YOU REALLY NEVER HAD IT SO GOOD, OR WHY BRITAIN'S POST-WAR NATIONAL ACCOUNTS COULD LEAD YOU ASTRAY

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WP 541
September 2024

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Working Paper no. 541

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September 2024

Abstract

Ten years ago, Britain's main statistics agency revised the figures describing the history of the nation's capital investment with results that, before 1997 and for many decades after the second world war, lack a coherent rationale and look wrong. The impact is still embedded in today's official national accounts. The effects of the revision can be seen, for example, in an implausible uplift to Britain's investment and growth record in the 1950s, the shifted scale and timing of the Barber Boom and Bust in the first half of the 1970s and in the improbable erasure of the post-war, thirty-year decline in company profit share. A deep investigation of the official figures is attempted and estimates made, but the task is hampered by incomplete documentation. It is regrettable that the Office for National Statistics decided some time ago not to correct the suspect capital investment figures. Those wishing to draw lessons from Britain's economic past are advised not to rely on the 'historic' national accounts.

Keywords: national accounts, capital investment, UK post-war economic history, R&D.

JEL Codes: C82, E01, N1.

Acknowledgements

I am most grateful to Dr Anne Harrison for her very helpful observations. The author is responsible for the outcome, warts and all.

Introduction

Ten years ago, Britain's national economic accounts were reformed and refurbished. New statistics were introduced, some excellent, some more debateable, and key figures about the economy substantially amended. The official accounts that stretch back to the early years of the country's recovery after the second world war presented an altered history with major revisions to the economy's rate of growth, the pattern of spending, the distribution of income, and much else besides. Less auspiciously, 2024 marks the ten-year anniversary of what looks like a very big blunder. In 2014, Britain's official statistics agency, the Office for National Statistics, may have miscalculated a number of major macroeconomic series – for the nation's total investment, the gross domestic product and company profits – leaving a legacy of possibly serious errors embedded in today's national accounts. If this suspicion is justified, Britain's post-war historical record will have been distorted: recessions would have disappeared, booms would have been shape-shifted and secular trends would have been exaggerated or eradicated, and for no good reason. There would be only a bad reason: a mistake, or possibly a combination of mistakes, that the statistics office – the ONS - has decided not to correct.

The agency's decision to retain the suspect figures was not taken lightly. Warned in 2018 that something was amiss, the ONS investigated, found a problem and proposed solutions, but none were put into effect. The process of investigation was prolonged, involving the oversight of several national accountants and a small number of outsiders. The investigation was not a secret, but neither was it publicised. A potted history will serve the purpose of the current paper. The process began in October 2018. Anne Harrison, an independent scholar and national accounts expert, had noticed that the official figures for the nation's total investment appeared mysteriously low for the post-war years between 1948 and 1959.[1] The swift ONS response to her communication suggested a problem may have arisen from a change in a statistical processing system in 2013. Comments were subsequently made (by me) about the wider implications for the nation's gross domestic product (GDP) and profits, and of possible data problems in periods much later than the 1948 to 1959 interval.[2] The ONS began an investigation into the investment figures, but drew a blank. Reporting in March 2020, the agency ruefully noted that the relevant statistical evidence could not be found and that the main architects of the suspect data had left the organisation.[3] The ONS proposed to make a temporary correction in advance of the 2020 annual national accounts, a publication still known as the 'Blue Book' because of the distinctive colour of its cover, with a more enduring correction pencilled in for the year after. But neither correction happened. After experimenting with 'various data science and time series analysis techniques',[4] the ONS admitted defeat. In

July 2021, the agency said, with regret, that no amendments would be made to the suspect investment data. There was no time to spare.[5]

It seems unlikely that the majority of users of today's national accounts will be aware of the question marks that still hang over their reliability. Only avid readers of ONS 'advisories' may know of its broadbrush qualification, issued in 2014, about the 'historic' investment data.[6] The ONS advised that all the national accounts investment figures before 1997 were 'inherently uncertain' compared with the investment figures for years since 1997.[7] The qualification was made because of a change in the way that the ONS chose to estimate the data. The ahistoric, though, in the circumstances, handy description of the figures before 1997 as 'historic' is explained by the limitations of the ONS data processing systems. These limitations make 1997 the year from which the ONS most actively maintains the national accounts. Being written in 2014, the ONS broadbrush qualification naturally omits any reference to what might be described as the Harrison-Martin suspicions. This absence of proper warning has consequences for the understanding and interpretation of Britain's macroeconomic history, in the before-1997 sense. Unsurprisingly, no paper in a sample of recent authoritative commentaries explicitly qualifies the national accounts data (insofar as they are used) for total investment, GDP or company profits.[8] Users of the national accounts, seasoned as well occasional, may instead be reassured by the official statistical kitemark of trustworthiness and quality. The suspect macroeconomic data enjoy the imprimatur of being 'National Statistics'.[9]

It is, alas, impossible to ascertain from published information exactly what the ONS did in 2014 when revising the 'historic' investment data. As it turns out, the current ONS custodians of these same figures do not know either. So, in what follows it is necessary to guesstimate by one means or another what the ONS may have done, eliminating, as far as possible, the most likely suspects. Unlike an Agatha Christie novel, this tale unfortunately has no revelatory final chapter, but the author likes to think it produces sufficient circumstantial evidence to return a guilty verdict. The author may be biased, of course; the reader must decide, and possibly move to appeal. The judgement recorded here on a balance of probabilities is that the historic oddities in the investment data, and the related impact on the historic GDP and company profits figures, are most likely to be the result of poor statistical judgement and possibly some outright mistakes, ones which the ONS would normally describe as 'processing' or 'production' errors. Or, in ordinary parlance, a ghastly mess.

The paper has three chapters. The first begins with definitions, presents the suspect investment figures in a series of charts and sketches the wider implications. The second chapter describes in greater detail the changes that the ONS made in 2014 and attempts by a process of elimination to identify the most

likely explanations of the strange behaviour of the investment figures. The final chapter outlines some of the consequences of the suspect investment figures for our understanding of the British economy's performance in the first three decades after the war.

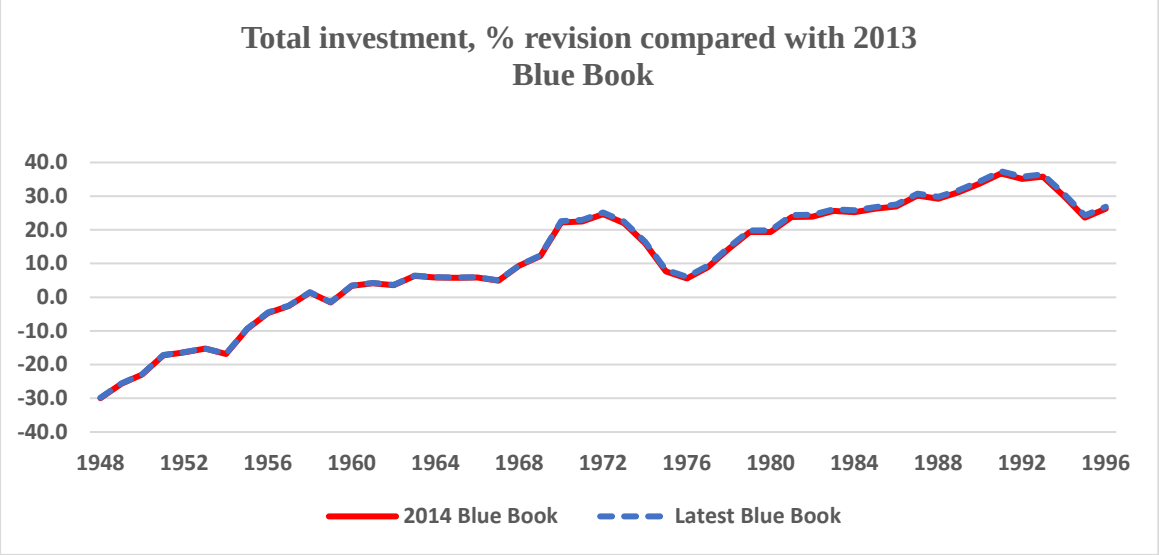
Chapter 1: The suspect investment figures

The statistical term ‘investment’ is used here to refer to what is more formally called ‘gross fixed capital formation’. The annual investment figures depicted in the charts that follow record the difference between additions and deductions; that is, between the value of investment spending undertaken each year to acquire assets of a capital nature, such as plant, machinery, buildings and computer software, and the value of the disposals of capital assets in the same year, for example from the sale of an old machine for scrap. In earlier times, the formal title read ‘gross domestic fixed capital formation’, the insertion of the word ‘domestic’ acting as a reminder that the only capital assets that counted were those located in the United Kingdom.[10] It is also worth noting that dwellings are treated as a fixed capital asset, and so when purchased from new are included in the investment total on the grounds that they yield over the years ‘housing services’ for renters and owner-occupiers. Values are at ‘current prices’, meaning that the values are estimated using the prices ruling at the time of the investment: 2014 prices for 2014 capital investments, for example. The term ‘fixed’ is used to distinguish investment spending on capital assets that should contribute to the production of other goods and services for a significant period of time, and, at a minimum, for a period of a year, from the type of capital formation that involves the build-up or run-down of inventories (formerly called ‘stocks’, and hence ‘stockbuilding’) of materials and work-in-progress, such as partly completed manufactured goods. Finally, the term ‘gross’, as opposed to ‘net’, means that the value of the depreciation of capital has not been deducted. Depreciation (also known as ‘capital consumption’) is the fall in the value of the capital stock that comes naturally as capital assets age or become obsolescent, the capital stock itself being the cumulative result of past investments.

Chart 1 is derived using figures for the level of the nation’s investment recorded in the national accounts at three different publication dates: the 2013 Blue Book (just before the release of the 2014 Blue Book), the 2014 Blue Book and the 2023 Blue Book, the latest available at the time of calculation.[11] These three series may be regarded as different ‘vintages’ of data describing the same thing. The term ‘Blue Book’ is being used here in a short-hand way to refer to the electronic datasets made available, and sometimes re-issued with corrections, with the quarterly national accounts publication known as the United Kingdom (UK) Economic Accounts. As a general rule – and one that was followed by the data releases cited above – the ONS reserves major statistical revisions of past periods for the annual Blue Book, usually released in the summer or autumn of each year, and for the related edition of the UK Economic Accounts. In between Blue Books, the UK Economic Accounts are subject to very limited changes, usually confined to the last few quarter-year periods of data unless material errors have been discovered.[12] The four UK Economic Accounts datasets that belong to a particular

Blue Book lineage include a longer history of figures than is printed in the Blue Book itself; in the case of the total investment figures the electronic datasets start in 1948.

Chart 1: Blue Book revisions to total investment data, per cent of 2013 Blue Book data



Sources: UK Economic Accounts published: 27 June 2014, 30 September 2014, corrected 6 October 2014; 28 March 2024, corrected 2 April 2024. **Notes**: The original 30 September 2014 UK Economic Accounts release contained a 'production error' affecting 'pre-1997 GDP and some components': 162 series were corrected in the 6 October 2014 release. Three further ONS corrections followed: 13 October 2014 (production error affecting financial corporations gross trading profits from 1997); 30 October 2014 (production error affecting the index levels of real household disposable income from 1997); 27 November 2014 (errors in the geographic breakdown of exports of goods from 2009). The 2014 Blue Book advisories note further errors: 9 January 2015 (errors in net and gross capital stock estimates); 24 June 2015 ((i) errors in insurance industry output estimates affecting higher level aggregates including GDP from 2009; (ii) errors in estimates of expenditure on narcotics, affecting higher level aggregates including GDP from 1997). The 2 April 2024 release corrected errors, caused by a 'processing issue', affecting a number of series in the 28 March 2024 release from the first quarter of 2023. The results in Chart 1 are not affected by these errors.

Chart 1 shows the revisions to the 'historic' (before 1997) total investment figures in the 2014 and 2023 Blue Books. In each case, the comparison is with the figures in the 2013 Blue Book, with the revisions expressed as a per cent of those figures. Little time need be spent on the 2023 Blue Book revisions: they are almost

identical to those recorded for the 2014 Blue Book. The 2014 Blue Book estimates for annual investment spending in the years before 1997 were not revised in any of the seven subsequent Blue Books. Only in the 2022 and 2023 Blue Books were amendments made to the total investment figures before 1997. These revisions were themselves minor and do not invite suspicion. [13.] The national accounts total investment figures that we see today for the years before 1997 are, save for a whisker, the same as those that appeared ten years ago in the 2014 Blue Book.

Compared with those in the 2013 Blue Book, the 2014 Blue Book total investment figures for the years before 1997 have some striking features, easily visible in the chart:

- The figures are materially lower, albeit by a declining margin, for the first decade or so of the recorded post-war period: in 1948, they are 30 per cent lower and, save for 1958, remain lower in each year until 1960.

- The figures oscillate in the late-1960s to mid-1970s period: they are 5 to 6 per cent higher from 1963 to 1967, 25 per cent higher in 1972, but again 6 per cent higher in 1976.

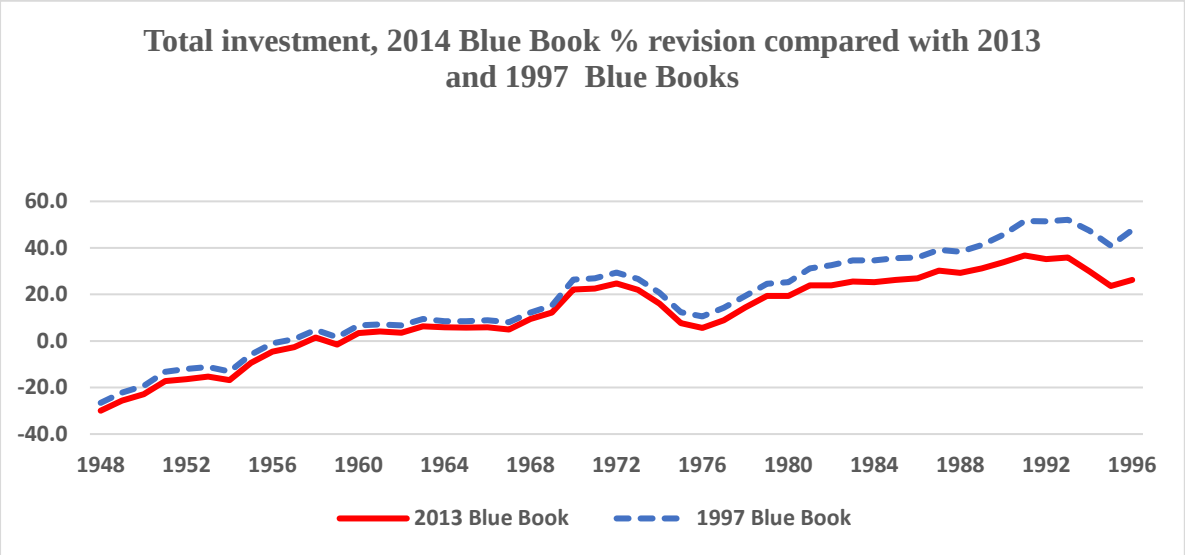
- The figures are higher, and increasingly so, in the 1977 to 1991 interval, declining thereafter: they are 9 per cent higher in 1977, 37 per cent higher in 1991, and 26 per cent higher in 1996.

Investigation of the causes of these striking features is reserved for the next chapter. Continuing with the presentation of facts, Chart 2 adds an additional comparison, that between the 2014 Blue Book data and those released seventeen years earlier in the 1997 Blue Book, which conformed to earlier accounting conventions. The point to be drawn from Chart 2 is that for the first thirty years it looks much like Chart 1. In the 1948 to late-1970s interval, the 2014 Blue Book revisions appear much the same whether the comparison is with the 2013 Blue Book or with the 1997 Blue Book. Before the 2014 Blue Book, the broad pattern of the total investment data over this thirty-year period was well-established.

After the late-1970s, the 2014 Blue Book revisions compared with the 1997 Blue Book are larger, sometimes much larger, than the revisions compared with the 2013 Blue Book. The range of the vertical scale in Chart 2 has to be wider than in Chart 1 to capture all the revisions to the 1997 Blue Book figures, which reach a peak of 52 per cent in 1993. As may easily be inferred, the reason for the difference scale of revisions is that the 2013 Blue Book figures are consistently higher than those in the 1997 Blue Book, and increasingly so after the 1970s. However, unlike the revisions that occurred between the 2013 and 2014 Blue

Books, the revisions that occurred between the 1997 and 2013 Blue Books are never downwards, and do not markedly oscillate.

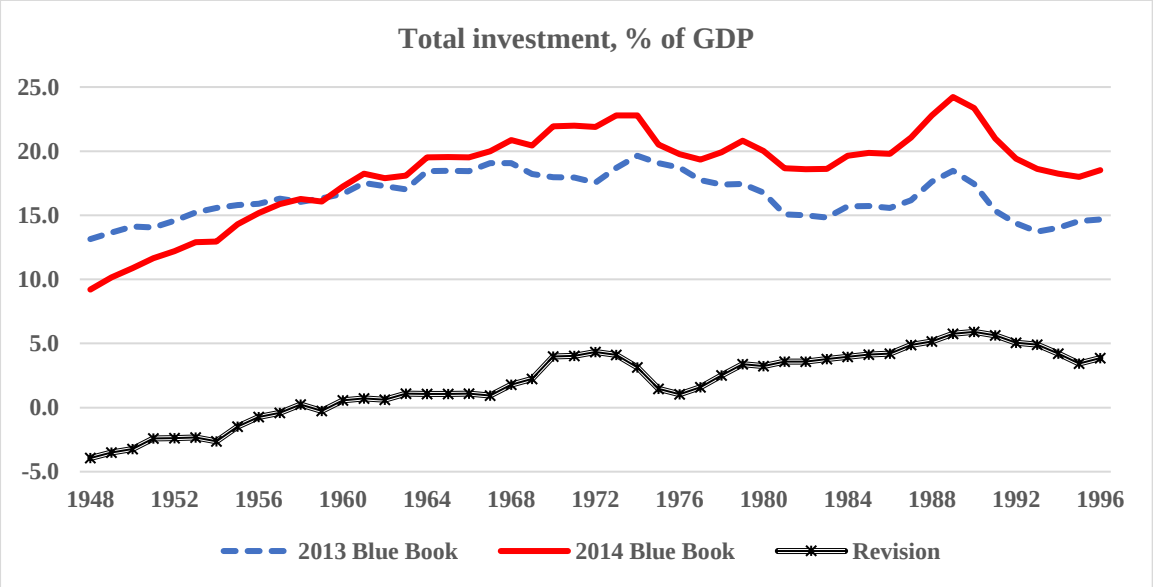
Chart 2: 2014 Blue Book revisions to investment data, per cent of previous Blue Books' data



Sources: Where relevant, as for Chart 1. 1997 Blue Book data are taken from 'Official historical national accounts data – the pre-ESA95 national accounts 1948-1997,' reconstructed by Anne Harrison, <National Accounts - ESCoE : ESCoE> [accessed 1 June 2024].

Chart 3 provides a means to appreciate the impact of the 2014 Blue Book revisions on the wider economy in the post-war period between 1948 and 1996. The figures for total investment in the 2013 and 2014 Blue Books, and the difference between them, are expressed as a share of the latest available figures for the nominal (current price) gross domestic product.[14] For the year 1948, total investment as a share of GDP was revised from around 13 per cent in the 2013 Blue Book to 9 per cent in the 2014 Blue Book, a downward revision of about 4 percentage points. This figure corresponds to the 30 per cent downward revision of total investment expressed not as a share of GDP but in relation to the 2013 Blue Book investment level, as shown in Chart 1.[15] After 1948 and through the 1950s, the downward revision expressed as a share of GDP gradually diminishes; by 1960, there is an upward revision worth ½ per cent of GDP. Thereafter, this measure oscillates in the late-1960s to mid-1970s period, from around 1 per cent of GDP in the 1963 to 1967 interval, to over 4 percent of GDP in 1972, then back to 1 per cent of GDP in 1976. Subsequently, the upward revisions gradually increase in scale until reaching a peak of 6 per cent in 1990,[16] falling to just under 4 per cent by 1996.

Chart 3: 2013 and 2014 Blue Book total investment data and revision, % of GDP.



Sources: Where relevant, as for Chart 1. **Notes**: GDP data of the latest vintage used to calculate percentage shares.

