1782-1900" (Veverka, 1961, p. 37).
[t]"Also...unpublished material supplied by the same author" (Veverka, 1961, p. 209).
[u]Estimates listed together as "gross national product at current prices" in table "Population, Prices, Gross National Product, and Government Expenditure" (Veverka, 1963, p. 114).
[v]Estimates listed together as "total national product" in table "The industrial distribution of the national income of Great Britain, 1801-1901" (Deane and Cole, 1967, p. 166). Aggregate measured is clearly GNP, as Deane and Cole (1967, pp. 165, 168) write: "Generally, however, it may be assumed that the incomes are gross incomes, inclusive of both capital consumption and incomes from abroad, and that the national-income aggregates related to gross national income or gross national product." However, GDP for 1821 and 1831 derivable as GNP *minus* "income (net interest and dividends) from abroad" (data from Imlah, 1958).
[w]See Deane and Cole (1967, pp. 148-152, 323-328).

[x]Extrapolation from 1840s income-tax assessments, wages-and-salaries data, and "certain ad hoc data" (Deane and Cole, 1967, p. 164). See also Deane and Cole (1967, p. 167, note 3 to table).
[y]Estimates listed together as "nominal personal income" (in deflated form) in table "Alternative Estimates of the National Income of England and Wales, 1688-1801/1803" (Lindert and Williamson, 1983a, p. 103; 1983b, p. 329).
[z]Adjusted figure. Lindert and Williamson provide a figure of 204.118139, which is altered in three ways. First, their computation includes an arithmetic error. Taking their figure of 198.576509 for "gross income for analysis of inequality" and adding the incomes of "groups set aside from analysis of inequality," the grand total is 204.317194 Second, the King's income is subtracted, as it is not included in the 1688 and 1759 estimates, which is noted by Lindert and Williamson (1982, p. 402, note d). This reduces income to 204.117194. Third, "incomes from the funds" is excluded, as a transfer payment, which again is suggested by Lindert and Williamson (1982, p. 402, note d). Income is thereby reduced to 199.062194. Lindert and Williamson make a convincing case for including other pensions: "the pension transfers being received by persons past service are used as a proxy for part of other persons' current earnings."

The aggregate measured by all the authors is effectively GNP at factor cost.[37] For one observation, GNP at *market* prices is also provided (see note e of Table 8); for two observations, *GDP* at factor cost is also computable (see note v of the table).

3. 1086 and 1300

Readers might be amazed to learn that it is possible to estimate the GDP of England for the year 1086, almost a millenium ago. The reason is the existence of Domesday Book, a record of a demographic and economic survey of England undertaken over 1085-1086 on the orders of William I (William the Conqueror), who had invaded and conquered England in 1066. Snooks (1993, p. 170) suggests that as many as 10,000 people were involved in the collection and recording of data for Domesday Book.

In essence, Domesday is an early census—of land, labor, output, wealth and income—although interpretation of the data in terms of modern economic terminology is not without controversy. Domesday Book has been called "the most comprehensive and yet the most neglected statistical source in European history"—Snooks (1993, p. 167), who goes on to observe that "Domesday Book has attracted a group of specialists, largely non-economic in focus, who are more interested in the document itself than in the realisty that gave rise to it....this data source...is without peer in the history of Europe, if not the world."[38] The Domesday Book provides a survey only of England, excluding Wales, the Welsh tribes having been "subdued but unconquered" (Snooks, 1993, p. 242).

Table 9 shows that two authors—Snooks and Mayhew—have developed GDP estimates, that are radically different, for England for the year 1086. Each relies heavily on Domesday Book, but the techniques are dissimilar. Because an empirically based GDP estimate for over 1000 years ago is so remarkable, some discussion of the estimates and their justifications are in order.

Table 9 Current-Factor-Cost GDP Estimates, England, 1086 and 1300[a]			
Author	Year	Amount (£ m.)	Data Source
Snooks (1993, p. 194)[b]	1086	0.136621[c,d]	Domesday Book and various secondary sources[e]
Mayhew (1995a, pp. 61, 72)	1086	0.300000[f,g]	Domesday Book, Titow (1969)
Mayhew (1995a, p. 58)	1300[h]	4.659300[f,i]	Dyer (1989)

[a]Estimates deemed consistent (by the author) with Gregory King's 1688 estimate as reworked by Deane or by Lindert and Williamson (see Table 8), except that 1688 estimate pertains to England and Wales. All authors in the table use an income approach. The aggregate concept measured by all estimates is effectively GDP at factor cost (see note n of Table 8).
[b]Also in Snooks (1994, p. 52; 1995a, p. 33).
[c]Consistent with 1688 estimate, manifested in table "The economic condition of England, 1086 and 1688" (Snooks, 1993, p. 246). Justification provided in Snooks (1993, pp. 240-244). See also Snooks (1994, pp. 54-55; 1995a, pp. 49-50).
[d]Listed as 0.137 in Snooks (1993, p. 246; 1994, p. 54; 1995a, p. 50). Range of 0.133133 to 0.139507 provided, depending on population (Snooks, 1993, pp. 178, 278).
[e]See Snooks (1993, pp. 175-194; 1995a, pp. 28-35).
[f]Consistent with 1688 estimate, manifested in table "Some estimated economic indicators, 1086, 1300, and 1688" (Mayhew, 1995a, p. 72). See also Mayhew (1995a, p. 56).
[g]Ranges of 0.137-0.400, 0.14-0.40, and 0.300-0.400 suggested—Mayhew, 1995a, pp. 61, 72; 1995b, p. 195.
[h]Around that year.
[i]Stated as "around £5.0 million" and "about £5.0 million" (Mayhew, 1995a, p. 59), and listed as 5.00 in Mayhew (1995a, p. 72).

Snooks estimates GDP at £0.136621 million, using an income approach with components demesne (domain) manorial income, subsistence-sector manorial income, unrecorded manorial income (because of counties omitted from Domesday Book), and burgal (town, urban) income.[39] Snooks' estimate rests on a number of assumptions:

1. Domesday Book provides net income (value added), rather than only rent, for each manor. Snooks argues that econometric evidence supports his interpretation.

2. Per capita manorial income can be applied to the urban population. This is justified, according to Snooks, by labor mobility within a given locality.

3. The subsistence level of unfree peasants is estimated correctly. For support, Snooks makes reference to empirical studies of later subsistence economies, including England in 1300 and other countries at later times.

4. The estimate of average rural household size, crucial for estimating total population, is correct. Snooks provides a sensitivity analysis, with GDP ranging from £0.133133 to £0.139507 depending on assumed household size.

5. The labor force recorded in Domesday Book is only a minimal (about five-percent) understatement. This view is justified by the peculiar socio-economic conditions in 1086 England, quite different from those in 1300 (on which proponents of the opposite view base their argument).

For consistency with later figures in the (to-be-constructed) GDP series of **What Was the UK GDP Then?** the criteria in section B.2 above are modified. It suffices to have an estimate for only *one* (pre-1830) year, provided that the estimate is deemed by the author (in present discussion, Snooks) to be consistent with the estimate for the earliest year in Table 8, that is, 1688. In fact, as Table 8 shows, there are two such estimates, each a reworking of Gregory King's figure, and provided by Deane (1955) and Lindert-Williamson (1982).

Snooks views his GDP figure for 1086 as consistent with that of Lindert and Williamson (appropriately adjusted to exclude Wales); for he includes both figures in tables "The economic condition of England, 1086 and 1688" (Snooks, 1993, p. 246; 1994, p. 54) and "The economic condition of England in 1086, 1300, and 1688" (Snooks, 1995a, p. 50). He converts the Lindert-Williamson figure of £54.44 million—*GDP at factor cost,* applicable to England and Wales—to *England* alone, essentially by multiplying the figure by the ratio of the population of England to the population of England and Wales (using 1801 Census data). The result is £50.80 million—which, purely by coincidence, is Deane's (1955) estimate of *GNP at market prices* for *England and Wales* together.[40] A purist might object to the twin assumptions that (i) the English/Wales population ratio was unchanged between 1086 and 1688, and (ii) per-capita GDP was equal in England and Wales in 1086.

An inconsistency noted by Snooks (1993, p. 243) is that "royal revenues are included in the 1086 national income figure but excluded in 1688." However, this differential treatment could be justifiable: the Crown's income was valuation of government output in 1086, when the King was the unchallenged head of government, but more of a transfer payment in 1688.

Interestingly, Snooks is more confident of his figure for 1086 than even the revised estimates of Gregory King : "the estimate by King, whether reworked by P. Deane or P. H. Lindert and J. Williamson, is not as firmly based as that for 1086" (Snooks, 1993, p. 242). "The underlying data and method for the calculation of GDP in 1086—basically estimates of numbers of families and estimates of annual family income—are far more reliable and robust that those used by Gregory King some six hundred years later" (Snooks, 1995a, p. 31). Therefore Snooks would disagree with the conventional wisdom expressed by Harley (1999, p. 164): "Estimates of British national income prior to the mid-nineteenth century involve projection backward into periods of less and less adequate data."

Turning to the estimate of Mayhew, his figure of £0.3 million is more than double that of Snooks—a far greater difference than, for example, the estimates of Deane and Lindert-Williamson for 1688 (see Table 8). Mayhew adopts a shortcut approach to estimating GDP. He takes recorded manorial income of £72,000 (the same demesne manorial-income figure used by Snooks), elevates it to £100,000 on grounds of omissions, and triples this amount to account for retained peasant income. The assumptions of Mayhew's method of estimation are as follows:

1. Recorded demesne income is rent, not value added. This is an alternative interpretation of the meaning of these Domesday figures.

2. There are serious omissions from demesne income. This view is a matter of judgment.

3. Demesne manorial rent is one-third of peasants' income. This is justified by the belief that peasantry income was substantially above subsistence level.

Mayhew is less confident of his estimate than is Snook, and in fact provides various ranges of GDP, the widest---£0.137-0.400 million—incorporating Snooks' figure as the lower limit.[41] Snooks' own range is far narrower—£0.133133-0.139507.[42]

Jumping ahead more than two centuries, there is one income-approach estimate of GDP for England for the year 1300. Snooks (1994, p. 54) is not the author; for he asserts: "[After 1086] the next year for which we have a reasonably reliable estimate of GDP per capita is 1688, calculated by Gregory King." However, producing a socio-economic table remarkably similar in structure to that of Gregory King, with operative columns "number of households" and "annual income (£) in cash & consumed produce," Mayhew (1995a, p. 58) computes GDP at £4.659300, as exhibited in Table 9.

In a table "Some estimated economic indicators, 1086, 1300, and 1688," Mayhew (1995a, p. 72) compares his 1086 and 1300 estimate with the same 1688 figure (£50.80 million) derived by Snooks. So the consistency criterion for considering Mayhew's estimates is fulfilled. However, while Snooks obtains the figure via a logical, if flawed, methodology, Mayhew (1995a, p. 56, note 3) refers to Deane and Cole (1967, p. 2) as the source of the 1688 estimate, which is a reprinting of the estimate of Deane (1955, p. 8). As mentioned above, the Deane figure of £50.80 million, GDP at market prices for England *and* Wales, is only coincidentally identical to that same Snooks figure (derived from Lindert and Williamson) for GDP at factor cost for England alone.

C. Estimates of Real Output

Estimates of real GDP over 1086-1831, summarized in Table 10, fall naturally into three groups. First is the landmark work of Deane and Cole (1967) and the close revision of Cole (1981). Deane and Cole generate indexes of real output for the following industries, with weights in parentheses: industry and commerce (.30) [composed of export industries (.18) and home industries (.12)], agriculture (.43), rent and services (.20), government and defense (.07). The weights pertain to the year 1700, and are based partly on contemporary (that is, Gregory King's) estimates of total product and partly on their own estimates of output of the home industries.

Table 10
Real[a] GDP Estimates, 1086 to 1831

Author	Year	Base Year	Territory	Technique	Data Sources
Deane and Cole (1967, p. 78)	1700-1800[b]	1700[c]	England and Wales[d]	output	various[e]
Cole (1981, p. 64)	1700-1800[b]	1700[c]	England and Wales	output	Deane and Cole (1967), Lee and Schofield (1981)
Harley (1982, p. 286)	1700, 1770, 1815	1700[c,f], 1841[g]	mixed[h]	output	Deane and Cole (1967), Crafts (1976, 1980), own industrial production
Snooks (1994, pp. 77-78)[i]	1086-1700[j]	_____	England	simulation[k]	various[l]
Clark (1999, p. 237)	1700, 1760, 1801, 1831	1700[c,f], 1770 1801, 1831[m]	mixed[n]	output	Crafts (1985), Crafts and Harley (1992), Wrigley and Schofield (1997), own agricultural production
Harley (1999, p. 178)	1700, 1760, 1780, 1800, 1830	1700[c,f], 1770 1801, 1831[m]	mixed[h]	output	Hoffmann (1955), Crafts (1985), Crafts and Harley (1992)

[a]Except for Snooks' estimate, "real" denotes "constant factor cost."
[b]Eleven decennial averages, roughly centered on 1700, 1710, ..., 1790, 1800.
[c]Around that year.
[d]"These estimates relate to England and Wales only" (Deane and Cole, 1967, p. 281).
[e]See Deane and Cole (1967, pp. 41-77).
[f]For 18th century.
[g]For industrial production.

[h]For industrial production, apparently Great Britain. For other sectors, England and Wales in 18th century, Great Britain in 19th century.
[i]Estimate for 1300 also in Snooks (1995a, p. 50).
[j]Sixty-one individual years.
[k]For details of procedure, see Snooks (1994, p. 65, 131, note 58; 1995a, pp. 51-52).
[l]See Snooks (1994, p. 131, note 58; 1995a, p. 52).
[m]Latter three years, for industrial production.
[n]For agriculture, England. For sectors other than agriculture and industry in 18th century, England and Wales. For industrial production, and for sectors other than agriculture in 19th century, Great Britain.

Cole (1981) adopts the same periods as Deane and Cole, the same industry composition, and the same weights. He describes his estimates as "based on revised versions of the index numbers of real output in Deane and Cole" (Cole, 1981, p. 63). There is a slight correction to the Deane-Cole output of export industries, a new agricultural index, and new population data used for computing output of agriculture, rent and services. The Deane-Cole indexes of home industries and of government and defense are unchanged.

