RESURRECTING THE UK SECTOR NATIONAL ACCOUNTS AFTER 1945

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Abstract

Building on the methodology explained in Martin (2009), this paper sets itself the task of backcasting the UK national sectoral accounts before 1987, the date prior to which fully comprehensive data are not provided by the Office for National Statistics. Backcast data cover the private, government and overseas sectors. Innovations compared with the earlier paper include the extension of the dataset to begin in 1946 rather than 1948, and, more importantly, an attempt to backcast financial balances for the household and corporate sectors. This attempt involves the backcasting of pension saving before 1963 and of major components of the household and corporate capital account before 1987. The household and corporate sector data are likely subject to greater measurement error than estimates for more aggregate sector balances, as shown in Martin (2009) and provisionally upheld in this paper by simple tests of stability across different data vintages. Subject to further verification and improvements, now in prospect, in official historic data, the derived postwar sectoral estimates may nevertheless enable more robust testing of a variety of long-run macroeconomic hypotheses.

Keywords: national accounts, financial balances, macroeconomics, UK statistics.

JEL Codes: C82, E01, N1

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‘A major strength of the national accounts is to offer long and consistent time series …’ ,
International Monetary Fund, *Quarterly National Accounts Manual: 2017*

In addition to a long history of Britain’s gross domestic product (GDP) and its major components, the Office for National Statistics (ONS) currently provides, but only from 1987, a comprehensive set of institutional national accounts data. Consistent with the European System of Accounts 2010 (ESA10), these ‘sector accounts’ describe the disposable income, expenditure and financial balances (‘net lending’) of households, corporations and government and transactions with the ‘rest-of-the world’.

The challenge is to resurrect an ESA10-compliant dataset of sectors’ disposable income, expenditure and financial balances before 1987. Such data may have many research uses: for example, for studies of the ‘great ratios’, such as the ratios to income of saving (Kuznets, 1942) and the sector financial balances (Cripps et al., 1974); for hypotheses concerning the perspicacity of the private sector – whether or not it pierces the government’s budget constraint (Barro, 1974) or the corporate veil (Auerbach, 1982); and for more recent concerns, such as the supposed ‘savings glut’ (Bernanke, 2005) and the pre-financial crisis surpluses of companies (Dao and Maggi, 2018). All such studies should benefit from having available a long historical context within which to test hypotheses.

Before 1998, researchers had access to just such a dataset. The ONS and its predecessor, the Central Statistical Office (CSO), published comprehensive UK sector accounts that at an annual frequency stretched back as far as 1948, and in some respects to 1946. But most of this highly useful, albeit imperfectly measured history was lost during the 1998 conversion to the then new European System of Accounts, ESA95 - a radical change imposed by European law. Meeting a minimum requirement for back data, the ONS chose the year 1987 to truncate the sectoral record. The comprehensive sector history before 1987 was duly lost and what remained was often of dubious quality.

One reason was pressure of time. The 1998 conversion, undertaken to a compressed timetable using a variety of antiquated database systems, placed ‘enormous demands’ on the national accountants (Brown, 1998; Doggett, 1998; Penneck 2009). Perhaps unsurprisingly, following an in-depth review, it was found necessary to take a second stab. ‘Significant changes and data revisions’ appeared in the 2001 National Accounts ‘Blue Book’ (Tse, 2001). Changes were taken back ‘as far as data exists, which, in some cases, is 1948’ (2001 Blue Book, preface). Regrettably, such pre-1987 sectoral data that initially survived the two-

stage ESA95 conversion were then poorly maintained, many records becoming corrupted (Martin, 2007a). In 2007, the ONS deleted a number of suspect historic series. Most of the remainder were purged in advance of the 2011 Blue Book publication (Everett, 2011).

It is encouraging that steps are now being taken to fill the gaps. In 2014, the ONS and Bank of England began a collaborative project to improve flow-of-funds data (Nolan, 2015, 2016; Thomas and Nolan, 2016; Al-Hamad, 2018) but this project is focused on financial account transactions and balance sheet levels, not the income and expenditure flow data of concern here. Some historic sectoral data have been usefully re-instated in the national accounts (Denley, 2016). Furthermore, the Bank of England has produced and updated a millennium macroeconomic dataset (Thomas and Dimsdale, 2017), a major contribution to one of the projects undertaken by the Economic Statistics Centre of Excellence (ESCoE) to develop historic national accounts statistics. Chadha et al. (2019) have carefully documented an inventory of historic data. More generally, following the critique and recommendations of the Bean Review (Bean, 2016), the ONS is engaged on a strategy to 'transform' economic statistics. But a full post-1945 ESA10 compliant sectoral dataset remains elusive.

On the positive side, the current ONS dataset offers a way to resurrect historic flow data for the general government, public corporations and overseas sectors in the format deployed in the sectoral accounts, though with limitations. From these sectoral records and national totals, a pre-1987 ESA10 compliant historic record can be reconstructed for the 'private' (combined household and 'private' corporate) sector or 'market' sector, the latter defined to be inclusive of public corporations.

On the negative side, it is unfortunately not possible to resurrect high quality ESA10 compliant pre-1987 sectoral data separately for the household and 'private' corporate sectors, the latter including some state-controlled financial institutions, such as, at one time, the former National Girobank and, after the financial crisis, nationalised private banks, as well as private financial and non-financial corporations. But lower quality data can be resurrected using official data and other sources.

For the household sector, official saving data are available from 1963, and can be estimated before that date back to 1946. By subtracting household saving from private sector saving, it is possible to derive a measure of corporate saving (broadly speaking, profit retentions). Data on household investment and capital transfers are absent, however. To obtain a measure of the financial surplus, which requires such capital ('accumulation') account data, it is necessary to rely on pre-ESA95 accounts, last published in the 1997 Blue Book and in the early-1998

publication *UK Economic Accounts*. The accounting standard followed by these old sectoral data was bespoke, but as a result of the influence of Richard Stone and other national accounting pioneers, was closer to former international standards developed by the United Nations and International Monetary Fund than to previous non-mandatory versions of the European System of Accounts.[1] They differ conceptually from the ESA10 accounts.

Three objections to this proposed approach should be immediately recognised and answered.

First, it is correct to say that the derivation of corporate saving and investment as the simple residual of the equivalent series for the private sector and household sector would impose household sector measurement errors on the corporate sector series, albeit with opposite sign. In principle, it would be far more desirable separately to estimate pre-1987 data for the household and corporate sectors and then to seek a reconciliation of the differences implied by identity restrictions.

In practice, because of major conceptual changes to the national accounts, in addition to regular data revisions, and in the absence of a full across-data vintage reconciliation – a herculean task – it is cost effective to settle for a less satisfactory approach. As the aim is to reconcile the derived estimates with official published data, corporate saving is derived residually, taking the official household saving data as given. But some items on the household and corporate capital account, notably gross fixed capital formation, can be considered in a balanced way, with the aim of using the most reliable information to inform the household and corporate sector pre-1987 estimates.

Second, it may be objected that no use has been made of the financial account record of transactions in financial assets and liabilities corresponding to sectors' financial balances. In principle, one might seek to reconcile the financial balance on capital account, derived 'above the line' as the difference between saving, on the one hand, and capital transfers and capital expenditure, on the other hand, with the financial balance derived 'below the line' as the acquisition of financial assets less the acquisition of financial liabilities. Examination of the flow and stock of financial assets and liabilities may also pay dividends in highlighting estimation errors. For example, ONS scrutiny of the too-low rate of return on variable interest corporate bonds implied by former estimates of accrued interest and the outstanding value of bonds led to large upward revisions to former corporate bond interest flow estimates and the size of the balance of payments current account deficit (Crane, 2017).

Unfortunately, the financial record is currently too incomplete to deploy as a means to balance the accounts. Even were it possible to match financial instrument classes across different vintages of the national accounts, there would likely remain large and variable statistical discrepancies between the above-the-line financial balance and the below-the-line balance of financial asset and liability flows. Sefton and Weale, who seek to balance pre-ESA95 data, conclude that 'the sectoral financial balances do not offer extra usable constraints' (Sefton and Weale, 1995, p10). Further deep research may alter that judgement, but it is beyond my scope.

Third, it may be objected that time-series and balancing techniques, such as those deployed by Sefton and Weale, would enable a more reliable means to backfill the data. However, at the three sector level (private, government and overseas), the combination of various ONS datasets provides a means of data resurrection free from the not uncontroversial assumptions that underpin balancing techniques and without the very high computational cost that has proven a barrier to their official use, despite the 'enthusiasm shown by some official statisticians' (Sefton and Weale, 1995, p27). For the household and corporate capital account, however, where reliance is placed on pre-ESA95 sources, consideration is given in a later section to the use of time-series and balancing techniques.

Before turning to the household sector, the following summarises the method used to derive historic private sector income, expenditure and financial balance data. The method, described in detail in Martin (2007(b), 2009, 2012) for the ESA95 accounts, is re-applied here with minor modification.

A) Private, government and overseas sectors

The method deploys standard national income accounting identities to backwards infer private sector data from the available long-run data in the national accounts, the public sector finance (PSF) accounts and the balance of payments accounts. National accounts data on expenditure and factor incomes stretch back as far as 1948 at an annual frequency, and from 1955 at a quarterly frequency. PSF data are available at annual and quarterly (not seasonally adjusted) frequencies from 1946. It should be noted that the regular ONS monthly PSF releases are subject to revisions that are not immediately captured by the latest national accounts (Moskalenko, 2017) but, helpfully, the ONS supplies each quarter PSF data as a set of analytical tables that should be consistent with the more slowly revised national accounts data. The estimates here rely on this national accounts consistent PSF dataset. The balance of payments accounts, consistent with both the IMF's sixth edition of its Balance of Payments Manual and ESA10, are available annually from 1946 and quarterly from 1955.

The presentations of the public sector finances and balance of payments data differ from the presentation of the national sector accounts, but after a modest amount of estimation and involved identity-rearrangement they can be used to retrieve a number of pre-1987 sector income, expenditure and financial surplus series, both annually and quarterly, for the general government, public corporations and overseas sectors, and by inference the private or market sector. The detailed accounting is set out in Martin (2007b, 2009) but can be briefly explained as follows.

Designating the three main sectors, private, government and overseas, with subscripts '*v*', '*s*' and '*w*' respectively, the key private sector identities can be summarised thus:

$$S_v \equiv YD_v - C_v \equiv GVA_v + CTR_v - C_h \tag{1}$$

$$CTR_v \equiv -\sum_i \left(CTR_{s,i} + CTR_{w,i} \right) \tag{2}$$

$$F_v \equiv S_v + KTR_v - GCF_v \tag{3}$$

$$KTR_v \equiv -\sum_j \left(KTR_{s,j} + KTR_{w,j} \right) \tag{4}$$

$$GCF_v \equiv GCF - GCF_s \tag{5}$$

Identity (1) defines the saving, *S*, of the private sector as the difference between disposable income, *YD*, and final consumption expenditure, *C*. The components of disposable income shown on the far right-hand side of the identity are gross value added, *GVA*, and transfer balances on current account, *CTR*. Private sector GVA comprises in broad terms the factor incomes of labour and capital: the compensation of employees, the gross operating surpluses of households and corporations and the mixed income ('mixed' because the wage and profit elements are conflated) of unincorporated businesses controlled by households (sole traders). Mixed income was previously referred to as self-employment income. Current account transfer balances - transfer receipts less payments – include taxes on income and wealth and social insurance benefits net of contributions. Also deployed on the far right-hand side of identity (1) is the equivalence of private sector and household sector final consumption expenditure ('consumers expenditure'), the latter designated with subscript '*h*'.

The decision to distinguish between GVA and current account transfers is motivated by the availability of pre-1987 data. The main national accounts provide data for the components of private sector GVA back to 1948. By contrast, official data on household and corporations current account transfers cease before 1987. However, the current account transfer balance of the private sector can be

inferred backwards from the same categories of transfers recorded in the PSF and balance of payments accounts. Identity (2) formalises the across-sector, zero-sum inferred relationship for each category of current account transfer balance, the categories designated with subscript *i*.

Two points should be noted. First, property income, such as dividends and interest net receipts, is regarded for these purposes as another type of transfer. This treatment is a departure from the emphasis in ESA95 and ESA10 on a sector's 'primary' income, defined as the sum of factor incomes and property income that arise from involvement in production and the ownership of productive assets. But before 1987, there are no explicit official data for private sector property income; hence for backcasting purposes, identity (2) has to be applied to property income as well as to transfers.

Second, the aggregation to the private sector nets out all transfers flows between households and corporations, such as inter-sector flows of dividends, interest, pensions paid and pension contributions. The only items of property income and transfers that remain are those between the private sector, on the one hand, and the government and overseas sectors, on the other hand.

Identity (3) defines the private sector financial balance (or 'net lending') as saving plus net receipts of capital account transfers, *KTR*, minus gross capital formation, *GCF*.

Capital account transfers include taxes on capital and capital grants. Before 1987, these are inferred separately for taxes on capital and other net capital transfers from the across-sector identity (4), with the separate items subscripted, *j*. Identity (4) is the capital account equivalent of identity (2).

Gross capital formation comprises gross fixed capital formation (previously known as 'gross *domestic* fixed capital formation') and changes in inventories (previously designated the 'value of the physical increase in stocks and work in progress' or, for brevity, 'stockbuilding'). A sector split of gross capital formation is not available from the main national accounts before 1987. Private sector data can however be inferred with a minimal amount of estimation and by residual from the economy wide *GCF* total (no subscript) and the PSF data for the public sector, available separately for general government and public corporations. To simplify exposition, identity (5) ignores the private sector's net acquisition of 'non-produced, non-financial assets': for example, transfers of ownership of farm land. The across-sector summation of these net acquisitions is zero.

The financial balances of the public and overseas sectors need little elaboration. They are equivalent respectively to the budget balance, the difference between current and capital government receipts and expenditure, and, with reverse sign, the UK international balance of payments on current and capital account. Since indirect taxes and government subsidies are included in the government and balance of payments accounts and because transfers and property income flows net out to zero across the economy, the summation of the three financial balances, private, public and overseas, is equivalent to the deduction of national expenditure from national income, both expressed at market prices. The only cause of difference between the two is statistical error – the national accounts residual error, *ERR* – which by convention is expressed as the excess of the expenditure measure of GDP, GDP(E), over the income measure of GDP, GDP(I).

It follows that the private sector financial balance could also be derived straightforwardly by deploying identity (6):

$$F_V \equiv -\left(F_S + F_W + ERR\right) \tag{6}$$

The advantage of identity (6) is its computational simplicity. Its disadvantage is the absence of any corresponding detailed disposable income and expenditure data, as in identities (1) to (5). Private sector income and expenditure data are themselves of interest, not least as a means to check the coherence of the national accounts sectoral accounts.

The above description covers the historic period from 1987 back to 1948, when the main national accounts begin. With less confidence, it is possible to take the calculations back further, to 1946 and 1947. For these early postwar years, PSF data are available for government final consumption expenditure and gross capital formation, indirect taxes and subsidies, and, from the balance of payments accounts, the export and import of goods and services and various other aggregate items, including total balances, on current and capital account.
These data can be used in conjunction with estimates of consumers expenditure and investment aggregates, derived by splicing pre-ESA95 equivalent series, to produce an estimate of the expenditure measure of GDP. This GDP(E) series can itself be spliced at 1948 to backcast the average and income measures of GDP, and the corresponding expenditure and income statistical discrepancies, and the national accounts residual error. Granted these crude estimates, the public sector finance and balance of payments data can be used to derive, by residual, private and market sector disposable income, expenditure and financial balance data for 1946 and 1947.

Provisos

Some important provisos must be added to this account. The reliability of these derived estimates depends on the reliability of the official national accounts, PSF and balance of payments data. In the process of constructing the private and market sector balances, a number of problems, actual and potential, have come to light, and drawn to the attention of the ONS. These problems, in so far as they need resolution, act to qualify the derived estimates presented here. Problems potentially arise for two broad reasons: first, the ONS practice of truncating revisions of past data at an arbitrary cut-off date, and, second, the backcasting methods used by the ONS for some series before 1987.

As regards revision practice, it can be agreed that there may be good reason to suppose that data prior to a cut-off date are not in need of material revision. Data may be absent and computational and disruption costs may greatly exceed the benefits of taking minor revisions back in time. It is generally accepted that quarterly economic accounts updates should carry back revisions for just a few quarters. But some ONS revision truncations arise for less defensible reasons, including the limitations of the ONS chosen database management system. If material revisions are not fully taken back in time, time series become vulnerable to discontinuities and identity breaches.

This is not a new phenomenon. Martin (2009) drew attention to the discrepancies that arose from the misclassification of the government's housing activities. In 2001, the Housing Revenue Account (HRA) was reassigned to public corporations from local government, but the record of capital expenditure and dividend payments was not properly amended in the national accounts. The resulting errors were material. The ONS now reassures that it has fully accounted for the reclassifications of the HRA and, more recently, of housing associations (ONS private correspondence, 2019). Yet other problems remain, or have since occurred. Notable examples, as of this writing, are as follows.