As the detail is missing, it is not possible accurately to decompose these revisions to the total investment figures before 1997 in a way that is consistent with the national accounts, distinguishing between the categories of capital asset affected, or between the investment spending of different industries. It is, however, possible to say something about the investment spending of the public and private sectors. Public sector investment can be defined as the investment spending of central government and local government – together known as 'general government' – and of public corporations, which include nationalised industries that remain at 'arms-length' from government as well as a variety of public bodies, like the British Council and parts of the BBC. The private sector engaged in investment spending comprises the remaining sectors recognised in the national accounts: companies (or 'corporations'), including industrial and commercial companies and, amongst financial companies, the banks and insurance companies; households (formerly known as the 'personal sector', albeit differently constituted); and a number of 'institutions', such as charities, that are deemed to serve the interests of households but do not make profits after allowing for depreciation.[17] Since the early-2000s, the ONS has included the majority of universities in this last sector, which goes under the inelegant, sneezing acronym of NPISH (non-profit institutions serving households).[18] The household and NPISH sectors were grouped together in the 2013 and 2014 Blue Books.[19]

There is a small proviso, and a limitation. The proviso is that nationalised banks and other public sector financial intermediaries are omitted from the chosen

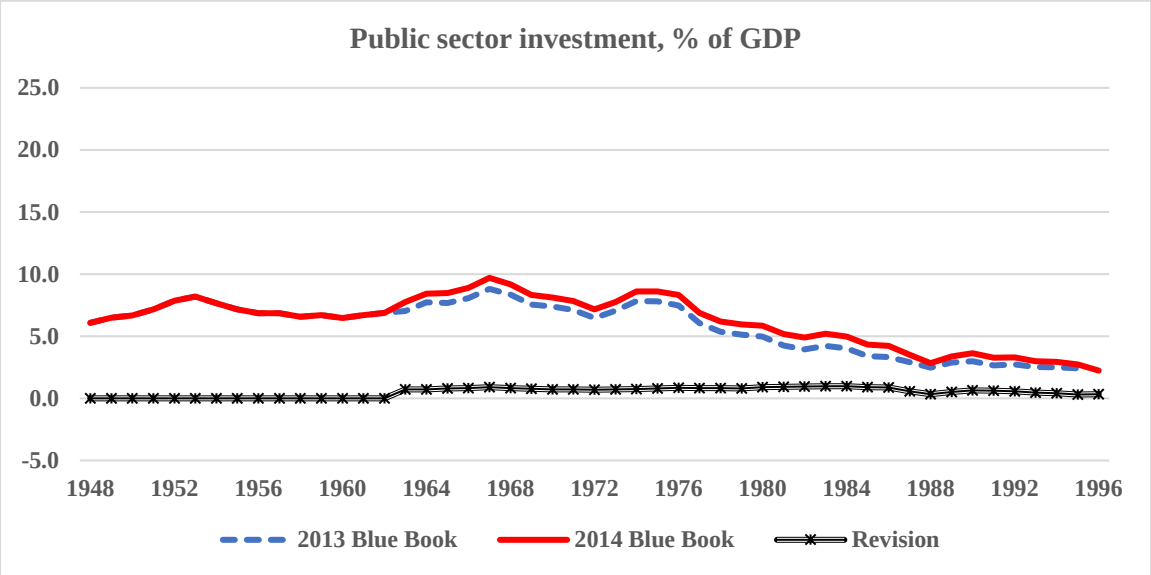
definition of the public sector, and so are included by default in the definition of the private sector. However, the collective investment spending of public sector financial companies is minor taken in the context of the economy as a whole.[20] The limitation arises because official national account series for the investment spending of private companies, households and NPISH do not now exist before 1987.[21] Although it is possible to attempt an historical reconstruction so further to decompose the private sector into its constituent parts, the national accounting methods available necessarily rely on the same suspect total investment data under investigation here.[22]

In order to circumvent the hole in the national accounts record, one can take recourse in an alternative source of information. The public sector investment figures before 1987 can be taken, with a small adjustment, not from the Blue Book but from a sister publication known as the Public Sector Finances Analytical Tables (often shortened to Public Sector Analytical Tables or 'PSAT'). These tables come in two varieties: a monthly publication of tables that make no attempt to be consistent with the national accounts and a special quarterly publication of tables that purport to be consistent with the UK Economic Accounts of the same vintage for the full span of the PSAT dataset, which starts in 1946.[23] A difficulty arises because, with irony unintended, the national accounts consistent PSAT data, while invaluable in themselves, are not fully consistent with the national accounts. This is the case today.[24] It was also the case in the 2013 and 2014 Blue Books.[25] Despite these reservations, the constructed data can be relied upon to illuminate the main features of the data under investigation. The procedure, recommended by a national accountant, is to use 'national accounts consistent' PSAT data before 1987 and UK Economic Accounts data from 1987. The result is that the revisions to the investment data that can be attributed to the changes in the 2014 Blue Book replicate the revisions presented in the underlying sources of information.

Chart 4 shows the level of public sector investment before 1997 recorded in the 2013 and 2014 Blue Books, and the difference between the figures, expressed, as in Chart 3, as a per cent of the latest available estimates for nominal GDP. The vertical scales in Charts 3 and 4 are the same. Public sector investment share shows no discernible trend until the early-1980s, varying in a range between 5 per cent and 10 per cent of GDP, but declines thereafter. The small gap between the investment shares recorded in the 2013 and 2014 Blue Books is mainly (and, before 1987, wholly) attributable to changes in the record for central government investment. In contrast to the revisions for total investment shown in Chart 3, the revisions to public sector investment before 1997 are notable in two ways: there are, first, no revisions before 1963[26] and, second, the revisions are small and fairly stable one year to the next. In 1963, the upward revision to public sector investment is equivalent to ¾ per cent of GDP. By the early-1980s, the revisions

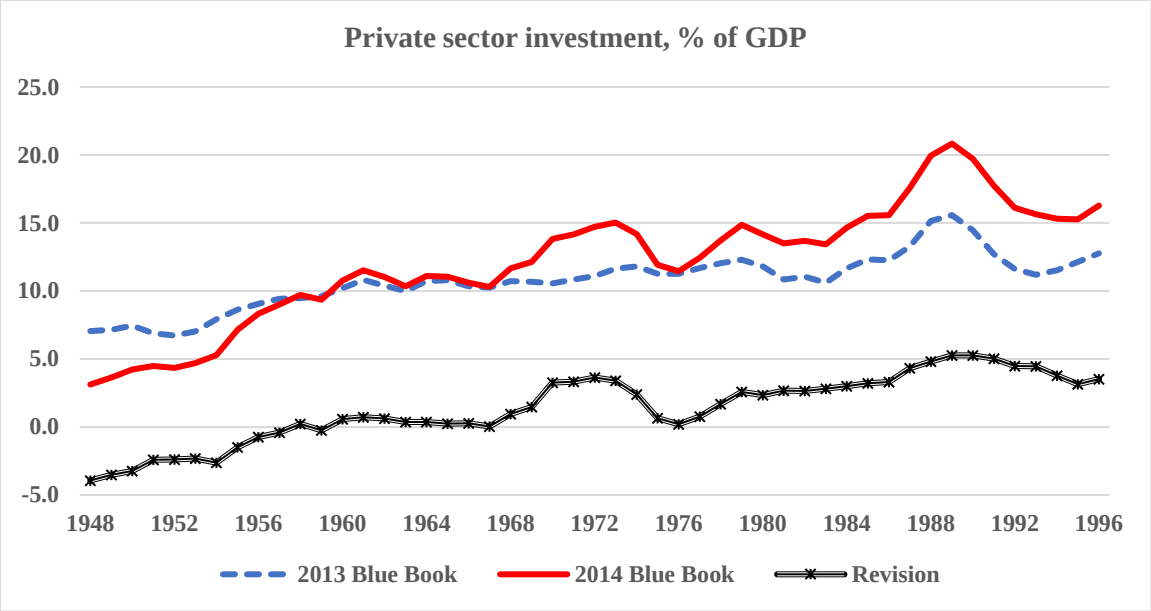
have gradually increased to about 1 per cent of GDP, falling thereafter to about ¼ per cent of GDP by 1996.

Chart 4: 2013 and 2014 Blue Book public sector investment data and revision, % of GDP.



Sources: Where relevant, as for Chart 1. Also: (i) UK Economic Accounts published 28 June 2011; (ii) UK Economic Accounts published 30 June 2015; (iii) Public Sector Finances Analytical Tables consistent with the national accounts of the same vintage published 25 June 2014 and 29 September 2014. **Notes**: Source (ii) used to backfill sector data consistent with the 2014 Blue Book between 1987 and 1996 (data for this period were omitted in the 2014 Blue Book UK Economic Accounts release of 6 October 2014); (i) used to backfill central government, local government and public corporations data before 1987 for the category included in the Public Sector Finances Analytical Tables definition of investment: 'acquisitions less disposals of non-produced, non-financial assets', such as land and sub-soil assets. To construct the chart, the UK Economic Accounts data for this seldom revised and relatively minor item of expenditure have been deducted from the corresponding sector investment data in the Public Sector Finances Analytical Tables. UK Economic Accounts investment data begin in 1987; all data before 1987 are taken from the Public Sector Finances Analytical Tables after adjustment for the net acquisition of non-produced, non-financial assets.

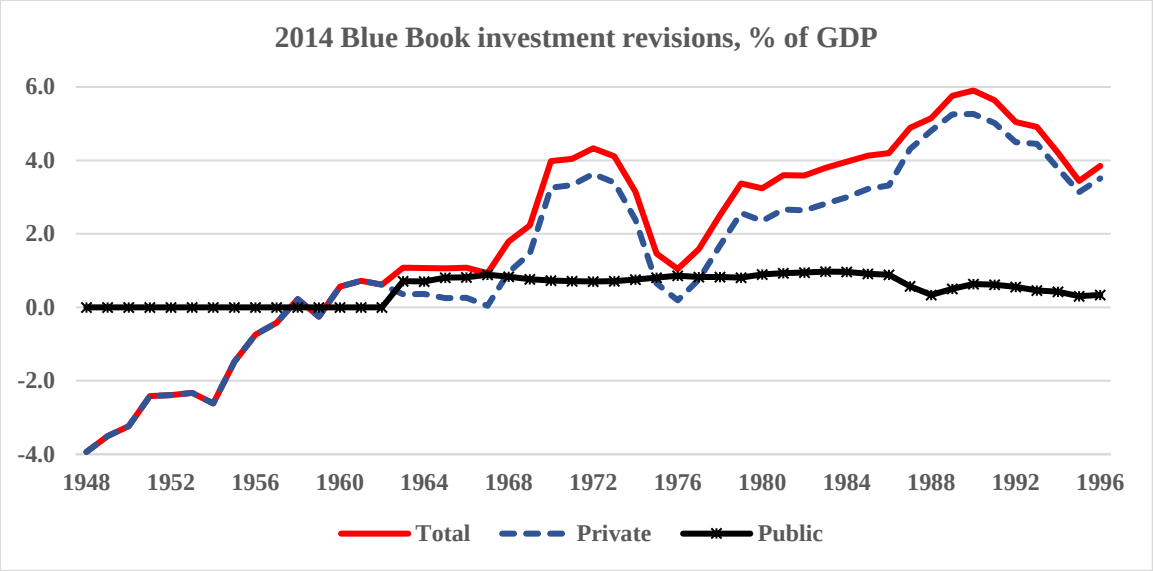
Chart 5: 2013 and 2014 Blue Book private sector investment data and revision, % of GDP



Sources and notes: See Chart 4.

It follows that the most striking features of the revisions to the total investment figures – the very large downward revision in 1948, the predominantly negative revisions in the 1948 to 1959 interval, the oscillations in the late-1960s to mid-1970s period, the upward trend in the subsequent revisions to the early-1990s and the decline thereafter - are echoed in the private sector investment series. This symmetry is easily discernible from Chart 5, which shows the private sector investment levels and revisions expressed as shares of GDP, with, again, the same vertical scale as Chart 3, and from Chart 6, which compares the revisions to the investment share figures: total, public and private. The vertical scale in Chart 6 is much narrower than those in Charts 3, 4 and 5, and so brings out clearly the sympathetic movements in revisions to total investment and to private sector investment.

Chart 6: 2014 Blue Book total, public and private sector investment revisions, % of GDP.



Sources and notes: See Chart 4.

These large and varying revisions to the investment data have a number of wider implications, which can be briefly sketched. First, they affect the level of GDP. Because investment is a component of the expenditure measure of GDP – derived by adding up consumer spending, government spending, investment spending and so on - higher or lower levels of investment mean higher or lower levels of GDP, other things remaining the same. For example, the 4 per cent of GDP downward revision of total investment for the year 1948 implies arithmetically a 4 per cent downward revision of the level of nominal (current price) GDP. The fact that the downward revision in the 2014 Blue Book was somewhat smaller (because of an upward revision to the consumer spending figures) does not remove the possibility that the level of GDP in 1948 may be materially understated if the downward revision to investment is a mistake.[27] Similar observations can be made about the oscillations and trends in the revisions that occur after 1948: if the investment figures are wrong, so too would be the figures for the level of GDP.

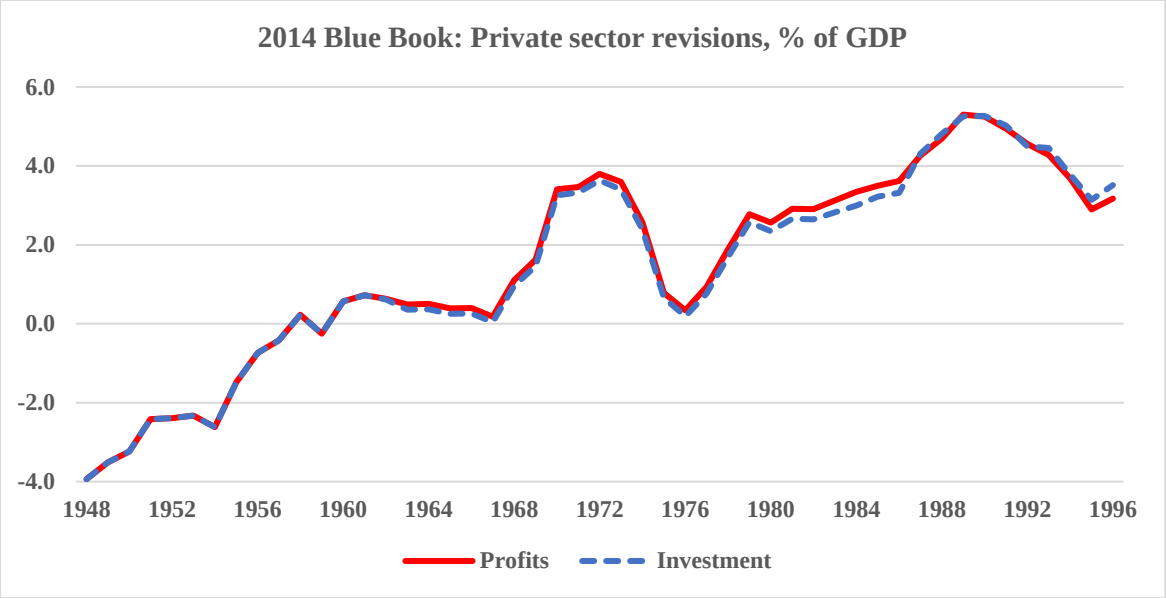
The second implication concerns the rate of growth of GDP, which will be distorted by variations in the scale of any error in the investment data. Consider, again, the example of the 1948 suspected underestimate of the level of investment and of GDP, and the impact on the subsequent rate of growth. By 1960, the decrement to investment disappears. If, at the same time, any errors in the investment data likewise dissipate, the rate of growth of nominal GDP over this period would be overstated, starting from too-low a base. Similar observations can be made about the puzzling oscillations in the scale of revisions seen in Chart

3: rates of nominal GDP growth may be successively overstated and understated. The impact on the real rate of GDP growth that abstracts from changes in prices depends in addition on the scale, and accuracy, of the related 2014 Blue Book revisions which took place to the price index ('price deflator') used to convert investment spending in current prices into investment spending measured in constant prices. These questions are revisited in Chapter three.

The third implication concerns profits, which become part of the wider story through a chain of relationships that equate different measures of GDP. If the level of money GDP has been miscalculated as a result of incorrect investment figures, affecting the expenditure estimate of GDP, the same in principle will be true of the other two estimates of GDP, one based on data for incomes (such as wages, self-employment income and profits), the other based on data for production (such as business sales revenues and costs). The equality of the three GDP measures, which holds in principle, more often than not will not hold in practice.[28] In the distant past, estimation of a central GDP figure relied on expert judgement and the averaging of the three measures, leaving a gap between the expenditure and income GDP measures for all to see. Things went badly wrong in the late-1980s. To improve on this state of affairs, the ONS has for most years since the early-1990s attempted to remove the differences in an annual process of reconciliation known as 'balancing'.[29] In the normal balancing process that occurs at a very detailed level, the various expenditure, income and production data are adjusted, with an eye on their reliability and other considerations, until the three measures of GDP give the same answer. The balancing of revisions to historic data is undertaken in a different fashion, much more top-down with far less detail involved. The precise approach adopted in the 2014 Blue Book is not documented. But, whatever the details, it was through a balancing process that the 2014 revisions to historic investment data fed through to the revisions to historic income data, and notably to profits.[30]

The impact is brought out in Chart 7, drawn with the same vertical scale as Chart 6. Chart 7 reproduce the revisions before 1997 to the private sector investment data, expressed as a per cent of the latest estimate of GDP, and adds similarly-expressed revisions to private sector profits. 'Profit' in the national accounts is more formally known as 'gross operating surplus', and like investment spending, is measured inclusive ('gross') of depreciation. The private sector figures combine the profits of non-financial and financial companies, the profit-like income that arises from the ownership of dwellings, and a number of minor items.[31] As the counterpart of the private sector definition of investment, this definition of private sector profits enables an exact comparison to be drawn between the revisions to private sector investment and to private sector profits in the 2014 Blue Book. Chart7 shows that the two sets of revisions in the period before 1997 are almost identical.

Chart 7: 2014 Blue Book private sector profits and investment revisions, % of GDP.



Sources: see Chart 4. **Notes:** Data missing before 1987 in the 2013 Blue Book for household and NPISH combined operating surplus and household mixed (sole trader, self-employment income) are backfilled and inferred using mixed income data from UK Economic Accounts published 28 June 2011. These earlier vintage mixed income data are concordant with the 2013 Blue Book data in the interval 1987 to 1990. The private sector profits aggregation in the 2014 Blue Book is inferred from the data for total incomes, public sector profits, employees' compensation and mixed income.

This completes the description of the basic facts. Attention now turns to the question of the reliability of the revisions to investment and of the wider implications for GDP, its level and growth, and the level of profits. The first step, the topic of the next chapter, is to understand what happened to the investment data in the 2014 Blue Book.

Chapter 2: The 2014 Blue Book: what happened to the investment figures?

In its call-for-evidence submission to Sir Charlie Bean's review of UK economic statistics, published in 2016, the British Treasury department complained:

> There is a lack of historical data on key economic statistics (e.g. business investment, labour market indicators) making it difficult to compare how the modern economy compares to the past. Furthermore, where historical data is [sic][32] available it is not always clear how methodological changes or variable and classification updates (e.g. geographies, occupations) impact the time series. It is rare that a clear and straightforward method has been used to bridge the break to create a consistent long time series.[33]

The Treasury's complaint, with one minor qualification, can be applied to the current investigation. The descriptions provided by the ONS of the methods used in the 2014 Blue Book to construct the history of UK investment before 1997 are far from straightforward, often confusing, frequently lacking crucial detail, with a red herring thrown in for good measure. The qualification to the Treasury view is that there is a veritable abundance of ONS advisories on the topic; there is a mass of detail. From it, the process of untangling what went on in 2014 might be compared to the rummagings of a bemused gumshoe condemned to sift through dusty archives for long-forgotten documents in search of clues and clarity. It is from such a process that the following brief account emerges.

In the 2014 Blue Book, the ONS was dealing simultaneously with a new (and mandatory) system of rules for national accounting together with the repercussions of a perfect pickle that had befallen the agency three years earlier. The new accounting standard, commonly called 'ESA10'[34] for brevity, was famous for introducing research and development (R&D) as a new category of investment spending. This change, along with many others, required the ONS to prepare and integrate into the national accounts many new data series: an onerous and complex task. The last time this had happened, in 1998, under an earlier major change in accounting rules ('ESA95'), the results were so poor that the ONS had to redo them a few years later.[35] The perfect pickle of 2011, from which the ONS was still recovering in 2014, was the result of a collision of new and long-standing problems. Matters had not been helped at the time by a very considerable loss of expertise: the vast majority of seasoned national accountants formerly located in London had chosen not to relocate to the new headquarters of the ONS in Newport, Wales.[36] Unable to cope for that and other reasons with the increasing complexity of the national accounts,[37] the agency decided severely to limit the amount of historic information in the 2011 Blue Book, reducing the publication of historic series for output, income and expenditure to a 'core dataset'.[38] Instead

of the 10,000 historic series usually published, only 300 to 400 appeared.[39] Ironically (since outdated information technology – IT - was one cause of the agency's compilation problems), the curtailment of the provision of historic data in 2011 coincided with the delivery, long delayed,[40] of an 'integrated production system on a new IT platform'. But the new IT, which provided the main processing system for national accounts data beginning in 1997, 'could not be populated with data pre-1997 in time for the Blue Book 2011 publication'.[41] The new IT system also lacked some of the finer detail on which the ONS relied for the estimation of the investment figures beginning in 1997.[42] The perfect pickle was rounded off by the introduction of a new classification of industries, which required the ONS to convert investment data collected on the old industrial basis to the new industrial basis.[43] Changes in what is known as the Standard Industrial Classification were a fairly familiar occurrence, the classification having previously been revised six times since its inception in 1948. Methods to perform the required data conversions were well known, tried and tested. But in 2011, the change to the new industrial classification proved especially daunting, with the result that the ONS, citing 'quality concerns', decided to pull at the eleventh hour much of the investment data that should have appeared in the 2011 Blue Book.[44] The capital stocks data were suspended altogether.