The second group of studies, while emanating from the work of Deane and Cole, makes fundamental breaks with it. Harley (1982) provides a new series of industrial production and revised series of agriculture and services (drawing on the work of Crafts, 1976). Clark (1999) generates his own estimate of agricultural output and uses Crafts and Harley (1992) estimates for industrial production and services. Harley (1999) uses a new series of industrial production, while basing output of agriculture and services on Crafts (1985).

Excluded from this group, and therefore from Table 10, are GDP indexes implicit in estimates of rates of growth of real output. A number of such studies—in the Deane-Cole-Crafts-Harley tradition— exist, and, providing the algorithm for computing the growth rate per year is known, an index of output in the final and year relative to the initial year is calculable. If the author or user of the growth rate makes the index explicit—as, for example, Harley (1999, p. 178) does in his use of sectoral growth rates of Crafts and Harley (1992, p. 715)—then the resulting index is included in Table 10.

The third group consists of a single study, that of Snooks (1994), who uses an "empirically based computer model which simulates tends in real GDP and real GDP per capita between 1086 and 1688" (Snooks, 1995a, p. 51). Unlike Mayhew, Snooks believes that there are insufficient data to estimate GDP directly between 1086 and 1688, in particular, for the year 1300; and so he has recourse to a simulation. As Snooks (1995a, p. 51) writes: "No direct estimate is possible of GDP in 1300 because there are insufficient data on expenditure, production or incomes received. The best that can be achieved is an approximate figure derived from an empirically based computer model."

Figures for "real GDP in 1688 prices" are shown for 61 years between 1086 and 1688. However, there are subjective elements in Snooks' procedure—both in the overall methodology and in the use of qualitative information—and the resulting series is perhaps better described as "synthetic" rather than "simulated."

VIII. Selection of Components of GDP Series

A. Components in Both Denominations

Having surveyed all available estimates of GDP or GNP, one now proceeds to a period-by-period selection of the components of the, long-run, GDP series for **What Was the UK GDP Then?** Considering series in the time span 1830-2000, such series are generally available in both (that is, current-price and constant-price) denominations. Only the *selection* of component series is considered in this section. Achieving *consistency* both within component series and of the overall series, as well as details of construction of especially created component series, is postponed to section IX. In the selection procedure, it is convenient to proceed backward in time. All series listed in Tables 4-7 are potential component series (or elements of component series for especially constructed components). Components of the series are summarized in Table 11.

Table 11
Components of GDP Series

Period	Source	Aggregate	Concept[a]	Territory	Approach/ Technique	Details
1989-2000	official website[b]	GDP	MP	U.K.[c]	balanced	Table 4
1920-1989	Sefton and Weale (1995)	GDP	MP	U.K.[c]	balanced	Table 7
1913-1919	Mitchell (1988)	GDP	FC	U.K.[d,e]	compromise[f,g]	text[h]
1870-1913	Solomou and Weale (1991)	GDP	FC	U.K.[d]	balanced	Table 7
1856-1870	Feinstein (1972), Mitchell (1988), Greasley (1989)	GDP	FC	U.K.[d]	compromise[i,g]	text[h]
1830-1856	Mitchell (1988)	GDP	MP	U.K.[d]	expenditure	Table 5

Table 11
Components of GDP Series

Period	Source	Aggregate	Concept[a]	Territory	Approach/ Technique	Details
1801, 1811, 1821 [1831][j]	Deane and Cole (1967)	GNP	FC	Great Britain[k]	income	Table 8
1688, 1759, [1801][j,l]	Lindert and Williamson (1982, 1983b)	GNP	FC	England and Wales	income	Table 8
1300	Mayhew (1995a)	GDP[m]	FC	England	income	Table 9
1086	Snooks (1993)	GDP[m]	FC	England	income	Table 9

[a]MP = market prices, FC = factor cost.
[b]nationalstatistics.gov.uk
[c]Excluding Republic of Ireland or Southern Ireland.
[d]Including Southern Ireland.
[e]Also, for 1920, excluding Southern Ireland.
[f]Geometric mean of expenditure and income series.
[g]For component series, see Table 5.
[h]Series constructed by present author.
[i]Geometric mean of expenditure, income, and output series.
[j]Used only to achieve consistent series; see text.
[k]Excludes Ireland.
[l]Estimate for 1801-1803, considered to pertain to 1801.
[m]Equal to GNP; no interest-and-dividend income to/from abroad in these early years.

1989-2000:The obvious choice is the latest revised official series. The reason is threefold: (i) the series is up-to-date, (ii) it is ongoing (so the constructed GDP series can readily be extended beyond 2000—although the shift to annual chain-linking for constant-price GDP in *Blue Book* 2003 will introduce some complications), (iii) it is balanced.

1986-1988: Sefton-Weale (1995) is chosen over the official series, because the latter (i) uses only later input-output tables for balancing, and (ii) is partly a compromise estimate, while the former (i) is fully balanced (albeit via a technique different from that of the official accounts and at a higher level of aggregation), and (ii) is continuous back to 1920. Compared to the other private balanced series, Sefton-Weale is the longest, the most recently constructed, and the only one that overlaps with the official balanced series. As indicated in Table 11, the Sefton-Weale series for 1989 is also pertinent, because of the necessity for overlap to achieve a consistent long-run series.

1920-1985: The Sefton-Weale (1995) series continued.

1913-1919: There is no balanced series for the World-War-I period. There exist compromise series, Feinstein (1972) and Mitchell (1988) (the latter preferred, because of revised input—expenditure and income—series); but they are computed via the arithmetic mean.[43] Multiplicative measurement errors seem to the present author to provide a more-realistic structure than linear errors. So, to construct the compromise series, the single-approach series serving as inputs in Mitchell (1988) are adopted, but the geometric (rather than arithmetic) mean is applied. Details on construction of this component are provided in section IX.A.

1870-1912: Solomou and Weale (1991) is the only balanced series for this period. The criticisms of Greasley and Oxley (1995) were considered in section VI.A above, and the ultimate compromise series of Greasley (1992) is a viable alternative. As a matter of judgment, the present author considers the balancing characteristic of the Solomou-Weale series to outweigh both the criticisms of Greasley-Oxley and the alternative income series of Greasley. So Solomou-Weale is selected for this time period. The year 1913 is also needed, for reason of overlap.

1856-1869: The compromise series of Feinstein in Mitchell (1988) and Greasley (1992) are pre-constructed alternatives (see Table 6). However, neither uses the best available input series in combination: expenditure of Feinstein in Mitchell (1988), income of Greasley (1989), and output of Feinstein (1972). Also, Greasley computes only a real series, and the nominal series in Mitchell excludes output as an ingredient. Following Greasley (and the argument for 1913-1919 above), the geometric mean is indicated. Details of the constructed component series are in section IX.A. The year 1870 must be included, for overlap.

1830-1855: The only type of series available is single-approach expenditure. The alternatives are Deane (1968) and Feinstein in Mitchell (1988). Feinstein is selected, because it is more recent and in fact makes use of the Deane series. Again, the end-year (1856) is needed for overlap.

B. Components in Only One Denomination

1. Adoption of Nominal Product

For estimated GDP in the pre-1830 period, the basic choice is between alternative single-approach directly computed sets of figures: nominal product versus real output. The two alternative sets are so divergent in methodology that this author deems it inadvisable to use both for the long-run GDP series; rather, one or the other must be chosen. The decision here is to consider only the *nominal-product* estimates. There are several reasons for this choice:

1.The "nominal" methodology is consistent with the compilation of the official national accounts and with the components of the long-run series for 1830-2000, outlined in section A.

2. The "nominal" methodology makes considerable use of the income approach (see Tables 8 and 9), whereas the "real" methodology is entirely output-based (see Table 10). Feinstein (1998, p. 183), in commenting on the fact that historians exploring the pre-1830 growth of the British economy use predominantly real-output estimates, argues that "the incomplete and fragile nature of the available [output] data creates a strong case for the construction, on a consistent basis, of independent estimates of national product from the income side." Charles Feinstein is a voice that deserves hearing, because of his pioneering work in developing long-run GDP series for the United Kingdom. If Feinstein declares that the income approach should be adopted for pre-1830 work on GDP, that in itself is strong argument for adoption of the "nominal" methodology.

3. Warnings of specific data problems of the real-output approach in the 18th century have been made by various authors:

a. Measurement of output of individual sectors: Wright (1965, p. 405) comments that services can seldom be measured and that statistics for a satisfactory index of industrial production are incomplete. Berg and Hudson (1992, p. 29) similarly note the scarce direct evidence on output of the services sector. They also question the quality of Crafts' (1985) estimates of agricultural output "because he relies on "inferences from questionable estimates of population growth, agricultural incomes, prices, and income elasticities."[44]

Hoppit (1990, pp. 179-180) argues that smuggling and fraud distort the available data on industrial production, founded on customs and excise (tax) data, while data for output of industries not subject to excise are even less reliable. As for agriculture and services, "there is very little direct evidence and resulting estimates are very imprecise" (Hoppit, 1990, p. 182).

b. Weighting of sectoral outputs: Berg and Hudson point out that 18th-century price data are scarce, making it difficult to compute value-added by sector. Hoppit (1990, p. 181) echoes this concern: "To calculate it [value added] depends upon data on costs of inputs such as raw materials and the cost of the final product. Inevitably the historian is drawn into the murky waters of prices....Such information is notoriously deficient."

c. Coincidence of the Industrial Revolution: The latter part of the 18th century witnessed the beginnings of the industrial revolution. Berg and Hudson believe that industrial expansion is likely to take place "first and foremost" among many small firms, that do not record their business and so the output of which is unknown to historians, "who confine themselves to easily available indices" (Berg and Hudson, 1992, p. 29). Also, during "periods of fundamental economic change...the proportion of total industrial and commercial activity showing up in the estimates is likely to change radically over time." The latter phenomenon gives rise to both omitted output and an index-number value-added problem. Wright (1965, p. 405) states the entire issue well: "The attempt to summarize, in a single dimension, growth at different speeds in a wide range of industries, often accompanied by the introduction of new goods, may seem doomed to failure."

On the other side, Crafts and Harley (1992) address the criticisms of Berg, Hudson, and Hoppit and argue that the concerns of these authors are overstated. Nevertheless, they do not deny that some validity of their critics' views remains. Furthermore, direct estimates of current-price GDP have their own limitations. They are contemporary-observer based, there are insufficient data, and there is a lack of consistency among the estimates for different years. These deficiencies are addressed here by selecting only sets of estimates that are (1) consistent within the group, (2) linkable, directly or indirectly (via another set) to the 1830-1855 component of the long-run GDP series, and (3) constructed or reworked by modern economic historians.

2. Selection of Estimates

a. 1688-1831

Groups of estimates are selected from the listings in Table 8 by process of elimination, and are included in Table 11. Groups V and VI, the Veverka estimates are rejected for lack of documentation. Group III, Deane estimates derived from Lowe, is excluded, because the technique—proportionality between taxable and "untaxable" income—is simplistic (except that the figure for 1822 is satisfactory as the basic Lowe estimate). Group IV, Deane estimates derived from Mulhall, is rejected because the formula for obtaining the figures is questionable.[45] Also, the 1811 and 1821 estimates in Deane and Cole (1967) are deemed superior to the 1812 and 1820 figures here.

Groups I and II, Deane (1955, 1956) estimates, are excluded because the estimates are either superseded by later work or have specific deficiencies. The 1688 figure results from a reworking of King that is not as thorough as that of Lindert and Williamson (1982). The 1798, 1800, 1812, 1822, and 1831 estimates are superseded by the Deane-Cole (1967) figures for 1801, 1811, 1821, and 1831. The 1770 estimate (£130 million) seems out of synch with the much lower Lindert-Williamson figure for 1759. It is strange that Lindert and Williamson (1982, p. 398) seem to imply otherwise; but the subsequent downward revision of their figure (from £71 to £67 million) might induce them to revise their comment.[46] The 1812 estimates are based on the contemporary work of Patrick Colquhoun, and Lindert and Williamson (1982, p. 405) warn that "all of Colquhoun's 1812 estimates are shaky."

One is left with groups VII and VIII. Group VIII consists of the estimates of Lindert and Williamson (1982, 1983a), which are the outcome of the most though revision and redoing of the contemporary estimates for the years 1688, 1759, and 1801-1803, selected by these scholars because of their amenability to reworking.[47] Group VII, the figures of Deane and Cole (1967) for 1801, 1811, 1821, and 1831, are at once more satisfactory and more questionable. They are more satisfactory, because three of the years (1801, 1811, 1831) make use of tax-assessment data and the fourth (1821) emanates from a contemporary estimate of Joseph Lowe.[48] In enabling a hybrid expenditure-output estimate, Lowe's work appears to be unique among contemporary authors that estimate total product.[49] Also, Lowe's figure appears to be in line with the rest of group VII.

Crafts (1985, p. 42) observes that "the [Deane and Cole figure for] 1831 current income for agriculture is probably somewhat questionable," further stating that "Deane and Cole's figure for agricultural income in 1831 is in error." Mokyr (1987, pp. 306-308) harshly questions the reliability of the Deane-Cole estimate of current-price agricultural output in 1801 and, especially, 1831. The criticisms of these authors are telling; but if the figure for agriculture is obtained via allocation of a predetermined total, then the *total* GDP figure is unaffected. Mokyr seems to admit this possibility, and it is true that Deane and Cole are unclear on this matter. In fact, they admit "our basis for the 1831 estimates was very weak." However, again only the *sectoral allocation* might be in question; for Deane and Cole (1967, p. 164) write: "For 1831 we reached a set of highly tentative figures for the main components." In any event, it will turn out that *empirical evidence is supportive of the Deane-Cole figures*; for their 1831 estimate corresponds well with the figure for 1831 in the Feinstein series in Mitchell (1988).[50]

b. 1086

The choice is between the Snooks and Mayhew GDP estimates, summarized in Table 9. The difference in their point estimates is substantial, reflecting radically different interpretations of the nature and coverage of Domesday data. Selection is a matter of judgment on which reasonable people could differ. The Snooks figure is chosen, for a number of reasons.

1. It is a carefully constructed income-approach estimate.

2. The estimate is supported by a model of the Domesday economy.[51]

3. Snooks argues much more forcefully in favor of his own methodology and estimate than does Mayhew, who indeed adopts Snooks' figure as the lower limit of a range of possible GDP. Mayhew (1995a, p. 61) himself states: "The highly conjectural nature of these figures [that underlie his own estimate of GDP] cannot be over-emphasized."