There are differences between the PSF and national accounts pre-1987 record of general government current expenditure on goods and services and its gross operating surplus. There is a case for not adjusting the public sector accounts data for these differences, which may be allied to yet-to-appear revisions to other items, such as gross fixed capital formation. Against that, there is a need here to preserve the integrity of the national account identities. To do so, I reconstruct pre-1987 PSF data using the latest national accounts data, so producing an amended record of the general government financial balance.
However, this procedure does not avert the possibility of discontinuities caused by the truncation at the ONS cut-off year 1987 of all past revisions to the national accounts consistent PSF dataset. Inconsistencies may present themselves in the

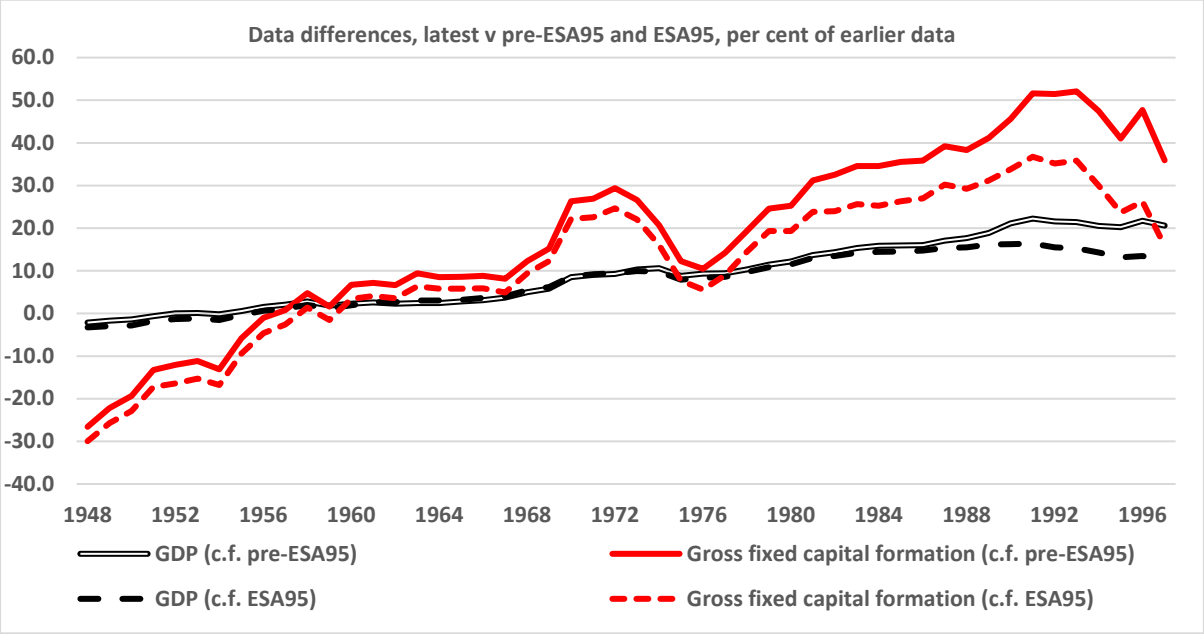
form of cliff-edges in the data: level and growth rate jumps. The ONS statisticians hope this year to refashion the compilation system to cope with pre-1987 revisions affecting the national accounts consistent PSF (ONS private correspondence, 2019).

Another error present in the national accounts consistent PSF arises because data changes introduced by ESA10 were not taken back before 1979. In the period 1973 to 1978, there is a resulting discrepancy between the regular PSF and national accounts consistent PSF records of European Union contributions ('VAT and GNI based EU contributions'). The regular PSF dataset records negative transactions for these years; the national accounts consistent PSF dataset records zero. The difference in the records carries through to other balances with the result that general government net borrowing is lower in the regular PSF dataset for these years. In 1974, the discrepancy is equivalent to nearly ½ per cent of GDP. As the ONS has no timescale for its plan to address the problem (ONS private correspondence, 2019), I have corrected the affected data to align with the regular PSF record.

Other provisos arise because of the way the ONS has constructed historic series. Two are noteworthy.

There is a potential problem with historic estimates of current price gross fixed capital formation, at least in the late-1940s and 1950s. In 2014, in the transition to ESA10, the ONS changed its method of backcasting fixed capital formation data before 1997. Davies et al. (2015) describe the new ONS 1997 linking factor but note, 'It is not possible to test how well the linking factor accounts for methods changes'. One result, seemingly undocumented, is a shortfall compared with both pre-ESA95 and ESA95 estimates of current price gross domestic fixed capital formation (GFCF) during the late-1940s and 1950s, as Chart 1 shows. A smaller shortfall is seen in estimates of current price GDP.

Chart 1: Comparison of vintages of GDP and GFCF data



Sources: *UK Economic Accounts* published 2Q 1998 ('pre-ESA95' data), 2Q 2014 ('ESA95' data) and 1Q 2019 ('latest' data); own calculations.

The shortfalls are larger by comparison with the last ESA95 data published in early-2014, but even if one focusses on the comparison between the latest data and the pre-ESA95 accounts published in early-1998, one finds an exceptionally large 27 per cent GFCF shortfall by 1948. Since government investment has not been similarly revised down – indeed it has been revised up due to capitalisation of military expenditure - the implied shortfall against the pre-ESA95 record of private sector fixed capital formation is even larger, an estimated 54 per cent. There appears also to be an impact on current price GDP, which falls below the pre-ESA95 figures in 1954 and again in 1951, and then increasingly so. The latest estimate of GDP in 1948 is 2 per cent below the pre-ESA95 data.

These shortfalls are counterintuitive. Conceptual changes and the inclusion since ESA10 of research and development (R&D) intangibles (Ker, 2014) would lead one to expect current price GDP and GFCF data to lie above the pre-ESA95 and ESA95 data, which is generally the case. The fear, which may be unfounded, is that the splicing of old and new GFCF data with a 1997 linking factor may have inadvertently caused errors in the historical estimates. The matter has been raised with the ONS.

The second proviso concerns the record of capital transfers, other than taxes on capital, in the late-1940s and early-1950s. Today's record for private sector other net capital transfers, inferred from the PSF and balance of payments accounts, falls short, and increasingly so, of the pre-ESA95 private sector data before 1954, but not afterwards. This marked break, from major to minor, in the revision pattern may be in part due to a possible omission from the ONS record of the capital account of the balance of payments of the grants, gifts and later capital repayments associated with postwar reconstruction and the European Recovery Programme: largely 'Marshall Aid'. At their peak, Marshall Aid and related net grants received by the British government were worth over 1 per cent of GDP. Under pre-ESA95 accounting, these grants were unusual in being the only capital transfers to appear on the capital account of the balance of payments (CSO, 1985, paragraph 9.104).

The possibility arises that Marshall Aid and related capital transfer receipts are embedded in today's PSF record of the unusually large government capital receipts from the private sector in the late-1940s and early-1950s, but not in the balance of payments capital account. This is conjecture, but if true the application of the across-economy accounting identity to the latest data would falsely attribute the capital transfers in fact received by government from overseas to capital transfers paid to government by the private sector. This matter has also been raised with the ONS for further exploration.

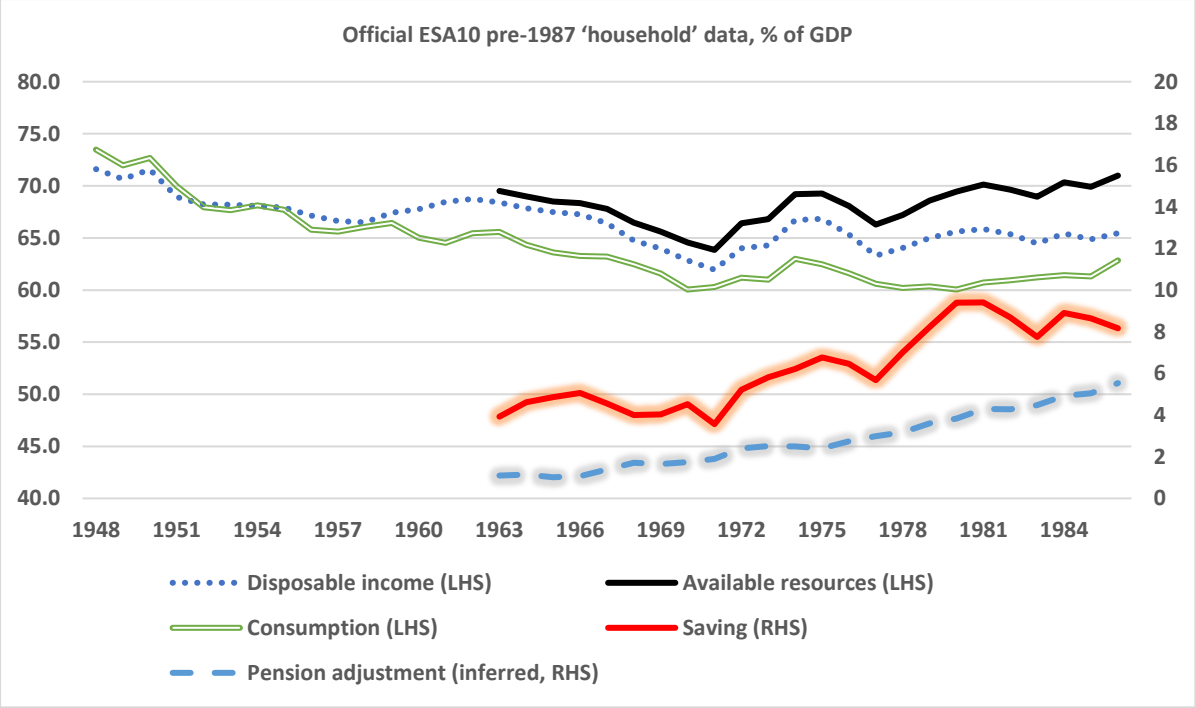
Another but minor proviso concerns quarterly data. The ONS seasonally adjusted quarterly dataset is found not to be wholly coherent with annual data: as of this writing, for example, quarterly data for household inventory building and the financial surplus do not align with the respective annual data. Some statistical authorities maintain that seasonally adjusted data need not add to the annual totals, but that is not the view taken here. The differences are small, however, and have not been corrected.

It should be noted that some seasonally adjusted PSF quarterly series are missing. As required, I seasonally adjust the PSF data using the ONS-preferred X-13ARIMA method, as implemented in the officially recommended program *JDemetra+*, and calendar year constrained.

B) Household sector saving

Before proceeding, it should be noted that the term 'household sector' is used here to refer to an older ESA95 and ESA10 definition that in addition to resident consumers and household unincorporated businesses also includes the collection of non-profit institutions that serve households' needs – 'NPISH', such as charities and universities. Since the 2017 Blue Book, the ONS has produced separate accounts for the household and NPISH sectors (Vassilev et al., 2017). In practice, the sector separation makes little difference: while a little lower, the saving rate of the household sector on the new narrow definition closely follows the saving rate of the older wider sector definition. Only the wider definition can be used as a comparator with earlier versions of the national accounts.

Chart 2: Available pre-1987 ESA10 household data



Sources: *UK Economic Accounts* published 1Q 2019; own calculations. Notes: The ONS does not publish pre-1987 data for the pension adjustment ('Adjustment for the change in pension entitlements') but it can be inferred from the difference between the series for disposable income and available resources. 'LHS', 'RHS' – left-hand side, right-hand side scales.

As Chart 2 shows, the ONS provides pre-1987 data for household disposable income, total available resources, consumption expenditure and saving, identically equal to total available resources less household consumption. The relevant identities are:

$$TAR_h \equiv YD_h + PEN_h \tag{7}$$

$$S_h \equiv TAR_h - C_h \tag{8}$$

The disposable income, *YD*, of households in identity (7) is conceptually similar to the disposable income of the private sector; that is, it can be derived from the sum of household gross value added income received, net transfers on current account and property income. The difference from the private sector series is the inclusion of household-corporate sector inter-sector transfer payments and property income. For reasons to be explained, these transfers do not include household saving through pension schemes, *PEN*, (formally, the 'adjustment for the change in pension entitlements') which has to be added to ensure pension saving is included within the household saving total. The so adjusted measure of income is referred to as household 'total available resources, *TAR*, as in identities (7) and (8).

The series for household disposable income and household consumption begin in 1948. Save for items that comprise the income measure of GDP (gross operating surplus, mixed income and the compensation of employees), no details are available before 1987 for the other components of disposable income. The remaining series for total available resources and saving begin in 1963.

One preliminary question concerns the provenance of these income and saving data. Since the economy-wide sector accounts are not maintained by the ONS before 1987 and were not converted to an ESA basis, it is pertinent to ask how the ESA10 data for household income and saving are derived.

The saving data are the most important. The ESA10 data are descendants of ESA95 compliant saving data that the ONS specially constructed at the time of the ESA95 conversion. Although the details of the conversion methodology for both saving and disposable income were subsequently mislaid by the ONS, and the data for disposable income, consumption and saving prone to identity breaches when revisions took place, official statisticians continued to put faith in the historic saving data, much more so than the data for income and resources (ONS private communication, 2006).

The ESA10 household sector history before 1997 - a key cut-off year within the ONS data management system - is now maintained using an ONS general-purpose backcasting procedure called 'layering'. Under this procedure, the ONS

cumulatively applies data innovations, however these transpire, to the preceding historic dataset having ensured that each set of data differences satisfies accounting constraints such as the equality of the different measures of GDP and the requirement that the across-economy sum of transfers of the same type is equal to zero. The layering procedure is applied by the ONS at the level of individual transactions between 1987 and 1996 and at a broader level for all years prior to 1987. The ONS may model data to backfill ESA10 series. For example, transfers between NPISH and households narrowly defined were simulated by the ONS using time series methods for the 1987-1996 interval (ONS private correspondence, 2019).

As noted previously, the quality of these historic data may fall foul of the arbitrary truncation of back revisions. The 2018 Blue Book revisions to household income and saving, for example, all fall to zero before 1985. The years 1985 and 1986 also contain an identity breach: saving does not equal household available resources minus consumption. The discrepancy is small, although equivalent to nearly ½ per cent of recorded saving. The ONS intends to correct the 1985-1986 errors in the 2019 Blue Book (ONS private correspondence, 2019).

Despite the reservations that arise from their under-documented provenance and the potential problems caused by revision truncation, the household saving data remain the best available.

The task that presents itself from these considerations is to estimate household saving before 1963 in a way that can be regarded as consistent with ESA10. To that end as a preliminary exercise, Chart 3 shows three rival alternative estimates of saving expressed as a per cent of GDP data of the same dataset vintage. Comparisons based on GDP as the denominator rather than household disposable income help avoid the complications that would arise were the household income data corrupted.

The alternatives are:

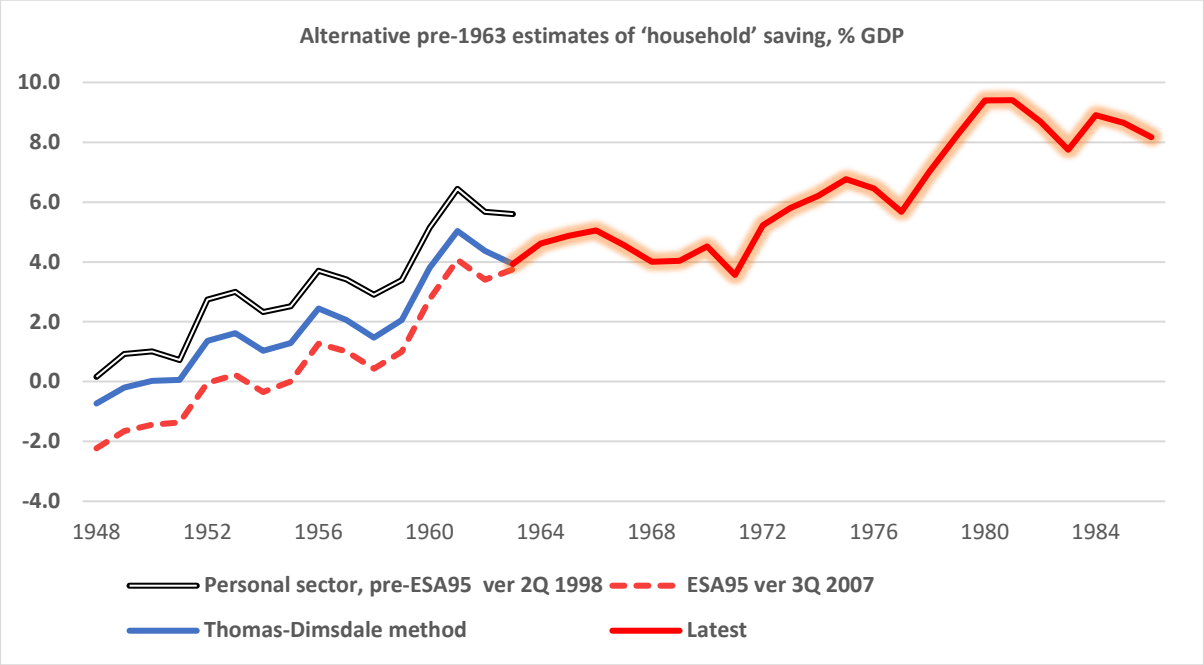
(i) the saving (excluding ‘stock appreciation’ or ‘inventory valuation adjustment’) of the pre-ESA95 concept of the ‘personal’ sector described below;

(ii) an ONS estimate of ESA95 household saving that featured in the *UK Economic Accounts* published in the first, second and third quarters of 2007; and

(iii) the saving implied by assuming equal rates of growth up to 1963 of household disposable income and household available resources, a method used, for example, by Thomas and Dimsdale (2017) in their collation of historic UK data.

Each of these alternatives requires further comment.

Chart 3: Alternative estimates of household saving before 1963, % of GDP



Sources: ONS, own calculations. Notes: Pre-ESA95 personal sector data are adjusted to exclude 'stock appreciation', the holding gain that arises from prices changes. Official ESA95 and ESA10 saving data exclude such gains. 'ver': (abbreviation of 'version') refers to the *UK Economic Accounts* publication date.