By 2014, the ONS had made a partial recovery from these outages, but the reinstatement of data was incomplete, leaving major gaps in the historic record, including the record of investment spending.[45] Longer historic time series of investment expenditure split into different classes of capital asset or into spending by different sectors were lost for good.[46] This state of affairs persisted despite the fact that the production of the 'core' historic data, of which the investment data were a part, 'was moved onto the main UK National Accounts IT platform that had been used since Blue Book 2011'.[47] Recovery was also impaired by an attempt by the ONS in the 2013 Blue Book to improve the main national accounts investment data beginning in 1997. The attempt back-fired, incurring the criticism of many users and notably of the then Governor of the Bank of England.[48] The ONS reluctantly retreated, but unaccountably did not apply a lesson that it might have learnt from this unhappy experience to the parallel attempts to reconstruct the very detailed historic investment data used by the capital stocks team. It was the capital stocks team – and not the national accounts investment team - that was primarily responsible for the production of the historic total investment figures that appeared in the 2014 Blue Book.

It follows from this potted history that a deeper understanding of the 2014 Blue Book historic investment revisions involves two lines of enquiry. The first concerns the changes to the investment record that arose from the new system of national accounts, ESA10. The second concerns all the other changes that arose from the recovery of the ONS from the perfect pickle of 2011, and in particular,

the way it chose to resurrect its capital stocks data that had been suspended for three years.

The introduction of R&D as an investment category was the main change, although not the only one affecting investment, that came with the implementation of the new ESA10 accounting standard. The change is an example of what is known as 'capitalisation', an extension of the capital asset boundary. It had happened before: in 1998, when the then new accounting standard ('ESA95') had led to the inclusion of intangible capital items such as original works of art and computer software. It is the inclusion of these intangibles that accounts for the lion's share of the upward revision to investment that occurred at that time and for the separate paths taken after the 1970s by the two comparisons, first against the figures in the 2013 Blue Book and second against those in the 1997 Blue Book, shown in Chart 2. The extension of the definition of investment in the 2014 Blue Book was, then, a second important step in the modernisation of the national accounts to make them more reflective of a digital and knowledge economy.

It may seem surprising that the national accounts had not formerly counted R&D as investment: it was surely how businesses and research institutions regarded such expenditure. However, under the previous accounting standards, R&D was treated as a business expense, no different from, say, business expenditure on materials or other components purchased in order that the business could make its products or provide its services to customers. Treated in this fashion, R&D spending was a business cost that was deducted from a business's sales revenue when calculating business profits. And since it did not add to investment or to profits, business spending on R&D did not add to national output, GDP. The new accounting standard fixed this anomaly by recategorising (or 'capitalising') business spending on R&D as investment spending, raising the economy's measured business investment, business profits and output by the same amount. A related though far less significant change introduced in 2014 under the banner of capitalisation was the recategorisation of the government's current spending on military weapons systems, such as tanks and ships. This change had a minor, second-round effect, raising GDP on account of the additional depreciation arising from the newly-calculated capital stock of military weapons.

The changed treatment of R&D featured in an important round-up advisory published by the ONS nearly four months after the release of the 2014 Blue Book. The specific focus of the advisory was on the major changes that had affected *historic* data before 1997. [49] The first change, which is a detour from our narrative but an instructive one, concerned the revised method used to convert historic estimates of consumer spending from cash to volume terms using the consumer price index in place of the retail price index. The original conversion undertaken

some years earlier had been criticised because the resulting volume growth of consumer spending 'was too strong' leading to 'a GDP level that was lower than expected in the early part of the series'.[50] Partly in response to this criticism, the ONS revised its approach in the 2014 Blue Book and succeeded in producing the opposite effect: a faster rate of historic price increase and a lower rate of volume growth of consumer spending. This example shows that the ONS was open to reviewing its methodology in order to accommodate a prior – and presumably defensible - view about the behaviour of key macroeconomic statistics. It is an example of 'sense checking' – or what some might call a 'sniff test' – of economic statistics. Of note is that this sense check focussed on the impact of the revision to consumer spending on the wider economy – on GDP. It is precisely this aspect of sense checking that is notable by its absence in the evaluation undertaken by the ONS of its revised historic investment data. As Sir Charlie Bean argued in 2016, there was far too little sense checking at the ONS.[51]

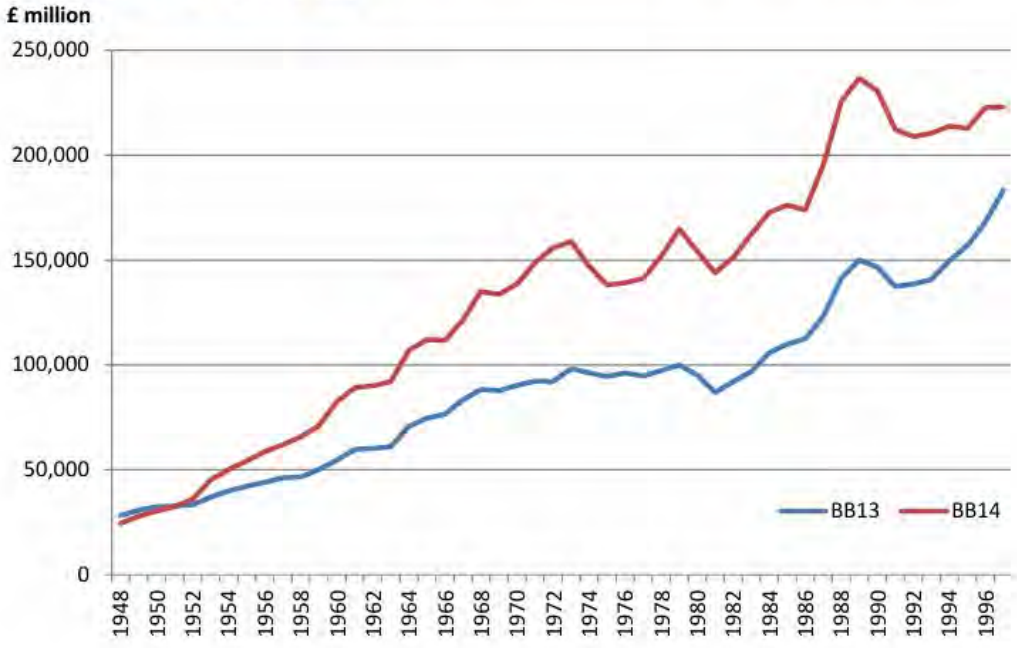
The revised historic investment data is the second topic addressed in the ONS round-up advisory. It briefly described the method used to obtain the new historic data and plotted the results in the form of a particular type of volume measure – known as a 'chained volume measure' or CVM – comparing the 2014 Blue Book with the 2013 Blue Book data. Exhibit 1 reproduces the ONS chart and the related official explanation. As an exposition, the ONS advisory is open to a number of criticisms. First, the use of volume figures of any type – whether the chain, CVM, variety or a plain vanilla constant price measure - is not best suited to the task. Volume figures introduce into the comparison of the 2014 Blue Book with 2013 Blue Book the revisions to both investment prices and current price investment spending, conflating the two changes. Second, it is not obvious how important the volume changes depicted in the ONS chart were in the context of the economy at the time. The economy was much smaller in 1948 than in 1997.

Exhibit 1: The ONS summary explanation of the revision to the historic investment data

3.6 Impact of the changes on estimates of GFCF

The inclusion of research and development in estimates of GFCF, in compliance with ESA 2010, is the most significant change to estimates of GFCF. It accounts for around three quarters of the increase in GFCF, in current prices, between 1997 and 2013. Figure 5 shows the impact of the changes on estimates of GFCF pre-1997.

Figure 5: Total GFCF, Blue Book 2014 compared with Blue Book 2013, 1948-1997; CVM, 2011=100



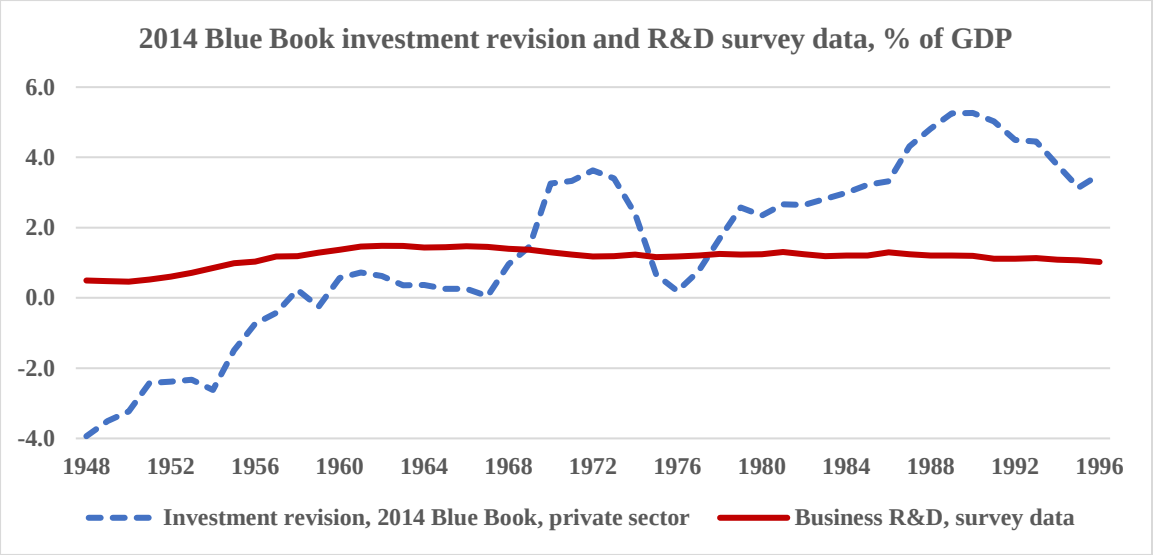
Source: Davies and others (23 February 2015), p. 6. **Note**: The ONS chart is mislabelled. The statement 'CVM, 2011=100' should read 'CVM, £ million, reference year =2011'. The 2013 and 2014 Blue Book chained volume measures are equal to the corresponding values of total investment measured in current prices in the 'reference' year; in this case, 2011.

The main problem with the advisory, however, is not the chart ('Figure 5') drawn by the ONS or the use of volume measures but rather the explanation of the differences. The explanation states:

> The inclusion of research and development in estimates of GFCF, in compliance with ESA 2010, is the most significant change to estimates of GFCF. It accounts for around three quarters of the increase in GFCF, in current prices, between 1997 and 2013. Figure 5 shows the impact of the changes on estimates of GFCF pre-1997.[52]

A reader might be slightly thrown by this explanation, if they had spotted the unhelpful elision that blurs the line between the figures from 1997 with those before 1997. However, even if so aware, the reader could easily be forgiven for concluding from the official explanation (with, after all, its focus on the *historic* changes) that the revisions to the investment data before 1997 were primarily the result of the capitalisation of R&D.[53] Robert Jump, an economics lecturer in quantitative methods, takes the main credit for considering this inference, and rejecting it as a red herring.[54] One of his concerns was the oscillations in the 2014 Blue Book revisions to the investment and related company profits data in the late-1960s and early-1970s. By examining a range of survey information on R&D expenditure during this period, he concluded that the explanation for the oscillations could not be the capitalisation of R&D. He decided to discard the official national accounts investment and profits data, noting, after consulting the ONS, that it 'has no record of the exact manner in which the 2014 gross fixed capital formation [investment] revisions were calculated […]'.[55]

Chart 8: 2014 Blue Book private sector investment revision and R&D business survey data



Sources and notes: see Charts 4, 6 and Appendix A, Chart A5.

Chart 8 extends Robert Jump's approach by constructing a series for business expenditure on R&D using survey information that would have been available in early-2014. The surveys are those cited by the main advisory on the way the ONS tackled the capitalisation of R&D, although the advisory itself contains no data on the resulting historic revisions.[56] The fact that the R&D survey information is subject to discontinuities, especially for the period before 1955, is of less importance than the fact that the information depicted is a reasonable best guess of the raw data that were available to the ONS at the time of the 2014 Blue Book.

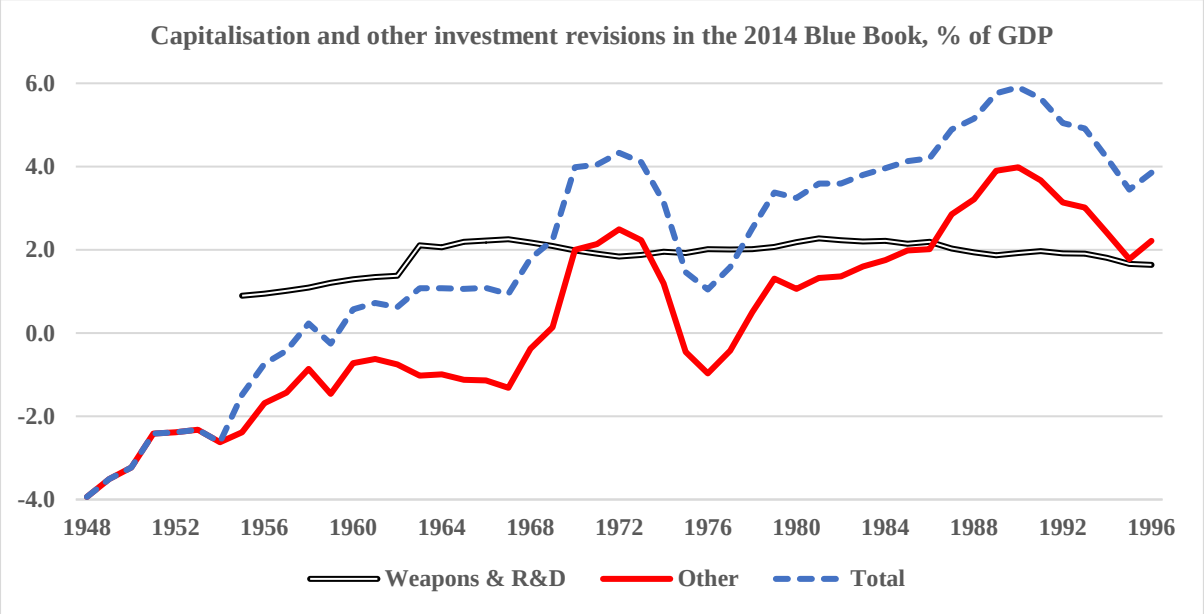
Chart 8 compares these survey data with the revisions to private sector investment in the 2014 Blue Book, as previously shown in Charts 5 and 6. The data are expressed as shares of GDP. The two series are not exactly comparable: the revisions are from the national accounts and the private sector is not the same as the business sector (which includes nationalised industries). However, this qualification does not undo the central conclusion that may be drawn from Chart 8: the weird and wild pattern of historic investment revisions in the 2014 Blue Book have nothing to do with the capitalisation of R&D. According to the survey data, business R&D spending has stayed within a narrow range of between ½ per cent and 1½ per cent of GDP since 1948. Self-evidently, the capitalisation of R&D, which adds to total investment, cannot explain why total investment was revised down, rather than up, for most years before 1960. Nor does the steadiness of business R&D spending as a share of GDP help to explain the huge range of variation of, and trend in, the historic investment revisions.

In order to eliminate the ESA10 changes from the list of suspects, it is desirable to be more precise about the scale of the investment revisions that resulted from the process of capitalisation in the 2014 Blue Book. One consideration to be taken into account is that the survey data depicted in Chart 8 are incomplete, leaving out R&D undertaken by the government, universities and various charities. Moreover, the survey data are not the same as the national accounts data: the survey information has to be adjusted to conform to national accounting principles while avoiding any double counting. A close reading of the relevant advisories also reveals that the ONS did not use the survey data to estimate government R&D. Instead, the ONS relied on an internal government database, which was additionally used to calculate the capitalisation of weapons systems.

There is also the question about the starting date of the revisions. It is highly likely that the revisions to government investment as a result of the capitalisations go back no earlier than 1963. This is what the ONS advisory on the capitalisation of military weapons systems, the available data and other considerations say.[57] Unhelpfully, the starting date of the remaining R&D revisions is left open in the ONS advisory. Considerations of data quality suggest that these R&D revisions went back no further than 1955 (and not to 1948), but the advisory itself could be read to indicate a starting date as early as 1955 or as late as 1981. Other information, to be discussed later, suggests that 1955 is the more likely date. All told, it can be asserted with some confidence that the estimates of the historic revisions due to capitalisation are likely to be quite close to those hidden in the undergrowth of the 2014 Blue Book and that any errors of inference are unlikely materially to undermine the central conclusions. Further details of the highly laborious task of reconstructing the historic capitalisation revisions are given in Appendix A.

Chart 9 traces these revisions expressed as shares of GDP. The vertical scale is the same as those used in Charts 6, 7 and 8. The working assumption is made that the main revisions to R&D investment start in 1955. The results can be briefly stated. Beginning in 1963, the capitalisation of military weapons systems adds investment worth about ¾ per cent of GDP for most of the historic period, declining to ½ per cent of GDP after the mid-1980s. The capitalisation of R&D adds investment worth between 1 per cent and 1½ per cent of GDP in the historic period back to 1955. The estimated effect of the two capitalisations together is to raise total investment by around 2 per cent of GDP during the historic period beginning in 1963 until the mid-1990s. The effect falls slightly to 1½ per cent of GDP by 1996.

Chart 9: 2014 Blue Book investment revisions due to capitalisation and other changes

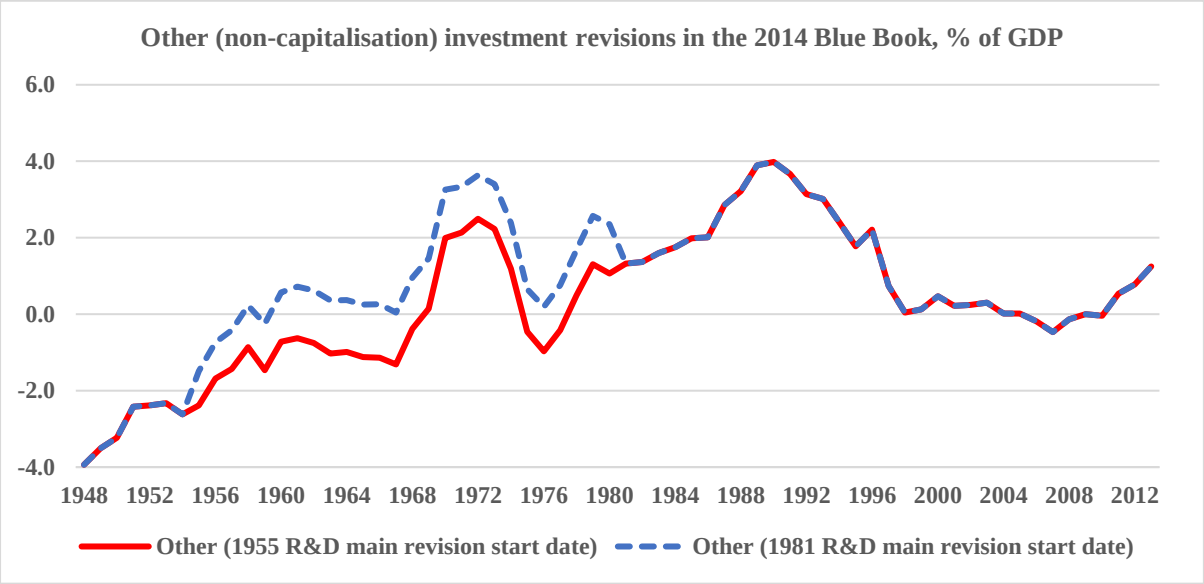


Sources and notes: see Charts 3, 6, Appendix A and main text.

Here then are the key observations. The estimated capitalisation revisions for the historic period in the 2014 Blue Book, expressed as share of GDP, look like a flat line which begins in 1955, with a jump up in 1963. This discontinuity, caused by the capitalisation revisions affecting government investment, is small taken in context. The remaining 'other' revisions, calculated by deducting the revisions due to capitalisation from the total investment revisions, are those traced by the solid red line in Chart 9. The 'other' revisions look like the historic revisions to total investment, only at a lower level. If, contrary to expectation, the starting date of the revisions to R&D investment, excluding government, is 1981 and not 1955, the revisions to total investment, on the one hand, and to total investment

excluding the effects of capitalisation, on the other hand, would look even closer. Irrespective of the assumption (1955 or 1981) made about the main R&D revisions starting date, the capitalisation revisions are zero before 1955.

Chart 10: Other investment revisions in the 2014 Blue Book



Sources and notes: see Appendix A. Newly capitalised small tool investment has not been deducted from the 'other' revisions beginning in 1997. The amounts involved are trivial (0.04 per cent of GDP).