4. Mayhew (1995b, pp. 195-196) attacks Snooks' estimate for (i) its basis on a specific interpretation of Domesday Book, (ii) the assumption that unfree peasantry had income at bare subsistence level, and (iii) the implication that exports were 20-24 percent of GDP, an "extraordinary" proportion; but Snooks anticipates such criticisms and addresses them well.

On the other side, Snooks attacks Mayhew's estimate as too high, complaining that Mayhew arbitrarily inflates total Domesday annual values, making too generous an allowance for omissions. Also Mayhew incorrectly (in Snooks' view) interprets the manorial annual values as rents rather than income (value added).

c. 1300

For the year 1300, there is only one nominal GDP estimate, that of Mayhew, in Table 9. Snooks (1995a, p. 51) disputes this estimate, arguing (as noted in section VII.C above) that "no direct estimate is possible of GDP in 1300 because there are insufficient data on expenditure, production or incomes received." Specifically, Snooks (1995b, p. 195) claims that Mayhew's figure is too high, because his indirect methods are insufficiently precise to take into consideration the very-low-income group of peasant and urban households. Snooks concludes: "It is just not possible to make even a heroic estimate of GDP for 1300 in this way."

Mayhew himself acknowledges the simplifications made to produce the income distribution that constitutes his table, but he seems relatively comfortable with the overall GDP level. In any event, he believes that the estimate of GDP for 1300 is well founded compared to any estimate of GDP for 1086. "Many guesses and estimates lie behind the figures it [the income-distribution table for 1300] contains, but the problems involved in the calculation of GDP for 1300 pale into insignificance alongside the difficulties of the same calculation for 1086" Mayhew (1995a, p. 60).

Mayhew's estimate for 1300 is accepted, for four reasons: (1) The estimate is an income approach. (2) It makes effective use of the available income-distribution data. (3) The structure of the socio-economic table is similar to that of Gregory King for the year 1688. (4) Those readers who believe the estimate is unworthy can simply neglect it; the long-run GDP and related series for other years are unaffected by inclusion of the year 1300.[52]

d. Consistency of 1086 and 1300 Estimates

The last two entries of Table 11 exhibit the selection of the Snooks GDP estimate for 1086 and the Mayhew estimate for 1300. The GDP figures are closely (and, or course, positively) related to the authors' respective population figures. This characteristic suggests the use of population estimates to assess the GDP estimates relative to one another. Snooks (1995a, p. 50) and Mayhew (1995a, p. 72) estimate population, millions of persons, in England in (1300, 1086) as (5.750, 1.531) and (6.00, 1.875), respectively.[53] The ratio of 1300 to 1086 population is, then, 3.8 for Snooks and 3.2 for Mayhew. Considering the Snooks population estimate for 1086 and the Mayhew figure for 1300, corresponding to the selected estimates for GDP, the ratio is 3.9—not much out of line with the authors' own ratios.

While other scholars have not estimated GDP for these early years of England's history, they have provided a variety of figures for population. These figures may be used to assess whether an almost fourfold increase in England's population from 1086 to 1300 is in line. Britnell (1995, p. 11) first considers "compromise" estimates of 2 million in

1086 growing to 6 million in 1300—a threefold increase. He then applies "extreme" figures found in the literature: 1.2 and 7.2 million in 1086 and 1300, implying a sixfold increase in population. He views this increase as much too high, stating that "much lower increases—as low, say, as from 2.5 to 4.75 million between 1086 and 1300—are within the bounds of current estimates, and would be more easily compatible with the history of agriculture" (Britnell, 1995, p. 12). The ratio here is only 1.9—less than a twofold increase. If accurate, such a ratio casts serious doubt on the GDP figures adopted here for 1086 and 1300.

Britnell's justification for the population figures of 2.5 and 4.75 million in the two years is twofold. First, Domesday Book has substantial omissions as a population census. Second, agricultural output in 1300 was insufficient to provide for a large population in 1300. Britnell (1995, pp. 11-12) quotes "a recent assessment of England's agricultural resources around 1300"--Campbell, Galloway, Keene, and Murphy (1993)—as issuing the challenge that "those historians who would favour a population in excess of 5 million need to demonstrate how, on known patterns of land use and productivity, that population could have been fed."

On Britnell's first point, the view of Snooks is decidedly different. Snooks (1995a, p. 31) believes that there are "relatively small omissions." He provides cogent argument against those who believe the contrary and proceed to provide "population estimates for 1086 that are up to 50 per cent too high." Snooks (1995a, pp. 34-35) concludes: "A population estimate of 1.53 million which assumes a household multiplier [average number of persons per household] of 5.0, and minimal underestimation from omissions, therefore appears most plausible and is that which is used here." Again, the estimated population of England in 1086 ultimately is a matter of judgment; but objectively one cannot deny that Snooks defends his estimate very well. Furthermore, if Snooks' methodology of estimating population is accepted, then even increasing average household size to 5.5 would increase population only to 1.67 million.[54] It appears that a population of about 1.5 million in 1086 is well-founded.

Britnell's second point can also be countered. He states: "It is inconceivable that the ploughed area of England even doubled between 1086 and 1300, except perhaps in the northern counties, so a threefold increase of population from 2.0 to 6.0 million is hard enough to explain" (Britnell, 1995, p. 12). However, there is also the matter of increases in agricultural productivity. Though he is a skeptic regarding the reliability of estimates of GDP for these early years, Dyer (1995, p. 197) observes: "Of course there were changes in the productivity and commercial orientation of peasant farming between 1086 and c. 1300 but...there is no evidential base." Still, given the selected figures for GDP in 1086 and 1300, there was a 34-fold increase in GDP from 1086 to 1300. Allowing for a fourfold increase in population (a slight overestimate) and even a fourfold increase in prices (an overstatement, according to the present author—see sections XI.B.2, XIII.B.2, and Table 18 below), overall productivity for the economy more than doubled. This productivity improvement, applied to agriculture, could combine with a less-than-doubling of farming acreage to provide sufficient food for the fourfold increase in population.

On balance, the GDP and related population estimates for 1086 and 1300 are consistent for each year relative to the other and do not appear inconsistent with agricultural history.

IX. Construction of GDP Series, 1830-2000

A. Internal Consistency of Component Series

It is logical to consider first the 1830-2000 segment of the long-run GDP series for **What Was the Interest Rate Then?** because (1) this segment comprises GDP in both current and constant prices, and (2) both the nominal and real long-run series will be continuous, with no missing years. Before combining the component series, each component must be made internally consistent throughout its time period. "Internal consistency" incorporates creation of compromise series. The component series are considered in the same order as in section VIII.A and as in Table 11, where they are listed as the first six entries.

To aid presentation in this and later sections, the following notation is used

X= name of component series
C = current market prices, millions of pounds
FC = current factor cost, millions of pounds
KYR = constant (19YR) market prices, millions of pounds
FKYR = constant (19YR) factor cost, millions of pounds

Combining these elements,

XC = component series X, current market prices, millions of pounds
XFC = component series X, current factor cost, millions of pounds
XKYR = component series X, constant (19YR) market prices, millions of pounds
XFKYR = component series X, constant (19YR) factor cost, millions of pounds

Subscript t denotes year t.

"Linking" of series U to a later series V via an "overlapping" year, generally the earliest year for which V is available, is the way to extend V backward to the years for which U is available. To "link" U_t, t = 0,...,m, to V_t, t = m,...,n, via the "overlap" in year m (also called the "m overlap"), means that U_t is transformed into $V_t = (V_m/U_m) \bullet U_t$, t = 0,...,m-1, while V_t, t = m,...,n, is left undisturbed. Year m is termed the "overlap year" or "link year."

Applying the above notation, the internal consistency of the component series of long-run GDP is examined as follows:

<u>1989-2000:</u> OB = official (balanced) series. OBC and OBK95 are internally consistent.

1920-1989: SEW = Sefton-Weale (1995) series. SEWC is internally consistent. SEWK38 (available 1920-1948) is linked to SEWK85 (available 1948-1990) via the 1948 overlap, thus achieving internal consistency for SEWK85.

1913-1919: COM = compromise series, constructed as follows. E = Feinstein expenditure series in Mitchell (1988, pp. 833, 839); I = Feinstein income series in Mitchell (1988, p. 829). ED38 = expenditure deflator (1938 = 1), defined as EFC/EFK38. The expenditure deflator is used to create the income series at constant factor cost, which is the practice begun by Feinstein and continued by others. Thus IFK38 = IFC/ED38. Then COMFC = (EFC•IFC)⁻ and COMFK38 = (EFK38•IFK38)⁻.

1870-1913: SOW = Solomou-Weale (1991) series. SOWFC and SOWFK00 are each internally consistent.

1856-1870: COM = compromise series, constructed as follows. E = Feinstein expenditure series in Mitchell (1988, pp. 832, 838); IFC = Greasley (1989, p. 258) income series at current factor cost, OFK = Feinstein (1972, p. T24) output series at constant (1913 = 100) factor cost. OFK is converted to constant (1900) factor cost, millions of pounds, by division by 100 (thus converting to 1913 = 1), further division by OFK_{1900}, which is 0.796, and by multiplication by $EFK00_{1900}$, which is 1787. Thus OFK00 = (1787/79.6)•OFK.[55]

ED00 = expenditure deflator (1900 approximately 1), defined as ED00 = EFC/EFK00.[56] The expenditure deflator is used to generate the income series at *constant* factor cost and the output series at *current* factor cost: IFK00 = IFC/ED00, OFC = ED00•OFK00. Then COMFC = $(EFC•IFC.OFC)^{1/3}$ and COMFK00 = $(EFK00•IFK00•OFK00)^{1/3}$.

1830-1856: Again, E = Feinstein in Mitchell (1988) expenditure series. EC and EK00 are each internally consistent.

B. Construction of Consistent Long-Run Series

1. Notation

The desired GDP series are denoted as follows.

GDPC = long-run GDP series, current market prices, millions of pounds
GDPK = long-run GDP series, constant (1995) market prices, millions of pounds

Notation consistent with that in section A suggests GDPK95 rather than GDPK; but symmetry with GDPC and lack of ambiguity as to base year suggest that "95" can be understood.

The series GDPC and GDPK will be developed continuously for 1830-2000 in this section, making use of the internally consistent component series in section A. In later sections, the series will be extended back in time for selected years, including 1086 and 1300.

2. Consistency over Time, by Territory

a. United Kingdom, with Northern Ireland: 1920-2000

1989-2000: The two long-run series are constructed as backward extensions of the official balancing series associated with *Blue Book 2002* and the National Statistics website as of December 31, 2002. Therefore GDPC = OBC and GDPK = OBK95.

1920-1988: GDPC (GDPK) is extended by linking SEWC (SEWK85) to 1989-2000 GDPC (GDPK) via the 1989 overlap.

Those familiar with Irish history could object legitimately that the Irish Free State (which became Eire in 1937 and the Republic of Ireland in 1949) was established on December 5, 1922, by Act of British Parliament; and therefore, legally—and logically for an annual series—Southern Ireland is excluded from UK territory only from 1923, decidedly not from 1920. The latter treatment, adopted here, is a consequence of a decision by Feinstein (1972, p. 3) to break his series in 1920, providing figures both inclusive and exclusive of Southern Ireland for that year.[57] His justification is: "Although it does some violence to the historical record it seemed more convenient to make the break at a point which would not interrupt the series for the inter-war period."

b. United Kingdom, with Ireland: 1830-1919

1913-1919: Several adjustments are made to COMFC and COMFK38. First, they need to be converted from factor cost to market prices. This is done by multiplying by the appropriate market-price/factor-cost expenditure ratio. As in 1913-1919, section A, E = Feinstein expenditure series in Mitchell (1988, pp. 831-833, 837-839). Then, for 1913-1919, COMC = (EC/EFC)•COMFC, and COMK38 = (EK38/EFK38)•COMFK38.

Second, the series should be adjusted for changes in definition that occurred with the exclusion of Southern Ireland in 1920. In other words, a consistent series requires that the definitions for 1920 onward (for UK exclusive of Southern Ireland) be applied to the earlier years (for UK inclusive of Southern Ireland). Feinstein (1972, p. 10) provides information to make this adjustment. The measure deconstructed is income-approach GDP at current factor cost (in millions of pounds) for 1920. Pre-1920-basis income (5434) *minus* Southern-Ireland component (195) *plus* difference in definition (27) *equals* post-1920-basis income (5266). So the income series entering the compromise estimates should be pre-multiplied by (1 + 27/5434). Feinstein shows explicitly that no difference in definition applies to the expenditure series. Although he does not discuss the output series, it is reasonable to assume that there is no change in definition here as well. Therefore only the income input into the compromise series requires adjustment. So COMC and COMK38 need to be multiplied by the square root of (1 + 27/5434), which is 1.002481279.

Third, COMK38 also needs to be converted from 1938 to 1995 prices, for consistency with the (already computed) 1920-2000 GDPK. This is done by means of the multiplicative factor "GDP at market prices for UK including Northern Ireland" (in 1995 prices)/(in 1938 prices) for 1920. The numerator (in 1995 prices) is $GDPK_{1920}$, already computed. The denominator (in 1938 prices) is $SEWK38_{1920}$. Therefore, combining the second and third adjustments, GDPC = 1.002481279•COMC and
GDPK = 1.002481279•($GDPK_{1920}$/ $SEWK38_{1920}$)•COMK38.

1870-1912: SOWFC and SOWFK00 are converted to market prices, similarly to the first adjustment for 1913-1919. For 1870-1913, SOWC = (EC/EFC)•SOWFC and SOWK00 = (EKOO/EFKOO)•SOWFK00. GDPC (GDPK) is obtained by linking SOWC (SOWKOO) to 1913-2000 GDPC (GDPK) via the 1913 overlap.

1856-1869: The compromise series are converted to market prices as they were for 1913-1919 above. For 1856-1870, COMC = (EC/EFC)•COMFC, and COMKOO = (EKOO/EFKOO)•COMFKOO. GDPC (GDPK) is extended from 1870-2000 by linking COMC (COMFKOO) via the 1870 overlap.

1830-1855: GDPC (GDPK) is extended by linking EC (EK00) to 1856-2000 GDPC (GDPK) via the 1856 overlap.

Thus the long-run series GDPC and GDPK are constructed continuously for 1830-2000.