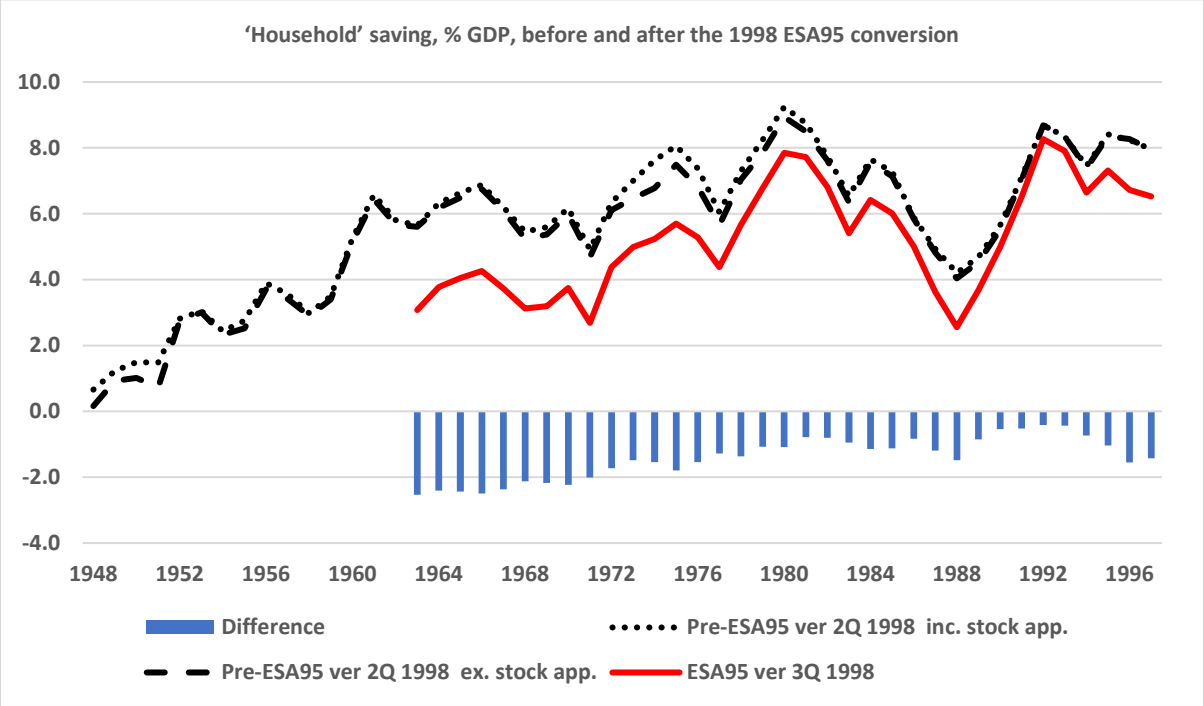
(i) *Pre-ESA95 personal sector saving*

As a share of GDP, ESA10 household sector saving as now recorded for the year 1963 is about 2 percentage points *below* that shown for the same year in the final pre-ESA95 accounts for the personal sector. This shortfall comes despite very large upward revisions, which have left ESA10 saving above the pre-ESA95 record for years since 1980. A more revealing comparison that removes the impact of the later ESA10 revisions is with the ESA95 series published in 1998 just after the ESA95 conversion. Original ESA95 estimates of the household saving GDP share in 1963 were some 3 percentage points below pre-ESA95 personal sector saving, as Chart 4 shows.

Chart 4 also shows that the original ESA95 annual saving series was persistently lower – on average by 1.5 percentage points of GDP - than the former (stock-appreciation adjusted) personal sector saving series over the 35-year period for which a comparison can be made. The null-hypothesis of equality of means of the two measures of saving is strongly rejected with a p-value for standard t-tests of 0.0001. The shortfall of the ESA95 series increases as one goes further back in time. Before 1980, the average shortfall is a statistically significant 2 percentage points. The shortfall after 1980 is not statistically significant. A null

hypothesis of variance equality over the whole sample is not rejected, however. The two series oscillate in a similar fashion. The broad conclusions from these mean and variance equality tests remain the same when the calculations are repeated using the revised and more comprehensive second-stage ESA95 converted data found in the 2001 Blue Book

Chart 4: Impact of ESA95 conversion on recorded 'household' saving



Sources: ONS, own calculations. Notes: 'ver': (abbreviation of 'version') refers to the *UK Economic Accounts* publication date. 'Difference' records the change in saving as a per cent of GDP between the newly ESA95 converted series (published 3Q 1998) and the former series for the personal sector excluding stock appreciation.

What accounts for these large differences between the personal and household sectors? The main answer is probably a mixture of the (undocumented) 'extensive long-run revisions' that the ONS put through at the time of the ESA95 conversion in 1998 (Brueton and Thorp, 1998) and the reclassification of the boundary between the personal and corporate sectors. Under ESA95, partnerships formerly included within the personal sector were reassigned to the private corporate sector as 'quasi-corporations', the largest single ESA95 change to affect the sector distribution of national income (Dolling, 1998, Annex 3, A3.3).

It is relevant to note the vulnerability of the definition of the sector boundary to the distinction between what is, and what is not, a quasi-corporation. The distinction originally rested on a clear separation of ownership from control: quasi-corporations were considered to be unincorporated businesses that have sufficient autonomy from their owners that they may be considered to act like corporations. Current statistical guidance stresses the need for a set of business accounts. Irrespective of the precise criterion, the ONS statisticians were forced to make a fine distinction. They concluded, 'For practical reasons the ONS has chosen to sectorise all partnerships as quasi-corporations and all sole traders as part of the household sector.…accountancy firms and dental surgeries etc. become part of the private non-financial corporations sector … but window cleaners, painters and decorators etc. remain part of the household sector.' (ONS, 1998, as quoted in Kellaway and Shanks, 2007).

The effect of the reclassification was to remove partnerships' undistributed profits from household sector income. The operating surplus of the corporate sector – broadly, company earnings before deductions - was increased by the re-classification of partnerships' combined wage and profit income that was formerly treated as personal sector self-employment income. At the time of the conversion, £30 billion of self-employment income in 1995 (4 per cent of GDP) was so reclassified (Dolling, 1998, Annex 2, A2.2). Partnerships' undistributed profits are struck after deduction of taxes and transfers, including corporate distributions back to households. The latter are identified under ESA95 and ESA10 as 'withdrawals from income of quasi-corporations'. Other current transfer receipts and payments were also partly affected by reclassification.

The conclusion is that the pre-ESA95 personal sector is conceptually and empirically a different animal to the ESA95 and ESA10 household sectors. The comparison is nevertheless not unhelpful, if one is prepared to make a back-of-the-envelope calculation based on the persistent and, as one goes further back in time, widening shortfall of the original ESA95 estimates of household saving compared with the saving of the former personal sector, as shown in Chart 4. This crude comparison leads one to deduce that households may have been dissaving to a substantial degree in the late-1940s. Extrapolated, and allowing for the later data revisions, the implied ESA10 saving of households in 1948 would lie between *minus* 1½ per cent of GDP, assuming a constant personal sector-household sector difference equal to that of 1963, and *minus* 2¾ per cent of GDP, extrapolating back a gradually widening personal-household sector difference before 1963.

(ii) UKEA pre-1963 estimates of ESA95 household saving published in 2007

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A qualitative similar conclusion comes from the ESA95 household saving series published in *UK Economic Accounts* (UKEA) in the first three quarters of 2007. The series in Chart 3 shows households dissaving in 1948 by the equivalent of 2¼ per cent of the then estimated level of GDP. In Martin (2012), I use these saving data to build estimates of household financial balances.

In retrospect, this may have been a mistake, even though my inference was based on what was assuredly 'official' data. The question posed but not fully answered in Martin (2012) is whether these official saving data could be trusted. After having briefly appeared, the savings data were deleted, along with pre-1963 data for household income, from the final UKEA publication of 2007.

In favour of the fleetingly-available pre-1963 saving data, four points stand. First, the corresponding household saving *rate* series continued to appear in the UKEA database until the ONS purge of historic sector data in 2011. Second, the ONS itself used these data to chart the saving rate series back to 1957 (*Pension Trends*, 2009, Figure 14.2). Third, the saving data back to 1963 were not materially revised when the data for previous years were deleted in late-2007. Fourth, the 2007 UKEA publications that contained the pre-1963 household saving data came with an official reassurance: 'The pre-1987 historic data has now been reviewed. Where data has been identified as corrupt and therefore no longer of sufficient quality to be useful for making long run comparisons the data has been deleted from the UKEA dataset'.

Nevertheless, there are reasons to doubt this 'quality statement'. In 2007, the ONS was taking on board the recommendations of the then official statistics watchdog, the Statistics Commission, the forerunner of today's UK Statistics Authority. The Statistics Commission had upheld my critique of the corrupted, 'not-fit-for-purpose' pre-1987 historic sector national accounts data (Statistics Commission, 2007). Many historic sector series were being deleted and a few corrected. The London-based national accounts team was also facing the severe disruption caused by imposed office relocation to Newport, Wales (Bean, 2016). It is quite possible that the pre-1963 household saving series was corrupted.

(iii) Pre-1963 saving implied by assuming equal rates of growth of disposable income and resources

Pre-1963 household saving back to 1948 can also be deduced from the difference between estimates of household consumption expenditure and a backcast series for household total available resources. The official series for total available resources begins in 1963 but can be backcast to 1948 by assuming that it grew up to 1963 at the same rate as household disposable income. The calculation is equivalent to applying a fixed scalar, evaluated at the 1963 link year, to the

disposable income series. This method of splicing the two income series - total available resources and household disposable income - is not uncommon: it is used, for example, by Thomas and Dimsdale (2017) and, it can be inferred, also by the compilers of the suspect 2007 *UK Economic Accounts* series.

As Chart 3 shows, application of the income splicing method to the latest ESA10 data produces an estimated level of household dissaving in 1948 of about ¾ per cent of GDP. This figure is materially smaller than the level of dissaving implied either by extrapolation backwards of the gap between household saving and the former concept of personal sector saving – implying dissaving of between 1½ per cent and 2¾ per cent of GDP – or by the suspect 2007 UKEA household series – implying dissaving equivalent to 2¼ per cent of GDP. There is, then, general accord that the household sector was dissaving in 1948, but the range of estimates is wide: from ¾ per cent to 2¾ per cent of GDP. What can be done to give greater precision to the historic household saving data?

The approach adopted here is to backcast household total available resources prior to 1963 and then subtract household final consumption expenditure. This gives rise to two problems. First, the approach relies on the quality of the official historic data for gross disposable income and household consumption. Both, but especially the income data, may be subject to errors arising from the ONS 'layering' and revision truncation data management practices. Calculated as the difference of two much larger numbers, any estimate of saving will be very sensitive to measurement error.

The second problem arises from the need to backcast pension saving in an ESA10 compliant fashion. The income-splicing method implicitly assumes that pension saving, relative to available resources, remains constant before 1963. This assumption is unlikely to be true, but how untrue is a matter that can only be ascertained on the basis of empirical evidence.

The next section of the paper falls into two parts. Consideration is given first to the complex national accounts treatment of pension saving, tracing it through the household sector accounts. Consideration is given second to the data sources that might be used to backfill pension saving before 1963. The following summary draws on a number of ONS and other sources including Audenis et al. (2002), Blake (2003), Doggett (1998), Jones (2014), and Levy (2011; 2017a; 2017b; 2018a; 2018b).

Pensions accounting in the national accounts

Before ESA95, the treatment of pension saving was simple, perhaps deceptively so. The property income received by life assurance companies and pension funds on the investment of pension fund assets was scored directly within the personal

sector, which was deemed to be the collective owner of the funds. Under ESA95, however, this property income was re-routed, attributed in the first instance to the life assurance and pension fund institutions themselves and then redistributed back to pension scheme members in the newly defined household sector (Doggett, 1998, pp505-506).

The practical implication of this accounting roundabout is that pension saving, embedded in the personal sector accounts, re-appeared under ESA95 as an explicit pension saving addition to household disposable income. Under ESA95, the addition was known as the 'adjustment for the change in net equity of households in pension fund reserves' - equivalent to *PEN* in identity (7). The roundabout accounting procedure under ESA95 and now under ESA10 has several stages, which are relevant to the backcasting method described later.

The first stage of the roundabout is the recording of pension contributions and property income in the household sector primary income account. The procedure next moves to households' 'secondary distribution of income account' where pension investment income, net of pension scheme expenses, and other pension contributions, are deducted and pension receipts added. At this stage of the accounting, pension contributions are regarded as a drain on disposable income, like an income tax, while pensions paid are regarded as an uplift, like the receipt of a welfare benefit.

In order to treat these pension transactions as saving, the act of deducting the net balance comprised of pension contributions, scheme expenses and receipts in the 'secondary distribution of income account' is unwound at the next stage in the household 'use of disposable income account'. The net balance – the ESA10 'adjustment for the change in pension entitlements' - is added as pension saving to disposable income to arrive at household total resources. The same net balance is recorded in the household financial accounts as the 'net acquisition of financial assets' in pension schemes.

It should be noted that only certain types of pension arrangement are regarded as pensions in the national accounts, reflecting statisticians' concept of 'social insurance'. Pensions in the national account that are thus subject to the roundabout accounting procedure include '*occupational*' pensions run by trustees under trust law in the private sector (and their equivalent in the government-run sector) and *group personal* pensions contracted with insurance corporations. There are many variations on this theme. Excluded from the national accounts pension definition, however, are *individual* personal pensions, typically arranged by the self-employed with insurers and since the second half of the 1980s available to employees in a variety of forms.

Individual personal pensions are not regarded as pensions in the national accounts but rather as a type of life insurance policy. Life insurance premiums are not deducted from household disposable income in the national accounts and the claims are not added. Individual personal pension saving is thus included in household disposable income and no further accounting adjustment equivalent to that for the national accounts concept of pensions is required.

Also relevant to this explanation are the benefit structures of pension schemes that are categorised as pensions within the national accounts. The two principal forms are occupational defined benefit (DB) schemes and workplace defined contribution (DC) schemes. Notionally guaranteed by the sponsoring employer, pension entitlements under DB schemes are typically determined by a member's years of service, the rate at which pension 'rights' accrue each year and the member's final, or career-average, salary at the point of retirement, although in early years of the schemes' development manual workers paid flat-rate contributions in return for flat-rate pensions. Typical DC schemes are not guaranteed by the employer, with pensions determined by the size of the accumulated pension pot, the result of contributions and investment income, and the annuitisation rate at the point of retirement, or, in retirement, the rate at which the pension pot can be drawn down.

Despite closures and the watering-down of defined benefits since the early-2000s, and the growth of DC schemes, including those provided as default schemes under the National Employment Savings Trust (NEST), DB schemes remain the dominant pension class as a result of large legacy liabilities.

The distinction between DB and DC schemes comes into play when one considers the additional backcasting challenges created by methodological changes introduced by ESA10. Prior to ESA10, pension entitlements under DB schemes were equated, as with DC schemes, with the market value of the pension funds. This equality for DC schemes is unaffected by ESA10. But for DB schemes, ESA10 stipulates that household entitlements to DB pensions should be equated not with the market value of the schemes' assets but with the present value, actuarially calculated, of the DB pension 'promises': the schemes' liabilities. Under the actuarial approach adopted by the ONS, account is taken of projected salaries to the point of retirement but future service of active members is ignored. By this actuarial criterion, many DB schemes have been in deficit ('underfunded'): the market value of funds has fallen short of accrued pension entitlements.

Compared with ESA95 accounting, household income flows in the national accounts are affected by the ESA10 pension methodology in two principal ways:

- Underfunded DB schemes give rise to a new category of positive 'imputed' employers' contributions that in principle make good the shortfall in actual contributions measured against the extra entitlement of active members who have added another year of service. In addition to any shortfall in contributions in respect of this 'current service increase', imputed employers' contributions also cover changes in DB pension fund entitlements that arise from 'experience effects'. Experience effects measure the difference, due to amended financial or demographic assumptions, between outturn and originally forecast scheme payments.

- The property income that flows to DB scheme members in the household sector is no longer limited to the actual investment income (interest and dividends) on DB asset holdings. Instead, the property income flow measures the increase, as the date of retirement approaches, in the discounted present value of working members' pension entitlement: the 'past service increase'. The process is known as the 'unwinding of the discount rate' (Jones, 2014).[2]

These new concepts are captured in official data back to 1987, but only firmly for government-run schemes. For non-government DB schemes, a full set of actuarial data exist only from 2010; before then back to 1987, the ONS resorts to modelling and second-best methods. The estimation of pension saving before 1987 relies on the ONS 'layering' process (ONS private correspondence, 2019).

Of the two new concepts introduced by ESA10, the changed measure of property income from DB schemes – the 'past service increase' - is empirically the most significant. The ONS calculates DB schemes' property income, part of 'property income payable on pension entitlements' in households' primary income account and 'households' social contribution supplements' in households' secondary income distribution account, as the product of a discount rate, a representative rate based on 15-year fixed interest gilt yields or a 5% rate for government-run DB schemes, and the extant DB actuarial entitlement at the start of the year. In contrast to the treatment of DC pensions, this calculation implicitly incorporates holding gains and losses on DB pension entitlements that were previously excluded from the definition of household saving. During years of low equity market returns and underfunding, the ESA10 measures of property income has greatly exceeded the corresponding ESA95 measure, leading to substantial upward revisions to households' recorded pension saving and the overall saving rate (Jones and Matthews, 2014).