Chart 10 provides a summary. It shows the 2014 Blue Book revisions to total investment that are not attributable to the impact of the capitalisation of weapons systems and R&D: the 'other' revisions. The vertical scale is the same as that used in Chart 9 but the period shown is extended to 2013. The chart therefore traces the ONS national accounts record of the 'other' revisions from 1997 as well as those estimated for the historic period before 1997. The two series shown correspond to the two assumptions made about the date from which the main revisions to R&D start: 1955 or 1981. Irrespective of those dates, the most striking feature of the chart is the scale and volatility of the historic 'other' revisions. There is, in addition, a marked contrast between the historic-period revisions before 1997 and those that follow. For most years from 1997, the official 'other' revisions are close to zero. When they are not – most obviously in 2013 – the revisions can be readily attributed to known causes, such as improvements in methodology and the incorporation of new annual business survey information.[58] What is not obvious is the cause of the volatile and apparently trending revisions to total investment before 1997 that are not due to capitalisation. This question opens up the second line of enquiry: to discover the rationale for these mysterious revisions. In what follows it will be argued that there is, in fact, no coherent

rationale, and that the volatile and trending revisions before 1997 that are not due to the capitalisation introduced in the 2014 Blue Book are predominantly the result of poor choices, and possibly computational error, that the ONS made at the time in its attempt to resurrect the capital stocks data, last seen in 2010.[59]

The ONS choices are described in a copious, mid-2014 advisory with five authors, whom for convenience can be referred to as the capital stocks team.[60] Unaccountably, this key advisory is not cited or directly linked in the later advisory that provided the important round-up of the 2014 Blue Book changes to historical data.[61]The mid-2014 advisory makes clear that the main problem facing the capital stocks team was a discontinuity. The team had somehow to bring into conformity with the quite separately maintained national accounts figures that began in 1997 the very long and detailed investment series, which in some cases went back to the early part of the nineteenth century, and the associated indices of investment prices, all these data being inputs in the calculation of the capital stock. The database containing these investment values and price indices is known now, if not then, as the 'PIM inputs' database, the acronym standing for the Perpetual Inventory Method used to calculate the surviving level of capital assets that have resulted from the accumulation of past investments.[62] The PIM database available to the capital stocks team was of 2010 vintage.

In attempting to bring the PIM investment series into conformity with the investment series in the national accounts, the team had to take several difficult computational steps that for purposes here can be boiled down to two: first, to convert the long history of current price investment data in the PIM database from the old to the new industrial classification already in use in the national accounts and, second, to align these reclassified historic investment figures with the concepts and data used in the 2014 national accounts, setting aside those changes to be introduced under ESA10.[63] The latter qualification means that the capital stocks team was not concerned with the impact of the capitalisations of R&D and military weapons systems. The industrial reclassification was performed using a standard technique, albeit one that relied on the reassignment of investment data between industries based on weights taken from business turnover, rather than ('too volatile') investment data, and at one brief point in time (December 2009) when data on the old and new industrial classifications co-existed.[64] This reclassification created errors. As the ONS notes, the true conversion weights 'might be expected to change over time' and turnover and investment are not the same thing.[65]

The results of this first step were reclassified, highly disaggregated investment figures of PIM 2010 vintage differentiated by the type of capital asset owned by each individual industry, down to a very fine level. To align these series with the national accounts series that began in 1997, the ONS decided to splice the old

PIM micro data, now reclassified in accordance with the new industrial definitions, with the national accounts micro data at the year 1997, using what the ONS refers to as 'linking factors'. These were calculated by dividing the 1997 value of the national accounts series to which the reclassified PIM series had to be linked by the 1997 value of the corresponding PIM series (at this point, still of 2010 vintage). The historic PIM series were then scaled up or down – it appears, mainly up – by multiplying each micro series by its corresponding linking factor, so changing by a constant proportion, and for the whole back run, the level of each micro investment series in the PIM database. The micro results were then added up to calculate a figure for total investment before 1997.[66] The updated PIM investment series beginning in 1997 should in theory have been exactly the same as the investment series in the national accounts.[67]

The important point to note is the effect of the splicing procedure on the estimates for total investment before 1997 as recorded in the PIM dataset. It is important because the PIM total investment series became the basis for the historic national accounts investment series from 1948 to 1996. As noted in the later historical round-up advisory: '[t]he historic (pre-1997) GFCF [gross fixed capital formation] [national accounts – ed.] estimates, by asset and industry, are consistent with those used as the input into estimates of capital stock'.[68] The capital stocks team's splicing and adding up procedure, which might be described as 'bottom-up', had the effect of preserving all the rates of growth of the micro data in the PIM database, albeit changing their levels. The procedure also had the effect of altering the levels *and* rates of growth of the total investment data. Faster growing micro series, for example, might after splicing form a larger part of total investment, with a resulting fall in the share of slow growing micro series, and so raise the rate of growth of the total. Many other outcomes are arithmetically possible. It becomes clear that the capital stocks team's choice of 'bottom-up' splicing created a number of arbitrary distortions in the total investment figures in the PIM database, which were carried over to the historic total investment figures in the national accounts.

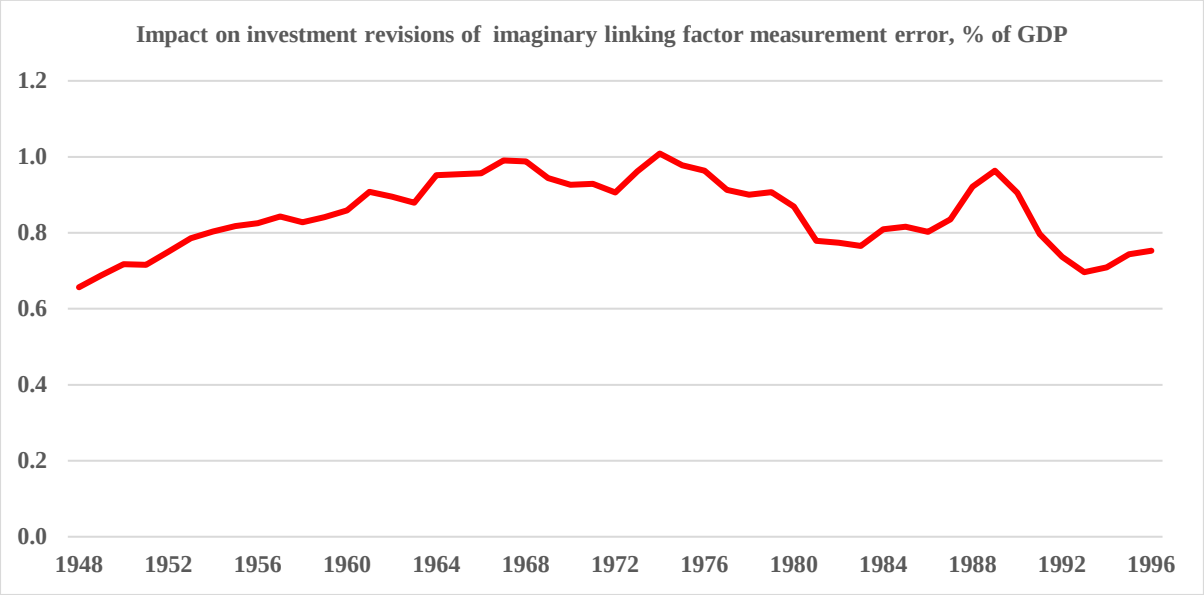
The implied criticism is not about the use of splicing as a technique. For want of better, splicing may be an acceptable, albeit crude, way of backfilling missing information, and is frequently used: in 2016, Sir Charlie Bean gave his qualified approval '[w]here consistent historical series are not yet available'.[69] The historic capitalisation revisions described earlier were derived by splicing. But there is a self-evident weakness: the series used for splicing may not be representative of the missing history that the series seek to recreate. It is therefore important as a precautionary principle to reduce the risk of non-representation by applying tests, two in particular. First, an old series, used as an indicator, should look like, or at least have a clear relationship with, the new series, to which the old series is to be spliced, over as long a period as possible when old and new data co-exist – an

overlapping period. Second, and with greater difficulty, the relationship between the spliced old data and the unknown true historic data should be evaluated. In the case of the backcast R&D data previously described, the R&D survey information provided considerable reassurance that the series selected for splicing, first, passed muster during a period of overlap beginning in 1997 and, second, did not go astray during the historic period before 1997. How well does the methodology described by the capital stocks team in 2014 measure up against this precautionary principle? The answer is badly.

Having, it claims, successfully recovered and reclassified the PIM investment data of 2010 vintage,[70] the capital stocks team had available to it an overlapping period, beginning in 1997, of 13 years within which the PIM and national accounts micro investment series could have been compared. The comparison could allow for the impact of several known revisions that had taken place. Yet very little detail is offered in the advisory. It states without elaboration that the choice of a single year, 1997, as the splicing point 'produced more plausible results than a linking factor derived from a longer time period'.[71] This sparse statement is nevertheless telling. By inference, the relationship between old and new data may not have been stable ('plausible') during the overlapping period, even allowing for the many revisions that had occurred since 2010.

The splicing procedure adopted by the ONS may well have been further compromised by disproportionate measurement error that exists at the micro level. Measurement error can arise because of quantifiable error in the samples from which some of the investment data are taken; because of less quantifiable errors arising from various methods of compilation, and because of classification mistakes: for example, misassigning spending on a capital asset owned by industry 1 to industry 2. As one of the five authors of the main ONS advisory notes in a companion piece, the measurement errors that affect all economic statistics are likely disproportionately to affect micro data.[72] It is perhaps surprising, then, that the ONS settled on a bottom-up approach relying on micro data for the historic total investment series, the more so as the agency had just recovered from an episode in which reliance on micro data had proven highly embarrassing. A much-trumpeted change in the way the investment data were balanced 'at a lower level of aggregation' and the quarterly data aligned with annual totals had led in the 2013 Blue Book to a predicted but, as it turns out, wholly unacceptable level of volatility in the quarterly current price investment series. A year on from these changes, the ONS felt obliged to issue another copious advisory in which it announced amongst other things the reversal of its 2013 balancing procedure in order to contain the extraneous volatility. This reversal was achieved by returning to a 'top-down approach starting with total GFCF [gross fixed capital formation]'.[73]

Exhibit 2: Simulated impact on historic investment revisions of imaginary linking factor errors



Sources: 'Capital stocks and fixed capital consumption, UK: 2023', 8 December 2023, <Capital stocks and fixed capital consumption, UK - Office for National Statistics>, accompanying dataset, <Perpetual inventory method (PIM) inputs - Office for National Statistics (ons.gov.uk)>, [accessed 16 May 2024]; UK Economic Accounts, published 30 July 2010. **Notes**: The value of total investment recorded in the PIM dataset was aligned with the value of total investment recorded in the 2010 Blue Book by scaling the PIM investment data over the set of 62 industries. The limited simulation, comprising 100 iterations, assumed a normal distribution of imaginary measurement errors affecting the 1997 linking factors, with a mean error of 5.0 per cent and a standard deviation of 7.5. Other assumptions produced similar qualitative results.

The possible effects of using mismeasured, non-representative linking factors can be illuminated from first principles. A suitable baseline history of micro investment data can be constructed and compared to a simulation of the same dataset recalculated using imaginary linking factors, which are mismeasured to varying degrees. A standard figurative approach is to imagine a hat containing many counters on which are written the sizes of the measurement errors that conform to a bell-shaped pattern of possibilities, with a certain average error and variation. After each draw, the counter selected is returned to the hat. This thought experiment is very limited in scope: it is concerned only with the possibility of errors affecting the linking factors in 1997; it is not concerned with the more troublesome possibility that the micro series have no stable relationship with the missing true investment series before 1997. Even so, the results of the exercise have some value. One example is depicted in Exhibit 2. It shows that

measurement errors, in the very limited sense being explored, can produce some of the properties seen in the 'other' historic revisions to total investment shown in Chart 10. These properties are the tendency of the revisions to oscillate and to trend, both upwards and downwards. Against that, the scale of the oscillations is much smaller, sometimes in a contrary direction to that observed, and there are no negative revisions. Something else is therefore going on.

Table 1: Linking factors given in the ONS advisory on the 2014 historic investment data

Industry (SIC 2007 division number)	Investment asset	1997 linking factor	Difference in 1997, %
Construction of buildings (41)	Buildings	1.9	90
Telecommunications (61)	Plant	7.8	680
Real estate activities (68)	Buildings	1.4	40
Publishing activities (58)	Artistic originals	8.8	780
Film & TV production, etc. (59)	Artistic originals	8.2	720
TV programming, etc. (60)	Artistic originals	17.9	1,690

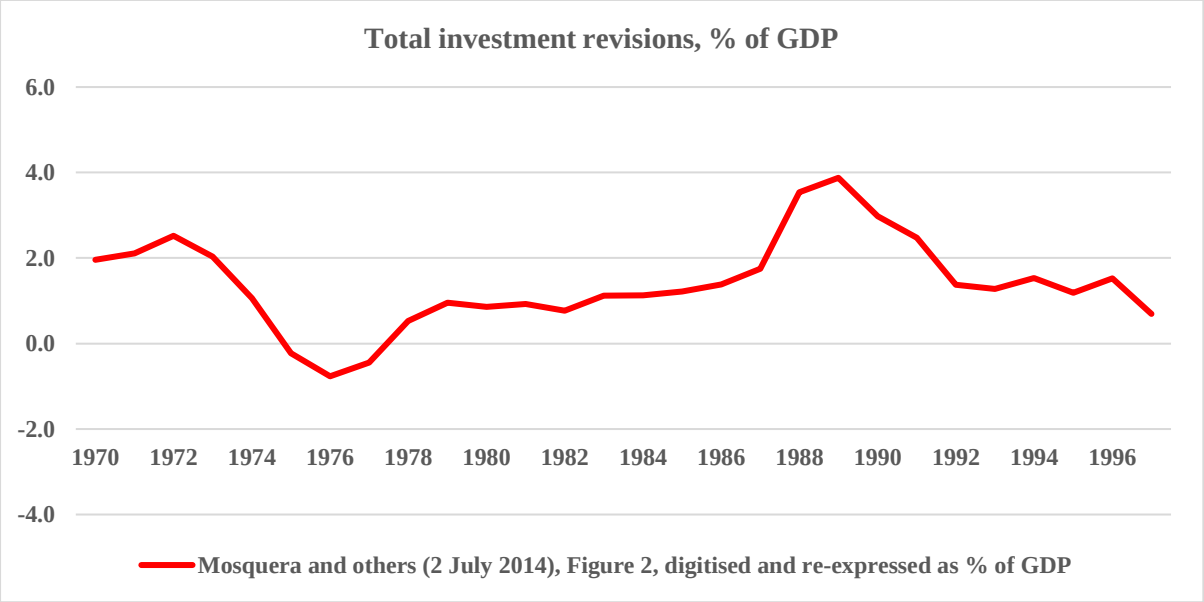
Sources: Mosquera and others (2 July 2014), 'Figures' 3 to 8. **Notes**: 'SIC 2007' stands for the 2007 version of the Standard Industrial Classification. It is assumed that the title to 'Figure 4' in the ONS advisory is mislabelled. The title refers to industry SIC 2007 division '61', the legend to 'Figure 4' states 'industry 68'. The final column in the table re-expresses the ONS linking factors in 1997 as the difference in 1997 between what the advisory refers to as the 'current version' and the 'Blue Book 2010 version' of each series expressed as a per cent of the 'Blue Book 2010 version', calculated as 100 multiplied by (the linking factor minus 1). The results will be subject to rounding error. The linking factors for 'artistic originals' (original works of art) are affected by 'improved' methods of estimation introduced in the 2013 Blue Book.

The presence of vastly erroneous linking factor errors is one distinct possibility. It can be tentatively inferred from the very limited information provided in the capital stocks team advisory that the likely measurement errors affecting the linking factors could be extraordinarily large and not symmetrically spread; and, therefore, not at all like the bell-shaped distribution of errors upon which Exhibit 2 was constructed. The advisory provides six charts on which are recorded the linking factors for certain industries and capital investment assets; only three of these charts provide data for the 13 overlapping years beginning in 1997 and these are affected by revisions not separately detailed. Table 1 lists these linking factors. The small sample was not selected at random by the capital stocks team; the linking factors it chose to report were precisely those that had a material impact

on the team's results. The linking factors are so large as to invite incredulity that the ONS thought its bottom-up approach worth pursuing: could the old series really be regarded as representative of the missing historical data given the size of linking factors involved? In the case of investment in plant by the telecommunications industry, for example, the reported linking factor of 7.8 means that the value in 1997 of the national accounts series to which the old data had to be linked was nearly eight times greater than the 1997 value of the corresponding and reclassified old investment data taken from the 2010 PIM database: an excess of 680 per cent.[74] This eye-popping excess is not the largest reported. Partly affected by 2013 Blue Book revisions, the corresponding excess in the case of investment in TV programming and broadcasting ('artistic originals') is 1,690 per cent.[75]

The capital stocks team offers the near-8 fold linking factor used in the case of the telecommunication industry's investment in plant as an explanation, at least in part, of the oscillation in the impact of the linking procedure on the total investment figures in the late-1980s and early-1990s. This oscillation is depicted in Chart 11, which has the same vertical scale as Chart 10. The ONS calculations show the difference in the total investment figures calculated before and after the PIM micro data were linked to the national accounts data. In the original ONS chart, the observations were expressed in current prices, with no data provided (as far as an extensive search can tell). It has therefore been necessary to extract the figures used in Chart 11 from the original ONS chart by the necessarily approximate process of digitisation, a computer software equivalent to using a ruler and pencil. The data extracted from the original ONS chart have been re-expressed as shares of GDP: a far more revealing way of depicting the ONS results over a period, from 1970 to 1997, when money incomes rose greatly. The results show that the ONS linking procedure caused upward revisions to total investment that increased from about 1½ per cent of GDP in the mid-1980s to a peak of around 4 per cent of GDP in 1989, falling back to 1½ of GDP by 1992. Behind this oscillation lies a switch, from negative to positive, of the impact of the ONS linking procedure on the record of investment in plant.

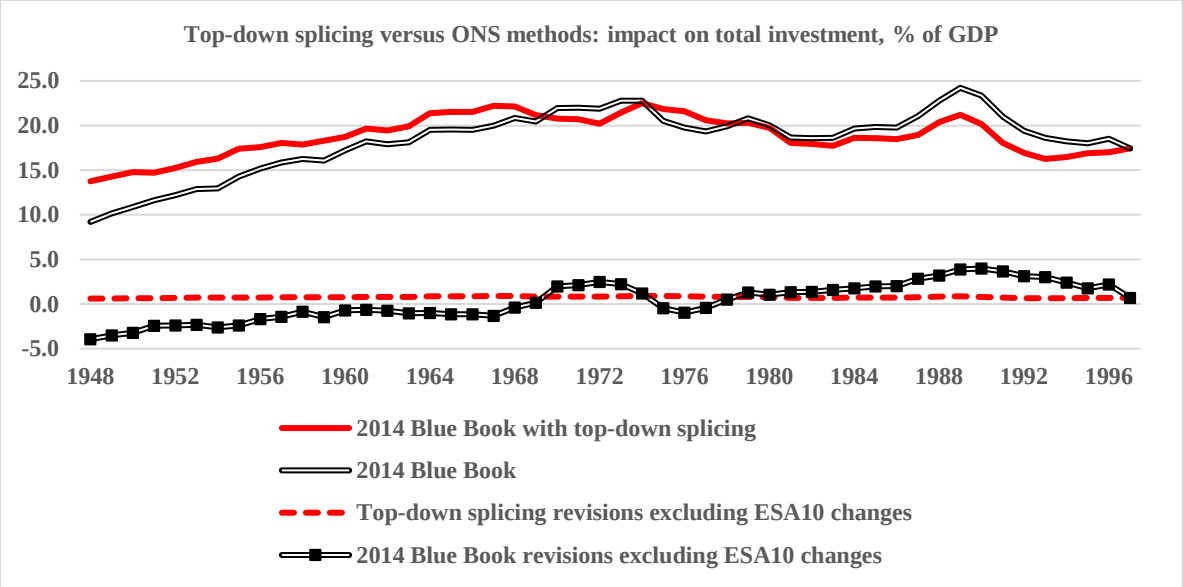
Chart 11: The impact of the ONS splicing method in 2014



Sources: Mosquera and others (2 July 2014), 'Figure 2'. **Notes**: The digitisation of the advisory's 'Figure 2' line depicting the impact of the ONS splicing method on total investment is necessarily approximate. Repeated trial attempts at digitisation produced similar results. The software used was: 'Plotdigitizer: 3.3.9, 2024, Plotditizer.com'.

The capital stocks team attribute other substantial splicing effects to the linking factors listed in Table 1, but argue that these outcomes do 'not represent a calculation error'.[76] The ONS defence of its splicing procedure is narrowly correct but broadly wrong. The defence is narrowly correct because the ONS results are the arithmetic outcome (presumably performed without error) of multiplying the old historic micro series by the linking factors. The defence is broadly wrong because the low-quality of micro data to which the team itself draws attention and the adverse consequences of which the ONS had experienced in the failed 2013 Blue Book reforms, the team's semi-admission that the comparison of old and new micro data in the overlapping period from 1997 revealed instabilities in the relationships, and the few extraordinarily large linking factors reported, all together strongly suggest, albeit do not wholly prove, that the old micro data were not reliably representative of the missing historic series before 1997 that had to be consistent with the national accounts series from 1997. The ONS bottom-up splicing approach created revisions to Britain's investment history that were arbitrary and large.