X. Consistency of Pre-1830 GDP with 1830-1855 Component

A. Methodology

The pre-1830 selected estimates of GDP for the long-run series are in nominal and not real terms. Therefore only GDPC can be extended directly to incorporate these estimates. GDPK will be extended in later sections (XI-XIII), via construction of a deflator to apply to GDPC.

To extend GDPC backward in time for the selected years—1086, 1300, 1688, 1759, 1801, 1801-1803, 1811, 1821, 1831—shown in the last four entries of Table 11 (first column), the estimates must be made consistent with EC, the (unadjusted) 1830-1855 component of GDPC. The same overlap factor as for 1830-1855 above can then be applied to achieve consistency with the continuous (that is, 1830-2000) segment of the series. The year 1831 is included for use in the consistency process. The 1801-1803 estimate of Lindert and Williamson is taken to pertain to the year 1801. Thus there are two estimates for 1801—Deane-Cole and Lindert-Williamson; but the latter is used only to achieve consistency.

B. Conversion from GNP to GDP

The estimates, except for 1086 and 1300, measure GNP rather than GDP. To obtain GDP, one applies the formula GDP *equals* GNP *minus* "net property income from abroad." Strictly speaking, "net factor income from abroad" should be the subtrahend (see section I.B); but the other components of "net factor income from abroad" for the pre-1830 period are either included in property income or deemed zero or quantitatively unimportant. The issue then becomes obtaining the data for "net property income from abroad."

<u>1821 and 1831:</u> "Net property income from abroad" is £2.8 million in 1821 and £3.9 million in 1831. The source is Imlah (1958, pp. 70-71), the column "balance on interest and dividends."

<u>1759:</u> Unfortunately, Imlah's series begins in 1816, so cannot be used for the earlier years. However, Brezis (1995, p. 51) extends Imlah's series to the 18th century, providing annual averages of "[net] debt service" by decade 1711-1720 to 1791-1800.[58] So it should be possible to decipher a figure for 1759. A sensitivity analysis with four sets of estimates (cases A-D for different initial net debt in 1710) is performed (Brezis, 1995, p. 53). Brezis' study is severely criticized by Nash (1997, p. 125), who, in particular, argues strongly in effect for Brezis' case D (initial net *credit* of £2) in place of Brezis' own selected case A (initial net *debt* of £2 million).[59] Brezis (1997, p. 132) sees Nash's comments as favoring rather her case C (initial net *credit* of £0.7 million), which does not appear correct—perhaps "C" is a misprint.[60] Considering Brezis' sensitivity analysis for varying initial debt, for 1751-1760 the range for net debt service is -£0.57 to -£1.42 million. Obviously, the uniform rounded figure of -£1 million can be taken for "net property income from abroad."

<u>1801:</u> For 1791-1800, estimated annual debt service ranges from -£0.78 to -£2.58 million, according to Brezis' sensitivity analysis. The former figure, in case D, is inferentially favored by Nash. Accepting the Nash preference and extending the decade by one year, "net property income from abroad" is again -£1 million.

<u>1811:</u> Brezis (1995, p. 55) states that: "between 1790 and 1815 the UK passed from being a debtor to being a creditor nation." This statement is supported in two ways. First, Brezis' sensitivity analysis shows almost uniform net-debtor status to 1790. Second, it appears that Imlah would agree with Brezis' statement. Consider that, for 1816, Imlah has +£0.6 million as the balance on interest and dividends, a number not far above zero. Furthermore, Imlah (1958, pp. 66-67) writes: "All in all, the foreign capital placed in Britain may have equalled the gross amount of British investment abroad in 1815. If there was a net balance in British favor at the close of the war it must, then, have been a modest one. I have assumed, as a guess, that the net balance at the close of the year 1815 was about £10 millions. If, as is not altogether unlikely, the figure should be smaller, the error is probably offset in the course of the ensuing five or six years by... [other items in the balance of payments]."

The year 1811 is within a period of great balance-of-payments uncertainty. If about that time Britain went from being a net debtor to net creditor, then approximately zero "net property income from abroad" is a good approximation. This guess is in line with Imlah's analysis of the situation, as quoted above.

1688: Out of total ignorance, with Britain's net creditor status in 1710 ranging from -£2 to +£2 million in Brezis' sensitivity analysis, again "net property income from abroad" is taken as zero.

1086 and 1300: The authors (Snooks and Mayhew) claim that their figures estimate GDP, which is reasonable. In these early times, interest and dividend flows did not exist. More generally, "net factor income from abroad" was in the nature of a transfer payment (for example, war booty) rather than a market return on factor services.

C. Conversion from Factor Cost to Market Prices

There are two techniques that can be used to transform GDP from factor cost to market prices. First, an estimate of net indirect taxes can be added directly to GDP at factor cost. Second, a factor that estimates the market-price/factor-cost ratio can multiply GDP at factor cost. That is the technique used in section IX.B.2.b.

1688: The first technique is used. Deane (1955, p. 8) has indirect taxes at £2.8 million, which is added to GDP at factor cost.

1831: The second method is applied. One recalls from section IX.B.2.b that EC (EFC) = Feinstein in Mitchell (1988, p. 831) market-price (factor-cost) expenditure series. Then the factor to multiply GDP at factor cost is $(EC/EFC)_{1831}$.

1759, 1801, 1811, 1821: The second technique is employed; but market-price/factor-cost ratios for these years are not available directly; they must themselves be estimated. Let R_t denote the market-price/factor-cost ratio for year t. Then R_{1688} = 57.24/54.44 = 1.05. R_{1830} can be estimated as $(EC/EFC)_{1830}$ = 501/440 = 1.14. These are endpoints for linearly interpolating R_t for t = 1759, 1801, 1811, 1821. There is no information to assess the robustness of R_{1688} as the lower endpoint; but, for the upper limit, it is pleasing to note that the average $(EC/EFC)_t$, over t = 1830 to 1834 is also 1.14. R for the four intervening years in question is estimated via linear interpolation.

1086 and 1300: In ignorance of indirect taxes, one assumes they are zero, so that GDP at market prices equals GDP at factor cost.

D. Consistency Under Territorial Change

1. Geographic Schemata

The Act of Union of England and Wales occurred in 1536. Therefore GDP of England alone should be measured in 1086 and 1300, while Wales should be included in 1688, 1759, 1801, 1811, 1821, and 1831. This rule is satisfied by the data.

On May 1, 1707, the Act of Union of Scotland and England came into effect. Therefore, ideally, Scotland should be included in territory covered by the GDP estimates for 1759 onward. This principle is fulfilled for the 1801, 1811, 1821, 1831 Deane-Cole figures; but Scotland is excluded from the Lindert-Williamson estimates. Of the latter estimates, that for 1688 legitimately is for England and Wales alone, those for 1759 and 1801-1803 violate the legal territorial principle in continuing to exclude Scotland. The only important violation is for 1759, as the 1801-1803 figure will be used only to achieve consistency.

On January 1, 1801, the Act of Union uniting Ireland and Great Britain in the United Kingdom of Great Britain and Ireland came into effect. However, the 1801, 1811, 1821, 1831 Deane-Cole estimates exclude Ireland. Again, the 1831 violation is unimportant, as the figure for that year will be used only for consistency purpose.

The legal territorial violations of the figures for 1759, 1801, 1811, and 1821 are a necessary consequence of the data and must be accepted. However, the task remains of making all the pre-1830 estimates consistent in definition, though not territory, with EC, the (unadjusted) 1830-1855 component of GDPC.

2. Definitional Consistency

a. 1801, 1811, 1821

The Deane-Cole estimates for 1801, 1811, 1821, 1831 exclude Ireland; EC for 1830-1855 includes Ireland. How can the Deane-Cole estimates be made consistent with EC on a definitional basis, while still retaining its territorial peculiarity? Using an income approach, Mokyr (1983, p. 10) estimates Irish income around 1841 as £124.39 million.[61] The concept is GNP at factor cost. Lowe, in Deane (1956, p. 344), estimates Irish income in 1822 as £70 million; and Deane and Cole (1967, pp. 164, 166-167) take this estimate as pertaining to 1821, which is reasonable (see note 48). Again what is measured is GNP at factor cost. Linear interpolation to estimate Ireland income for 1831 involves simply averaging the figures, yielding £97.195.

Therefore the Deane-Cole 1831 factor-cost GNP figure extended to incorporate Ireland is their estimate for Great Britain (£340 million, from Table 8) plus the estimate for Ireland (£97.195), which equals £437.195. This compares well to EFC (£446) for that year. So, for consistency with the definitions of Feinstein in Mitchell (1988) but still excluding Ireland, the Deane-Cole figures for GDP at market prices (computed in section C above) are multiplied by 446/437.195 = 1.020139755. This is done for 1801, 1811, and 1821. As indicated earlier, the 1831 estimate is used solely to construct the adjustment ratio.

b. 1688, 1759

The Lindert-Williamson estimates for 1688, 1759, and 1801 are for England and Wales, whereas the Deane-Cole adjusted figures for 1801, 1811, and 1821 are for Great

Britain (that is, they also include Scotland). To make the Lindert-Williamson figures comparable in definition to Deane-Cole but still excluding Scotland, one needs an estimate of income for Scotland in 1801. Deane (1956, p. 340) develops GNP at factor cost around 1800 as £228 million for Great Britain and £200 for England and Wales.[62] GNP at factor-cost for Great Britain relative to England and Wales in 1800, therefore, is 228/200 = 1.14.

Now, the Lindert-Williamson 1801 estimate of "GDP at market prices" (obtained by the adjustments in sections B and C above) is £224.3898. Multiplying that figure by 1.14 yields £255.8044, which is an estimate of GDP at market prices, on *their* definitional basis, for Great Britain. This estimate is compared to £261.3328, the Deane-Cole figure for 1801, obtained from sections B and C in the same way, and which directly pertains to Great Britain. Therefore, for definitional comparability with the Deane-Cole adjusted figures (for 1801, 1811, 1821) while retaining England and Wales as the territory, the Lindert-Williamson figures for 1688 and 1759 are multiplied by 261.3328/255.8044 = 1.02161825. Then, for definitional conformity with Feinstein in Mitchell (1988), they must also be multiplied by 1.020139755—the factor applied to the Deane-Cole estimates for this purpose.

c. 1086, 1300

The Snooks and Mayhew estimates are for England, whereas the Lindert-Williamson figures are for England and Wales. Therefore the Snook and Mayhew estimates must be made comparable in definition to the Lindert-Williamson figures but still excluding Wales. Both authors view their estimate as consistent in definition with the Lindert-Williamson for 1688 (for Mayhew apparently by accident).[63] Hence, in the absence of information to the contrary, the same adjustments for the Lindert-Williamson 1688 and 1759 figures are applied to the 1086 and 1300 estimates.

E. Link to Continuous Segment of Series

GDP at market prices resulting from the adjustments in sections B-D is shown in Table 12. These figures are consistent only with the Feinstein in Mitchell (1988) current-price expenditure series (denoted as EC in section IX) *prior* to its use in extending GDPC to 1830-1855. Then the same linking factor as for EC must be applied, to achieve consistency with 1830-2000 GDPC. Specifically, the ratio $(GDPC/EC)_{1856}$ is the multiplicative overlap factor, as it was for 1830-1855 in section IX.B.2.b.

Table 12
GDP[a] Consistent with Feinstein[b] Expenditure Series, 1086-1830

Year	Territory	Amount (£ m.)
1086	England	0.1424
1300	England	4.8559
1688	England and Wales	59.6550
1759	England and Wales	77.4169

Table 12 GDP[a] Consistent with Feinstein[b] Expenditure Series, 1086-1830		
Year	Territory	Amount (£ m.)
1801	Great Britain	266.5960
1811	Great Britain	346.4811
1821	Great Britain	333.4891

[a]At current and market prices.
[b]In Mitchell (1988, p. 831-833).

The series GDPC is now extended, consistent except for territory, from the continuous segment 1830-2000 back to 1821, 1811, 1801, 1759, 1688, 1300, 1086 (these years termed "1086-1821"). The territory covered for each year of the discontinuous (1086-1821) segment of the series is shown in Tables 11 and 12. The continuous segment has two territorial components: UK inclusive of Ireland (1830-1919) and UK inclusive only of Northern Ireland (1920-2000), as indicated in Table 11.

The series GDPC is now complete, but GDPK exists only for 1830-2000. To extend GDPK to 1086-1821, GDPC for these years is to be divided by a constructed GDP deflator.

XI. Construction of Deflator: Existing Price Indexes

A. 1830-2000

For 1830-2000, the GDP deflator, indexed as 1995 = 1, is readily constructed in the traditional implicit manner, as PGDPI = GDPC/GDPK. For the customary index of base year equaling 100 (1995 = 100), the GDP deflator is PGDP = 100•PGDPI.

B. 1086-1821

For 1086-1821 (the discontinuous segment of GDP), GDPC but not GDPK has been obtained directly. Therefore an implicit deflator cannot be computed. Not only must the deflator be estimated exogenously, but also it is needed to obtain GDPK—via deflation of GDPC.

It is convenient to separate the 1086-1821 period into two subperiods: 1086-1688 (considered in section 2), and 1688-1821(treated first, in section 1). Because existing price indexes for the latter period begin as early as 1660 and as early an initial year as possible is desirable for linking to the price index for 1086-1300, the time period considered begins in 1660. Because any estimated deflator is to be linked to the previously computed deflator, PGDPI, for 1830-2000, the period ends in 1830.

1. 1660 to 1830

a. List of Potential Deflators

Table 13 summarizes all known price indexes with time period within 1660-1830 (including the end-points) that are aggregate in nature and that are not cost-of-living or retail price indexes. In the table, the time period of the indexes is generally truncated at 1830, the latest year required of a deflator. The indexes must be aggregate, or be composed of subindexes below the aggregate level but capable of being aggregated, so that a reasonable representation of the price level for total product is, or can be, achieved. Cost-of-living and retail price indexes are excluded, because they are narrowly based solely on the consumption component of GDP.