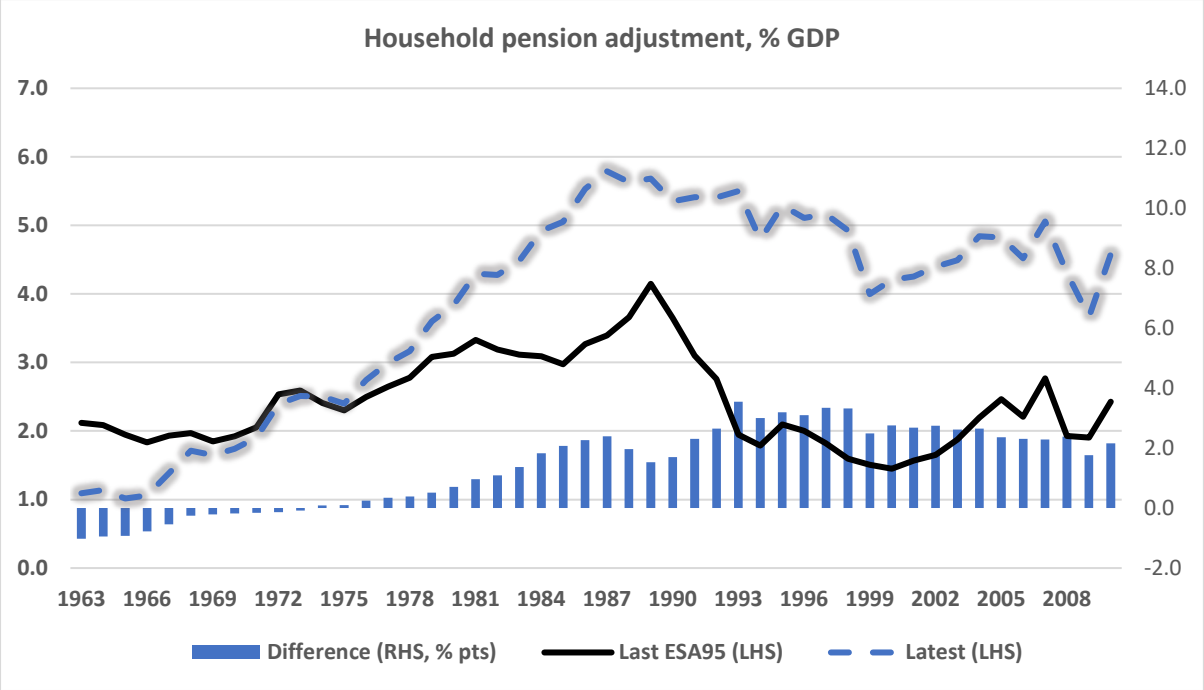
Pension saving national accounts data

Having summarised the complex accounting, the paper turns to the available data on pension saving, starting with a comparison of the ESA95 and ESA10 official national accounts data for the household sector. Chart 5 records the impact of the ESA10 DB valuation requirement and other data revisions, notably to estimated DC entitlements (Levy, 2017a) and to employers' imputed contributions (Arias, 2018). A comparison is drawn between pension saving as currently recorded with the last available ESA95 series that extends back to 1963. The latter was published in early-2011, just prior to the ONS purge of historical data.

The chart traces large and variable differences between the two series back to 1987, with the ESA10 series the greater of the two; on average by some 2½ percentage points of GDP. Prior to 1987, the ESA10 excess smoothly diminishes, turning negative to become a shortfall in the early-1970s. The shortfall of the ESA10 pension adjustment relative to the ESA95 measure smoothly increases between 1973 and 1963, when the shortfall reaches 1 percentage point of GDP.

It is evident that the ESA10 pension saving series is materially different to the ESA95 series. The null-hypothesis of equality of means or variances of the two measures over the period 1963 to 2010 is strongly rejected with a p-value for standard tests of 0.0000. It is also the revised measure of pension saving that accounts for the major difference between the ESA95 and the latest series for total household saving as a share of GDP: excluding pension saving, the null hypothesis of equality of means and variances over the 1963 to 2010 interval is not rejected.

Chart 5: Household pension adjustment (saving): latest versus last published ESA95 series



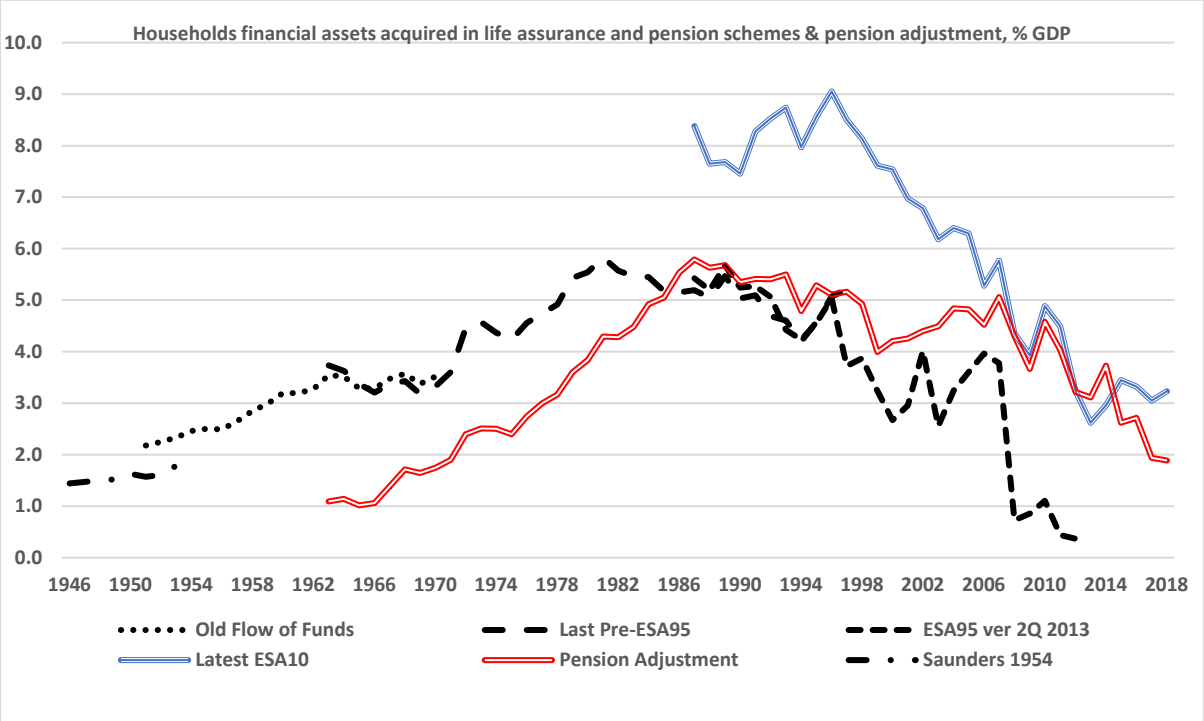
Sources: ONS, own calculations. Notes: 'Last ESA95' – data presented in *UK Economic Accounts* dataset published 2Q 2011. GDP data are of the same vintage as the pension adjustment data. The adjustments are: 'adjustment for the change in net equity of households in pension funds reserves' in ESA95; 'adjustment for the change in pension entitlements' in ESA10.

These major series breaks frustrate attempts to backcast the ESA10 pension adjustment data, and to answer the question whether it is reasonable to assume a constant pension saving rate, as defined in the national accounts, prior to 1963. One can turn for a clue, but not for a fully quantitative answer to old national account 'flow of funds' data (the Bank of England's preferred terminology). Regrettably, before ESA10, the national accounts flow of funds (or 'financial' accounts) did not differentiate pension saving from other saving through life assurance vehicles. The same is true of the available balance sheet data (Levy, 2017b). For the purposes of historical comparison, one must resort to different national account vintages of the wider measure of household acquisition of life assurance and pension fund claims, flow of funds data that can be traced back to 1951. Exceptionally, estimates for earlier years are provided by Saunders (1954) for the acquisition of assets through life assurance, measured by insurers' net receipts, and, separately, for private pension schemes.

Chart 6 shows these series, most previously drawn by Thomas and Nolan (2016, Figure 7), expressed relative to GDP. The ESA10 flow of funds series is wildly different from the previous national account series, which, while subject to breaks, trace a coherent path. Of note is the 'old flow of funds' measure of the personal sector's acquisition of life assurance and pension fund financial claims: as a share of GDP, this flow of claims falls from 3.5 per cent in 1963 to 2.2 per cent in 1951. Although discontinuous at a lower level, the Saunders' data suggest that this flow was smaller still in the early postwar years before the early-1950s.

The inference, perhaps unsurprising, is that it would probably not be reasonable to backcast pension saving before 1963 assuming equal rates of growth of disposable income and household resources and, implicitly, a constant rate of pension saving. The postwar growth in the coverage of pension schemes implies that pension saving was probably lower in the late-1940s compared with the early-1960s. But by how much is difficult to ascertain from the available information on pensions.

Chart 6: Household saving through life assurance and pensions, % of GDP



Sources: Saunders (1954), 1954 Blue Book for 'Saunders 1954'; Bank of England, 1966, 1972; Blue Book (1966, 1971) for 'Old Flow of Funds'; ONS *UK Economic Accounts* published 2Q 1998 for 'Last pre-ESA95'; ONS *UK Economic Accounts* published 2Q 2013 for 'ESA95 ver 2Q 2013'; latest ONS *UK Economic Accounts*. Notes: GDP data are of the same or similar vintage as those for the net acquisition of financial assets in life assurance and pension schemes.

Pension data sources

To progress, the paper first briefly reviews the relevant data sources on non-state pensions, with the sources broadly divided between the official, the academic and the actuarial, although each category has informed the other. Attention then turns to a tentative method by which pension saving can be backcast before 1963.

Official data on the history of occupational pension schemes are sporadic. A Ministry of Labour survey gave estimates of scheme membership in 1936, but no financial information (Ministry of Labour, 1938). The Government Actuary drew on the 1954 (Phillips) Committee on the Economic and Financial Problems of Provision for Old Age (Cmd. 9333) to provide updated membership data for 1953. In 1958, the Government Actuary published the first comprehensive survey of occupational pension schemes, providing information on contributions and pensions as well as on membership for the year 1956 (Government Actuary, 1958). Another publication followed eight years later for the year 1963 (Government Actuary, 1966). Neither offered data on accumulated funds. In much later surveys, the Government Actuary reported annual estimates of the value of occupational pension rights, with historic figures, based on a less sophisticated methodology than was later possible, for the years 1975, 1974, 1971 and 1966 (Board of Inland Revenue, 1980, Table 4.18, p123). The ONS assumed responsibility for the survey of occupational pension schemes in 2005.

Now discontinued in its present format, a different ONS survey of insurance companies and pension funds (MQ5) provides limited data on balance sheets back to 1962. But data on contributions begin only in 1970 and those for pensions in payment in 1984. Other official sources include the pre-ESA95 national accounts data which conflate life assurance and pension schemes (1997 Blue Book, Table 4.10) and the ONS Annual Survey of Hours and Earnings and the publications of HM Revenue & Customs and the Department for Work and Pensions, all of which lack relevant historical data.

Outside of official sources, and in addition to the ‘very rough’ estimates by Saunders (1954), there are a few academic and actuarial studies of note. Emulating the Government Actuary’s methods, Blake and Orszag (1999) offer long-run, tentative estimates back to 1948 of accrued pension rights in occupational pension schemes, benchmarked to what the authors refer to as the ‘rough and ready’ Government Actuary’s historic figures. The authors’ unadjusted estimates of pension rights overstate the Government Actuary’s estimates by 4 per cent in 1975 and by 15 per cent in 1966. These scaling factors are backcast by the authors; the scalar used in 1948 is not reported. Blake and Orszag also interpolate annually the number of active and retired members back to 1948, taking the Ministry of Labour 1936 figure as a starting point. The authors

do not provide corresponding flow data on contributions, pensions paid, investment income or scheme costs.

Other data come from the Faculty of Actuaries and Institute of Actuaries, who provided rudimentary estimates on pension saving to the Phillips Committee. The estimates for privately administered schemes are described by the actuaries as a 'best guess' (Institute and Faculty of Actuaries, 1954, p149). In the 1955 Blue Book, the Central Statistical Office used the actuaries' report and the Phillips Committee estimates to revise up former too-low estimates of employers' pension contribution (CSO, 1956, pp. 78-79). A subsequent actuarial Working Party summarised the Phillips Committee estimates for the year 1952 and provided updated figures for 'privately invested pension funds' (which include government-run schemes) for the year 1963 (Institute and Faculty of Actuaries, 1964-66). The data cover pension contributions, pensions paid, accumulated funds and membership. The actuaries also provided data for 'insured schemes' with insurers' Life Offices. Unfortunately, the latter data are incomplete and include individual personal pensions that lie outside the scope of pensions as defined by the national accounts.

A tentative method to backcast pension saving

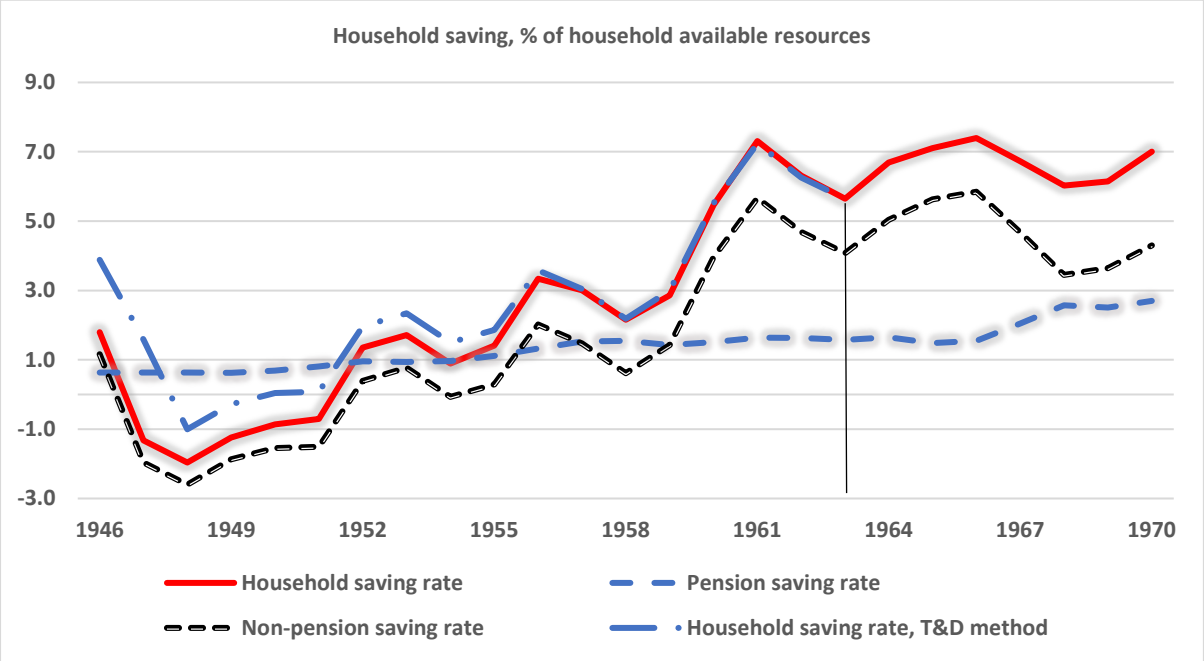
Against this background, an attempt can be made to simulate ESA10 pension saving using the actuaries' estimates for non-insured schemes in 1952 and 1963. The key assumption made is that the schemes are fully-funded DB schemes, an assumption that is possibly not too unreasonable for that period. Two points follow. First, employers' imputed contributions within ESA10 are set to zero: by assumption, employers' contributions exactly cover the increase in entitlements that arise as a result of extra service (the 'current service increase') and 'experience effects' due to changed financial or demographic assumptions. Second, the schemes' property income, the 'past service increase' arising from the 'unwinding of the discount rate', is set equal to the product of the opening value of pension fund assets, by assumption equal to the schemes' accrued liabilities, and the schemes' discount rate. The discount rate is taken to be a weighted average of long-bond yields and a 5 per cent rate for government-run DB schemes. The remaining item concerns scheme service charges. Informed by more recent estimates, DB scheme charges are assumed to be 0.5 per cent of assets.

Table 1: Estimates of household pension saving using actuaries' sample of pension schemes

Actuaries' non-insured schemes pension funds sample, £mn unless stated	**1952**	**1963**
Employers' pension contributions		
Actual	130	276
Imputed	0	0
Households' pension contributions		
Actual	61	167
Supplements = unwinding of discount rate effect = property income	50	231
(-) Pension scheme service charge	-6	-21
(-) Pension benefits received	-139	-337
Adjustment = pension saving	**96**	**315**
(% of GDP)	**0.6**	**1.0**
Pension entitlements = funds (end year)	1,230	5,040
Memo:		
Pension entitlements = funds (begin year)	1,165	4,387
Discount rate (%)	4.30	5.26
ONS adjustment for change in pension entitlements	na	**342**
(% of GDP)	na	**1.1**

Sources: Institute and Faculty of Actuaries (1954, Table 8) for beginning-year 1952 pension entitlements (equal to accumulated pension funds in privately administered pension funds and 'Local Government superannuation funds' (LGSF); Institute and Faculty of Actuaries (1964-66, Appendix A) for actual contributions by employees and employers (normal plus special annual contributions), pension benefits received (annual pensions paid) and end-year pension entitlements (equal to accumulated funds in 'privately-invested pension funds'); Blake and Orszag (1999, Table 12) for occupational pension wealth (used to interpolate end-year pension funds); Thomas and Dimsdale (2017, A31) for yields on 10-year or medium-term British Government Securities and on consols (as a simple average, equal to the assumed discount rate for private-sector DB schemes); ONS (2016) for DB scheme charge rate (average ratio 1997 to 2014 of 'Social Insurance Scheme Service Charge' to previous end-year pension entitlements for private and government-run funded DB schemes); ONS March 2019 *UK Economic Accounts*. Notes: Discount rate is a weighted average of private-sector discount rate and a 5% rate with the weight for the latter equal to the share of LGSF accumulated funds in sample scheme funds at end-1951; Pension scheme service charge equals the product of the charge rate (0.5 per cent) and beginning-year pension entitlements.