Chart 12: Top-down splicing: an example using the 2014 Blue Book data



Sources: See Charts 3 and 9; Nolan and Jones (29 May 2014); Walker (29 May 2014); Wild and Whiting (31 October 2014). **Notes**: The 2014 Blue Book series with top-down splicing is derived by adding the 2014 Blue Book capitalisations of R&D and military weapons systems to a rescaled 2013 Blue Book total investment series. The rescaled series splices the 2013 Blue Book total investment data to the corresponding 2014 Blue Book data in 1997 that *exclude* the effects of changes to investment data required to comply with the ESA10 accounting standard. Two changes required under the previous (ESA95) accounting standard that came into effect in the 2014 Blue Book were: (a) improved estimates for investment by businesses and households (mainly the latter) in the construction of new dwellings and repairs for their own use; and (b) the reversal of the 2013 Blue Book 'bottom-up' balancing procedure. These changes added £861mn (0.1 per cent of GDP) and £5,783mn (0.6 per cent of GDP), respectively, to the value of total investment in 1997. Another change required under the ESA95 accounting standard that improved the conversion of data to the 2007 standard industrial classification apparently affected the national accounts after 1997: 'between 2010 and 2011', according to Nolan and Jones (29 May 2014, p. 4). The ESA10 changes that are excluded from the revisions shown in the chart comprise the major impact of the capitalisation of R&D and military weapons systems and other minor changes (more investment in small tools and nuclear plant decommission costs). Under ESA10, the minor changes raised investment in 1997 by £365mn (0.04 per cent of GDP) and are assumed to be zero before 1997.

There was a simpler alternative available to the capital stocks team. To backcast the missing historic series, the team could have spliced the total investment data in the 2013 Blue Book to the national accounts figure for 1997 after taking account of the very few revisions that were going to happen irrespective of the requirements of the new 2014 accounting standard. These revisions had increased the value of investment as recorded in the national accounts by the equivalent of ¾ per cent of GDP in 1997. This alternative 'top-down' splicing procedure would have provided historic figures for total investment devoid of the aberrations created by the ONS calculations.

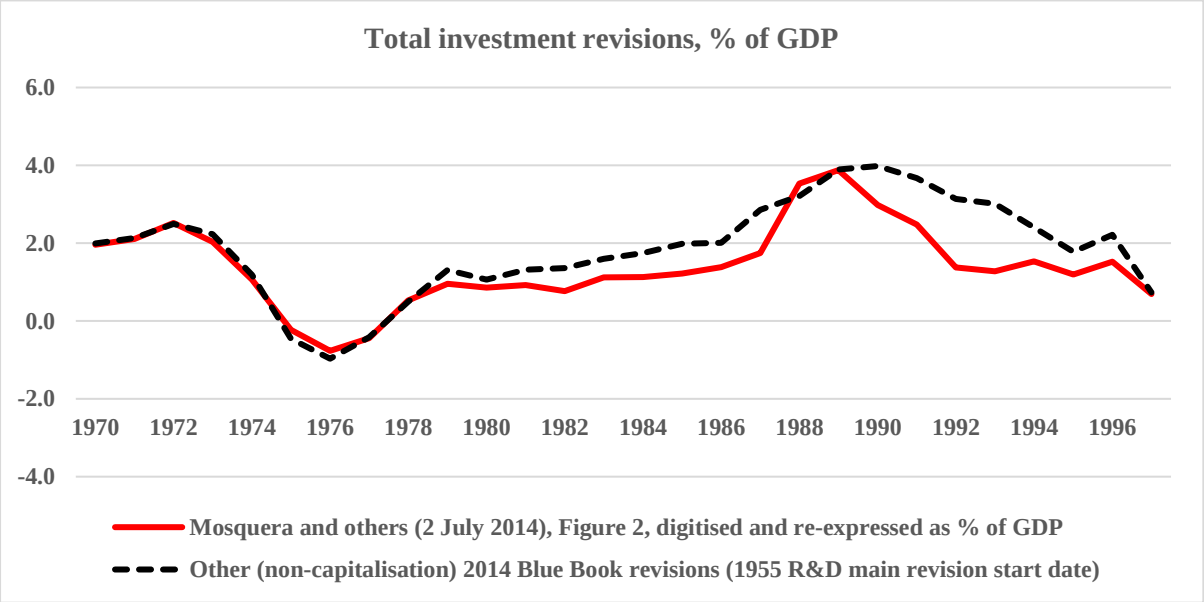
Chart 12, drawn with the same vertical scale as Chart 3, shows an example of how the historic 2014 Blue Book data could have looked with top-down splicing after adding on the effect of the capitalisation of R&D and military weapons systems. The chart also shows the implied revisions to the 2013 Blue Book historic data, excluding the impact of capitalisation: as might be expected, the historic upward revisions to total investment are small and stable. There are none of the large oscillating revisions that resulted from the ONS calculations. The top-down derived history would also have provided a controlling total within which the ONS could have calculated industry, asset and sector investment detail using known shares to divide up the total or by using more elaborate methods. One set of well-known techniques could have been used to give more weight to the more reliable PIM micro data constructed by the capital stocks team, and less weight to the more unreliable micro data, subject to the requirement that the micro data calculations added up to the top-down total.[77] Then, as now, the ONS was well versed in 'various data science and time series analysis techniques.' Yet the capital stocks team decided to work bottom up, simply stating without elaboration that, '[i]t was decided to link the lower level series to preserve the asset by industry growth rates'.[78]

There are two remaining puzzles on which, with the limited published information available, it is possible to throw only a faint light. The first puzzle is that in the historic period since the early-1980s the revisions to total investment, excluding the impact of capitalisation, are not wholly explained by the impact of the bottom-up splicing technique: the ONS estimates shown in Chart 11. The second puzzle is the very large downward revision to investment in the late-1940s and persisting with diminishing force through most of the 1950s, as shown in Charts 1 and 3.

Addressing the first puzzle, Chart 13 adds to Chart 11 the estimates of the 2014 Blue Book revisions to historic investment that are not accounted for by the capitalisation of R&D and military weapons systems: the 'other' revisions in the 2014 Blue Book. This additional series, denoted by the dashed line, is the one shown for a longer period in Chart 10, which has the same vertical scale. The

'other' revisions to historic investment traced in the chart are calculated on the assumption that the main R&D revisions embedded in the 2014 Blue Book began in 1955, rather than in 1981. This choice of assumption appears to be correct: over the 1970s, there is a very close fit between the 'other' revisions as a share of GDP and the ONS estimates of the impact of its splicing method. Had the main R&D revisions not begun until 1981, the record of the 2014 Blue Book revisions to historic investment excluding the effect of capitalisation would have materially exceeded the impact estimated by the capital stocks team of its splicing methodology in the 1970 to 1980 interval.

Chart 13: The impact of the ONS splicing method and 'other' revisions



Sources and notes: see charts 10 and 11.

The puzzle referred to begins in the early-1980s: there is a gap of variable size, briefly changing sign in 1988 and averaging ¾ per cent of GDP, between the estimated historic investment revisions in the 2014 Blue Book not due to capitalisation and the ONS estimates of the impact of its splicing method. Some part of the gap can be explained by likely errors in the estimation of the historic capitalisation revisions and in the digitisation of the capital stocks team chart on which the data in Chart 13 are based. However, the R&D survey evidence together with other considerations provide reassurance that the estimated capitalisation revisions are likely to be reasonable approximations to the revisions actually embedded in the 2014 Blue Book. The digitisation errors are unlikely to be anything more than minor. The close fit between the two series in the 1970s bears out the judgement that the explanation for the later variable gap lies elsewhere. The explanation may, in fact, lie in the presence of tapered balancing items introduced by the 'central GDP balancing team' to improve the coherence

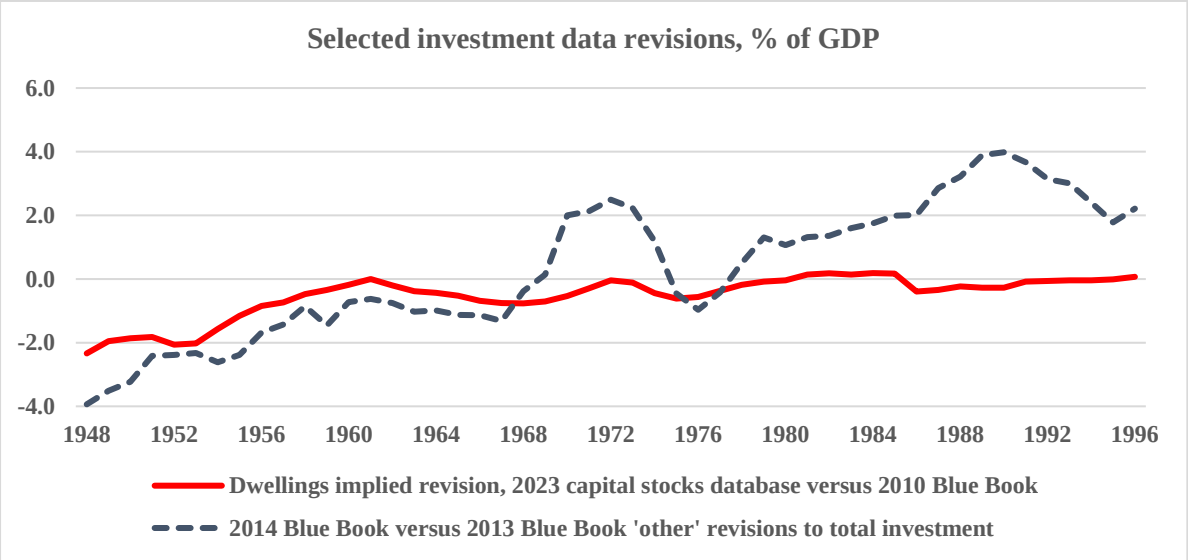
of the estimates for GDP back to the early-1980s.[79] There is no ONS documentation to corroborate or to refute, although such absence is not in itself proof against the idea: the ONS has form when it comes subtly to amending the historic national accounts without informing its users.[80] There is one observation in 1997 which might be significant, or a red herring. The ONS estimate of the impact of its splicing method in 1997 fits with the revision introduced in the 2014 Blue Book to undo the impact of the balancing process unsuccessfully introduced in the 2013 Blue Book.[81]

With regard to the second puzzle, it is possible that the ONS may have further undermined the reliability of the derived historic investment data by making computational mistakes. One speculative reason for this possibility is an over-reliance on the investment data used in the construction of the capital stocks. Although not mentioned in the mid-2014 advisory or, it seems, at the time, the release many years later of the PIM database is now accompanied by a warning that its historic investment series may not be consistent with the national accounts before 1997.[82] What is true today may also have been true in 2014 when the capital stocks team worked with a version of the capital stocks database first released in 2010. Unfortunately, it is not possible to establish from the published information whether a misalignment existed or not.[83] Any misalignment could matter because the splicing technique deployed by the capital stocks team is sensitive to the baseline figures from which it was working. A proportionate uplift, for example, resulting from the 1997 'linking factors' would as a matter of arithmetic create a larger positive revision in absolute terms when the baseline data are large than when they are small. A linking factor of 1.1, implying a 10 per cent uplift on, say, a £1,000 level of investment is worth an extra £100; a 10 per cent uplift on zero investment is still zero. If the baseline PIM investment figures were too low in the early post-war period but closer to the correct level later on, the measurement error in the baseline data combined with the splicing technique that involved linking factors with values typically greater than 1 would have had the effect of imparting an erroneous upward trend to the historic investment revisions. A second and related possibility has been suggested by Anne Harrison. Based on her experience of the UK national accounts data, she advised the ONS that a computational error may have arisen as a result of a technical issue affecting the figures on investment in 'new buildings and works' before 1960.[84] A third possible source of computational error arises from a change in the way the 2014 capital stocks team allocated PIM investment data in new dwellings. The revised method allocated 'the dwelling assets into four industries', instead of just one.[85] A changed routine may have been accompanied by a coding mistake.

Examination of these possibilities back to the early post-war period cannot be undertaken using the current national accounts: figures for investment that are distinguished by the type of capital asset involved begin in 1987. An exercise

comparing the record Blue Book by Blue Book also proved to be a dead end, and gave no hint of the key finding that emerged from an alternative procedure. This alternative involves subtracting the historic investment data differentiated by types of capital asset last presented in the 2010 Blue Book from the corresponding data in the capital stocks PIM database, albeit one of a much later vintage. The supposition is that the later vintage version of the PIM database – the one released in December 2023 is used - incorporates the results of the 2014 splicing procedure adopted by the capital stocks team, although also subsequent revisions, which will muddy the waters. Changes to classifications confound detailed comparisons between the 2010 Blue Book and PIM database records for two types of capital asset: machinery and equipment, on the one hand, and intangibles (now called 'intellectual property products'), on the other hand. The differences for two asset classes – buildings and structures, other than dwellings, and transport equipment (such as cars and ships) – display an upward trend over the historic period. The differences in the figures for buildings and structures other than dwellings were negative (the 2010 Blue Book data exceeding the corresponding PIM data) in the late-1940s and 1950s, but not by a greater margin than in the 1960s.

Chart 14: The implied revision to dwellings investment: 2010 Blue Book versus 2023 PIM



Sources: 2010 Blue Book (30 July 2010 release), 8 December 2023 release of the capital stocks database ('Perpetual inventory method (PIM) inputs'), see also Chart 9. **Notes**: 'Other' revisions in the 2014 Blue Book exclude the estimated impact beginning in 1955 of the capitalisation of non-government R&D and, from 1963, of military weapons systems and government R&D.

What stands out from these comparisons is the materially different behaviour of the figures for investment in dwellings. For 1948, the deduction of the 2010 Blue

Book estimate from the later vintage PIM estimate implies a very large downward revision to the dwellings figures, equivalent to 2¼ per cent of GDP. The scale of implied downward revision then diminishes. By 1960, the implied revision is small as a share of GDP, and stays that way for much of the remaining historic period. This odd behaviour is consistent with the presence of a data 'drop out' before 1960, the result of possible errors in the PIM database that have made their way to the total investment figures in the historic national accounts. As Chart 14 illustrates, with the same vertical scale as Chart 9, the implied revision to the dwellings figures accounts, in the arithmetic sense, for about half of the downward revision to total investment in 1948 that occurred between the 2013 and 2014 Blue Books. With the available information, little further progress can be made in divining whether the ONS made 'processing' or 'production' errors affecting the historic record of investment in the 2014 Blue Book; Chart 14 suggests it may have made at least one of considerable magnitude.

It is unfortunate that the capital stocks team did not subject its backcast historical data to further scrutiny: to test the likely stability of the relationship between the spliced old data and the unknown true historic data. The team asserted that it was unable to apply such a test, to determine 'how well the linking factor accounts for methods changes, as no information on the real impact [of the splicing] is available'.[86] Yet the team could have sense checked the resulting estimates for their wider impact on GDP, as the ONS did in the case of historic changes to the consumer spending figures. The failure to do so might be explained in part by the aims of the capital stocks team: the tests it applied were focussed on the impact of the spliced micro investment series on the capital stocks estimates. At the time, a revision to investment equivalent to an additional 1 per cent of GDP, material when one's concern is with the record of economic growth, would have caused an immediate revision to the capital stock, similarly measured gross of depreciation, of only ¼ per cent, albeit with a long echoing effect during the lifetime of the extra investment. Other causes of the failure of the team properly to examine the wider GDP impact of the investment revisions (working in silos; distractions of the ESA10 conversion, and so on) are similarly speculative. A qualification is that the ONS balancing team might have moderated the impact on GDP of the historic investment revisions through the 1980s and 1990s. But even if this were the case and the putative balancing done well, much of Britain's recorded history after the second world war could still be seriously distorted. As this chapter has sought to argue, the 2014 Blue Book revisions to the historic investment figures resulted from a poorly chosen arithmetic procedure, producing results that lack a coherent statistical or economic rationale. Computational error is also suspected. The next and final chapter sketches some of the consequences for the statistical depiction of the economy from the late-1940s to the late-1970s.

Chapter 3: You really never had it so good, and other warnings

Worldly wisdom teaches that the ONS is unlikely now, or in the foreseeable future, to amend the historic investment data. The agency's earlier attempt ended in an admission of defeat. More generally, the resources of the ONS, and the way it chooses to allocate them in response to many competing demands, mean that the historic national accounts have for many years been overlooked.[87] In the absence of any amendment of the data, users of the historic national accounts might wish to avoid the potholes that threaten to ruin the transmission of the history lessons that scholars and policy makers may seek to find in Britain's economic past. A full inventory would take the resources and stamina of a team of inspectors; the aim here is necessarily more modest, sketchy and selective. The focus is on three topics: (a) the first 'half' of the post-war 'golden age' economic expansion, (b) the 1970s boom and bust and (c) the post-war decline in profitability.

A) The early post-war expansion

It was before a 'large weekend audience at Bedford football ground on 20 July 1957' that the Prime Minister, Harold Macmillan, gave his famous warning about the fragility of the recovery, a warning cloaked within his encomium on Britain's (and the Conservative government's) achievements.[88] Macmillan enthused that 'most of our people have never had it so good.' Macmillan's phrase has since been redeployed, with and without irony, to describe the social, political and economic conditions of the 1950s. The decade did not start promisingly. The pen portrait offered by David Thorpe, the biographer of three Conservative prime ministers, gives a sense: rationing remained in force; in 1951 another sterling crisis forced Rab Butler, the new Conservative Chancellor, to announce drastic import cuts; the next year began with the unexpected early death of King George V1 and closed with the great London 'smog', 'lethal in its effects'.[89] The Conservative Party won the 1951 general election by appealing to an electorate disenchanted with austerity and open to the Party's promise 'to build 300,000 new homes a year during the course of the Parliament'.[90] Plus ça change.

Economic historians have at least two broad narratives to tell. The decade marks the first 'half' of Britain's economic decline relative to strongly growing European rivals during the 'golden age' expansion of the 1950s and 1960s. Nicholas Crafts, the greatly respected economic historian, called it the 'Postwar British Productivity Failure', the result of 'inadequate investment', as well as 'inefficient use of inputs'.[91] Stop-go economic policies – a description that may have first appeared in *The Daily Telegraph* in 1962[92] - were sometimes held responsible. The underlying cause of 'stop-go' was believed to be the pursuit of apparently incompatible policy aims: the defence of sterling; the promotion of

recovery; the containment of wage inflation. The result of these incompatibilities was lurches in economic policies that successively restricted (‘stop’) and promoted (‘go’) economic growth, undermining, it was alleged, the willingness of industry to invest and innovate.[93] The second broad narrative, more in keeping with Macmillan’s speech, applauds, and seeks to explain, Britain’s outstanding post-war achievement: full employment. In an influential, albeit contested, lecture in 1968, Robin Matthews – the main author of a landmark book on the British economy, co-authored by the celebrated national accounts economist Charles Feinstein and a younger economist, John Odling-Smee – attributed the attainment of full-employment to high post-war investment that had the ‘nature of a gigantic cyclical boom’. [94] The 1950s are, then, the first ‘half’ of a narrative in which Britain’s investment record can be both lamented and lauded, depending on the perspective of the viewer. Important, then, that today’s economic historians can rely on the national accounts investment figures without inadvertently tripping over ONS mistakes.

Scholars interested in ‘stop-go’ may be surprised to find that two well-known years of recession, 1952 and 1958, have been transformed into years of modest expansion, and that the rebound of 1953 now appears even stronger.[95] Table 2 details the significant upward revisions to GDP growth in volume terms, comparing today’s national accounts record – those in the 2023 Blue Book were the latest available at the time of calculation - with the record in the 2013 Blue Book. Table 2 also shows the main cause of these upward revisions: the revisions to the investment data that occurred 10 years ago in the 2014 Blue Book. The contributions of these revisions are calculated consistently with the way that the ONS derives what it calls ‘chained volume measures’. The volume growth of the various types of expenditure that make up GDP are multiplied by the relevant shares (‘weights’) of each type of spending in the value of GDP of the same data vintage.[96] Add up all the contributions and, by construction, one ends up with the growth of GDP in volume terms.

Table 2: You really never had it so good: the impact in selected years of suspect investment data

% or % points	1952	1953	1958
GDP volume growth, %			
2023 Blue Book	1.5	5.6	1.3
2013 Blue Book	0.3	4.1	0.7
Revision since 2013 Blue Book (percentage points)	1.2	1.4	0.7
of which:			
Contribution of revision to investment (total)	1.1	1.6	0.9
Contribution of revision to investment (ex. R&D)	1.1	1.6	0.7

Sources: see Chart 1, Appendices A and B. **Notes**: Revisions can differ from the differences between the growth rates in the two Blue Books because of rounding error. The revisions to GDP volume growth and to the contribution to GDP volume growth, attributable arithmetically to investment volume growth, are the same, within 1 decimal point, whether the comparison with the 2013 Blue Book data is taken from the perspective of the 2023 Blue Book or the 2014 Blue Book. Consistent with ONS chained-volume methodology, the annual contribution of investment growth is equal to the growth of investment in volume terms multiplied by the weight in the previous year of investment in current price terms in current price GDP of the same vintage. The contributions (not shown) of all the expenditure components add up to annual GDP volume growth. The last contribution listed in the table excludes the estimated impact of the 2014 Blue Book revision to R&D investment assuming that the starting date for the R&D revisions was 1955.