Table 13
Aggregate Price Indexes of Output, 1660-1830[a]

Author	Time Period[b]	Coverage	Nature of Prices	Subindexes	No. Items	Weights: Type[c]	Weights: Base Year
Taylor (1848, pp. 466-468)[d]	1784-1832[e]	food and raw materials[f]	wholesale	____	90	equal	____
Jevons (1865, pp. 314-315)[g]	1782-1830	food and raw materials	wholesale[h]	____	40	equal	____
Sauerbeck (1886, p. 634)[i]	1818-1830	food and raw materials	wholesale[j]	____	31	equal	____
Silberling (1923)[k]	1779-1830	food and raw materials	wholesale	domestic[l], imports[m]	35	equal	____
Kondratieff (1928, p. 72)[n]	1786-1830	food and raw materials	wholesale	____	25	equal	____
Rousseaux (1938, p. 266)[o]	1800-1830	food and raw materials	wholesale	agricultural, industrial	42	equal	____
Schumpeter (1938, pp. 34-35)[p]	1660-1823[q]	food, clothing, candles, raw materials	contract and wholesale	consumer goods[r,s], producer goods[s]	14, 44[t]	equal	____
GRS (1953, p. 468)[u]	1790-1830[v]	food and raw materials[w]	wholesale	domestic, imports	78	cons.	1820-1840
Hueckel (1973, p. 388)[x]	1790-1820	food and raw materials[y]	contract and wholesale	agricultural[s], industrial[s]	22	prod.	not stated

O'Brien (1985, pp. 787-795)[z]	1660-1820[A]	food and raw materials[B]	contract and wholesale	agricultural[s], industrial[s]	29	cons. and prod.	1789-1794, 1805[C]

[a]Cost-of-living indexes excluded.
[b]Series annual except where otherwise stated. Series truncated after year 1830.
[c] cons.= consumption weights, prod. = production weights.
[d]Reprinted in Silberling (1919, pp. 321-322). Series described and compared to that of Jevons in Silberling (1919, pp. 284-285).
[e]Seven-year periods, 1784-1790 to 1826-1832.
[f]Also, candles.
[g]Reprinted in Jevons (1884, pp. 144-145) and GRS (1953, p. 521). Series described in Jevons (1865, pp. 294-301, 312-313), Silberling (1919, pp. 282-284), and GRS (1953, pp. 519-521). Series criticized in Rousseaux (1938, pp. 65-67).
[h]1801-1820: both gold and paper prices.
[i]Reprinted in GRS (1953, p. 522). Series described in Sauerbeck (1886, pp. 632-635) and GRS (1953, pp. 520-521), criticized in Rousseaux (1938, pp. 69-70).
[j]1818-1820: gold prices.
[k]Reprinted in GRS (1953, p. 524) and, recomputed with gold prices for 1801-1820, in Kondratieff (1926, p. 600). Described in Silberling (1923, pp. 223-230) and GRS (1953, pp. 523-524), criticized in Rousseaux (1938, pp. 67-68) and in GRS (1953, pp. 461, 463-467).
[l]And imports bearing relatively low freight charges.
[m]Bearing relatively high freight charges.
[n]Reprinted in GRS (1953, p. 526), described in GRS (1953, pp. 525-526), and criticized in Mitchell and Deane (1962, p. 466).
[o]Reprinted in GRS (1953, p. 528), Mitchell and Deane (1962, p. 471), and Mitchell (1988, p. 722). Described in Rousseaux (1938, pp. 72-77) and GRS (1953, pp. 526-527). Criticized in Mitchell and Deane (1962, p. 466), Hueckel (1973, p. 386, note 36), and Mitchell (1988, p. 716).
[p]Commonly called "Schumpeter-Gilboy price indexes," recognizing related work of Gilboy (1936). Reprinted in Mitchell and Deane (1962, pp. 468-469) and Mitchell (1988, pp. 719-720). Criticized in Mitchell and Deane (1962, pp. 465-466), Mitchell (1988, p. 715), and implicitly in Deane (1955, p. 23, note 71).
[q]Years beginning about October 1 ("harvest years"). Separate indexes for 1660-1697 and 1695-1823. Producer-goods index ends in 1801.
[r]From 1695 both including and excluding cererals.
[s]Subindexes not combined into aggregate index.
[t]For 1660-1697 and 1695-1823, respectively.
[u]GRS = Gayer, Rostow, and Schwartz. Series described in GRS (1953, pp. 461-485), criticized in Mitchell and Deane (1962, p. 466) and Mitchell (1988, p. 716).
[v]Monthly. Derived annual series in Mitchell and Deane (1962, p. 470), and Mitchell (1988, p. 721).
[w]Also, soap.
[x]Reprinted in Mokyr and Savin (1976, p. 211), described in Hueckel (1973, pp. 386-387).
[y]Also, shoes and soap.

[z]Reprinted in Chartres (1994). Described in O'Brien (1985, pp. 790-792, 795-798).
[A]O'Brien's data sources involve both calendar and harvest years. He does not make explicit his conversion of harvest to calendar years. In fact, he makes no mention of harvest years, whence it may be inferred that his series are meant to pertain to calendar years. Though it is not certain, it appears that, in the construction of his indexes, a given year of a harvest-year component series is allocated to the calendar year in which the harvest year begins.
[B]Also, linens, woolens, candles, and building wages.
[C]Around that year.

b. Price Indexes Used by Previous Authors

Table 14 lists the use by previous authors of price indexes for the purpose of correspondence between nominal and real GDP within the time period 1660-1831 or, more precisely, 1688-1831. Such correspondence encompasses not only deflation of nominal to obtain real GDP but also inflation of real to estimate nominal GDP and looser comparisons of price movements with (real or nominal) GDP movements. Interestingly, not all the price indexes entered in Table 13 have been so utilized. Furthermore, some price indexes not in that table have been employed by authors.

Table 14
Price Indexes Used for Real/Nominal Correspondence of GDP[a], 1688-1831

Author	Time Period	Index[b]	Function of Index[c]
Deane (1955, p. 36)	1688-1812	Schumpeter (1938)[d,e,f]	"price indicators"[g]
Deane (1956, pp. 345-346)	1792-1822	GRS (1953)[h]	deflator[i]
Deane (1956, p. 353)	1800-1831	Rousseaux (1938) with GRS (1953)[d]	deflator[i]
Deane (1957, p. 459)	1800-1831	Rousseaux (1938)[d]	deflator[j]
Veverka (1961, p. 37)	1792-1831	GRS (1953)	deflator
Veverka (1963, p. 114)	1790-1830	unstated[k]	deflator
Williams (1966, p. 583)	1801-1831	Silberling (1923)[l]	deflator[m]
Williams (1966, pp. 585-586)	1751-1791	Schumpeter (1938)[n]	deflator[m,o]
Deane and Cole (1969, pp. 170, 282)	1801-1831	Rousseaux (1938)[e,p]	deflator
Mathias and O'Brien (1976, p. 605)	1715-1812	Gilboy (1936)[d,q]	deflator[r]
Cole (1981, p. 64)	1700-1800	Deane and Cole (1967)[s]	inflator
Lindert and Williamson (1983a, pp. 103-105; 1983b, p. 329)	1700-1800	Schumpeter (1938)[e]	deflator
Williamson (1984, p. 695)	1761-1800	Gilboy (1936)[d,q]	inflator
Williamson (1984, p. 695)	1801-1830	Rousseaux (1938)[e,p]	deflator

Table 14
Price Indexes Used for Real/Nominal Correspondence of GDP[a], 1688-1831

Author	Time Period	Index[b]	Function of Index[c]
Crafts (1987, p. 248)	1761-1800	Schumpeter (1938)[t]	inflator
O'Brien (1988, p. 3)	1670-1810	O'Brien (1985)[d,u]	inflator
Weir (1989, pp. 98-99)	1780-1831	Rousseaux (1938) with Schumpeter (1938)[e]	inflator
Cuenca Esteban (1994, p. 88)	1801-1831	Rousseaux (1938) with O'Brien (1985)[e,v]	deflator[w]

[a]GDP level; or other variables as noted.
[b]Listed in Table 13, except where otherwise noted.
[c]Deflator used to convert nominal to real GDP, inflator used to convert real to nominal GDP—except as otherwise noted.
[d]Five-year averages used.
[e]Subindexes used.
[f]Reference is also made to movement of Silberling (1923) index (Deane, 1955, p. 35, n. 115).
[g]In conjunction with estimates of nominal GDP; formal deflation not applied.
[h]GRS = Gayer, Rostow, and Schwartz.
[i]Rate of growth of per-capita real GDP computed.
[j]Per-capita real GDP computed.
[k]Described only as "developed by the author" (Veverka, 1963, p. 115).
[l]Cost-of-living index, for 1779-1850. Not listed in Table 13. Fifteen items, wholesale prices, consumption weights from various periods 1790-1921 (Silberling, 1923, pp. 234-235).
[m]Per-capita real consumption computed.
[n]Unstated which subindex used.
[o]Also may have been used as inflator, to convert real to nominal GDP, but arithmetic unclear.
[p]Nine-year averages used.
[q]Cost-of-living index, for 1695-1815. Not listed in Table 13. Thirty-one items, contract and wholesale prices, consumption weights from 1790-1796 (Gilboy, 1936, pp. 134-137).
[r]For tax revenue.
[s]Deane and Cole (1967, p. 91) index of: (1) wheat prices—unweighted average of prices at London and Winchester, from Beveridge (1939)—used for agriculture, (2) "other prices"—unweighted average of Schumpeter (1938) consumer-goods (excluding cereals) and producer-goods indexes—used for other sectors.
[t]Ten-year averages used. Unstated how subindexes are used.
[u]Weighted average of agricultural (0.7) and industrial (0.3) indexes.
[v]O'Brien industrial index adjusted for author's estimate of textile prices.
[w]For "manufacture, mining, building" component of GDP.

The price indexes in Table 14 are considered in turn. First, the Silberling (1923) and Gilboy (1936) indexes measure only the "cost of living," and therefore are not appropriate for GDP deflation. They need not be discussed further.

The remaining indexes in Table 14 are considered from the standpoint of judgments of their suitability made by scholars other than the present author. Two such criticisms have general applicability, that is, are applicable to all available price indexes for the pre-1830 period.

The first general criticism of pre-1830 price indexes is that services are not covered. As Crafts (1980, p. 179) observes, referring to Silberling (1923) and Rousseaux (1938), "the tertiary sector is completely unrepresented in either index. It is immediately obvious that neither index bears any resemblance to one which would be desirable for a GNP deflator."

The comment of Crafts should be moderated. It is true that a GDP deflator should price all sectors of the economy; but, given that data exist only for goods, the search for the best possible deflator should not be abandoned. Rather, the best possible measure of the price level of the goods sectors of the economy should be achieved. Then, for evaluation of the index, it is important to note the percent of GDP that is omitted from coverage. This will be done, for the present study, in section XIII.B.1.

The second criticism is applied by Wright (1965, p. 406) only to Rousseaux (1938), but also has general applicability. Prices pertaining to the industrial sector are principally of raw materials rather than manufactured goods, and the ratio between raw-materials and manufacturing prices changes over time.[64] Regarding the Rousseaux index of industrial products, Wright sees only coal and pig iron as included items for which "prices might fairly be regarded as representing 'net values added' or 'factor cost' of part of British industry." Crafts (1985, p. 30) similarly comments that Rousseaux's index "does not represent a basket of goods relevant to finished manufacturing output."

Again, the response is to do the very best that one can with the available data, meaning the existing price indexes. Also, one can select a price index that has good coverage of manufactured goods or of raw materials (such as coal and pig iron) that are representative of manufacturing.

One now turns to specific disadvantages of the indexes previously used.

Turning to judgments of previous scholars specific to the indexes in Table 14, only two indexes have been subject to distinct criticism: Rousseaux and Gayer-Rostow-Schwartz [GRS].

<u>Rousseaux (1938):</u> Mitchell and Deane (1962, p. 466) and Mitchell (1988, p. 716) note that the Rousseaux index is not based on material as comprehensive as that of GRS. Hueckel (1973, p. 386, note 36) criticizes Rousseaux for making no effort to determine proper weights for the individual price series and for including prices of imported goods.

Crafts (1985, pp. 11, 20, 30) calls the weighting "arbitrary," "uncertain," and "quite dissimilar to the weights of the sectors in national output." It appears, though, that Rousseaux uses an equal weighting pattern, that is, the items in his indexes are unweighted and his overall index is an unweighted average of the two subindexes. The first and third comments of Crafts nevertheless remain. Jackson (1994, p. 89) calls Rousseaux's index of industrial prices "poor," while Deane and Cole (1967, p. 282), in spite of their utilization of Rousseaux's index, judge that "as an index of changes in the value of money it is exceedingly dubious."

Gayer, Rostow, and Schwartz [GRS] (1953): Mitchell and Deane (1962, p. 466) and Mitchell (1988, p. 716), citing Ashton (1955, p. 381), note that GRS overweight certain commodities and, of course, underweight others. Also, there is no commodity (and, they might have added—pertinent to GDP use—no sectoral) breakdown, just the domestic and imported subindexes. Nevertheless, Deane and Cole (1967, p. 14) describe the GRS index as "the best general price index currently available for this [the 18th-century] period."

c. Selection of Index to Proxy Deflator

Having considered others' critiques of available indexes, one can conclude that the Rousseaux index is particularly unreliable and that the GRS index deserves consideration as proxy for a deflator. However, the selection process follows from the judgment of only the present author.

Obviously, a national-accounts deflator is preferred; but this variable is nonexistent prior to 1830. Indeed, such a deflator is what one wants to proxy. Wholesale and contract price indexes are all that is available. Furthermore, as observed in section b, indexes incorporating prices of services do not exist (although some data exist on wage rates—not the same thing). All that can be reasonably obtained is a price index that covers a broad spectrum of tangible (goods) output. Then the following criteria for selection of the price index to form the GDP deflator are adopted, with the indexes in Table 13 rejected or not accordingly.

1. The index must be weighted, according either to production or consumption patterns, with the former preferred from a GDP standpoint. An unweighted index is not suitable for the proxy of a GDP deflator. This principle eliminates all indexes with equal weights, that is, that are unweighted. Only three indexes remain: GRS, Hueckel, and O'Brien.

2. The index should explicitly price sectoral output. This criterion tentatively excludes the GRS index.

3. The index should incorporate a lengthy time period, covering as much of the 1660-1830 period as possible. On this basis, O'Brien (161 years) is selected over both Hueckel (31 years) and GRS (41 years). Nevertheless, O'Brien's work has two problems. First, the index terminates in 1820, and an overlap with the GDP deflator for 1830-2000

(PGDPI) in the year 1830 is mandated. So the O'Brien index requires extension in both directions, forward from 1820 and backward from 1660. Though the Hueckel index has the same problem, the GRS index exists to 1830 and beyond. However, the GRS index begins only in 1790, so does not incorporate 1688 and 1759, years for which current-price GDP figures have been obtained and are to be deflated—and O'Brien (but not Hueckel) includes these years. On the other hand, GRS incorporates 1821, another GDP year, which O'Brien does not.