Chart 7: Household saving rate backcast from 1963 to 1946



Notes: From 1952 to 1963, interpolation of the actuaries' sample of accumulated pension funds and active and retired membership uses Blake and Orszag (1999) data for end-year pension wealth and membership. The sample's average pension per retiree is interpolated using the average annual growth rate over the 1952 to 1963 interval. The actuaries' sample average contribution per active member is interpolated using a discontinued ONS index of basic weekly wages of manual workers for all industries and services. From 1952 to 1948, the same interpolators are used to backcast accumulated funds, membership and average contributions. Growth rates for the series between 1948 and 1952 are constrained to follow the same average growth rate differences observed between the actuaries' series and their interpolators over the 1952 to 1963 interval. The end-1947 accumulated fund is backcast using the 1949 growth rate of 8 per cent. Average pensions are backcast using the 1952 to 1963 annual average growth rate. Before 1948, consumers' expenditure and household disposable income are spliced, respectively, to pre-ESA95 ONS data on consumers' expenditure and personal sector disposable income (which embodies pension saving). Stock appreciation, estimated from the national total and the personal sector's 1948 share, is deducted from personal disposable income. In 1946 and 1947, the pension saving rate is assumed fixed at its 1948 level. 'T&D': the Thomas and Dimsdale (2017) method assuming a constant pension saving rate applied to the latest ONS data.

Based on these fragile estimates and assumptions, Table 1 puts the value of pension saving in 1963 for the non-insured schemes sampled by the actuaries at £315 million (1 per cent of GDP), very close to the corresponding ONS figure for household sector pension saving of £342 million (1.1 per cent of GDP). In 1952, the equivalent calculation puts the value of pension saving for the actuaries' sample of schemes at £96 million, 0.6 per cent of GDP, the same as that very roughly calculated by Saunders (1954). Spliced to the ONS series, the actuaries' sample-based estimate implies an ESA10 pension adjustment in 1952 worth 0.7 per cent of GDP, 0.4 percentage points below the 1963 figure. The fall from 1963 to 1952 fits with the presumption that the pension saving rate rose in the postwar years.

With further assumptions, the estimates for the actuaries' sample can be interpolated between 1952 and 1963 and backcast to 1948, and then spliced to the 1963 ONS figure. The results for the household saving rate (saving as a share of household available resources), both in total and split between pension and non-pension saving, are shown in Chart 7. The chart extends the data back to 1946 on even cruder assumptions: that household available resources and consumers' spending move in line with, respectively, the pre-ESA95 measures of the personal sector disposable income (excluding stock appreciation) and of consumers' expenditure. The chart's notes give details.

Sense checking the results

Can these estimates be tested for reliability? An approximate answer based on good sense can be given. Bean (2016) is not alone in believing in the importance of sense checking data, to which the actuaries' sample-based saving estimates can be subjected as follows.

In 1948, the household saving rate is put at minus 2 per cent, equivalent to dissaving relative to GDP of 1½ per cent. As such, the actuaries' sample-based estimate lies well within the range of dissaving, from ¾ per cent to 2¾ per cent of GDP, derived from the comparison with, at the upper end, the pre-ESA95 personal sector series and, at the lower end, the series, consistent with the Thomas and Dimsdale (2017) method, that assumes a constant pension saving rate. (The suspect 2007 *UK Economic Accounts* series indicated dissaving in 1948 of 2¼ per cent of GDP.) That the actuaries' sample-based saving rate estimate falls within, and not outside, the rough boundaries established by alternative techniques provides some measure of reassurance.

As one would expect, there is a widening gap before 1963 back to 1948 between the household saving rate estimated using the actuaries' sample and those that assume a constant pension saving rate. By 1948, the pension saving rate extrapolating the actuaries' data is 1 percentage point below its 1963 level; so, therefore, is the associated rate of household total saving compared with the constant pension saving rate, Thomas-Dimsdale consistent, series.

Before 1948, there are larger differences that warrant explanation. In 1946, the difference in the total saving rate recorded by the (lower) backcast actuaries' sample-based series and the series consistent with the Thomas and Dimsdale method is 2 percentage points. Only 1 percentage point of this difference is explained by the difference in pension saving rates. The remaining 1 percentage point difference in 1946 arises mainly because of the method used by Thomas and Dimsdale to backcast consumers' expenditure. In 1946, it is scaled down by over 1 per cent to observe a GDP(E) adding-up constraint. They derive GDP by splicing to the 1948 ONS data the balanced GDP figures in Sefton and Weale (1995). But Thomas and Dimsdale do not subject their measure of disposable income or household available resources to an equivalent adding-up constraint.
By contrast, the method used here derives GDP(E), as in the national accounts before balancing, from the sum of its parts, using ONS expenditure estimates where available and backcasting other expenditure components, including consumers' expenditure, using pre-ESA95 data. The series for household available resources is similarly backcast from the pre-ESA95 series for personal disposable income. The backcasting method used before 1948 for both household available resources and consumer's expenditure is therefore symmetrical.

While clearly open to improvement, and based on very tentative data, the actuaries' sample-based saving estimates appear to pass a basic sense check and to incorporate reasonably the impact of the growing postwar membership of occupational pension schemes. The main annual saving estimates are available from 1948 with more basic estimates for 1946 and 1947. Quarterly saving data from 1955 are derived using a cubic-spline interpolation of the annual pension saving data before 1963.

C) Historic estimates of household and corporate capital account transactions

The remaining task is to backcast the pre-1987 household and corporate sector financial balances. To do so, saving data need to be supplemented with estimates of other transactions on capital account: the payment of taxes on capital, other capital transfers received and paid, spending on fixed capital and inventories, and the net acquisition of non-produced, non-financial assets, such as the transfer of ownership of farm land. The approach taken focusses on the household sector accounts but takes into consideration information on the corporate sector and key

accounting constraints. The estimation of historic data for household taxes on capital, other net capital transfers and gross fixed capital formation all depend on these wider across-economy considerations.

The long-run national accounts data source used for this purpose is the pre-ESA95 national accounts for the personal sector. There are two challenges: first, to complete the postwar pre-ESA95 record of the personal sector capital account and, second, and with greater difficulty, to deploy this information to infer ESA10 compliant series for the household and corporate sectors.

Pre-ESA95 capital account data

The electronic versions of the 1997 Blue Book and early-1998 *UK Economic Accounts* provide the last available pre-ESA95 record, but incompletely so. Personal sector data on gross saving, taxes on capital and net capital transfers are available from 1946; and for stock appreciation and the financial surplus from 1948. Other net capital transfers, excluding taxes on capital, and capital transfer receipts can be inferred by identity manipulation. Stock appreciation in 1946 and 1947 can be crudely estimated from the national total and the personal sector's 1948 share. The financial surplus series is unaffected by any errors in the stock appreciation data which to aid comparison with current national accounting conventions can be deducted from both personal sector gross saving and the increase in the book value of personal sector stocks.

It is unfortunate that the last published pre-ESA95 electronic databases do not provide personal sector gross capital formation data before 1963. However, as Sefton and Weale (1995) find, the relevant data are recorded in the Blue Books of the time. Using a least-squares balancing adjustment to apportion revisions, and a combination of the 1991 CSO electronic database and the 1958 and 1968 Blue Books, Sefton and Weale (1995, pp 130-132, Table 7.11) succeed in recompiling the personal sector capital account between 1948 and 1961 although it may be noted that the authors' record of the 1953 'net acquisition of financial assets' (the former term for 'net lending') is misstated, possibly the result of a typographical error. Sefton and Weale also make minor adjustments to the personal sector saving data in 1955, 1957 and 1960 to remove a discrepancy in the national record of investment income. Wishing to preserve the official personal sector saving record, I have instead applied these adjustments to their fixed capital formation data. With little extra effort, the main components of the personal sector capital account can be recovered back to 1948, as in Table 2.

A means to check these data has been generously provided by Anne Harrison, the editor of the 2008 *System of National Accounts*, who is engaged on a very long-term project, effectively an archaeological dig through a variety of electronic official datasets with a view to reconciling the different data vintages (Harrison, 2017; Chadha et al., 2019, p19). The raw data from her datasets corroborate from 1946 the data on saving and taxes on capital and, from 1948, the data on other net capital transfers, total gross capital formation, stock appreciation and financial balance data that are deployed in Table 2. There are minor data differences in the division of total gross capital formation between fixed capital formation and stockbuilding, available in Ms Harrison's raw dataset from 1952. In preference to the mixing of different sources which do not have a strong claim to superior quality, Table 2 relies on the recompiled Sefton and Weale division for the gross fixed capital formation and stockbuilding data which are derived using a consistent methodology back to 1948.

Table 2 also shows constructed series for gross fixed capital formation in dwellings and, as a group, in the remaining asset classes: transport equipment, plant and machinery, other new buildings, and purchases less sales of land and existing buildings, a category that includes the associated transfer costs such as stamp duties, agents' commission and legal fees. The last-published pre-ESA95 electronic databases provide figures from 1965 for personal sector gross fixed capital formation divided into asset types, including dwellings. Before 1965, the dwellings data are inferred in Table 2 from official data for private sector dwelling investment available from 1948 with an allowance for the small share attributable to corporate dwelling investment. The backcast data for dwellings aligns reasonably well with those provided by Saunders (1954), whose estimates are spliced to provide a dwelling investment series back to 1946.

Non-dwelling fixed capital formation data back to 1948 are derived by subtraction and, in 1946 and 1947, by splicing the 'mostly very rough' estimates in Saunders (1954) for investment by farmers and other unincorporated enterprises. Total personal sector fixed capital formation in 1946 and 1947 is calculated as the sum of the spliced series for investment in dwellings and the residual non-dwelling asset classes. The data in Saunders (1954) for the change in the book value of stocks in 1946 and 1947 are taken without further ado, save for the deduction of estimated stock appreciation.

Saunders (1954) is also the preferred source for *net capital transfers* in 1946 and 1947. Saunders' data, and those for the corporate sector that can be inferred from across-economy identity, present a description of capital transfers in the early-postwar years that seems more credible than the one portrayed in the pre-ESA95 electronic dataset. The latter implausibly attributes all market sector (personal plus corporate sector) net capital transfers in those years to the personal sector.

The evidence to support the decision to rely on the Saunders data requires an archaeological dig through old records, which are summarised in Table 3.

It can be inferred from the estimates in Saunders (1954) and the 1954 Blue Book on which Saunders draws that the personal and corporate sectors were each recipients of exceptionally large capital transfers in 1946 and 1947. In 1946, capital transfers received by the personal sector, before payment of death duties, and by private corporations were equivalent to 3½ per cent and over 2 per cent of GDP respectively. The personal sector received capital grants – mainly war damage compensation and lump sum payments ('war gratuities and pay credits') to demobilised armed service personnel (CSO, 1956, p203; 1954 Blue Book). The corporate sector was also the recipient of war damage compensation and, in addition, of refunds of the excess profits tax levied during the war to discourage profiteering. These refunds were treated by the CSO as a capital rather than as a current transfer on the grounds that the refunds were conditional on their being used to develop or re-equip the recipient's business (CSO, 1956, p152 and p203).

Together, receipts by the personal and corporate sectors of net capital transfers, before payment of death duties, amounted to around 5½ per cent of GDP in 1946 and 3½ per cent of GDP in 1947. As Table 3 details, the 1997 Blue Book electronic database records the same figures for taxes on capital and approximately the same market sector totals in 1946 and 1947 for net capital transfers after payment of those taxes but a radically different split between the personal and corporate sectors.

For the years 1946 and 1947, but not 1948, the 1997 Blue Book database scores these net capital transfers wholly to the personal sector, a change of recording that can be traced back to late-1970s vintages of the CSO's publication *Economic Trends Annual Supplement*. At that point, the period displayed in the publication's sector financial accounts stretched back to 1946. Later, the publication reverted to a truncation of the data before 1963. So, while there is agreement between the 1997 Blue Book and the Saunders-1954 Blue Book records for 1948, there is a radical difference in the sector attribution of net capital transfer receipts for 1946 and 1947. A choice of data source is required.
My preference for the Saunders (1954) and 1954 Blue Book record is strengthened in the lower right-hand side of Table 3, which shows the 1954 Blue Book record to be internally consistent. The total of net receipts of other capital transfers received by the personal and corporate sectors that comprise the market sector finds an exact counterpart in the record of central government capital transfer payments to the market sector. Assuming that the personal sector was the recipient of all the 'war gratuities' and the whole of the small 'other' category shown in the central government accounts, and ignoring any refunds of the 'small amounts of excess profits tax' paid by sole traders and partnerships (CSO, 1956,

p62), it can be inferred that the personal sector also received about two-thirds of the government's compensation for war damage, which included damage to private property.

If so, the corporate sector would have received the remaining third of these capital transfers that covered war damage to business plant and equipment (CSO, 1956, p203), as well as the bulk of the refunds of excess profits tax. The corporate sector continued to be a recipient of war damage compensation and refunds of excess profits tax into the 1950s (CSO, 1956, p152). It is telling that these items *are* counted as net capital transfer receipts of industrial and commercial companies in the 1997 Blue Book record (ONS database code AAAR), but *only* from 1948.

My inference is that the 1997 Blue Book null record for corporate net capital transfers in 1946 and 1947 and the attribution of all such transfers to the personal sector is a database processing error. Should this judgement prove wrong, the data in Table 3 provide the means for correction.

Table 2: Estimation and reconstruction of the pre-ESA95 personal sector capital account

£ mn	Saving, excludes stock appreciation	Capital transfers				Capital formation					Financial balance
		Receipts	Payments		Net total	Fixed			Stock Building	Total	
			Taxes	Other		Dwellings	Other	Total			
	i	a	b	c	ii = a-b-c	d	e	f = d+e	g	iii = f+g	iv = i+ii-iii
BB97	1948	1963	1946	1963	1946	1965	1965	1963	1963	1963	1948
1946	295	330	143	0	187	52	83	135	-10	126	357
1947	68	260	164	0	96	68	142	210	31	241	-77
1948	19	116	215	0	-99	48	178	226	35	261	-341
1949	116	94	254	0	-160	56	197	253	31	284	-327
1950	133	84	190	0	-106	54	210	264	42	306	-279
1951	105	70	194	0	-124	65	291	356	106	462	-481
1952	433	62	159	0	-97	113	228	341	-15	326	10
1953	508	49	165	0	-116	197	224	421	33	454	-62
1954	416	39	183	0	-144	242	278	520	47	567	-295
1955	487	67	184	0	-117	280	323	603	37	640	-270
1956	769	60	166	0	-106	310	278	588	28	616	48
1957	748	51	176	0	-125	315	275	590	30	619	3
1958	664	54	182	0	-128	337	319	656	14	670	-134
1959	823	57	212	0	-155	399	304	703	46	749	-81
1960	1330	64	236	0	-172	471	327	798	62	860	298
1961	1767	74	259	0	-185	524	352	876	48	924	659
1962	1634	94	266	0	-172	561	323	884	4	888	574
1963	1714	108	308	4	-204	619	322	941	26	967	543

Sources: Saunders (1954), Sefton and Weale (1995), mainly Table 7.11; ONS: *UK Economic Accounts* published 2Q 1998, Blue Book 1997. Notes: Except for the backcast dwelling and non-dwelling fixed capital formation data (see main text), all 1963 data are from ONS. 'BB97' row records earliest available data in the electronic version of Blue Book 1997. S*aving*, Col. (i), saving gross of stock appreciation from 1946 and *financial surplus*, Col. (iv), from 1948, from ONS. Financial surplus 1946 – 1947 is calculated. Stock appreciation is backcast from national total in 1946 - 1947. *Net capital transfers*, Col. (ii), 1946 – 1947 calculated from Saunders (1954); thereafter ONS and consistent with Sefton and Weale (1995). *Taxes on capital*, Col. (b), from 1946 from ONS. *Other capital transfer payments*, Col. (c) assumed zero before 1963. *Capital receipts*, Col. (a), inferred from Cols. (ii), (b) and (c) 1946 to 1962. *Capital formation*: Col. (f) backcast and Col. (g) from Saunders (1954), 1946 – 1947; Cols. (f) and (g) 1948 to 1961 from Sefton and Weale (1995) with small adjustments (plus £5mn (1955), plus £1mn (1957), minus £4mn (1960)) to total fixed capital formation, Col. (f), to preserve accounting identity; Col. (iii) for 1962 is inferred; Col. (g) for 1962 from Sefton and Weale (Table A.41): balanced data for increase in book value of stocks similar to unbalanced data; Col. (f) in 1962 inferred from Cols. (g) and (iii).