The figures in the penultimate row of Table 2 show the difference between the contributions of investment growth in the 2023 Blue Book and in the 2013 Blue Book. These contributions account for much the greater part of the revisions to the volume of GDP growth; for example, in 1952, the investment revision contributes about 1 percentage point to the upward revision to GDP growth, also about 1 percentage point. These growth revisions and contributions are within one decimal point of those that first appeared in the 2014 Blue Book. What you see now is what happened then. There is also the question of the impact of the capitalisation of R&D investment. The answer is provided in the final row and column in the table. The figure for 1958 is adjusted on the assumption, for which evidence has already been provided, that the revisions arising from the capitalisation of R&D were taken back by the ONS to the year 1955, but not to an earlier or later year. The adjustment for R&D makes little difference to the comparison. Although the capitalised R&D investment was quite possibly growing strongly, its weight in GDP, at around 1 per cent, means that the volume

growth of R&D investment in 1958 contributed little to the volume growth of GDP: about 0.1 percentage points.[97]

Scholars of the causes of Britain's post-war full employment and, by international standards, relatively weak productivity may also be surprised by the additional uplift that the national accounts, since the 2014 Blue Book, attribute to the pace of investment. Table 3 documents some key features of the post-war expansion until 1960. The choice of 1960 as the final year of the period is guided by the strong suspicion that an error in the 2014 Blue Book depressed the official investment data, not necessarily in 1960 but in the preceding years and increasingly so back to 1948. If so, average growth rates over the twelve-year period as recorded in the 2014 and later Blue Books would be too high, starting from too-low a base. The figures in Table 3 are not inconsistent with this interpretation.

The top half of the table shows the average rates of growth over the 1948 to 1960 interval of the value of total investment, of the average price of the capital assets that make up that investment, and, abstracting from those price changes, of the volume of investment. The first two columns record how the figures looked at the time of the 2013 Blue Book and how they look today, in the 2023 Blue Book. The penultimate column shows the corresponding revisions to growth rates, expressed in percentage points. A glance at the final column shows that these revisions are the same, within a rounding error, as those that occurred ten years ago in the 2014 Blue Book. Again, what you see now is what happened then. The growth rates in the top half of the table show a very substantial upward revision to the average rate of growth of the value of the nation's investment: over the 1948 to 1960 interval, the average recorded annual growth rate increased from 9¼ per cent to 13 per cent. The upward revision to the growth of the volume of investment was greater still: from 5½ per cent a year to 10½ per cent a year. The immediate cause of the larger upward revision to the growth of the volume of investment as opposed to its value was the downward revision to the recorded rate of growth of investment prices. Changes in the composition of the total investment figures may help to explain the revision to investment prices, but the precise reasons are not documented in ONS advisories. The revision to prices turned an upward revision to the annual rate of growth of the value of investment of 3½ percentage points into an upward revision to the annual rate of growth of the volume of investment of 5 percentage points.

Table 3: Britain's post-war expansion until 1960

Expenditure and GDP	Average annual rate of growth, 1948 to 1960, % and % points			
	Vintage of Blue Book		Revisions since 2013 Blue Book, % points	
	2013	2023	2023 Blue Book	2014 Blue Book
Investment				
Value	9.3	12.9	3.6	3.6
Prices	3.5	2.1	-1.4	-1.4
Volume:				
as published	5.6	10.6	5.0	5.0
excluding R&D	5.6	10.5	4.9	4.9
GDP volume	3.1	3.4	0.3	0.3
Contributions (% points):				
Investment ex. R&D	0.8	1.3	0.5	0.5
Consumer spending	1.9	1.7	-0.2	-0.2
Other	0.4	0.4	0.0	0.0

Sources: See Table 2. **Notes**: Shorthand and formal national accounts terms are as follows: 'Investment': 'Gross Fixed Capital Formation'; 'Consumer spending': 'Households Final Consumption Expenditure'; 'Investment prices': Gross Fixed Capital Formation price deflator; 'Value': Current price measure; 'Volume': Chained volume measure'; Investment volume excluding R&D: Chained volume measure excluding the estimated 2014 Blue Book revision to R&D in volume terms (does not affect the 2013 Blue Book data). The arithmetic contributions of the growth of the expenditure components to GDP volume growth over the period are calculated approximately from the annual average of their cumulative impact. The 'other' component in the table is calculated as a residual. The 2013 Blue Book series for NPISH Final Consumption Expenditure records a volume growth rate of 918 per cent in 1955. This glitch in the official data does not distort the recorded volume growth of total national expenditure or the results in this table. Revisions may not accord with the levels data shown in the table due to rounding error.

This comparison is not quite right: account needs to be taken of the effect on the latest Blue Book data of the capitalisation of R&D investment. If the assumption made about the starting date of the 2014 Blue Book revision is correct, the capitalised R&D investment will have raised the recorded increase in the value of total investment between 1948 (no R&D) and 1960 (R&D added). The revision will also have raised investment price inflation: official figures, albeit

'experimental' and of a later vintage, show R&D investment prices rising relative to other investment prices. After removing the effect of these price changes, the result is that the revision to investment volume growth in the 1948 to 1960 interval, comparing the 2013 Blue Book with the later Blue Books, is little affected whether or not the figures of the later Blue Books are adjusted to exclude the capitalisation of R&D. The upward revision to the rate of volume growth is still 5 percentage points.

The cumulative effect of the investment revision is quite remarkable. An annual growth rate of 5½ per cent, as recorded in the 2013 Blue Book, meant that the volume of investment was, by 1960, slightly less than double its 1948 level. But at a 10½ per cent annual growth rate, as now recorded, the volume of investment by 1960 was over three times its 1948 level.[98]

The impact of the investment revisions on the growth of the volume of GDP is shown in the lower half of Table 3. It also shows the contribution of the volume growth of consumer spending, with other minor contributions left as a residual. The investment volume contributions recorded exclude the effect of the 2014 capitalisation of R&D. This is a simple accounting exercise, but a revealing one. It shows by how much measured investment and consumer spending added arithmetically to measured GDP growth, and, by inference, by how much a revision to the volume growth of one component would add or subtract from GDP growth assuming the contributions of other components remained the same. This line of argument is open to the correct objection that a revision to the growth of investment, for example, could over time alter the share of investment in GDP, and so the contribution not only of investment but also of all the other types of expenditure whose shares would likewise change even if their rates of growth remained the same. With this proviso accepted, the accounting exercise nevertheless offers a useful guide to orders of magnitude, which are material.

Over the 1948 to 1960 interval, the average rate of growth of the volume of GDP was upwardly revised by ¼ percentage point a year. This came despite a downward revision to the volume of consumer spending growth, which deducted an average ¼ percentage point a year from the growth of GDP. The revision to consumer spending can be assumed to be justified by good statistical practice at the time.[99] But if the analysis of Chapter 2 is accepted, the same cannot be said of the upward revision to investment growth. It added an additional ½ percentage point a year to GDP growth over the period. Even in the context of the average GDP growth rates of that distant era, 3 per cent a year or more, the boost from the investment revision is not without significance. The more so because of the duration of the impact. An economy that grew ½ percentage point a year faster would be 6 per cent larger in twelve years' time. This change is of a size comparable to the one that excites the continuing fractious debate about the

output loss associated with Britain's decision to leave the European Union.[100] One official guess put the output loss at 4 per cent; others argue for more, or less. Changes in growth of the order of ½ percentage point a year over many years can also appreciably affect the fine calculations used in productivity analysis designed to reveal the pace of technical progress and other underlying forces that shape long-term economic growth. In his classic study published in the late-1960s, Edward Denison calculated that underlying productivity in the UK grew by just 1¼ per cent a year in the 1950 to 1955 interval.[101]

Seen in that light, a revision to annual GDP growth of ½ percentage point sustained over many years takes on greater significance, and could lead the economic historian or policy maker astray should they be unaware of the probable deficiencies of the historic national accounts.

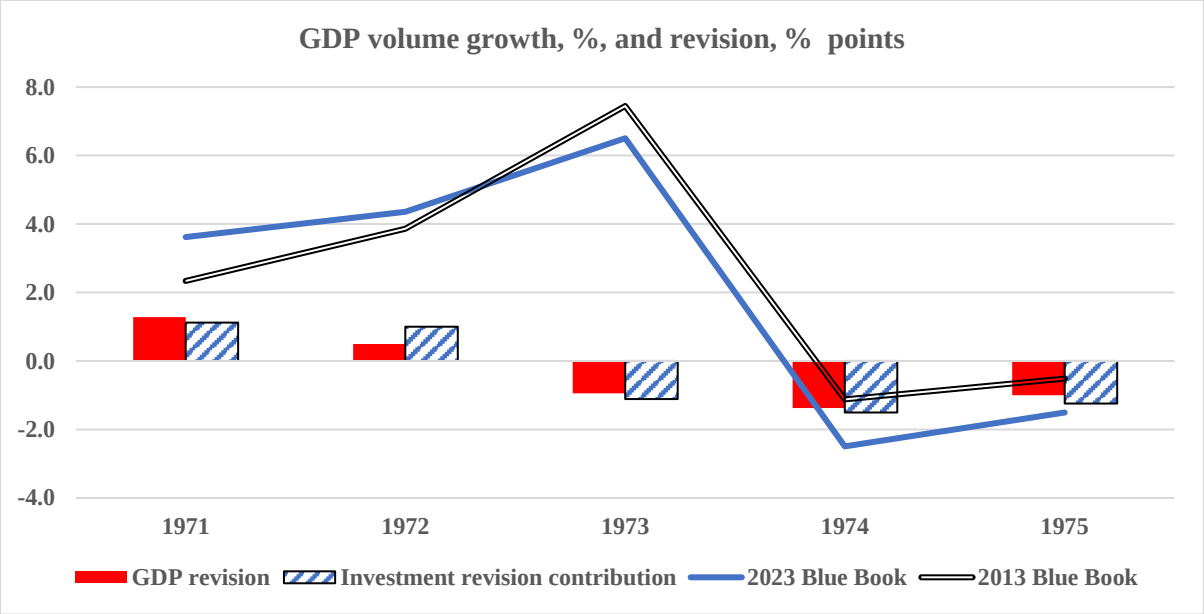
B) The Barber Boom and Bust

In the fraught 1970s, there was an acute shortage of effective remedy for Britain's mounting economic problems but no shortage of rival explanations for the coincidence of high, unstable rates of inflation and, judged by the standards of the day, high unemployment. The explanations for 'stagflation' – a term coined some years earlier by the Conservative politician Iain Macleod – ranged from the establishment view that inflation was either imported or the result of labour militancy – 'wage-push' – aggravated by 'threshold' agreements explicitly linking pay to price increases - to those of the emergent, later to be ascendant, monetarist school, which attributed the malaise to excess monetary growth accompanying lax budgetary policy and heightened expectations of future inflation. A compendium of rival explanations published in the *American Economic Review* in September 1976 gives a good sense of the debate at that time. It is one that continues today. In a recent collaborative paper, Jonathan Haskel, at the time of writing a member of the Bank of England's Monetary Policy Committee, argued that the 1970s inflation was self-feeding, with expectations of inflation 'more responsive to actual inflation' than in the modern era.[102] Although reframed in new language, Haskel attributes the surge in UK inflation that began in 2021 to cost-push factors – 'external shocks (energy and food prices and shortages)'. Against this point of view, critics have argued, in an echo of the 1970s debate, that it was easy money that at least enabled the recent inflation to last longer, and rise far more, than the Bank of England had forecast. It seems the economy may have been operating at a greater pressure of demand than the Bank of England had imagined, with GDP above some notion of the economy's full-employment potential: a positive 'output gap'. Mistaken estimates of the output gap, not a term widely used 50 years ago,[103] have come to be seen as one of the main contributors to the policy errors of the 1970s from which monetary policy makers and economists have sought to learn lessons.

Estimates of potential output in the early-1970s were confounded by an unwillingness to accept that the growth rates achieved in the 1950s and 1960s were no longer achievable. There were also many revisions to the national accounts record of GDP.[104]

Researchers now seeking to derive lessons from the 1970s stagflation experience face a subtly different problem, one of separating valid from rogue revisions to the GDP data. The late-1960s to mid-1970s oscillation in the revisions to the investment data that came with the 2014 Blue Book has left a legacy today in the form of a material revision to the nature of the early-1970s boom and the mid-1970s bust. The boom associated with the name of the then Chancellor, Anthony Barber, appears to have started earlier, in 1971, ironically the year of rising unemployment that provoked the controversial policy U-turn: the reflationary budget of 1972 and the decision to let sterling fall.[105] Compared with the picture of the period conveyed in the 2013 Blue Book, the upward revision to GDP growth in 1971 is 1¼ percentage points, nearly all of this coming arithmetically from the upwardly revised rate of growth of the volume of investment: from 2 per cent to 7½ per cent.[106] It no longer needs stating that this revision, and the others in this period, are within a rounding error of those found ten years ago in the 2014 Blue Book. The upward revision to GDP growth in 1971 is followed by a smaller but still upward revision to GDP growth in 1972 of a ½ percentage point. This revision is more than accounted for by the upward revision to investment growth, worth an extra 1 percentage point on the growth of GDP.[107] After 1972, the revisions to investment growth reverse sign, in keeping with the weird oscillation in the investment revisions first noted in Chart 1. The reversal slices off growth from the economy's cyclical peak in 1973 and amplifies the extent of the mid-1970s bust. The negative impact of the investment revisions on recorded GDP growth runs at over 1 percentage point each year between 1973 and 1975.

Chart 15: The Barber Boom starts earlier and the bust is worse



Sources and **notes**: See Table 2. The investment revision contribution abstracts from the revision due to the capitalisation of R&D and spending on military weapons systems.

Chart 15 summarises the results for the boom-bust period. As a result of the arbitrary revisions to investment spending introduced in the 2014 Blue Book, today's national accounts artificially raise the level of output in 1971 and 1972 by a cumulative 2 per cent. The subsequent reversal of the investment revisions reduces this addition and turns it into a deduction of 1¾ per cent by 1975. With some poetic licence, the changes can be read as revisions to the estimated size of the output gap, first two points up, then two points down, in a period of history when policy makers believed the economy was generally operating below its full-potential. Variations in estimates of the output gap of the order of plus or minus 2 percentage points would be significant even taken in that context: Edward Nelson and Kalin Nikolov, two former Bank of England economists, have estimated that revisions to GDP accounted for 4 percentage points of policy makers' underestimation of the size of output gaps that occurred in the 1970s.[108] The suspected errors arising from the investment revisions in the 2014 Blue Book may additionally have an impact on the diagnosis of the 1970s inflation process. An illustrative calculation performed on the back of an envelope suggests that the two points up, two points down output gap revisions could add some 4 percentage points to the predicted rate of inflation in both 1973 and 1974, and a still not insignificant two percentage points to predicted inflation in 1976.[109] Inflation lessons from the past may be easily undermined when the national accounts cannot be trusted.

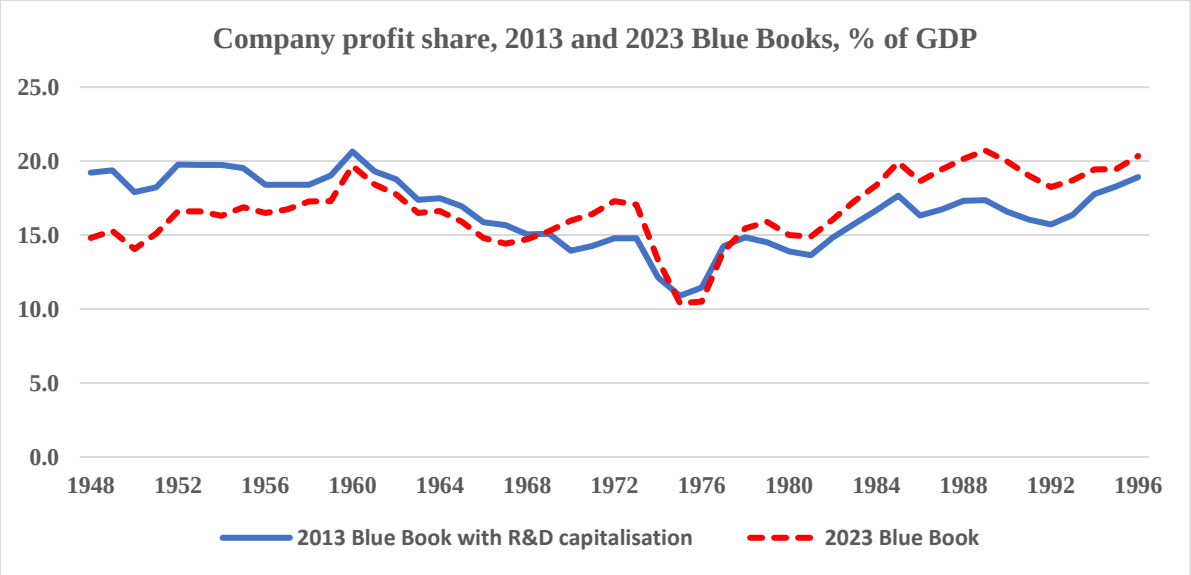
C) The post-war decline in profitability

If a date had to be chosen for peak anxiety about the state of British industry, the year 1974 would be a strong contender. The hike in global oil prices in the previous October, the jump in cost inflation, the state of emergency declared in response to coal and electricity shortages (the miners and power engineers were taking industrial action), the operation of a code restraining prices and the fall in activity all conspired to create for British industry 'a cash crisis of alarming proportions'.[110] Following a highly influential article by Anthony Merrett and Allen Sykes,[111] experts in the budgeting and finance of investment projects, the Chancellor introduced special November measures to give companies very substantial tax relief. The immediate cash crisis was averted but more general concern about companies' profitability continued. Struggling with data revisions and rival accounting concepts,[112] a consensus nevertheless formed around the idea that the rate of return on British capital had fallen secularly and again during the stagflation to aberrantly low levels, threatening, in the most apocalyptic visions, the end of British capitalism. Such visions had already been conjured by economists who followed in the Marxian tradition, which as the distinguished economist Anwar Shaikh noted in 1978 'identifies a falling rate of profit as the basic cause of capitalist crises'.[113] The response from the polar opposite camp contended that the profits squeeze resulted from the excessive expansion of the state which had led to a poverty of 'too few producers'.[114] The middle ground was occupied by those who saw the secular decline in profitability as evidence of diminishing returns to the great post-war investment boom, sustained until it stopped by cheap finance. Others feared that the pursuit of full-employment since 1945 had created a moral hazard in which unions would resist any cut in their members' real wage, regardless of the effect on employment and activity which would have to fall to prevent a runaway inflation. Profits would be squeezed and potential supply constrained because the real wage was too high. The Bank of England's Panel of Academic Consultants considered the profits question in late-1978, and other think tanks contributed. In April 1980, the business department organised a conference in which all these points of view, and more, were rehearsed.[115] The decline in profitability was, then, a central policy concern.

Although some optimism was expressed, participants at the business department conference did not predict that the decline in profitability would shortly reverse. It did; partly as a result of buoyant North Sea oil profits but more generally under new polices that evolved during Prime Minister Margaret Thatcher's Conservative governments. It would come as a much greater surprise to those participants to find that the post-war decline in profit share in national income had been revised away. Chart 16 reveals the surprise. Ideally, the history in the chart would trace company profits, adjusted for depreciation and nationalisation, expressed as a percentage of the stock of capital. But without the historic data

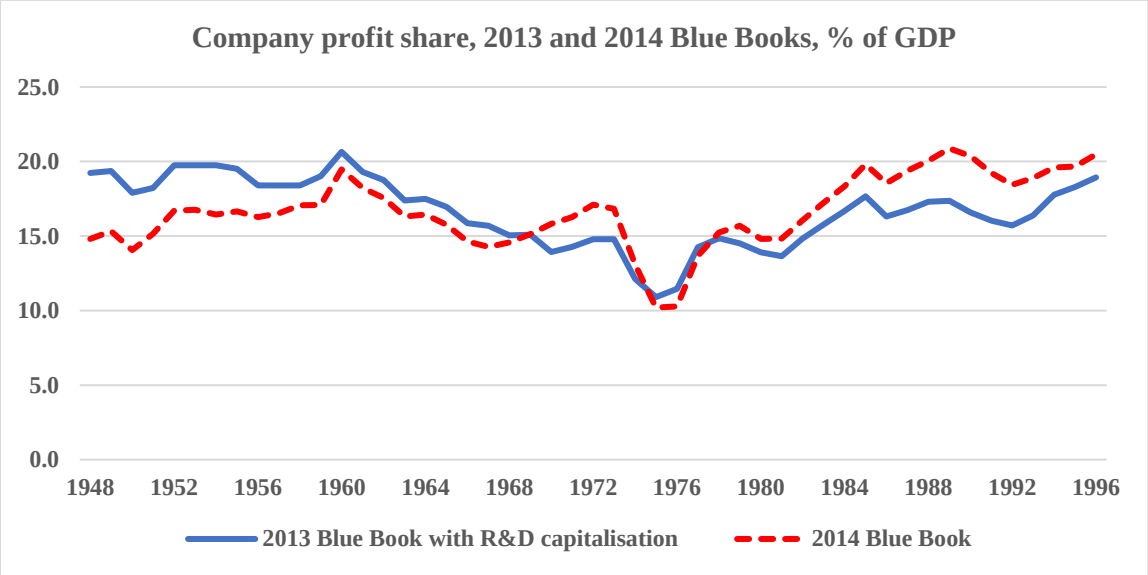
that were previously available in the national accounts, Chart 16 settles for a simpler solution: the share of the (gross) profits of private non-financial companies in GDP. The downward slide in profit share measured in this fashion and using the 2013 Blue Book data can be clearly seen over the post-war period until the 1970s. Having hovered close to 19 per cent of GDP between 1948 and 1959, private profit share fell from a peak in excess of 20 per cent in 1960 to 15 per cent in 1968. There followed a brief respite until 1973, after which profit share sunk to a low of 11 per cent in the mid-1970s. Despite a modest recovery, private profit share by the end of the decade was still somewhat lower than it had been 10 years earlier. In 1979, profit share was over 4 percentage points below the high plateau of the late-1940s and 1950s. Since it is likely that the share of depreciation in GDP and the ratio of the capital stock to GDP rose for at least part of this period, the secular decline in the share of profits may well have come with a steeper decline in the net rate of return on capital.[116] After 1979, a secular recovery in profit share emerged such that by 1996, the last year of the ONS historic period, profit share was back to its post-war high plateau.