The second problem with O'Brien is also shared by Hueckel. O'Brien (1985) does not combine his "subindexes"—prices of agricultural and industrial output—into an aggregate price index.[65] On the other hand, GRS, though presenting an aggregate index for domestic commodities, does not derive this index by pricing sectoral outputs (point 2 above). To address the two problems, one begins with investigation of the structure of O'Brien's indexes (in section XII.A below).

2. 1086 to 1688

Snooks (1993, p. 245) takes the weighted average of (i) the price of a "composite unit of consumables," representative of that part of 1688 national income consumed, and (ii) the price of wheat, representative of the remainder of national income (investment, exports, government spending). The consumables price index is from Brown and Hopkins (1981, pp. 28-30); the wheat price series from Rogers (vol. 1, 1866, pp. 226-228; vol. 5, 1887, pp. 270-274), Farmer (1956, p. 37), and Lloyd (1973, pp. 38-44).[66]

There are two strange features of the wheat price series. First, in Snooks (1995a, p. 50), Beveridge (1939) is also listed as a source of (presumably) wheat price data—bizarre, because Snooks (1993, p. 245) specifically states that "the wheat data in Rogers, rather than Beveridge, were employed," and provides reasons for this choice. Second, Snooks does not reveal how he combines the three (or four?) wheat series.

The weights are .82 for consumables and .18 for wheat. It is unclear how this weighting pattern is obtained. Lindert and Williamson (1982) do not provide an expenditure breakdown of their revised King table; while, according to Deane (1955, p. 8), consumer expenditure is 90.55 percent of GNP. It is also strange that, although the Brown-Hopkins index begins in 1264, and the (Rogers, Farmer, Lloyd) series in (1259, 1165, 1209), Snooks (1993, p. 245) computes his aggregate index for 1165/74 (relative to 1683/93 or 1688). Presumably the price of wheat alone is used for 1165/74; but no explanation is given. Indeed the pertinent table (Snooks, 1993, p. 245) is titled "A weighted price index, England, 1066-1693." The index is also provided for 1300 (Snooks, 1995a, p. 50).

Snooks (1993, p. 245; 1994, p. 54; 1995a, p. 50) projects the 1165/74 value of his index back to 1066. Justification is that "the scattered evidence prior to the middle of the twelfth century suggests that prices during the previous two centuries were remarkably stable" (Snooks, 1993, p. 244). Miller and Hatcher (1978, pp. 67-68) are quoted for evidence from prices of specific commodities and the statement that "this [inflation from around 1200] was something new.” Snooks (1993, p. 246; 1994, p. 54; 1995a, p. 50) uses his price index to convert 1086 and 1300 GDP from current to constant (1688) prices.

Mayhew (1995a, pp. 72-73) likewise provides a price index for 1086, 1300, and 1688; but does not explain its generation, stating only that it is “cruder” than that of Snooks. It is probable that Mayhew (1995a, p. 73, note 64) simply rounded Snooks’ figures “for ease of calculation” (see Table 18 below). Following Snooks, Mayhew uses his price numbers to transform 1086 and 1300 GDP from nominal to real (1688-prices) denomination.

Interesting is Mayhew’s justification of a constant price level for some 200 years back to 1086. He refers to data on specific prices not only in Miller and Hatcher (1978) but also in Harvey (1988) and Farmer (1956, 1988, 1991), and decries the “extreme scarcity of eleventh-century data,” going on to state that “lacking better evidence, the Angevin price level has been imposed on the Domesday period, implying static prices from 1080 to 1180, which roughly accords with the impressions of Miller and Hatcher” (Mayhew, 1995a, p. 73).[67]

The conclusion for the present study is that the specific price indexes of Snooks and Mayhew are insufficiently reliable and a new price index spanning 1086 to around 1660 (for linking to an index to be derived here from O’Brien’s work) needs to be derived. However, the arguments of both Snooks and Mayhew for the same price level in 1086 and about 200 years later are accepted.

XII. Construction of Deflator: New Price Indexes

A. 1685 to 1820

1. Structure of O’Brien Indexes

Each of O’Brien’s (1985) price indexes—for agricultural products, and industrial products—has subindexes, and each of the subindexes has sub-subindexes.[68] The structure of the indexes is as follows, with sub-subindexes following the colon.

<u>Agriculture</u>
grains: wheat, barley, oats
animal products: beef, mutton, pork, milk, wool
vegetables: beans, peas, potatoes

<u>Industry</u>
metals: iron, copper, tin
textiles: linens, woolens
brewing
salt
coal
leather

candles
construction: bricks, timber, tiles, lime, sand, cement and tarras [mortar], lead,
building wages

In many cases, the items in subindexes or sub-subindexes have multiple varieties, which are generally unweighted (iron being the exception). O'Brien (1985, pp. 790-792, 795-798) describes the data sources and weights of the items in his indexes, subindexes, and sub-subindexes.[69]

The vegetables subindex is not constructed for 1660-1684 and is assumed to move with the price of wheat, because O'Brien (1985, p. 791) claims that data on vegetable prices are unavailable. In fact, such data do exist for this period (and earlier). Therefore, for a more-reliable deflator, the O'Brien indexes will be employed beginning in 1685 rather than 1660, and they end in 1820. Then 1685 will be the overlapping year with the index developed here from 1086.

2. Weighting of O'Brien Indexes

O'Brien (1985) does not aggregate his agricultural and industrial indexes into a total-output index. The only author to perform this task is O'Brien (1988, p. 3) himself; but, as observed in note 65, there is inadequate justification of the weights for the aggregation. Therefore the aggregation must be redone here. For weighting of the agricultural subindexes, O'Brien (1985) uses information for 1789-1794. For the industrial subindexes, the weights are for around 1805. Therefore, to combine the indexes, it is reasonable to employ data on the sectoral distribution of output (GNP) for the year 1801, available in Deane and Cole (1967, p. 166). "Agriculture, forestry, fishing" accounts for 58 percent and "manufacturing, mining, building" 42 percent, of the total output of the two sectors.

So for the years 1685, 1688, 1759, 1801, 1811, 1820, the O'Brien aggregate index (now called "the 1685-1820 index") is computed as .58•(agricultural index) *plus* .42•(industrial index). This is the basis of the discontinuous segment of the deflator series. The years 1685 and 1820 are required for overlapping, while current-price GDP has been generated for the remaining years and are to be deflated.

The weights for a given sub-subindex in the aggregate index is the product of the weights of (i) the pertinent index (agriculture or industry) in the aggregate index, (ii) the pertinent subindex in the index, and (iii) the sub-subindex in the subindex. The resulting weighting pattern is exhibited in the column headed "1685-1820" (the fourth column) in Table 15. It may be noted that coal and pig ion constitute seven percent of the total weight. If the "manufactured goods" linen, woolens, and candles are added, coverage reaches 22 percent of total. For the industrial index alone, coverage increases to .22/.42 = 53 percent. Thus Wright's criticism (in section XI.B.1.b) that manufacturing output is not represented adequately is addressed.

Table 15 Deflator Weighting Patterns, 1172-1830				
	Period			
Commodity	1172-1300	1300-1685	1685-1820	1820-1830
wheat	.6346	.3187	.1819	.2103
barley	____	.1024	.0585	.0676
oats	.2946	.1479	.0844	.0976
beef	____	____	.0858	.0992
mutton	____	____	.0494	.0571
pork	____	____	.0107	.0124
milk	____	____	.0021	.0025
wool	____	.1165	.0665	.0769
peas	.0708	.0356	.0081[a]	.0094
beans	____	.0356	.0081[a]	.0094
potatoes	____	____	.0244[b]	.0282
iron	____	____	.0573	.0662
copper	____	____	.0240	.0278
tin	____	____	.0111	.0128
linen	____	____	.0323	.0373
woolens	____	.1790	.1021	.1181
brewing	____	____	.0882	____
salt	____	____	.0042	.0048
coal	____	____	.0126	____
leather	____	____	.0168	____
candles	____	.0294	.0168	.0194
bricks	____	____	.0112	____
timber	____	____	.0071	.0082
tiles	____	.0024	.0014	____
lime, etc.[c]	____	.0086	.0049	____
lead	____	____	.0027	.0032
wages: laborer	____	____	.0137	.0158
wages: craftsman	____	.0239	.0137	.0158
Total	1.0000	1.0000	1.0000	1.0000

[a]Weight for 1760-1820 in O'Brien index. For 1685-1760, weight is .0203, extended back to 1172 for Table 16.
[b]Weight for 1760-1820 in O'Brien index. For 1685-1760, zero weight, extended back to 1172 for Table 16.
[c]Sand, cement, and tarras [mortar].

B. 1820 to 1830

1. Methodology

The 1685-1820 index is carried forward to 1830 by generating an index based on its items and weights, but not necessarily the same data sources: data deemed superior are used where available.[70] This index (termed "the 1820-1830 index") is constructed for the years 1820, 1821, 1830—1820 for linking to the 1685-1820 index, 1821 to deflate the current-price GDP estimate for that year, 1830 for linking to the 1830-2000 deflator (PGDPI).

A data issue is the treatment of "harvest years," which is the mode of recording for many price series used in the indexes to be developed here and also for many series in O'Brien's indexes. 'Harvest years" originated as "extending from the gathering of one harvest to the gathering of the next" (Farmer, 1957, p. 208), and traditionally ran from Michaelmas (September 29 of a given calendar year) to Michaelmas (September 29 of the subsequent calendar year). In practice, the beginning date could vary; so the harvest year [over calendar years 1700-1701] is better described as "twelve months from about Michaelmas 1700 to Michaelmas 1701" (Beveridge, 1939, p. lviii). Thus Schumpeter (1938, p. 33) writes: "The harvest year extended from the beginning of October in one year to the end of September in the following year, or from Michaelmas to Michaelmas."

So a harvest year begins at about October 1 and runs to the end of the following September. Thus harvest-year t (sometimes denoted as t/t+1) runs from about October 1 of year t to September 30 of year t + 1. Then there is a disconformity with the GDP series, which, of course, are on a calendar-year basis. Furthermore, harvest and calendar years are mixed in historical prices—for example, those entering the O'Brien indexes and those entering the indexes to be constructed here—and prices recorded under the two types of years are combined in the indexes. The issue is: for any harvest year, to which calendar year should the harvest year be assigned? There is no perfect solution. In the present-author's view, it is only logical that the harvest year correspond to the calendar year encompassing the majority of the harvest year. Therefore, in this study, harvest year t (or t/t+1) is taken as calendar year t + 1.[71]

2. Data Sources

Data sources for the individual items in the index are listed below. Prices are characterized as either "market" (generally at the wholesale level) or "contract" (applying to a particular purchaser). Whether recording in the source is by harvest or calendar year is also identified. To repeat, the years for which data are taken is 1820, 1821, 1830.

John (1989)
market prices (calendar year): wheat, barley, oats, beans, peas (p. 975);
potatoes (p. 1006)
contract prices (harvest year): beef, mutton (p. 999)

Beveridge (1939)
contract prices (harvest year): pork (p. 426), beef (two varieties, pp. 210, 425), milk (p. 429), potatoes (p. 427), linen (p. 437), woolens (Eton, p. 147; Lord Chamberlain, five varieties: livery cloth, fustion, maundy, serge, Holland, p. 458), mutton (Eton, two varieties, p. 147; Steward, p. 426), salt (p. 433), candles (Eton, p. 438; Steward, three varieties, p. 436)

Mitchell (1988)
market prices (calendar year): wool (three varieties, p. 766), iron (two varieties, p. 762), coal (p. 750)

Hyde (1977)
market prices (calendar year): iron (pp. 137, 139)

Tooke (1938)
market prices (calendar year): iron (p. 406), tin (p. 418), lead (p. 404), timber (two varieties, p. 417) [Average taken of up to four quotations during year. Where the quotation is a range, the midpoint is taken.]

Lemon (1838)
*market prices (calendar year):*copper (p. 70)

Marshall (1833)
market prices (calendar year): copper, lead (p. 33) [Midpoint of range taken.]

Brown and Hopkins (1955)
*market wage rate (calendar year):*building craftsman, building laborer (p. 205)[72]

There are ten items with multiple varieties: beef (3), potatoes (2), mutton (4), wool (3), iron (4), woolens (6), candles (4), lead (2), copper (2), timber (2)

3. Procedure

All items (and varieties of a given item) are rebased to 1820 = 1, by dividing by the value for that year. For a multi-variety item, the average is taken. The weight of a given item in this (1820-1830) index is its weight in the 1685-1820 index divided by the sum of these weights over all items in the 1820-1830 index. The resulting weighting pattern is shown in column headed “1820-1830” (the final column) in Table 15.

The 1820-1830 index is linked to the 1685-1820 index via the 1820 overlap. In other words, the 1685-1820 index is extended to 1821 and 1830 by multiplying each of the 1821 and 1830 values of the 1820-1830 index by the (1685-1820 index)/(1820-1830 index) ratio for 1820. Therefore the extended 1685-1820 index encompasses the following years: 1685, 1688, 1759, 1801, 1811, 1820, 1821, 1830. This index will be termed “the 1685-1830 index.”

C. 1086 to 1685

1. Methodology

The earliest year for which the index will be computed is 1172. That is the earliest year for which *usable* price series exist for three items (wheat, oats, and peas).[73] The earliest such year for two items (wheat and peas) is 1171, and for one item (wheat) is 1166. Then, on the basis of the justification given in section XI.B.2, the value of the index in 1172 is projected back to 1086. The loss in years in going from 1166 or 1171 to 1172 is deemed to be more than compensated by the increase in coverage of the index.

In fact, two price indexes are constructed: the "1172-1300 index," and the "1300-1685 index." The 1172-1300 index is composed of the three items (wheat, oats, peas) mentioned above. The 1300-1685 index consists of the maximum number of items (the three in the 1172-1300 index and eight others, listed in section 2 below) for which a consistent price series can be obtained for 1300 and 1685. This coverage is generally (true, with only one exception) indirect. Because no item has a price series that exists from 1300 to 1685, a sequence of series must be linked for each item using overlapping years, and such overlapping years can vary between the items. The objective is coverage of years 1300 and 1685 on a consistent basis. For the items that also constitute the 1172-1300 index, coverage extends back to 1172.