Table 3: Net capital transfers after the war: data comparison

£ million unless stated	**1997 Blue Book**			**1954 Blue Book**		
	1946	1947	1948	1946	1947	1948
(i) Net capital transfers						
Personal sector	388	198	-99	187	96	-99
Private corporations	-1	-1	64	211	114	73
Public corporations	1	1	4	0	1	4
Market sector	388	198	-31	398	211	-22
(ii) Taxes on capital						
Personal sector	143	164	215	143	164	215
Private corporations	0	0	0	0	0	0
Public corporations	0	0	0	0	0	0
Market sector	143	164	215	143	164	215
(iii) Other net capital transfers						
Personal sector	531	362	116	330	260	116
Private corporations	-1	-1	64	211	114	73
Public corporations	1	1	4	0	1	4
Market sector	531	362	184	541	375	193
Memo: (iii), % of GDP						
Personal sector	5.3	3.4	1.0	3.4	2.5	1.0
Private corporations	0.0	0.0	0.5	2.2	1.1	0.6
(iv) Central Government revenue account						
Capital payments to market sector				541	375	193
of which						
War gratuities & pay credits				229	60	1
War damage compensation				123	257	155
Post-war refunds of excess profits tax				167	40	15
Other*				22	18	22

Sources: *UK Economic Accounts* published 2Q 1998 ('1997 Blue Book'); 1954 Blue Book, Tables 7, 8, 27, 30, 31, 34, 42; Saunders (1954). Notes: Item (i) - identically equal to item (iii) less item (ii). Item (ii) - corporations did not pay capital taxes in these years. Item (iii) - personal sector from Saunders (1954); private corporations derived from across-economy identity. Item (iv) - Central government revenue account item 'Transfer to capital accounts' excluding central government 'Capital grants' (1954 Blue Book, Table 30) and 'War damage compensation' (1954 Blue Book, Table 34, footnote) payable to local authorities. * The 'other' category includes investment grants to universities and compensation to doctors for the loss of right to sell medical practices (CSO, 1956,

p204). Note that central government capital transfer payments to, and capital transfer receipts from, abroad are excluded from the central government capital transfers recorded on Revenue Account. Overseas capital transactions are recorded in the central government capital account. Certain overseas capital grants (sales of surplus war stores held abroad and overseas settlements) were later reclassified as current grants to central government, but the reclassification does not affect the data in this table. 1946 and 1947 GDP in 1997 Blue Book derived by splicing to its GDP(E) estimate. The market sector comprises the personal and corporations (private and public) sectors.

Backcasting using the pre-ESA95 household capital account: data description

The remaining step is to deploy the reconstructed pre-ESA95 personal sector capital account data to backcast the ESA10 compliant equivalent series. There is a maximal eleven-year overlap (1987 to 1997 inclusive) between the pre-ESA95 and later datasets: a short period but not an uninformative one. The data series exhibit high variance over these eleven years, which cover the economic ups and downs of the 'Lawson' boom and bust and the recovery of the economy after sterling was ejected from the European exchange rate mechanism.

Before turning to backcasting methodology, it is relevant to compare the pre-ESA95 series with later data, tracing over time the sequence of revisions and their proximate causes. It is desirable to assess the closeness of the datasets, and the reasons for similarities or differences. The main purpose is to assess whether the short overlapping period of old and new data provides a sound basis for backcasting methods using balancing and other time series techniques. The short answer is 'no'. The longer answer below begins with a calculation of overlapping period-average revisions across datasets; complements these comparisons with simple summary regressions and tests for robustness to dataset revisions and, finally, explores some of the many reasons for the differences.

Table 4 and Charts 8 and 9 compare the pre-ESA95 personal sector data with the equivalent household sector record after both the 1998 conversion to ESA95 and the 2014 conversion to ESA10. Each series in the table and charts is expressed as a per cent of same-vintage household available resources or personal sector disposable income less stock appreciation, as appropriate.

As the 1998 Blue Book does not provide the full household sector gross capital formation breakdown by asset class back to 1987, the more completely revised and developed 2001 Blue Book is used to represent the early ESA95 compliant record. At the time of writing, the ESA10 compliant 2018 Blue Book is the latest available ONS source to show the asset detail of household gross capital formation. The 2018 Blue Book also captures the fruits of the ONS continuing overhaul of economic statistics.

Table 4: Household capital account net payments, % available resources: revisions & latest

Unless stated, revisions to annual averages, 1987 to 1997 inclusive, percentage points	1997 to 2001 BB	2001 to 2018 BB	1997 to 2018 BB	2018 BB average, %
Capital account total net payments	-1.1	-0.2	-1.3	5.3
of which:				
Fixed capital formation	-0.7	-0.3	-1.1	5.7
of which:				
Dwellings	0.0	-0.9	-0.9	3.3
Non-Dwellings	-0.7	0.6	-0.1	2.4
of which:				
Transport equipment	-0.1	-0.1	-0.2	0.2
Plant, machinery, intangibles	0.0	0.4	0.4	0.9
Other buildings & structures	-0.1	-0.1	-0.2	0.2
Transfer costs	-0.5	0.3	-0.1	1.1
Other net payments				
Total	-0.4	0.1	-0.3	-0.4
of which				
Taxes on capital	-0.3	-0.1	-0.4	0.3
Other net capital transfer payments	-0.1	0.2	0.1	-0.7
Other: inventories etc.	0.0	0.0	0.0	0.1

Sources: *UK Economic Accounts* published 2Q 1998 ('BB 1997'), Blue Books 2001 and 2018. Notes: The total of capital account net payments equals saving minus the financial surplus. 'Other: inventories etc.' comprises changes in inventories and acquisitions less disposables of both valuables and non-produced, non-financial assets. The denominators are of the same dataset vintage as the capital account data – personal disposable income (less stock appreciation) for BB97 data; otherwise household total available resources. Parts may not sum to totals due to rounding error.

For the average annual levels of each series evaluated over the overlapping period between 1987 and 1997, Table 4 shows the changes in the detailed capital account record between the 1997 Blue Book (and early-1998 *UK Economic Accounts*) pre-ESA95 data and, sequentially, those in the 2001 and 2018 Blue Books. For example, the 1997 Blue Book to 2001 Blue Book comparison in the first row shows the difference between period averages for the totality of capital account net payments (saving less the financial surplus) in the two datasets expressed as a per cent of personal disposable income, in the case of the pre-ESA95 data, and household available resources, in the case of the ESA95 dataset. The respective period averages are 6.7 per cent and 5.6 per cent, the difference recorded in the first row as minus 1.1 percentage points. The table shows too the total change between the pre-ESA95 accounts and the 2018 Blue Book record: in the first row, a difference between the pre-ESA95 dataset period average of 6.7 per cent and the 2018 Blue Book dataset average of 5.3 per cent, recorded in the table as minus 1.3 percentage points after rounding. As a guide to the size of the individual components, the right-hand side column in the table shows the 2018 Blue Book period averages.

Chart 8 traces the totality of capital account net payments for the three dataset vintages from 1948; Chart 9 does the same for fixed capital formation, the largest single component of the household capital account. Net capital transfers account for most of the difference between the total net payments on capital account and fixed capital formation series traced in the two charts. To aid visual clarity, the outlier observations for the years 1946 and 1947 are not displayed.
The following features of the data vintages are notable:

- At both the aggregate level of total net payments on capital account and its major sub-total, fixed capital formation, the pre-ESA95 and later series trace similarly-shaped paths over the volatile overlapping period, 1987 to 1997, with the later vintages deflected downwards.

- On average, as a per cent of available resources, total net capital payments and fixed capital formation are a little over 1 percentage point below their pre-ESA95 equivalents.

- The major part of the downward adjustment arose in the transition to ESA95. Of the 1.3 percentage point downward adjustment compared with the pre-ESA95 accounts of total net capital payments, 1.1 percentage points came in the transition to ESA95, the remaining 0.2 percentage points thereafter. The fixed capital formation vintages show a similar pattern.

- In the transition to ESA95, the largest downward adjustment arose in non-dwelling fixed capital formation, notably transfer costs. Dwelling investment was not materially revised.

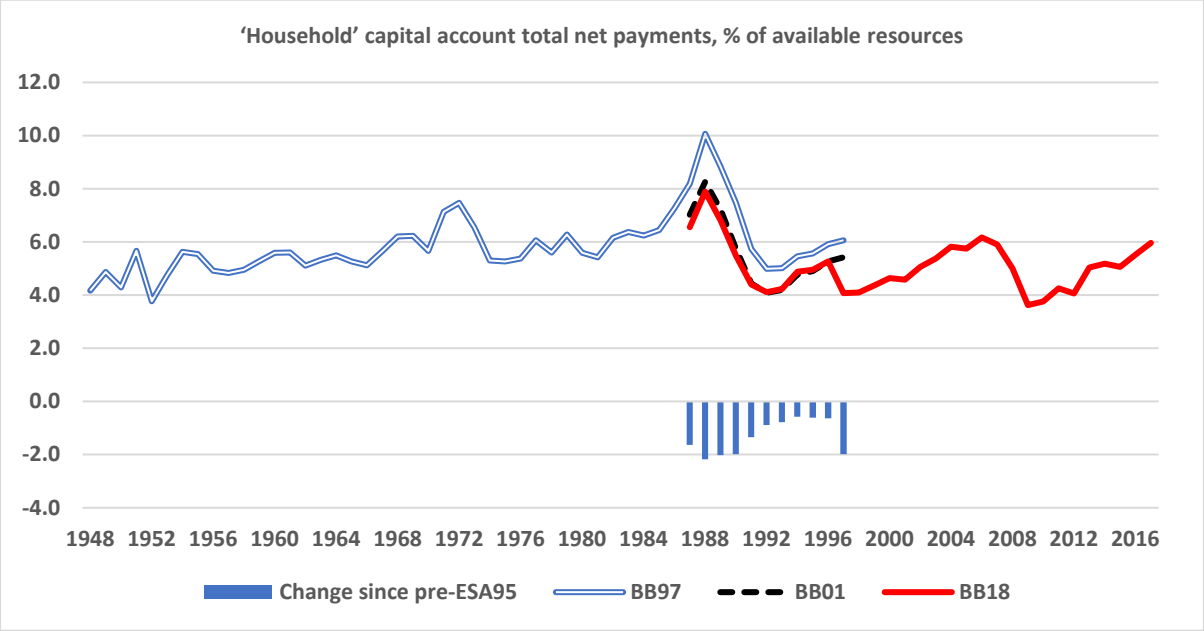
- Revisions since the 2001 Blue Book show a different pattern: gross fixed capital formation in dwellings was revised down; capital formation represented by transfer costs was revised up. With upward revisions to the combined category of investment in tangible plant and machinery and in intangibles, the 2018 Blue Book record shows little change compared with the pre-ESA95 account for non-dwelling investment as a whole.

- Taxes on capital and, to a lesser extent, other net capital transfer payments, were downwardly revised in the transition to ESA95. Subsequent upward revisions to other net capital transfer payments left their record by 2018 little changed from the pre-ESA95 account.

- A more detailed examination shows a volatile transition from the pre-ESA95 data to today's record. Compared with the pre-ESA95 data, a peak downward revision in total net capital payments as a per cent of available resources was scored by the 2010 Blue Book (down 1.5 percentage points). This observation was followed five years later by a trough (a downward adjustment of 0.6 percentage points) scored by the 2015 Blue Book. Unsurprisingly, a peak to trough movement is also seen in the sequence of downward revisions, compared with the pre-ESA95 record, of fixed capital formation as a per cent of available resources: a peak downward revision of 1.1 percentage points in the 2010 Blue Book is followed by a downward revision trough of just 0.2 percentage points in the 2015 Blue Book.

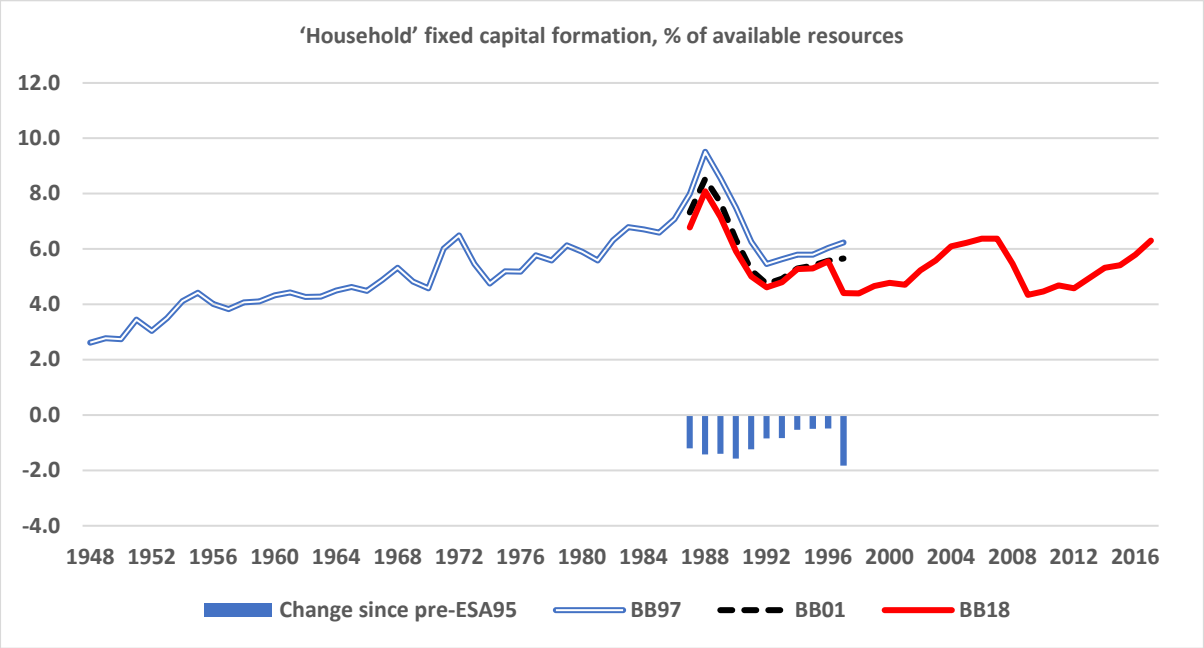
- Comparing the pre-ESA95 data with the 2018 Blue Book data, the charts reveal a generally declining scale of downward revision for both total net payments on capital account and for gross capital formation, from the start to the end of the overlapping period, with the exception of the year 1997. In 1997, the 2-percentage point downward revision is materially larger than in the immediately preceding years. The main contributor to the 1997 outlier is the revision to gross capital formation and, within that total, to dwellings and to transfer costs: down 1 percentage point and 0.5 percentage points, respectively. By contrast, the comparison between the pre-ESA95 data and the 2001 Blue Book data does not reveal a 1997 outlying revision. The later ONS practice of truncating revisions at 1997 appears to be responsible for this feature.

Chart 8: Household saving minus financial surplus: Blue Books 1997, 2001 and 2018



Sources: Table 2 sources, *UK Economic Accounts* published 2Q 1998 ('BB97, 'pre-ESA95'); Blue Books 2001 and 2018. Notes: See Table 4 notes.

Chart 9: Household fixed capital formation: Blue Books 1997, 2001 and 2018



Sources: Table 2 sources, *UK Economic Accounts* published 2Q 1998 ('BB97, 'pre-ESA95'); Blue Books 2001 and 2018. Notes: See Table 4 notes.

Table 5: Regression results: household capital account data vintages

Regression estimation period: 1987-1997	**2001 Blue Book**			**2018 Blue Book**			**Wald test**
	α	β	$\overline{R}^2$	α	β	$\overline{R}^2$	χ^2, p-value
Total net capital payments							
coefficient	0.35	0.78	0.96	0.68	0.70	0.89	5.1
t-value	1.0	14.9		1.3	9.1		0.079
Fixed capital formation							
coefficient	-0.04	0.90	0.97	0.26	0.80	0.88	12.0
t-value	-0.1	17.7		0.4	8.6		0.002
of which:							
Dwellings							
coefficient	-0.58	1.14	0.99	0.08	0.76	0.94	626.7
t-value	-3.1	26.0		0.3	12.7		0.000
Non-dwellings							
coefficient	0.19	0.64	0.83	0.26	0.84	0.78	39.7
t-value	0.8	7.0		0.7	6.0		0.000
of which:							
Transport equipment							
coefficient	-0.01	0.68	0.83	0.00	0.49	0.68	242.8
t-value	-0.3	7.0		0.0	4.7		0.000
P&M, intangibles							
coefficient	0.16	0.66	0.57	0.84	0.17	-0.08	124.4
t-value	1.6	3.8		4.6	0.5		0.000
Other buildings/structures							
coefficient	0.06	0.58	0.38	-0.05	0.65	0.92	29.0
t-value	0.6	2.6		-2.1	11.1		0.000
Transfer costs							
coefficient	-0.02	0.64	0.83	0.00	0.89	0.76	47.2
t-value	-0.1	7.1		0.0	5.6		0.000
Taxes on capital							
coefficient	0.22	0.14	0.73	0.18	0.12	0.74	2195.3
t-value	12.2	5.2		12.4	5.4		0.000
Other net capital transfers							
coefficient	0.12	0.93	0.94	0.18	0.65	0.93	209.4
t-value	2.0	13.0		3.8	11.8		0.000

Sources: See Table 4. Notes: 'P&M': 'plant and machinery'. Dependent variables are the annual 2001 Blue Book and 2018 Blue Book vintages of household capital

account items as a per cent of available resources. The independent variable in each case is the pre-ESA95 personal sector closest equivalent. The estimation period is confined to the overlapping eleven years from 1987 to 1997. Regressions using variables expressed as a per cent of available resources help to avoid the problem of heteroscedasticity evident in regressions using levels of each series. The linear regressions, which include a constant, can be equivalently estimated using ordinary least squares or as seemingly unrelated regression equations: since the independent variables are the same in each case, SURE estimation does not affect the efficiency of the estimates. The Wald test is of the null hypothesis of equality across the 2001 and 2018 Blue Book vintage regressions of their intercepts, α , and slopes, β .

Attention is now turned to the stability of the relationships between the pre-ESA95 data and the later datasets. With the results to be taken sceptically due to the small sample, Table 5 summarises these relationships using simple regressions. The 2001 and 2018 Blue Book data for each series are regressed, with an intercept, on the pre-ESA95 closest equivalent over the 1987-1997 period. A test is performed of the null hypothesis that the regression intercept and slope parameters remain unchanged across the data vintages.