Chart 16: Private company profit share in the 2013 and 2023 Blue Books



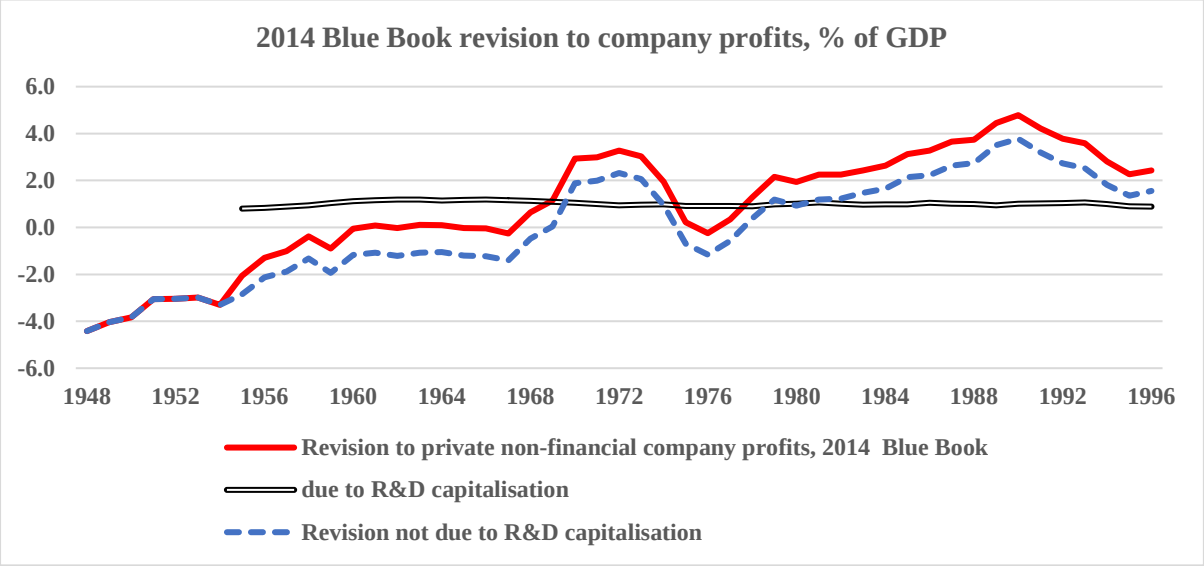
Sources: See chart 1 and appendices A and B. **Notes**: The profits (gross operating surplus) data are those attributed by the ONS to private non-financial corporations. The 2013 Blue Book data have been adjusted to include the impact of the capitalisation of R&D that occurred in the 2014 Blue Book assuming the R&D revisions began in 1955. The apportionment to the private non-financial company sector of the estimated historic revision to economy-wide R&D investment is approximate: see appendix B for details. To maintain consistency with previous charts, GDP is used as the denominator in the share calculation rather than the conceptually more appropriate measure of gross value added.

Chart 17: Private company profit share in the 2013 and 2014 Blue Books



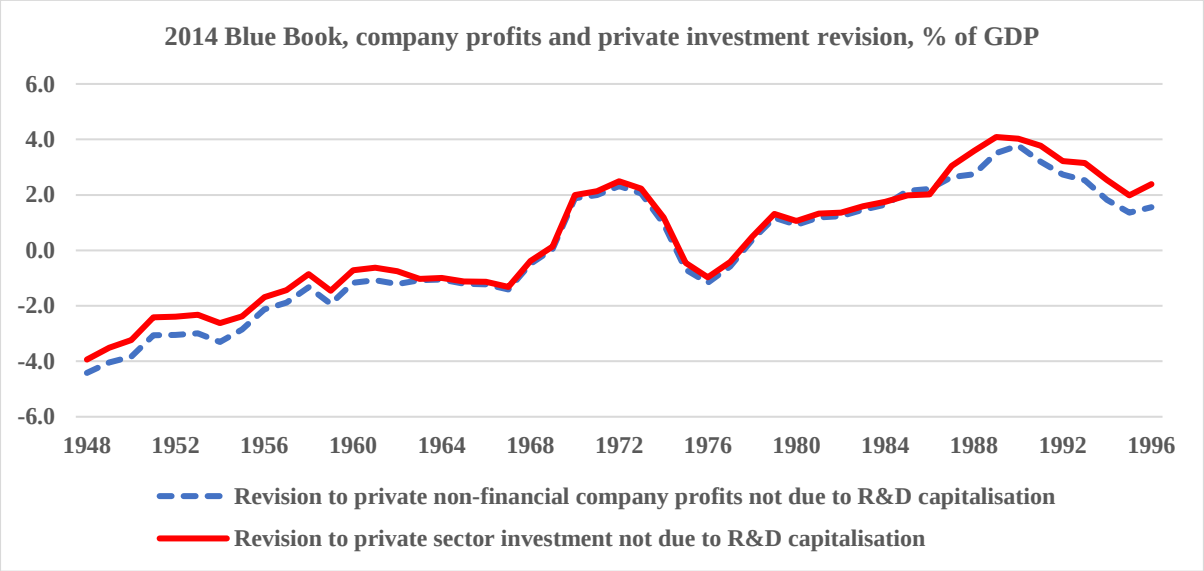
Sources: see Chart 16, UK Economic Accounts releases 30 June 2015 and 23 December 2015. **Notes**: The 2014 Blue Book historic data for private non-financial corporations profits that were not published in the 2014 Blue Book or in the related UK Economic Accounts were backfilled using the December 2015 UK Economic Accounts release consistent with the 2015 Blue Book but adjusted for the small revisions in 1985 and 1986 noted in Banks, McCrae and Hughes (30 September 2015).

Chart 18: Private company profit revisions in the 2014 Blue Book, % of GDP



Sources and notes: see Charts 16 and 17.

Chart 19: Private company profit and private investment revisions in the 2014 Blue Book



Sources and notes: see Charts 4, 5, 10, 16 and 17. It is assumed that the ONS introduced the revisions due to the capitalisation of R&D from 1955. The apportionment to the private sector of the estimated historic revision to R&D investment is approximate: see appendix B for details.

These 2013 Blue Book figures are adjusted for the justified upward revision to company profits that accompanied the capitalisation of R&D under the 2014 accounting standard, assuming the official R&D revisions began in 1955. The adjusted figures can therefore be compared with the profit share recorded in the latest Blue Book, which also includes the profit uplift due to R&D capitalisation. The result is again shown in Chart 16. In the 2023 Blue Book, the high profit share plateau of the late-1940s and 1950s has been erased from existence. Profit share now shows no secular decline in the post-war period between 1948 and the late-1970s and scales even higher heights thereafter. A glance at Chart 17 shows that this alteration of history is not the result of recent revisions. The substance of the revision occurred in the 2014 Blue Book and has been embedded in the national accounts ever since.

The nature of the revision to profit share that occurred in the 2014 Blue Book is shown in Chart 18. The chart shows separately the revision to profit share due to R&D capitalisation assuming that the ONS introduced this change from 1955, and not before 1955, or later. Drawn on a chart with a vertical scale that runs from minus 6 per cent to plus 6 per cent, the revision due to capitalisation looks like a straight line. By comparison, the trace of the remaining revision to profit share that cannot be attributed to R&D capitalisation looks very familiar. Its trace looks like the revision to economy-wide investment, last seen in Chart 10. It can be

argued that a better comparison would be between the revisions to profit share of private non-financial companies and the revisions to private sector investment, although the comparison is not direct: the private sector includes other sectors, notably the household sector.[117] The comparison is shown in Chart 19, again assuming that the ONS introduced the R&D revisions from 1955. There are some differences between the profit share and investment revisions, but the general picture is clear, as, in principle, is the reason behind it. The 2014 Blue Book historic revisions to private sector investment that, save for the introduction of capitalisation, are peculiar, devoid of a coherent rationale and quite possibly subject to computational error before 1960 have through an undocumented balancing process eradicated one of the most important features of Britain's post-war economy: the secular decline in company profit share.[118]

Conclusion

These attempts to bring alive just a few of the times and controversies of Britain's economic past are skimpy and inadequate, but do serve as a warning. Another can be given. Today's researchers into Britain's economic history have an invaluable resource: the historical datasets curated by two Bank of England economists, Sylaja Srinivasan and Ryland Thomas, under the purview of the Economic Statistics Centre of Excellence, supported by the ONS. Within these datasets is the 'Millennium of Macroeconomic Data for the UK', which is not just a highly impressive compilation of scholarly work; it also very helpfully constructs continuous long-run series.[119] Splicing is the technique commonly used, with an eye on ensuring that spliced series that form part of a whole, such as the expenditure components of GDP, add up to the series representing the whole, like GDP, which is similarly derived by splicing old series onto new.

The splicing technique is, of course, dependent on the reliability of the series being spliced. For the national accounts, the millennium dataset available at the time of writing relies on the 2016 Blue Book to depict the latest data, to which different sources of older data are spliced to form continuous series back to 1830. The 'linking year' for the Blue Book figures is 1948, with the result that the preceding 'old' series for the value of investment – one derived from a balancing exercise by national accounts experts James Sefton and Martin Weale – is downscaled by 27 per cent. If the arguments in Chapter 2 are accepted, this downscaling of the investment data will be the result of an erroneous revision first committed in the 2014 Blue Book. There is a saving grace, however. The millennium dataset provides an alternative investment series, given a rather forbidding title, that before 1948 maintains the shares of investment in GDP that are recorded in the old source.[120] The result is that the impact of the ONS investment data on the previous investment estimates provided by Sefton and Weale is substantially moderated to a downgrade of just 3 per cent. The alternative series is an example of the advantage of a top-down calculation that uses established shares to backcast the parts that make up a simply spliced total.

It was said of Nicolas Crafts, the economic historian who died in 2023, that he was "passionate about taking what we learned from the past into what we learn today".[121] Those who are similarly convinced of the need to learn lessons from the past can more easily achieve their goal if they have access to well-maintained historic economic statistics and are aware of their inevitable weaknesses. This investigation has sought to argue that the revisions to historic investment data introduced a decade ago by Britain's main statistics agency fail the test of trustworthiness and quality. The ONS at one time sought to correct the figures, but in the end felt it had other, more pressing, things to do. The conclusion reached here is one of regret. Those seeking to learn lessons from the history of Britain's

post-war investment boom, the descent into stagflation in the 1970s, the decline and recovery of British industry's profitability and other things not yet thought of are best advised not to rely on the official 'historic' national accounts.

Appendix A: Backcasting the 2014 Blue Book capitalisation revisions

Table A1 summarises what is known in detail about the revisions to the investment data in the 2014 Blue Book. The publicly available information is confined to the 1997 to 2013 interval.

Table A1: Revisions to investment data in the 2014 Blue Book

£bn	Weapons	R&D	Construction	Other	Total
1997	4.1	12.6	0.9	6.1	23.7
1998	4.1	13.2	0.9	-0.5	17.8
1999	3.8	14.2	1.2	0.1	19.3
2000	4.4	14.7	1.3	3.9	24.3
2001	4.1	15.3	1.4	1.1	21.8
2002	4.4	16.0	1.7	1.2	23.3
2003	4.8	16.4	1.8	2.0	25.0
2004	5.0	17.0	1.7	-1.5	22.2
2005	5.2	19.0	1.8	-1.6	24.5
2006	5.8	19.9	1.6	-4.3	23.1
2007	4.7	22.3	2.0	-9.3	19.8
2008	5.2	24.0	3.9	-6.1	27.0
2009	4.9	23.0	4.2	-4.2	27.9
2010	4.9	24.8	3.7	-4.4	29.0
2011	5.2	25.9	4.1	4.8	40.1
2012	4.1	26.1	4.0	9.3	43.5
2013	4.5	29.0	3.9	18.4	55.7

Sources: Nolan (30 September 2014, Table 2.1, p. 6); Wild and Whiting (31 October 2014); **Notes**: Nolan (30 September 2014) used for 2013 values (rounded); other values from Wild and Whiting (31 October 2014). Revisions, compared to 2013 Blue Book, in the 2014 Blue Book resulted from: (a) capitalisation of military weapons systems; (b) capitalisation of R&D; (c) improvements in the estimation of own account construction; (d) the inclusion of more expenditure on small tools; (e) new data from the Annual Business Survey; (f) the inclusion of the costs of decommissioning nuclear power plants; (g) other revisions including annual revisions to data and changes to the supply and use balancing adjustments. Nolan's definition of the 'other' category excludes (d), (e) and (f). The total revision shown in the table may not accord with the sum of the individual revisions due to rounding.

Nolan (30 September 2014) provides a commentary on the revisions. The major changes that consistently raised the level of recorded investment came from the capitalisation of military weapons systems and of R&D. The recategorisation as

investment of some minor spending on small tools is another example of capitalisation, not detailed in Table A1 and ignored in the calculations that follow. The revision to 'own-account' construction was required to remove an outstanding European blackmark on the national accounts, known as a 'reservation'. The remaining revisions resulted in large changes in some years during the 1997 to 2013 interval, but were not consistently positive. The purpose of this appendix is to describe the methods used to backcast the historic revisions resulting from capitalisation of military weapons systems and of R&D, and to estimate the possible scale of those revisions.

1) Capitalisation of government spending on military weapons systems

Gittins (10 June 2014) provides a detailed explanation of the sources and methods used to capitalise government spending on military weapons systems. He does not provide any data. Key points in his explanation that are relevant to the current exercise are:

- Spending on weapons systems, such as planes and ships, was reclassified as fixed investment; spending on single use weaponry (such as ammunition) was reclassified as inventories.
- Spending on military equipment was previously counted as part of government intermediate consumption.
- As a result of the way government output is calculated, spending on military equipment also added to government final consumption, a component of the expenditure measure of GDP.
- The capitalisation of weapons systems expenditure reduced the value of government final consumption and increased the value of government investment by equal and opposite amounts, leaving GDP unchanged save for a second-round impact on depreciation costs.
- The second-round impact arose because, once treated as capital, weapon systems spending raised the stock of government capital, the decline in the value of which added to the cost of government depreciation ('capital consumption') and government profits (government 'gross operating surplus', equal to government 'capital consumption').
- Military expenditure data were entered by the Ministry of Defence into an internal government database ('OSCAR' – 'Online System for Central Accounting and Reporting') and its predecessor ('COINS' – 'Combined Online Information System').[122]
- The military expenditures were attributed to central government.
- To derive a back series, the ONS had partly to infer data prior to 2002: series for central government intermediate consumption were used as 'indicator'

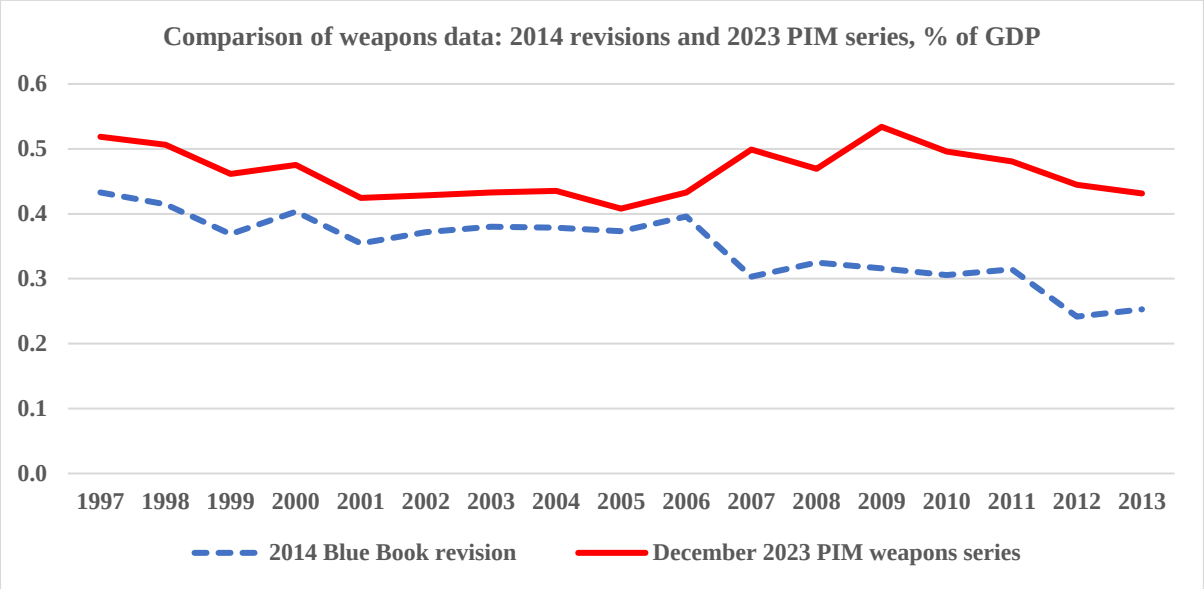
series in the interval 1987 to 2001 (intermediate consumption on defence) and in the interval 1963 to 1986 (total central government intermediate consumption). The historic series was not taken back before 1963.[123]

- In order to estimate capital consumption, use was made of the ONS capital stock model. Based on the Perpetual Inventory Method (PIM), the model accumulates investment flows to derive capital stock series, after allowing for depreciation over the assumed lives of the capital assets. In 2014, 'weapons systems' became a new PIM asset class, assigned to the central government sector and to industry 84 (public administration and defence in the Standard Industrial Classification).

The data used by the ONS to construct the weapons investment series in the 2014 Blue Book cannot be replicated from publicly available information, which is itself sparse. Weapons investment data are not published in the annual national accounts release that presents investment data by industry and by asset. However, weapons investment data, with a start date of 1867, are available in the capacious PIM dataset.[124] These data may serve as an indicator series – to use Gittins' useful terminology – by which to backcast the weapons revisions in the 2014 Blue Book. In this context, the available versions of the PIM datasets have two disadvantages: first, they are of a later vintage and will be affected by revisions that came after 2014; second, the PIM investment series before 1997, and for some series after 1997, are generally not consistent with the national accounts.[125] The inconsistency (or conformity) of the PIM data for weapons systems, before or after 1997, cannot be verified for the simple reason that the national accounts data are not published. An ONS response to a specific query about the PIM weapons (and R&D) data confirms that they may not conform to the national accounts before 1997.[126] More encouragingly, the PIM weapons series does not suffer from any of the obvious discontinuities that can occur at either of the ONS processing system cut-off dates (1987 and 1997).

Chart A1 compares the revisions to weapons investment in the 2014 Blue Book, as shown in Table A1, with the December 2023 PIM version of weapons investment, both series expressed as a share of GDP. The two series part company in the later years of the 1997 to 2013 period, a departure that can be plausibly attributed to revisions that occurred after 2014. By contrast, the two series are close over the 1997 to 2004 period, with the revisions series averaging about 84 per cent of the PIM series. The differences each year in the 1997 to 2004 interval are equivalent to 0.1 per cent of GDP. The tentative conclusion drawn is that the PIM weapons data may serve as a reliable indicator series with which to backcast the revisions to weapons investment in the 2014 Blue Book.