Therefore, the years for which a consistent ("1172-1685") index is to be constructed are 1172 (for projection to 1086, and deflation of GDP for that year), 1300 (for direct deflation of current-price GDP), and 1685 (for linking to the 1685-1820 index).

2. Data Sources

For the 1820-1830 index, listing of data sources was first by source, then by item; year was irrelevant, because all price series existed for 1820-1830. Here the listing is first by item, then by years to which a specific source applies.[74] The reader will note the obvious overlapping years used for linking to achieve consistency for a given item from 1172 (for wheat, oats, peas) or 1300 (for the eight other items) to 1685.

<u>wheat, barley, oats, peas</u>
(market prices, harvest years)
1641, 1685: Bowden (1985, pp. 828-829)
1451, 1641: Bowden (1967, pp. 815-821)
1172 [except for barley], 1300, 1451: Farmer (1988, pp. 787-789; 1991, pp. 502-504)

<u>beans</u>
(market prices, harvest years)
1642, 1685: Bowden (1985, pp. 828-829)
1451, 1642: Bowden (1967, pp. 815-821)
1300, 1451: Rogers (vol. 1, 1866, p. 228; vol. 4, 1882, p. 285)

<u>wool</u>
(market prices, calendar years)
1450, 1685: Bowden (1962, pp. 219-220)
1300, 1450: Lloyd (1973, pp. 38-43)

<u>woolens</u>
(contract prices, harvest years)
1395, 1685: Beveridge (1939, pp. 85-90)
1300, 1395: Rogers (vol. 1, 1866, pp. 588-592) ("cloth: 2nd quality")[75]

<u>candles</u>
(contract prices, harvest years)
1564, 1685: Beveridge (1939, pp. 495-496)
1395, 1564: Beveridge (1939, pp. 85-87)
1301, 1395: Rogers (vol. 1, 1866, pp. 438-444)

<u>tiles</u>
(contract prices, harvest years)
1553, 1685: Beveridge (1939, pp. 495-496) (plain tiles)
1300, 1553: Rogers (vol. 1, 1866, p. 516; vol. 4, 1882, p. 472) (plain tiles)

<u>lime</u>
(contract prices, harvest years)
1553, 1685: Beveridge (1939, pp. 495-496)
1399, 1553: Beveridge (1939, pp. 85-87)
1300, 1399: Rogers (vol. 1, 1866, pp. 479-483)

<u>wages rates: building craftsman</u>
(contract wages,[76] calendar years)
1300, 1685: Brown and Hopkins (1955, p. 205)[77]

3. Procedure

Each of the eleven items is rebased to 1684 = 1, by dividing by the value in that year. The weighting pattern for the 1300-1685 index (that includes all eleven items) is constructed the same way as for the 1820-1830 index (see section B.3 above). The resulting weights are shown in the column headed "1300-1685" (the third column) in Table 15. Of the eleven items, the three that have price data available for the year 1172 constitute the 1172-1300 index. The weighting pattern for this index again is computed the same way as for the 1820-1830 index. The weights are in the column "1172-1300" (the second column) in Table 15.

The 1172-1300 index (one figure, for 1172) is linked to the 1300-1685 index (two figures, for 1300 and 1685) via the overlapping year, 1300. Thus an "1172-1685" index is created. As the year 1172 is projected to 1086, the index is termed rather "the 1086-1685 index," incorporating the years 1086, 1300, 1685.

The 1086-1685 index is linked to the 1685-1830 index (obtained in section B.3) via the overlapping year, 1685. The resulting index, called the "1086-1830 index," then embodies the following years: 1086, 1300, 1685, 1688, 1759, 1801, 1811, 1820, 1821, 1830; but 1685 is dropped, because its sole use (for overlap) has occurred.

XIII. Construction of Deflator: Extension, Use, Evaluation

A. Extension of Existing Deflator

The 1086-1830 index is linked to the 1830-2000 deflator, PGDPI (constructed in section XI.A) via the overlapping year, 1830. Then PGDP (1995 = 100) is extended as it was constructed for 1830-2000: 100•PGDPI. Thus the series PGDPI and PGDP exist for the years 1086, 1300, 1688, 1759, 1801, 1811, 1821, and then continuously 1830-2000.

B. Evaluation of Deflator

1. Coverage

The extended (that is, 1086-1821) part of the deflator is based on linking to the 1685-1820 index, which, as the aggregate O'Brien index, is the segment of 1086-1821 with the most coverage. Table 16 compares coverage of the other segments of the 1086-1821 deflator with that of 1685-1820. The percent coverage of a given time segment relative to 1685-1820 is simply the sum of the weights *for 1685-1820* over the items (that have positive weight) *for the given time segment*. Thus there are three such items for 1172-1300, eleven for 1300-1820, and 22 for 1820-1830—compared to 28 items for 1685-1820.

The coverage for each time segment is shown in Table 16. Of course, coverage of the 1685-1820 period is 100 percent. As one would expect, given the pattern of the items, coverage of the remaining segments decreases backward in time.

Table 16
Coverage of Deflator

Period	Coverage[a] (percent)
1172-1300	28.66[b]
1300-1685	57.08[b]
1685-1820	100.00
1820-1830	86.49

[a]Coverage compared to 1685-1820. Sum of weights in 1685-1820 column of Table 15 for items with positive weight in period.
[b]See notes a and b in Table 15.

A second measure of coverage involves included versus excluded sectors of the economy. This measure is the percent of output accounted for by the sectors covered in the deflator. The underlying assumption of this measure is that there is (i) complete coverage of covered sectors, and (ii) zero *indirect* coverage of uncovered sectors. Of course, there is zero *direct* coverage of uncovered sectors; what (ii) implies is zero correlation between the price levels of covered and uncovered sectors. The two assumptions are extreme, but they imply opposite-direction biases for the measure.

The computed measure is shown in Table 17 for the specific years for which GDPC and PGDPI are estimated, except that—for lack of data—1759 is replaced by 1770, the closest available year for which data are available. Interestingly, it is no longer generally true that coverage falls as one moves further into the past. Indeed, coverage is at a *maximum* for the earliest year, 1086. The reason, of course, is the overwhelmingly rural nature of the economy, presumed to be fully represented by the three items for which data are available: wheat, oats, and peas.

Table 17
Sectoral Coverage of Deflator

Year	Covered Sectors (percent of GDP)	Uncovered Output (sectors)	Source
1086	92.2	urban	Snooks (1995a, pp. 35-36)
1300	82.4	urban	Mayhew (1995a, p. 58)
1688	60.8	government and services	Deane and Cole (1967, p. 156)
1770	68.0	government and services	Deane and Cole (1967, p. 156)
1801	55.9	government and services	Deane and Cole (1967, p. 166)
1811	56.5	government and services	Deane and Cole (1967, p. 166)
1821	58.7	government and services	Deane and Cole (1967, p. 166)

Method of Computation
1086: Total GDP *less* urban-sector output, as percent of total GDP.
1300: Total GDP *less* urban-households income, as percent of total GDP.
1688, 1770: GDP arising in sector—"agriculture" *plus* "manufacture, mining, building," as percent of same *plus* "commerce," "professions and domestic service," "government and defence," and "rent of housing."
1801, 1811, 1821: GDP arising in sector—"agriculture, forestry, fishing" *plus* " manufacture, mining, building," as percent of same *plus* "trade and transport," "domestic and personal," "housing," and "government, professional, and all other."

2. Comparison with Other Indexes

Another way of assessing the extended segments of the deflator is to compare them with other indexes. There is little point in doing so for 1688-1830, because the O'Brien index, that underlies the deflator for that time period, was selected as the best available index on fundamental grounds.[78] The 1086-1688 segment of the deflator, however, does warrant examination in the light other work.

The indexes of Snooks and Mayhew have already been discussed, evaluated, and found wanting.[79] The great advantage of the present index is its incorporation of price data for three commodities (wheat, oats, peas) for the full 1172-1300 period. In contrast, Snooks has only wheat prior to 1264 (and the Mayhew index is most likely a rounded version of the Snooks index). Considering that wheat, important a commodity as it was, has a weight of less than two-thirds in the 1172-1300 index (see Table 15), it is obvious that reliability is increased via inclusion of the other two commodities.

Table 18 shows the three price indexes on base 1086 = 1. From 1086 to 1300, the difference between the present (Officer) index and Snooks-Mayhew is not great: Officer's price level in 1300 relative to 1086 is 86 percent that of Snooks. However, the price movement from 1086 to 1688, according to Officer, is only 65 percent that of Snooks. The main reason for these differences is most likely the varying composition of the price indexes rather than the specific beginning year (1172 for Officer, 1165 for Snooks).

Table 18
Price Indexes, 1086-1688

Author	Initial Year[a]	Level of Price Index in: 1086	1300	1688
Snooks	1259	1.0	4.1	19.2
Mayhew	1180[b]	1	4	20
Officer	1172	1.00	3.54	12.47

[a]Initial year of index, from which price level projected back to 1086.
[b]Mayhew's assertion. Index is not formally computed; see text.

C. Completion of Constant-Price GDP Series

Constant-price GDP, GDPK, is now extended to 1086-1821 by the usual formula: GDPK = GDPC/PGDPI. Thus construction of consistent series of current-price GDP (GDPC), constant-price GDP (GDPK), and the GDP deflator (PGDP), is complete for **What Was the UK GDP Then?** To summarize, the years covered are 1086, 1300, 1688, 1759, 1801, 1811, 1821, 1830-2000.

XIV. Computation of Per-Capita GDP

A. Population

1. Consistency of Data Sources

To compute per-capita (nominal and real) GDP, the population for the pertinent territory of the GDP series must be obtained for every year. Table 19 shows, period by period (or year by year) the territory concerned and the source from which estimated population is taken for that territory. It is convenient to list the periods in descending order, as was done for Tables 3, 4, 6, 7 (partially), and 11.

Table 19
Components of Population Series

Period	Territory	Source
1982-2000	U.K.[a]	National Statistics website[b,c]
1965-1981	U.K.[a]	*Annual Abstract of Statistics*, 2000, p. 26
1951-1964	U.K.[a]	Mitchell (1988, p. 14)[d]
1920-1950	U.K.[a]	Feinstein (1972, p. T121)
1855-1920	U.K.[e]	Feinstein (1972, pp. T120-T121)
1830-1854	U.K.[e]	Mitchell (1988, pp. 11-12)[f]
1801, 1811, 1821	Great Britain[g]	Mitchell (1988, p. 11)[h]
1759	England and Wales	Wrigley and Schofield (1981, pp. 533, 577)[i]
1688	England and Wales	Lindert and Williamson (1982, pp. 386-387)[j]
1300	England	Mayhew (1995a, pp. 57, 72)
1086	England	Snooks (1993, p. 178; 1995a, p. 35)

[a]Excluding Republic of Ireland or Southern Ireland.
[b]nationalstatistics.gov.uk
[c]Final population estimates revised in light of results of the 2001 Census.
[d]Sum of figures for England and Wales, Scotland, Northern Ireland.
[e]Including Ireland.
[f]Sum of figures for England and Wales, Scotland, Ireland.
[g]Excludes Ireland.
[h]Sum of figures for England and Wales, Scotland.
[i]Population figure for England expanded to include Wales via application of 1801 figures for England and Wales relative to England. Computation performed by present author; see text.
[j]Lindert and Williamson accept population estimate of Gregory King.

For 1801 1811, 1821, and 1830-2000, care is taken to achieve consistency from one data source to another going backward in time. An issue is the 2001 Census revisions, which are incorporated here. The National Statistics Office has not provided revised figures for years earlier than 1982; but the order of magnitude of a potential adjustment can be gauged by comparing the revised figure for 1982 (56.2907 million) with the superseded figure (56.325, from *Annual Abstract of Statistics*, 2000, p. 26). The divergence of the superseded from the revised figure is only 0.06 percent.

For 1759, Wrigley and Schofield (1981, p. 533) have a population of 6.062922 million for England. This figure must be extended to incorporate Wales. The inflation (multiplicative) factor to do this is obtained from the 1801 figures for the separate entities: the ratio of “England and Wales” population to “England” alone =

8.872980/8.285852 = 1.070859. The numerator and denominator of this ratio are from Wrigley and Schofield (1981, p. 577).[80]

The population of England and Wales for 1688 is the estimate of Gregory King, which is accepted by Lindert and Williamson (1982, pp. 386-387). Justification for the joint use of the 1086 and 1300 population figures of Snooks and Mayhew, respectively, is provided in section VIII.B.2.d.

2. Timing of Estimates

The 1759, 1801, 1811, 1821, and 1830-2000 population figures are explicitly mid-year estimates. The earlier (1086, 1300, 1688) figures do not explicitly pertain to a specific date within the year, and such precision is beyond reason for this early period.

3. Treatment of Military Personnel

For 1801-1914, 1921-1940, and 1951-2000, the series is for the resident population, regardless of nationality. In particular, UK military personnel stationed outside the UK are excluded, while foreign military personnel stationed in the UK are included. For 1915-1920 and 1939-1950, treatment of armed forces is reversed: UK military personnel serving overseas (and merchant seamen at sea) are included, while other-countries' military in the UK are excluded.[81] Thus, for these years, all UK military personnel are included irrespective of location.

For the earlier years, English (1086 and 1300) or British (1688 and 1759) military personnel again are included irrespective of location, though this treatment is only implicit.[82]

B. Per-Capita GDP

The population series, POP, is expressed in millions of persons. It is recalled that nominal GDP, GDPC, is denominated in millions of pounds; and real GDP, GDPK, in millions of constant (1995) pounds. So per-capita nominal GDP, constructed as GDPC/POP, is the number of pounds per person; and per-capita real GDP, computed as GDPK/POP, the number of constant (1995) pounds per person.

XV. Summary of the Study

In sum, the series GDPC, GDPK, PGDP, POP, GDPC/POP, GDPK/POP are generated in this study and exhibited in **What Was the UK GDP Then?** for the years 1086, 1300, 1688, 1759, 1801, 1811, 1821, and then continuously for 1830-2000. It is hoped that these series will be of use to economic historians and others who study the British economy or who wish to glean the state of that economy in particular time periods or at specific points in time.

Each series has been constructed to be consistent to the maximum extent possible, both internally over time and externally with the other series in any given year. However, there is a trade-off between these objectives of consistency and the goal of generating the series for the maximum length of time, and judgments have been applied by the present author in approaching the trade-off. Other researchers may bring different judgments to bear; and this study has been written to assist such scholarly endeavor.