The key results are simply stated. Intercept terms are generally statistically insignificant, notable exceptions being the regressions for taxes on capital and other net capital transfer payments. Slope terms are generally statistically significant, the plant, machinery and intangibles regression using 2018 Blue Book data being an exception. Most important, the null hypothesis of parameter stability across data vintages is rejected in every case save the regression for total net capital payments. These rejections are not auspicious for the reliable use of regression techniques to backcast historical data using the pre-ESA95 dataset. A new data vintage could overturn previously estimated relationships.
Finally, in this section, consideration is given to some of the reasons for these revisions. A number of forces have been at play:

- *Reclassifications*: The reclassification of partnerships from the personal sector to the corporate sector and a sector reallocation of, in aggregate, largely unchanged investment transfer costs appear to explain much of the pattern of revisions in the transition to ESA95. Capital expenditure estimates were generally lower, except for dwellings. Maurice (1968, p99) notes that unincorporated enterprises within the personal sector accounted for most of its inventory building and fixed investment, save that in dwellings, existing buildings and land. In addition, taxes on capital were redefined to exclude capital gains taxes.

- *Intangibles*: Both ESA95 and ESA10 widened the coverage of investment to include intangible fixed assets ('intellectual property products'), such as computer software, literary and artistic originals (for example, fine art and copyrighted books) and, under ESA10, expenditure on research and development (R&D). Non-profit institutions serving persons account for 95 per cent or more of household sector investment in intangibles.

- *Database overhaul*: The ONS has redeveloped its estimation system for fixed capital expenditure in line with a five-year strategy launched in 2015, following the 2014 Barker Review (Barker and Ridgeway, 2014), and the recommendations in the 2016 Bean Review. The result has been the discovery and correction of a number of processing errors and other data improvements, with revisions extending back to the 1987-1997 overlapping period.

There are several relevant examples of the impact of the database overhaul.

Despite upward revisions in the 2015 Blue Book to estimates of spending on dwelling improvements counted as part of dwelling gross capital formation (Duff, 2015), household dwelling investment has been downwardly revised. There were two stages. A downward correction to data for dwellings improvements was effected in the 2016 Blue Book to address a processing error (Walton, 2016). In the 2017 Blue Book, household investment in new dwellings was further downwardly revised: the ONS found that the split of the dwelling investment data had attributed too much to households and too little to private non-financial corporations (Kent, 2017). The latest data put household dwelling investment at a fixed, exact 80 per cent of private sector dwelling investment between 1997 and 2007; thereafter it varies around an 85 per cent average. Unaccountably, the share between 1987 and 1996 is set at 99 per cent, the result possibly of an arbitrary truncation of past revisions by the ONS at the 1997 cut-off date. Such a truncation would create the cliff-edge that appears to explain in part the outlying 1997 revision seen in Chart 9. Investment transfer costs were also revised down in 2017 as a result of improved sector allocation, having been substantially upwardly revised in the 2012 and 2013 Blue Books. Current estimates of transfer costs still exceed those in the 2001 Blue Book.

The broad conclusion is that a seemingly straightforward revision to the pre-ESA95 record of total net capital payments seen in Chart 8 hides a number of material changes to the component series that can be offsetting and unstable across dataset vintages. The similarity of the records for total net capital payments, adjusted by a scalar, may thus be regarded as accidental, and not indicative of robust relationships that could be confidently deployed to backcast ESA10 compliant data.

Backcasting using the pre-ESA95 household capital account: methods and results

On the basis of this analysis, the decision was made to use a variety of bespoke methods, with effort geared to the importance of each series to the household capital account.

Minor items are backcast crudely. The net acquisition of valuables, part of fixed capital formation, and of non-produced, non-financial assets, items for which there are no pre-ESA95 equivalents, are set to zero before 1987. Changes in household sector inventories before 1987 are backcast by applying to household non-dwelling investment, a series itself backcast using the methods described below, the pre-ESA95 ratio of personal sector stockbuilding to personal non-dwelling investment.

Taxes on capital payable by the household sector before 1987 are assumed to equal ESA10 government receipts of taxes on capital, even though the latter include taxes on capital paid by corporations. The error so introduced is unlikely to be large. The latest accounts record zero corporate payments of capital taxes after 1990 and trivial amounts before then back to 1987. It is also the case that ESA10 compliant data for government receipts of taxes on capital, available from 1946, closely if not exactly align with the pre-ESA95 series for personal sector payments of taxes on capital until 1963, after which direct comparison is invalidated by the inclusion in the latter of capital gains taxes.

Other net capital transfers received by the personal sector are equated back to 1954 with the difference between the currently estimated other net capital transfers series for the private sector and the pre-ESA95 equivalent series for private corporations. The rationale is two-fold. First, the current and pre-ESA95 vintages of the series for private corporations other net capital transfers are exactly the same between 1987 and 1990, and differ by trivial amounts in 1991 and 1992. Compared with the pre-ESA95 series, the currently recorded revisions are confined to the household sector between 1987 and 1990. Second, compared with the pre-ESA95 series, the scale of revisions to the private sector total are themselves trivial – typically less than 0.1 per cent of currently estimated GDP - back to 1954.

Before 1954, different considerations apply. Compared with the pre-ESA95 series, the downward revisions to the private sector total are very large, rising to in excess of minus 1 per cent of GDP before 1951. This break in the scale of revisions is associated in the ESA95 and later public sector accounts, but absent from the pre-ESA95 accounts, with very large central government receipts of capital transfers from the private sector (ONS code ANNN). As noted earlier,

there exists the possibility that the shift in revision pattern might be the result, in part, of an omission of Marshall Aid and related grants from the capital account of the balance of payments. In order to protect estimates of household sector other net capital transfers from possible anomalies, the household sector data before 1954 are derived by splicing the pre-ESA95 personal sector series to the value of the residually-derived household series. The series for corporate sector other net capital transfers becomes the residual of the private sector and derived household sector series, and is thus exposed to any errors in the private sector data, the result of possible deficiencies in the official records.

Fixed capital formation is the major item on household capital account. The backcasting approach adopted aims to make best use of the available pre-ESA95 series while observing the key identity set by current estimates of private sector fixed capital formation. As in the case of other net capital transfers, the currently estimated private sector series is derived from the identity manipulation exercise described in the first section of the paper. The backcast household and private corporate sector fixed investment series need to add up to the given private sector total. Two steps are involved: first the use of proxies to backcast the household and corporate series and, second, the combining of these proxies in a manner that aims to reflect their reliability and satisfies the accounting constraint.

It should be noted that the satisfaction of the constraint gives rise to two proxies for the same series: there is, for example, both a direct proxy for household capital formation, derived from the pre-ESA95 data, and an indirect proxy calculated by subtracting from the given private sector total the proxy for corporate fixed capital formation, similarly derived from the pre-ESA95 data. The balanced estimator of household fixed capital formation can be formed as a weighted average of the two proxies, direct and indirect, where the weights capture their relative reliability.

Relevant to this approach is the extensive literature, described in Sefton and Weale (1995) and Dagum and Cholette (2006), on techniques to balance the national accounts, an idea that began with Stone et al. (1942), and to interpolate and extrapolate time series using related proxies (for example, Chow and Lin, 1971). It is instructive to cast within this balancing framework the very simple backcasting method, a mixture of splicing and pro-rating, used later in this paper. Doing so helps to formalise the assumptions underlying the chosen method to backcast sectoral fixed capital formation data and to articulate the obstacles to deployment of more complex balancing techniques.

The balanced estimator for household capital formation, $\hat{I}_{h,t}$, at time *t*, for *t* equal to 1946, 1947 … 1986, is construed as a weighted average of both its direct proxy, $\vec{I}_{h,t}$, and its indirect proxy calculated by subtracting the direct proxy for corporate sector fixed capital formation, $\vec{I}_{c,t}$, from the given private sector total $I_{v,t}$. The indirect proxy for household capital formation is thus $I_{v,t} - \vec{I}_{c,t}$.

The two proxies for the same household sector series are combined by reference to their relative reliability. The relative reliability weights for the direct and indirect proxies are respectively $1-u_{h,t}$ and $1-u_{c,t}$, where the $u_{i,t}$ for $i = h, c$ measure the proxies' respective relative unreliability. The weights sum to one and may vary over time. A symmetric relationship holds for the balanced estimator for corporate fixed capital formation.

The two balanced estimators for household and corporate fixed capital formation sum to the private sector total thus:

$$\begin{aligned}
\hat{I}_{h,t} &= \left(1-u_{h,t}\right)\vec{I}_{h,t} + \left(1-u_{c,t}\right)\left(I_{v,t} - \vec{I}_{c,t}\right) \\
\hat{I}_{c,t} &= \left(1-u_{c,t}\right)\vec{I}_{c,t} + \left(1-u_{h,t}\right)\left(I_{v,t} - \vec{I}_{h,t}\right) \\
u_{h,t} + u_{c,t} &= 1 \\
\hat{I}_{h,t} + \hat{I}_{c,t} &= I_{v,t}
\end{aligned} \qquad (9)$$

These relationships can be simplified by adding together the direct proxies for the household and corporate sector series to form an aggregate private sector proxy:

$$\vec{I}_{v,t} \equiv \vec{I}_{h,t} + \vec{I}_{c,t} \qquad (10)$$

The combination of equations (9) and (10) yields:

$$\begin{aligned}
\hat{I}_{h,t} &= \vec{I}_{h,t} + u_{h,t}\left(I_{v,t} - \vec{I}_{v,t}\right) \\
\hat{I}_{c,t} &= \vec{I}_{c,t} + u_{c,t}\left(I_{v,t} - \vec{I}_{v,t}\right)
\end{aligned} \qquad (11)$$

Very simply, the balanced estimators for the household and corporate sectors are each equal to their direct proxies plus a proportion of the discrepancy between the given private sector total and the private sector total implied by the summation of the direct proxies for households and corporations. It makes sense that the more relatively unreliable the direct proxy, the more of the private sector discrepancy it should attract when calculating the balanced estimate.

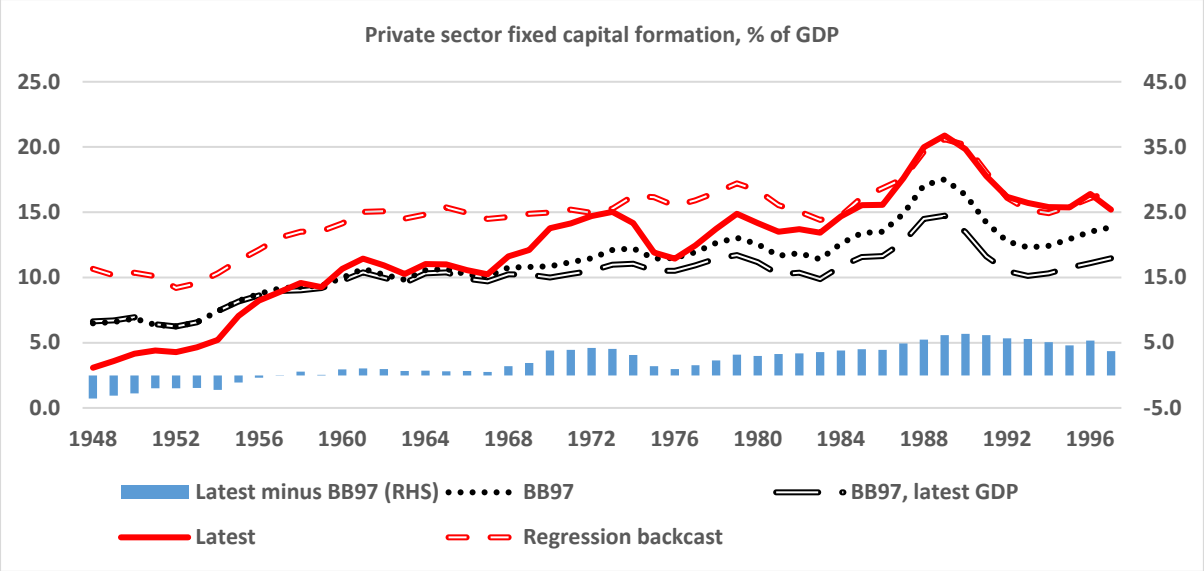
In the least squares balancing literature, equations equivalent to (11) emerge as the mathematical solution that minimises a loss function expressed as the sum of squared deviations of the balanced estimators from their respective proxies weighted by the proxies' reliability (for example, Sefton and Weale, 1995, p14, equation 2.4 and proof).[3] The balanced estimates remain as close as possible to their direct proxies while satisfying the accounting identity. In this literature, reliability is measured by the variance-covariance matrix of measurement errors that link the proxies with the true data. In the simplest case, in which measurement errors are in general serially uncorrelated, the relative unreliability of the direct proxy for household fixed capital formation, for example, would be calculated as a constant equal to the sum of the variance of the proxy's measurement errors and their covariance with the errors associated with the direct proxy for corporate capital formation, the sum being expressed as a share of the variance of the two combined.

For a least-squares balancing approach to be valid, the proxies must be unbiased estimates of the true data. This being so, the expected values of the proxies equal the true data: in this case, $\mathrm{E}\left(\vec{I}_i\right) = I_i$ for $i = h, c$. It follows that $\mathrm{E}\left(I_v - \vec{I}_v\right) = 0$ and $\mathrm{E}\left(\hat{I}_i\right) = I_i$ for $i = h, c$.

Against this background, it might seem desirable to deploy regression analysis linking the pre-ESA95 and ESA10 series, and the associated variance-covariance matrix of errors, to backcast balanced estimates of the ESA10 data. Regrettably, such an approach is thwarted by too few degrees of freedom – the overlapping period of just 11 years – the evidence already considered of non-robustness to data vintage changes (Table 5) and, most important, the changing past relationship between the latest private sector data and those in the pre-ESA95 accounts.

To illustrate, Chart 10 shows the results of adding together the fitted and backcast values of simple regressions estimated over the 1987 to 1997 period that link the latest and the pre-ESA95 data for household and corporate fixed capital formation as shares of GDP. Added together, the so constructed private sector proxy fits the estimation period well, but, backcast, greatly and increasingly overstates the ESA10 consistent 'true' data. As the chart shows, a major cause of the breakdown in the regression relationships is the diminishing excess, turning before the late-1950s to an increasing decrement, of ESA10 private fixed capital spending figures compared with the pre-ESA95 equivalent.

Chart 10: Private sector fixed capital formation: pre-ESA95, latest & regression backcast



Sources: *UK Economic Accounts* published 2Q 1998 ('BB97') and 1Q 2019 ('latest'). Note: 'BB97' calculated using GDP data of the same vintage; other series use latest GDP as the denominator.

The diminishing excess before 1987, and subsequent decrement before the late-1950s, cause the backcast fitted values of regressions based on the 1987-1997 relationships between the ESA10 and pre-ESA95 data seriously to overstate the past level of private sector investment as now recorded. A key explanation for the changing relationship in the basic data is to be found in the widening coverage of fixed capital formation under ESA10 to include more intangibles, notably R&D, which has increased rapidly over time (Banks et al., 2014). But unexplained and seemingly undocumented is the *shortfall* of ESA10 consistent private sector fixed capital formation data (and GDP) relative to the pre-ESA95 accounts before the late-1950s. This counterintuitive decrement, as previously noted, appeared in the transition to ESA10; it is not a feature of the ESA95 current price data.

While the pre-ESA95 data cannot be used reliably to backcast ESA10 compliant *levels* of investment, there is tentative evidence to support their use as a proxy for rates of *growth* of the latest ESA10 compliant series. A simple regression over the 1947 to 1986 interval relating the growth of the latest data for private sector fixed capital formation to the pre-ESA95 private sector series scores a so-so fit, $\bar{R}^2 = 0.42$, but does not fail standard diagnostic tests including a Chow test for predictive stability over the subsequent eleven year 1987 to 1997 interval. Nor are the restrictions of a zero intercept and unit slope coefficient rejected by a standard Wald test.

Having considered and rejected as infeasible more elaborate balancing procedures, I adopt a backcasting method that combines splicing and pro-rating as a simple, albeit unavoidably crude way to capture the growth rate information in the pre-ESA95 series while at the same time observing the private sector accounting constraint. The pre-ESA95 data for personal sector dwelling and non-dwelling fixed capital formation and for private corporate fixed capital formation as a whole are spliced to the latest data at the year 1987. Backcast, these spliced series grow at the rates of growth recorded in the pre-ESA95 series. However, as expected, the private sector total calculated by adding up the spliced component series differs from the latest data for private sector capital formation. This discrepancy needs to be removed. To do so, I apportion the discrepancy to the spliced component series in proportion to their respective shares of the private sector spliced-series aggregation.

This procedure amounts to the pro-rating of the spliced series by the quotient of the private sector total and the spliced series private sector total. The equivalence, which may not be intuitive, can be understood in terms of equation set (11), which simplifies by conflating dwelling and non-dwelling household capital formation. The allocation of the private sector discrepancy is governed by the unreliability weights $u_{h,t}$ and $u_{c,t}$. Under the method employed, the weights take the form:

$$u_{h,t} = \frac{\vec{I}_{h,t}}{\vec{I}_{v,t}} \text{ and } u_{c,t} = \frac{\vec{I}_{c,t}}{\vec{I}_{v,t}} \tag{12}$$

The combination of equation sets (11) and (12) yields the simple pro-rating formulae:

$$\begin{aligned} \widehat{I}_{h,t} &= \vec{I}_{h,t} \frac{I_{v,t}}{\vec{I}_{v,t}} \\ \widehat{I}_{c,t} &= \vec{I}_{c,t} \frac{I_{v,t}}{\vec{I}_{v,t}} \end{aligned} \tag{13}$$

While crude, this method is not without all merit. It avoids the mistake of deriving the corporate sector backcast series as the difference between the private sector true data and the household sector spliced series, a method that would without justification treat the household sector spliced series as wholly reliable and the corporate sector spliced series as wholly unreliable ($u_{h,t} = 0$ and $u_{c,t} = 1$). Second, the relative unreliability of the spliced series is determined by their relative magnitude, a feature of the method that is not inconsistent with the presumption that the variance of measurement errors grows over time as the series increase in scale: the measurement errors are likely to be heteroscedastic. Quenneville and Rancourt (2005) and Quenneville and Fortier (2012) of Statistics Canada, Canada's national statistical office, describe their implementation of this method

interpreted as a constrained weighted regression with the error variances set equal to the proxy indicators.[4]

D) Historic estimates of household and corporate sector financial balances

The estimates of household saving, investment and capital transfers, and the partly residually-derived equivalent measures for corporations, can be brought together to backcast historic estimates of the sectors' financial balances. Full analysis of these data is left for subsequent research, but it is relevant here briefly to compare the constructed estimates with the pre-ESA95 series.

Separately for households and corporations (the latter including public as well as private corporations), Charts 11 and 12 trace the financial balances depicted by the two dataset vintages over the maximal overlapping period, which runs for the 52 years from 1946 to 1997. Financial balances are shown as a share of GDP. The results of standard tests for the equality of means and of variances of the two dataset vintages are recorded in Table 6 for the full period and the two 26-year half periods. The equality tests extend to the market sector financial balance, the aggregation of the household and corporate sector financial balances. As previously noted, the market sector nets out to zero all intra-sector transfers, which include dividend, interest and pension saving flows between households and corporations. Some measurement errors, notably those affecting series derived residually, such as the pre-1987 data for corporations undistributed profits, will similarly net out.

The immediate impression is of two datasets that are not wildly different but with distinctive patterns.

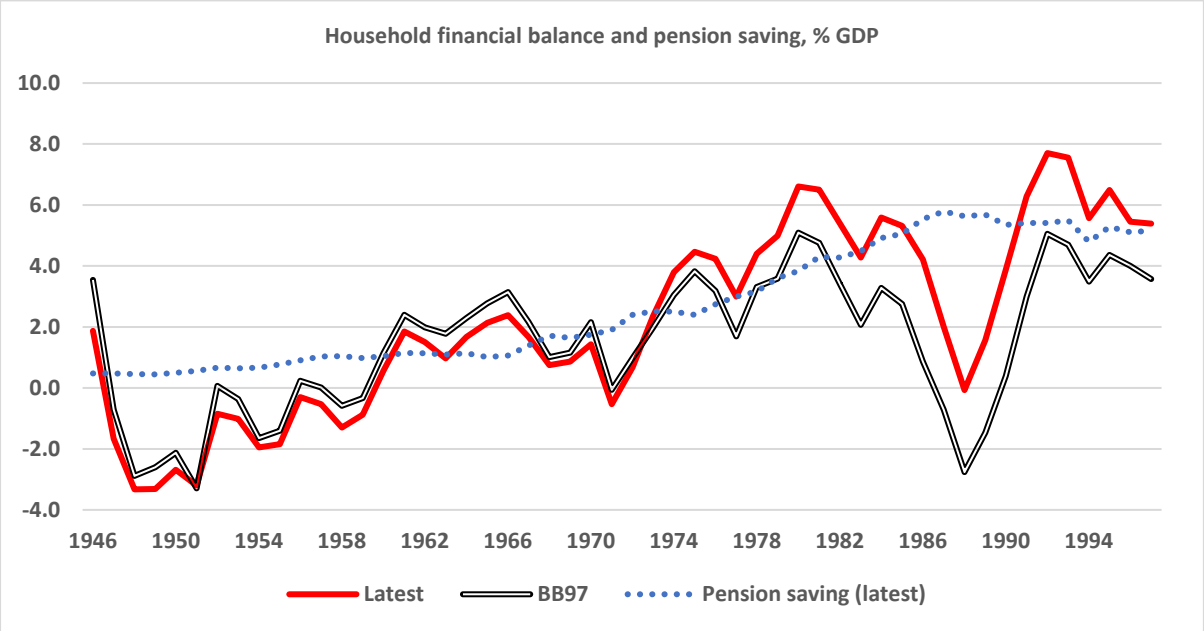
Common features for household financial balances are the negative balances of the 1950s, the subsequent unsteady rise to the early-1980s and the great oscillations associated with the Lawson boom and bust. Distinguishing the two datasets is the lower level of household financial balances recorded by the latest estimates until the early-1970s. Thereafter, there is a level reversal, with the latest estimates exceeding the pre-ESA95 figures. Chart 11 suggests one cause may be the level of pension saving as now recorded under ESA10. After the early-1970s, the ESA10 compliant figures rose above earlier estimates that included actual rather than actuarially-based property income flows from DB pension schemes, as previously shown in Chart 5.

Common features of the two dataset vintages for corporate financial balances are the apparent postwar downtrend until the mid-1970s, and the Lawson boom oscillation. Distinguishing the two datasets, as in the case of the household sector, is a level reversal. The corporate financial balances seen in the latest data are above those in the pre-ESA95 dataset until the early-1970s; then the reverse applies.

Table 6 brings out some of these features more formally. The null hypothesis of equality of means revealed by the two datasets is not rejected over the full sample period for either the household sector or the corporate sector. But mean equality is rejected in the case of households after the early-1970s and for corporations in both sample half periods. The null hypothesis of equality of variances is not rejected for either sector in both sample half periods, but is rejected over the full period.

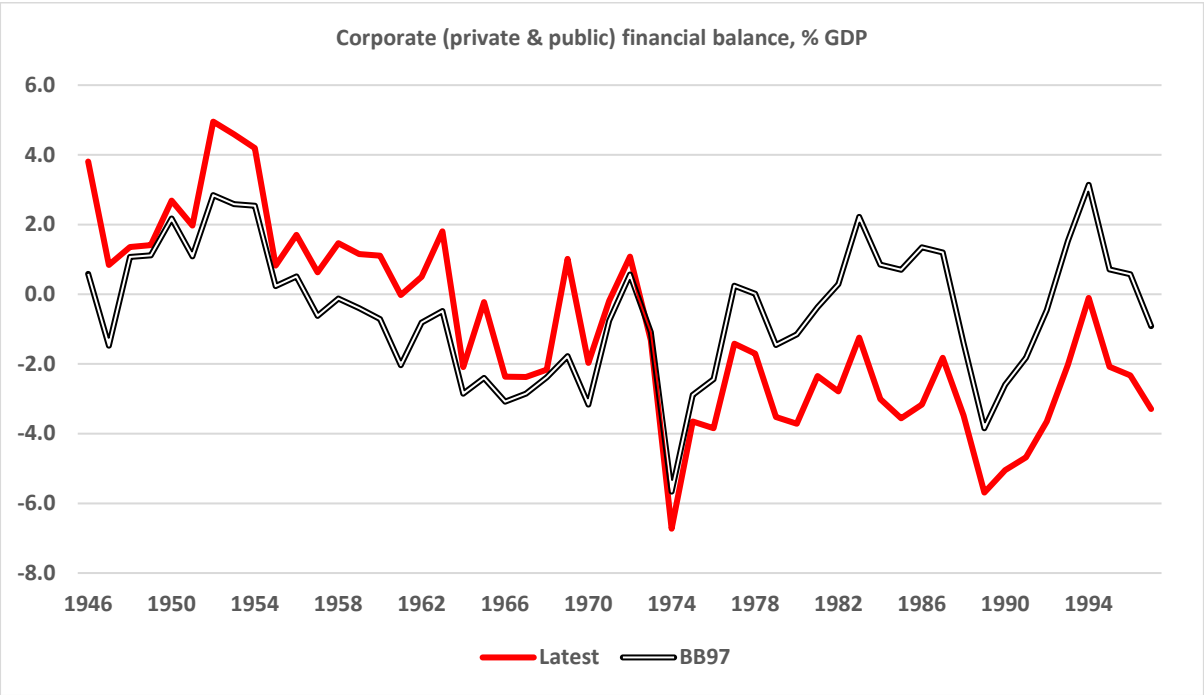
By these simple tests, the market sector data emerge as relatively robust to changes in dataset vintages. The null hypotheses of equality of means and variances as recorded in the two datasets over both the full sample period and each half period are not rejected. This robustness of the market sector aggregation is quite striking in view of the major data revisions and material conceptual changes that separate the pre-ESA95 dataset and the latest estimates. It is a finding in keeping with the results in Martin (2009) and with the strong preference for a private sector aggregation expressed by Godley in his empirical work (Godley, 1999, appendix 1). In stark contrast, Godley firmly rejected such aggregation in favour of a household-firm two sector separation in his theoretical work (Godley and Lavoie, 2007, p25). This tension between empiricism and theory, and whether it can be resolved, is a subject that will repay further investigation.

Chart 11: Household financial balance: pre-ESA95 & latest



Sources: Saunders (1954), 1954 Blue Book, *UK Economic Accounts* published 2Q 1998 ('BB97') and 1Q 2019 ('latest'); own calculations. Note: series calculated using GDP data of the same dataset vintage.

Chart 12: Corporate financial balance: pre-ESA95 & latest



Sources: Saunders (1954), 1954 Blue Book, *UK Economic Accounts* published 2Q 1998 ('BB97') and 1Q 2019 ('latest'); own calculations. Note: series calculated using GDP data of the same dataset vintage.

Table 6: Equality tests comparing pre-ESA95 and latest data for sector financial balances

Financial balances, % of GDP	1946-1997	1946-1971	1972-1997
Number of annual observations	52	26	26
Equality of means by sector			
Household	0.21	0.26	0.00*
Corporate (public plus private)	0.26	0.01*	0.00*
Market (household plus corporate)	0.75	0.11	0.54
Equality of variances by sector			
Household	0.03*	0.76	0.96
Corporate (public plus private)	0.01*	0.55	0.44
Market (household plus corporate)	0.30	0.23	0.33

Sources: *UK Economic Accounts* published 2Q 1998 (pre-ESA95 data) and 1Q 2019 (latest data); own calculations. Note: series calculated using GDP data of the same vintage. The table reports the p-values for the Welch F-test for the equality of the sample-period means and for the F-test for the equality of the sample-period variances. * results reject the null hypothesis of equality of the means or variances of the two dataset vintages at the 5 per cent level of significance.

E) Conclusion

This paper set itself the task of backcasting UK national sectoral accounts before 1987, the date prior to which comprehensive ONS data are unavailable.
Investigation of occupational pension scheme data allowed a crude backcast before 1963 of household pension saving, enabling the backfilling of ONS household saving data to 1948. Further cruder efforts were made to extend the saving data to 1946. Corporate sector undistributed profits were derived by residual, subtracting the household saving estimates from private sector saving. The latter series was itself derived, along with other broad sector aggregations, by manipulation of national accounting identities and the integration of the ONS national, public finances and balance of payments accounts.

Pre-ESA95 data, which had to be reconstructed, were used to backcast elements of the household sector capital account. Investigation of the limited eleven-year overlap between pre-ESA95 and later data, the disruptive impact on relationships of the sequence of multiple revisions, and the major differences that have emerged since ESA10 between pre-ESA95 and ESA10 compliant estimates of private sector fixed capital formation led me to reject as infeasible the use of elaborate backcasting techniques. Instead, various backcasting techniques were deployed, depending on the empirical importance of the capital account item in

question and knowledge of the accounting. Special attention was given to the backcasting of fixed capital formation, where an attempt was made to allow, albeit very crudely, for the relative reliability of household and corporate sector spliced proxy data.

Missing from this account is a fully objective criterion by which to gauge the reliability of the resulting estimates. This weakness is not unique to these data. Former CSO statisticians helpfully provided margins of error for the pre-ESA95 accounts, but with the recognition that the margins were necessarily 'very rough and mainly subjective judgements' (CSO, 1985, paragraph 3.38). Personal sector saving was rated 'D', the lowest rating on the CSO scale, taken to imply a 90 per cent probability that the true figure lay within a plus or minus range between 20 per cent and 35 per cent of the national accounts estimate (CSO, 1985, ibid; Sefton and Weale, 1995, p103). Financial balances, not surprisingly, were regarded as very unreliable.

On this reckoning, the pre-1987 household and corporate sector financial balances estimated here would warrant an even lower subjective rating, albeit with the recognition that some measurement errors will be offsetting. Attention has been drawn to official data weaknesses, some of which arise from the truncation by the ONS of past revisions at the 1987, and sometimes 1997, cut-off date. Except to the extent that I have made explicit provision, such as in the reconciliation of the PSF data, estimates here naturally inherit any weaknesses in the ONS income, expenditure, saving and transfers data. The estimation of pension saving before 1963 and of the household and corporate capital account before 1987 adds a further degree of uncertainty, which has been only partly appraised by sense checking against alternative measures and by comparison with the pre-ESA95 accounts.

Remaining data tasks are to develop quarterly capital account data and to take on board the impact of the forthcoming 2019 Blue Book and further ONS investigations, which may resolve some of the data weaknesses. Once further analysis of the results is complete, it is the intention to make the historic sector dataset publicly available.

Note: The cut-off date for data used in this paper is March 2019

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Abbreviations

CSO: Central Statistical Office.

ESCoE: Economic Statistics Centre of Excellence.

HMSO: Her Majesty's Stationery Office.

IMF: International Monetary Fund

OECD: Organisation for Economic Co-operation and Development.

ONS: Office for National Statistics.

NBER: National Bureau of Economic Research

UK: United Kingdom

USA: United States of America

Notes

1 I am indebted to Anne Harrison for this point. See also Vanoli (2005).

2 The ONS ESA10 decomposition can be formalised by considering the current present value of a DB pension scheme's liabilities using a simplification of the Projected Benefits Obligations method:

$$V_t = \int_{s=R-t}^{s=D-t} a\left(t-W\right) y_R e^{-is} ds \qquad \text{(A1)}$$

where: V_t denotes the present value, at time *t*, of the DB scheme's liabilities; *a* denotes the accrual rate; *i* denotes the discount rate; *D*, *R*, *W* denote, respectively, the times of death, retirement and start of scheme membership; y_R denotes expected final salary at retirement. Salary is expected to grow at rate, *g*, so that: $y_R = y_t e^{g(R-t)}$.

It follows that:

$$\frac{dV_t}{dt} = \left(\frac{dy_t}{dt}\frac{1}{y_t} - g + \frac{1}{t-W} + i \right) V_t \qquad \text{(A2)}$$

With a constant discount rate, equation (A2) shows that the change in DB pension entitlement from one period to the next falls into three parts:

I. Increase in entitlement due to any unexpected growth in salary: $\left(\frac{dy_t}{dt}\frac{1}{y_t} - g \right) V_t$.

II. A 'current service increase' in entitlement: for each year of work, the active member builds up another year of entitlement: $\frac{V_t}{t-W}$.

III. The 'unwinding of the discount rate' effect or 'past service increase' in entitlement: for each year that passes, the scheme members are closer to retirement and death and therefore there is one less year to apply a discount factor: iV_t.

3 Robert Rowthorn has very helpfully demonstrated that equation set (11) in the main text can be alternatively derived as the solution to a quadratic minimisation problem subject to the condition:

$$\hat{I}_{h,t} + \hat{I}_{c,t} = I_{v,t}$$

The quadratic loss function is:

$$F = \frac{\left(\hat{I}_{h,t} - \ddot{I}_{h,t}\right)^2}{u_{h,t}} + \frac{\left(\hat{I}_{c,t} - \ddot{I}_{c,t}\right)^2}{u_{c,t}}$$

Eliminating $\hat{I}_{c,t}$ and noting that $u_{h,t} + u_{c,t} = 1$ yields:

$$F = \frac{\left(\hat{I}_{h,t} - \ddot{I}_{h,t}\right)^2}{u_{h,t}} + \frac{\left(I_{v,t} - \hat{I}_{h,t} - \ddot{I}_{c,t}\right)^2}{1 - u_{h,t}}$$

Differentiating and setting the result to zero:

$$\frac{dF}{d\hat{I}_{h,t}} = 2\frac{\hat{I}_{h,t} - \ddot{I}_{h,t}}{u_{h,t}} - 2\frac{I_{v,t} - \hat{I}_{h,t} - \ddot{I}_{c,t}}{1 - u_{h,t}} = 0$$

Therefore:

$$\left(1 - u_{h,t}\right)\left(\hat{I}_{h,t} - \ddot{I}_{h,t}\right) - u_{h,t}\left(I_{v,t} - \hat{I}_{h,t} - \ddot{I}_{c,t}\right) = 0$$

Re-arranging, noting that $\ddot{I}_{v,t} \equiv \ddot{I}_{h,t} + \ddot{I}_{c,t}$:

$$\hat{I}_{h,t} = \ddot{I}_{h,t} + u_{h,t}\left(I_{v,t} - \ddot{I}_{v,t}\right)$$

Likewise:

$$\hat{I}_{c,t} = \ddot{I}_{c,t} + u_{c,t}\left(I_{v,t} - \ddot{I}_{v,t}\right)$$

4 The authors impose a variance-covariance matrix which is block diagonal with zero contemporaneous covariance and zero serial correlation of the proxies' measurement errors, ε, whose time-varying variances (*Var*) at each point in time can be described in the case here by:

$$Var\left(\varepsilon_{\tilde{h},t}\right) = \tilde{\tilde{I}}_{h,t}$$
$$Var\left(\varepsilon_{\tilde{c},t}\right) = \tilde{\tilde{I}}_{c,t}$$
$$Var\left(\varepsilon_{\tilde{v},t}\right) = Var\left(\varepsilon_{\tilde{h},t}\right) + Var\left(\varepsilon_{\tilde{c},t}\right)$$

Dagum and Cholette (2006, chapter 11) also propose this method.

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