Notes

[1]Clark estimated UK "gross national income" (what would later be termed "gross national product") for 1924-1936 in the 1937 publications cited. Arndt (1988, p. 2) writes: "He [Clark] was the first to use gross national product (GNP) rather than national income—he may reasonably be regarded as the inventor of GNP." Stone (1951, p. 85) notes that "'gross national income'...was Colin Clark's phrase for what is now called the gross national product, i.e. the national income plus depreciation allowances plus indirect taxes net of subsidies." Ironically, the gross concept was employed systematically first in U.S. rather than UK official data, in 1942, and it was the U.S. use that was "influential in its subsequent adoption by many other countries" (Studenski, 1958, pp. 154; 528, note 37).

[2]The U.K. "economic territory" is defined in *United Kingdom National Accounts: Concepts, Sources and Methods*, p. 194.

[3] Of course, the "income" is for services rendered; transfer payments are excluded from domestic and national product.

[4]See *United Kingdom National Accounts: Concepts, Sources and Methods*, p. 208, and *Blue Book 2002*, p. 35. An example of a tax on products is a value-added tax; an example of a non-product tax on production is a license fee.

[5]For discussion of the three approaches, see *United Kingdom National Accounts: Concepts, Sources and Methods*, pp. 205-208.

[6]See Tables 4, 6 and 7.

[7]With multiplicative error terms, $Y_i = Y \cdot e_i$, or $\ln Y_i = \ln Y + u_i$, where $u_i = \ln(e_i)$.

[8]With multiplicative error terms, the pertinent loss function, $\sum(\ln(Y_i/\ddot{Y})^2$ is minimized by $\ddot{Y}$ equaling the geometric mean of the Y_i.

[9]In this model, the technique of "manipulation of the least-reliable estimate" takes the form $\ddot{Y}$ equaling the mean of Y_i, $i \neq j$, where Y_j is the "least-reliable estimate." (Y_j is set equal to the mean of Y_i, $i \neq j$.) With two single-approach estimates and $j = 2$, $\ddot{Y} = Y_1$. (Y_2 is set equal to Y_1.)

[10]These objections are mentioned in Stone (1988, p. 23), and Solomou and Weale (1991, p. 56; 1996, pp. 101-102).

[11]It is assumed again that $E(e_i) = 0$ for all i. Obviously, only the relative values of $\mathrm{var}(e_i)$ are pertinent: $\mathrm{var}(e_i)$ may be replaced by $\mathrm{var}(e_i)/\ \mathrm{var}(e_j)$, all i, for fixed j. Note that, if $\mathrm{var}(e_i) = v$ for all i, the objective function is $\sum(Y_i - \ddot{Y})^2/v$, which, for the purpose of minimization, can be construed simply as $\sum(Y_i - \ddot{Y})^2$.

[12]The reference is to Stone, Champernowne, and Meade (1942).

[13]At the highest level of aggregation, GDP itself, the $\ddot{Y}$ that minimizes $\Sigma(Y_i - \ddot{Y})^2/var(e_i)$ (the simplest case) in effect "resets" the original estimates, Y_i, so that Y_i now equals $\ddot{Y}$ for all i.

[14]See Barker, der Ploeg, and Weale (1984, pp. 475-477), Stone (1984, pp. 197-198; 1987, pp. 253-254; 1988, pp. 23-27), Weale (1988, pp. 212-215), Anonymous (1989, p. 83), Blake and Pain (1991, pp. 68-70), Solomou and Weale (1991, pp. 55-57; 1993, pp. 90-96; 1996, pp. 114-115), Baxter (1992, p. 83), Sefton and Weale (1995, pp. 12-27, 34-47, 57-67), Smith, Weale, and Satchell (1998, pp. 111-120).

[15]For the early history of UK official national accounting, see Stone (1951, 1977), Studenski (1958, pp. 457-458) and Utting (1955, pp. 435-436, 442-447).

[16]For the years covered by the main tables in the 1941-1951 White Papers and 1952-1954 *Blue Books*, see Utting (1955, p. 446).

[17]Official studies of the final three traditional rebasing exercises—the change to 1985, then 1990, then 1995—are Bryant and Daniel (1989), Caplan (1993), and Jones (1998).

[18]The 2003 *Blue Book* will initiate *annual* chain-linking, which means essentially that rebasing occurs every year: the periods of Table 3 become single years. Official studies of annual chain-linking are Cresswell (1994), Lynch (1996), Brueton (1999), Tuke and Reed (2001).

[19]See *Blue Book* 2002, p. 40.

[20]With the 1998 *Blue Book*, basic prices replaced factor cost as the valuation alternative to market prices.

[21]The figures for gross domestic capital formation for 1939-1945 are determined residually in *Statistical Digest of the War* (1951, pp. 20, 234).

[22]The former compromise technique is discussed in *Blue Book* 1987, p. 7, and Anonymous (1988, p. 79).

[23]See *Economic Trends, Annual Supplement 1989*, p. 10.

[24]Outlines of the compromise techniques for 1948-1985 are in Anonymous (1988, p. 80); *Blue Book* 1991, p. 8; and *Blue Book* 1997, p. 195.

[25]See also *Blue Book* 1997, p. 26, which shows zero statistical discrepancies for 1985 (rather than 1986) onward.

[26]See National Statistics website and *Blue Book* 2002, p. 46.

[27]For an outline of the balancing-compromise technique, see *Blue Book 1997*, pp. 195-196.

[28]The 1915-1919 segment, which is based on country-bank clearings and therefore highly questionable, is from Brown (1940); data for 1920-1938, based on an index of national income in Stone (1945), were provided privately to Prest by Richard Stone; the 1938-1946 figures are official data. The non-original segment of Prest's series, 1915-1946, is reprinted in Mitchell and Deane (1962, p. 368).

[29]However, Prest (1948, pp. 50-51) notes that this concept is not quite measured exactly.

[30]See Solomou and Weale (1991, p. 58, note 4). Their technique is open to criticism. See section IX.A and note 55 below.

[31]It is interesting that, even though Mitchell explicitly states that Feinstein's revised expenditure series is adjusted (for inventory change and trend) for use in the compromise estimate; Feinstein's (1972) *unadjusted* series is closer to the revised series than is Feinstein's *adjusted* series.

[32]See sections III.C.2 and III.C.3.

[33]The independent measure of output at current prices became available only with *Blue Book* 1998, which is after the private balancing studies in Table 7 had been published.

[34]This issue is discussed in section IV.B above.

[35] Studies that provide only one or the other denomination, clearly—with the exception of Greasley in Table 6—are superseded by later work. These studies are SW in Table 4, Jefferys-Walters in Table 5, Godley-Gillion and Reid in Table 6, Stone in Table 7.

[36]The neglect of investment is explained by Studenski (1958, p. 28): "He [Petty] was aware of the fact that in years of peace and prosperity, nations saved part of their income and added it to the stock of wealth, but he apparently considered this proportion to be relatively small. At any rate he did not attempt to estimate it." Studenski also provides details of Petty's computation.

[37]See notes c, e, n, v in Table 8.

[38]For historical background to Domesday Book and summary description of its contents, see Darby (1977, pp. 1-9), McDonald and Snooks (1986, pp. 7-10), Harvey (1989, pp. 51-63), and Snooks (1993, pp. 167-171).

[39]For details of the estimation procedure and its robustness, see Snooks (1993, pp. 178-197, 278-279; 1994, pp. 50-54; 1995a, pp. 28-32, 194).

[40]See note e in Table 8.

[41]See note g in Table 9.

[42]See note d in Table 9.

[43]See Table 6.

[44] Crafts (1985) is an important work in development of the post-"Deane and Cole" estimates of 18th-century real output.

[45]The formula is a weighted sum of individual-sector nominal output indicators. See Deane (1957, p. 457).

[46]See Lindert and Williamson (1983b, p. 329).

[47]Lindert and Williamson (1982, p. 386) write: "Perhaps the time is now ripe for such revisions, since information is now available which was unavailable to King, Massie, and Colquhoun. The new data should improve our guesses, as long as we prudently repair to the original hunches when the new data are meager or unpersuasive. The new data do indeed fall short on a number of counts, and for this reason we can only contemplate revising, and not overturning, the original estimates."

[48]As Lowe's work appeared in 1822, it might be appropriate to date the estimate one year earlier, as Deane and Cole do. Deane (1956, p. 343) follows Lowe in selecting 1822 as the date, but provides argument for either year.

[49]See the final column of Table 8.

[50]See section X.D.2.a below.

[51]See Snooks (1993, pp. 197-205; 1995a, pp. 335-349).

[52]The same remark applies to the estimate for the year 1086.

[53]Mayhew's figure for 1086 is the midpoint of his range (1.50-2.25 million).

[54]See Snooks (1995a, pp. 34-35).

[55]This technique is more logical than that of Solomou and Weale (1991, p. 58, note 3), as these authors involve the income figure for 1913.

[56]The reason why $ED00_{1900}$ is not exactly unity is Feinstein's procedure of correcting export and import prices, actually unit values, in 1900 (and 1901) for distortions due to the Boer War. See Solomou and Weale (1991, p. 60, note) and Feinstein (1972, p. 117).

[57]Sefton and Weale do not offer alternative figures inclusive of Southern Ireland in 1920 (or any year), nor do they discuss the matter. Probably, their (balancing) methodology would thwart adopting the Feinstein procedure of a double set of estimates for 1920. Also, from their standpoint, there is little value in an overlap, as 1920 is the initial year of their series.

[58]The method of construction is described in Brezis (1995, p. 63).

[59]Those who consult Brezis (1995) should be aware that her "balance of foreign debt" corresponds to the *negative* of what is customarily called the "net international investment position." Thus, for Brezis, a positive (negative) sign denotes net debtor (creditor) status.

[60]Brezis redoes the sensitivity analysis, fixing initial creditor status at her preferred net debt of £2 million and varying the interest rate, though it is not clear how her stipulated interest-rate series (Brezis, 1995, p. 63) is altered for the alternative cases. In any event, this analysis is not particularly interesting, as the stipulated interest-rate behavior is appropriate and, in fact, is not disputed by Nash.

[61]Details of estimation and discussion are in Mokyr (1983, pp. 10-11, 24-28).

[62]The figure for England and Wales is described as "a little under £200 million," whereas Deane (1955, p. 29) derived an estimate of £200.2 million for around 1798, described as "a little over £200 million" in Deane (1956, p. 350, note 1). The figure of £200, therefore, is appropriate.

[63]See section VII.B.3.

[64]Similarly, Crafts could have noted that the ratio of the price of services to price of goods changes over time.

[65]However, as observed in Table 14 (note u), elsewhere O'Brien (1988, p. 3) does combine the agricultural and industrial indexes, with weights .7 and .3, and lists the resulting aggregate series for 1665-1815 in the form of five-year averages. He does not justify or explain his weights, except to refer to Crafts (1985, p. 126—actually p. 127). It is not obvious how the (.7, .3) weighting pattern is obtained. Figures on domestic production and consumption (meaning absorption, that is: adding imports to, and subtracting exports from, production), based on Deane-Cole (1967) data and other sources, are shown for the years 1801, 1841, and 1851. Converting the figures from £ millions to proportions, the only weighting pattern close to (.7, .3) is (.27, .74), for consumption in 1801. If (.7.3) is indeed a rounded version of (.27, .74), then—from the

standpoint of national accounting—O'Brien is to be criticized for using consumption rather than production weights. GDP, after all, is a production rather than absorption concept: gross domestic *product*, not gross domestic *absorption*.

[66]The consumables price index was originally published in Brown and Hopkins (1956, pp. 311-313), and is reprinted in Ramsey (1971, pp. 38-40).

[67]The Angevin dynasty in England begins with the reign of Henry II in 1154.

[68]In Table 13 and in section XI.B.1.c, O'Brien's indexes are termed "subindexes." For convenience, the designation is changed here.

[69]No doubt inadvertently, O'Brien does not provide information on his data sources for timber, but he does state its weight.

[70]Crafts (1985, p. 41, note 6) extends O'Brien's agricultural (but not industrial) price index to 1831, but in a fashion both cruder and less faithful to O'Brien than done here. Crafts does not show the extended index.

[71]An excellent discussion of recording issues of harvest years is in Schumpeter (1938, p. 33). For O'Brien's treatment, see note A of Table 13.

[72]The data are reprinted in Carus-Wilson (1962, p. 117), Brown and Hopkins (1981, p. 11), and Mitchell (1988, p. 165).

[73]A "usable" price series in this context means one that has an overlap with—and so can be linked to—a later price series, and (ultimately) indirectly, if not directly, linked to the 1685-1820 price index on the basis of the overlap in the year 1685.

[74]For explanation of harvest versus calendar years, and contract versus market prices, see sections B.1 and B.2 above.

[75]Generally, a contact price pertains to a specific purchaser. The Rogers data are unique in averaging contract prices, that is, over several purchasers (where data for more than one purchaser exist).

[76]The market is described in Brown and Hopkins (1955, p. 196) as "a market of individual contracts."

[77]The basic data are taken from Rogers.

[78]See section XI.B.1.c.

[79]See section XI.B.2.

[80]Wrigley and Schofield use the reciprocal of the ratio as a *deflation* factor, to reduce other authors' estimates of population of "England and Wales" to England alone.

[81]In this respect, the Feinstein (1972, p. T121) series for 1915-1920, which is adopted here, differs from that of Mitchell (1988, p. 13). Mitchell's population figures for 1915-1920 exclude *all* military personnel, and so are lower.

[82]The nature of the Wrigley-Schofield method of estimating population for 1759 is such that the military is not explicitly considered. However, as the method is based on the size and age structure of the population, those serving in the armed forces anywhere (or at sea) are implicitly included. For 1688, Gregory King's head count includes "naval officers," "military officers," "common seamen," and "common soldiers" (Lindert and Williamson (1982, p. 389).

For 1086 and 1300, Snooks and Mayhew certainly mean to include military personnel in their population figures. Snooks' figure, for 1086, is based on average household size, and so implicitly incorporates military personnel. For 1300, Mayhew's figure is not so easily deciphered regarding military personnel. He considers other authors' estimates and takes a "middling figure" (Mayhew, 1995a, p. 57). However, one input in these authors' estimates is again the "household-size multiplier." Certainly, these authors do not mean to exclude military personnel from their population figures.

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