Chart A1: Comparison of weapons data: 2014 Blue Book revisions and 2023 PIM series

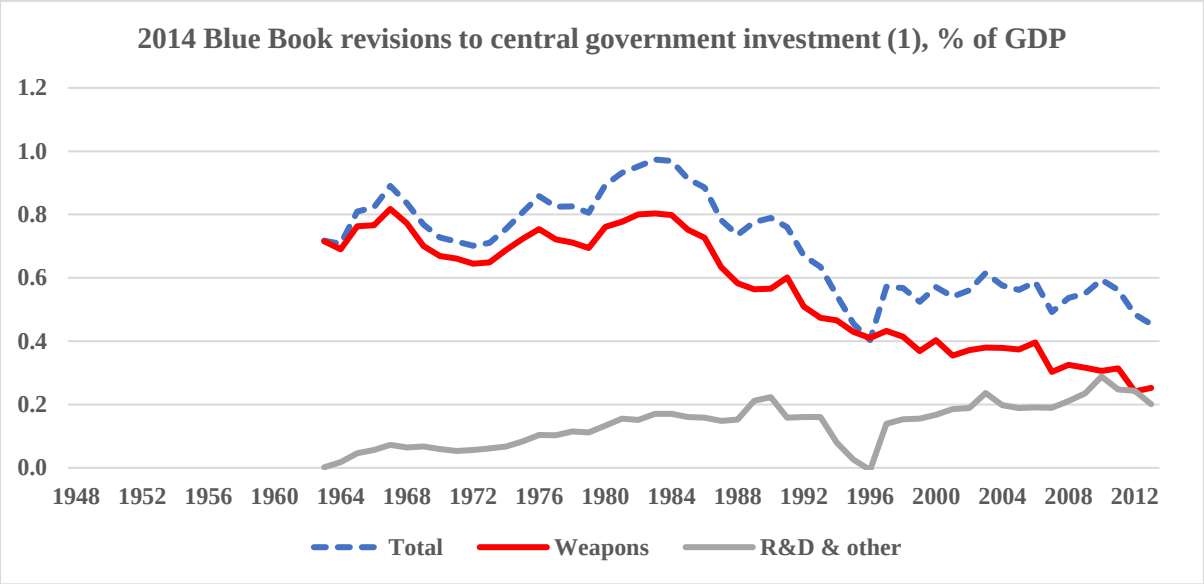


Sources: See Table A1; Perpetual inventory method (PIM) inputs, 8 December 2023 <Perpetual inventory method (PIM) inputs - Office for National Statistics (ons.gov.uk)> [accessed 14 May 2024]; UK Economic Accounts release 2 April 2024. **Notes**: GDP data of the latest vintage available at the time of calculation are used to calculate per cent shares.

The method adopted is a simple one of splicing the value of the PIM series in 1997 to the 2014 Blue Book revision to weapons investment in 1997, the £4.1 billion figure shown in Table A1. The resulting weapons revisions series is taken back to, but not before, 1963, consistently with the method described by Gittins (10 June 2014). As a partial test of the plausibility of these calculations, Chart A1 shows the revisions to central government investment, expressed as shares of GDP, both in total and then split between the backcast weapons revisions and, by subtraction, the remaining revisions. The latter are assumed to comprise revisions arising largely or wholly from the capitalisation of R&D, although (unknown) national accounts balancing or other adjustments may also play a role. The chart shows that the tentatively backcast revisions to weapons investment account for most of the revisions to central government investment in the historic period before 1997. The remaining component of the revisions to central government investment gradually declines as one moves back towards the earlier years. The remaining component is only trivially greater than zero in 1963. The ONS practice, adopted in some cases, of gradually scaling down ('tapering') an historic revision back towards its start date fits with this finding, which comes as a result of the simple splicing method and indicator series chosen, and is not in any way enforced in the calculations. The behaviour of the inferred revisions to central

government investment in R&D provides some reassurance about the plausibility of the backcast revisions to weapons investment before 1997.

Chart A2: 2014 Blue Book revisions to central government investment (1)

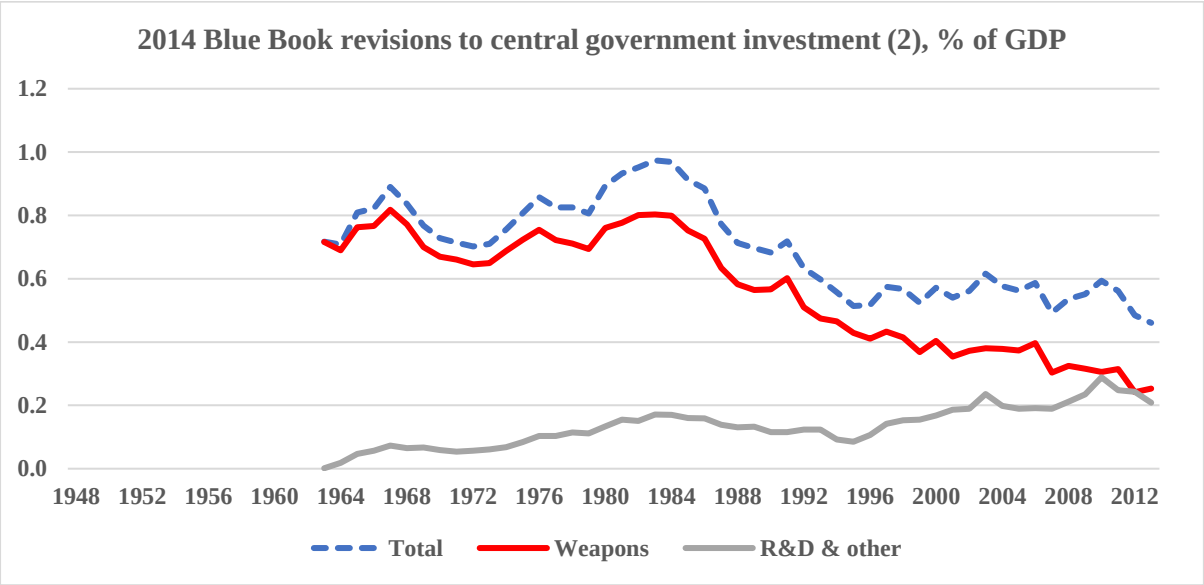


Sources and notes: See Chart 4 and Chart A1.

One qualification to this conclusion concerns the behaviour of the revisions in the 1987 to 1996 interval. In particular, the materially smaller upward revision to central government investment in 1996 compared with 1997 results in a downward revision in the remainder series arrived at by deducting the backcast revisions to weapons investment. It is unlikely that the remainder series would act in this fashion if it solely comprised revisions to central government R&D investment; it is more likely that the remainder series in 1996 and possibly over the whole 1987 to 1996 interval conflates revisions to central government R&D investment with other changes, which might be undocumented national accounts balancing adjustments. Chart A3 tests this possibility by changing the data source for the revisions to central government investment after 1986 from the UK Economic Accounts used in Chart A2 to the national accounts consistent Public Sector Analytical Tables.[127] Over the 1987 to 1996 interval the PSAT data differ from the UK Economic Accounts data with which they are supposed to be consistent. Apart from trivial discrepancies in 1997 and 2013, the two datasets concur after 1996. The difference in the 1987 to 1996 interval is most marked in 1996: the PSAT data for central government investment is £1 billion in excess of that recorded in the 2014 Blue Book UK Economic Accounts. The resulting series for the revisions to central government investment other than those accounted for by the backcast revisions to weapons investment is similarly £1 billion higher. Although this difference is a minor (0.1 per cent) share of GDP, the PSAT data

present a more plausible picture of the inferred revisions to central government R&D in the 1987 to 1996 interval. These inferred revisions to central government R&D investment and the backcast revisions to weapons investment before 1997 are taken to be acceptable guesstimates of what the ONS did in the 2014 Blue Book.

Chart A3: 2014 Blue Book revisions to central government investment (2)



Sources: See Chart 4 and Chart A1. **Notes**: In contrast to Chart 4 and Chart A1, which use UK Economic Accounts data for the 1987 to 2013 interval, the revisions to central government investment in Chart A3 are taken for all years from the Public Sector Analytical Tables published 25 June 2014 and 29 September 2014 after adjustment for the net acquisition of non-produced, non-financial assets.

2) Capitalisation of Research and Development

Ker (10 June 2014) provides the main explanation of the sources and methods used in the 2014 Blue Book to capitalise expenditure on research and development. Abramsky (10 June 2014) describes how the resulting estimates were incorporated in the national accounts. Neither advisory provides any historic data. Beginning in the 2000s, a number of researchers had prepared the ground, either with a view to providing R&D 'satellite accounts' to complement the national accounts, or as part of a project better to understand the sources of UK productivity growth. Contributors to the development of ONS satellite accounts, in anticipation of what was to become ESA10, include Galindo-Rueda (December 2007); Evans, Hatcher and Whittard (September 2008); and Wenzel, Khan and

Evans (September 2009). Building on the work of Oulton and Srinivasan (2003), Vaze (November 2003), Wallis (November 2005), and Wallis and Dey-Chowdhury (December 2007) present experimental ONS estimates of capital services, a concept familiar in the productivity accounting literature. Further ONS articles in a similar vein followed each year until 2012, and then in January 2014. The extension of the capital services calculations to include R&D was considered in Edworthy and Wallis (February 2007). Several of these earlier papers present tentative estimates of the impact of the capitalisation of R&D. Following the seminal work of Corrado, Hulten and Sichel (2005), there additionally exists a large body of academic research that sought, and still seeks, to reframe the national accounts to take on board the full impact of intangible investments, including but not confined to R&D. Articles at the time include those by Marrano, Haskel and Wallis (2009) and Borgo and others (2013). These academic works provide guidance on best estimates of intangible investment, including R&D, but are not focussed on the main purpose at hand, which is to appreciate what the ONS did in the 2014 Blue Book. The same point can be made about the compendious 2014 Eurostat manual, to which the ONS contributed. The manual, not being completed until late 2013, arrived 'too late to affect the ONS methods design'.[128] The aim here requires a close reading of the main ONS advisory authored by Ker, from which the following points emerge:

- Some R&D expenditure was recorded in the national accounts under the former accounting standard, ESA95; the included items comprised service exports and some R&D undertaken by charities within the NPISH sector. The amounts involved were minimal. Omitted under ESA95 was R&D undertaken by businesses 'in-house', for their own use, and R&D undertaken by universities, part of the NPISH sector. Business spending on R&D was treated as a current cost of production ('intermediate consumption') and deducted in the calculation of GDP. R&D undertaken by the government or by the NPISH sector was treated as final consumption expenditure.[129] Under ESA95, the acquisition of scientific patents was classified under the heading of non-produced intangible assets and not therefore as part of gross fixed capital expenditure.[130]
- Under the new accounting standard, ESA10, patents were no longer 'recognised as assets', and businesses' expenditure on R&D was reclassified as investment, raising GDP and profits by the same amount.
- As in the case of the capitalisation of military weapons systems, the value of the output of government and NPISH (part of the 'non-market sector') was raised as a result of the depreciation of the newly-calculated R&D capital stock. The extra depreciation added to 'gross' non-market output and non-market profit (equal to non-market capital consumption).
- The R&D of the 'market sector' (essentially businesses whose products are priced in active markets) was estimated using a 'sum-of-costs' approach similar to that used for non-market output, but with an extra imputed net-of-depreciation

profit added. As in the case of the non-market sector, total imputed profit for market sector R&D included depreciation. Unlike the non-market sector, an addition was made to the market sector estimates to account for the net profit associated with its R&D, calculated by multiplying the newly-calculated R&D capital stock by an average rate of return on capital. This estimation approach offered a solution to the problem caused by an absence of active R&D markets with observable prices; R&D is often undertaken by companies in-house, partly to guard against the loss of new ideas and knowledge to competitors.

- The sum-of-costs plus imputed net profit approach to calculate market sector R&D had to avoid including expenditure on computer software already classified as a separate capital investment asset in the national accounts.
- The 2014 Blue Book relied on two main sources of information to revise the R&D estimates: first, surveys of R&D expenditure and, second, an internal government expenditure database. Balance of payments figures for exports and imports of R&D services were not revised.
- Ker notes that the UK has a long series of surveys undertaken in compliance with the internationally agreed, and evolving, framework generally referred to as the 'Frascati Manual'.[131] UK survey data also goes back to earlier years, before the Frascati approach took effect. Ker notes that the 'UK has a relatively long back-series of reasonably comparable R&D expenditure data […] in some periods as far back as 1930'.[132] He also states that '[i]nformation on the institutional sector making the expenditures, as well as some information on the types of expenditures (e.g. current or capital) are available from 1955 onwards.'[133] He adds: '[f]ull annual datasets [of the Frascati data] are available from 1981 onwards', noting that '[s]ince 1981, the sources have been improved to provide much greater detail on the types of expenditures (e.g. 'land and buildings' or 'equipment and machinery' rather than simply capital expenditure)'.[134]
- The ONS amended the Frascati data to align them with national accounts concepts; in particular, the investment costs of undertaking R&D recorded under the Frascati approach had to be replaced with the imputed national accounts estimates of R&D profit.[135] The survey sources had also to be aligned with national accounts sectors: R&D spending by businesses in the Frascati like-data was assigned to the national accounts corporate sector, public as well as private. R&D spending by higher education institutes (mainly universities) and charities in the Frascati-like data was assigned to the national accounts NPISH sector.
- Although the Frascati dataset also covers government, the ONS chose to use the internal UK government database 'OSCAR'. 'OSCAR' can be presumed to be the 2014 Blue Book source of information for central government spending alone, with any R&D expenditure by local government ignored. Ker notes that local authorities 'are unlikely to be conducting considerable amount of R&D': 'this missing data is not likely to lead to a significant understatement of the R&D stock of Government or the economy as a whole'.[136] The OSCAR record for

government spending on R&D in the 1997 to 2012 interval was found to be materially (22 per cent) higher than the equivalent record in the ONS ('GovERD') survey.[137]

The task that presents itself is to select indicator series that may be used with a reasonable degree of confidence to backcast the 2014 Blue Book R&D revisions shown in Table A1. It is clear from Ker's account that the revisions to the central government sector data, based on OSCAR, have to be treated in a different manner to the remaining revisions, based on Frascati-consistent surveys and possibly their predecessors. This distinction can be made empirically: use of the known revisions to central government total investment, and of the indicator-based revision arising from the capitalisation of weapons systems provides, by residual, an estimate of the 2014 Blue Book revisions to central government R&D. These revisions are those traced in Chart A3, granted an assumption that any other source of revision, apart from weapons and R&D capitalisation, has a zero impact before 1987.[138] The inferred revisions to central government R&D investment start in 1963; there are none in earlier years. Regrettably, Ker's account does not make clear the start date of the non-central government R&D data introduced in the 2014 Blue Book; he mentions three dates – 1930, 1955 and 1981. The likelihood that the new 2014 Blue Book R&D data began at these or other years has to be guesstimated.

For the non-central government R&D revisions, possible indicators are available in three sources. The first source is the long history of R&D expenditure surveys cited by Ker. With some licence, this source will be called 'Frascati'. The second source is the PIM dataset, described in the section on military weapons systems. The PIM dataset contains a very long and detailed history of investment in current prices. The third source is a related dataset that derives from the PIM dataset estimates of capital services in real, inflation-adjusted terms. This dataset is commonly known by its acronym of VICS: 'volume index of capital services'. [139] The VICS dataset also contains figures for investment in current prices, but, compared with the PIM dataset, has far less detail and history (none before 1950). The VICS dataset is confined to the market sector (that is, the government, household and NPISH sectors are excluded) and further excludes several asset classes (such as weapons and dwellings).[140]

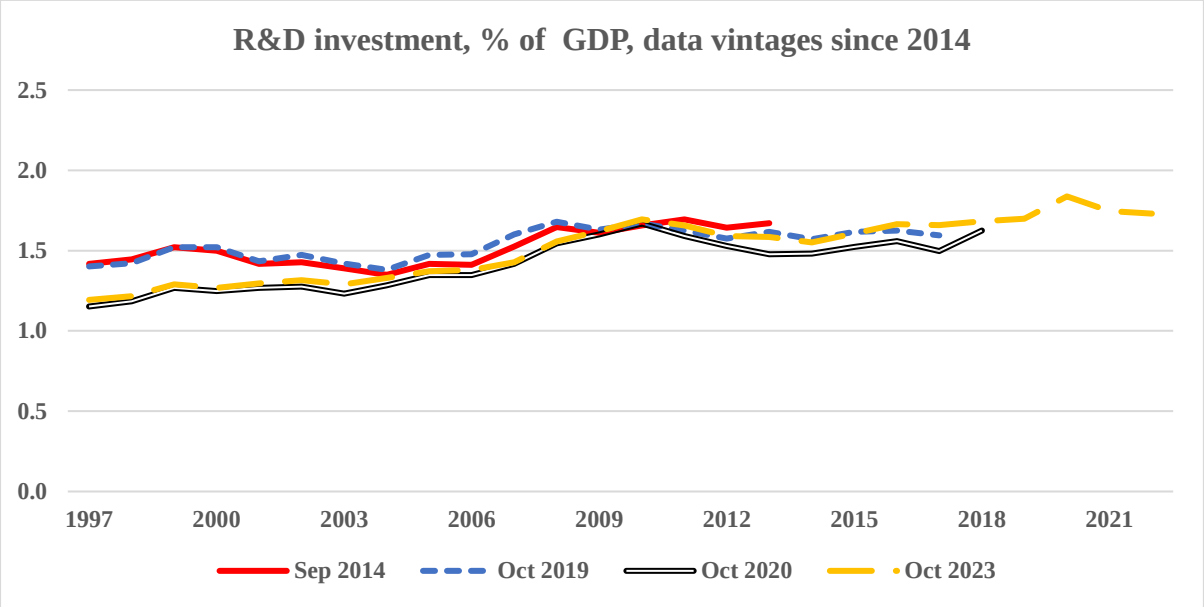
For the purpose of selecting reliable indicator series from the alternative sources, it is necessary to consider their different strengths and weaknesses, some of which are shared. None of the sources can be assumed to be consistent with the national accounts. As Ker describes, the Frascati source data have to be adjusted to align with national accounts concepts, notably by adding a measure of net-of-depreciation profits and by deducting from costs wrong-concept capital spending and any computer software investment already accounted for in the national

accounts. PIM and VICS data may not be consistent with the national accounts before 1997, and some series part company with the national accounts after 1997. It was found that the available PIM data for central government R&D expenditure suffer from a drop-out at the ONS data processing system cut-off date of 1987. (Before 1987, the data cells record zero values. The 1987 value is £841 million.) On the other hand, it can be verified that at least one version of the total R&D data in the PIM dataset is consistent with the national accounts data of similar vintage from 1997.[141] This reassurance carries over to the VICS dataset, which presents estimates for market sector R&D.[142] The VICS data are nevertheless officially described as 'experimental'; they have been so designated since 2003 when they first appeared.

There is also a matter of data vintage. Frascati data have the advantage that they can be reconstructed to be close to the version available to national accountants in 2014. Published versions of the PIMS and VICS datasets that contain current price R&D investment figures are of a later vintage, and so incorporate revisions that occurred after 2014.[143] These revisions are significant. As Chart A4 records, not insubstantial revisions to the R&D data came after the 2018 Blue Book, the result of changes in the ONS estimation system, more up-to-date survey information and a new method to exclude software expenditure otherwise embedded in the R&D cost estimates.[144] The downward revisions compared with the 2014 estimates reduced the level of R&D investment in the 1997 to 2000 interval by the equivalent of 0.2 per cent of GDP.

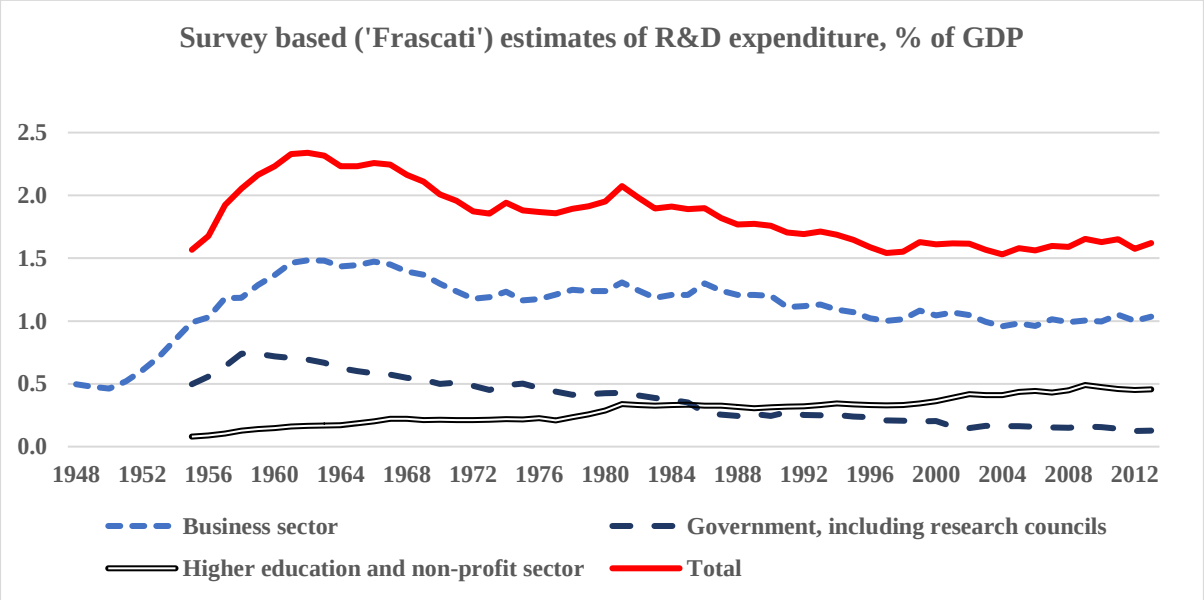
Two tests are applied in the selection of indicators to backcast the non-central government revisions of R&D investment in the 2014 Blue Book. The first is the closeness of the candidate indicators one to another. None of the sources can claim consistency with the national accounts, but as the raw data used by the ONS in 2014 for the non-central government sectors, the Frascati data can be presumed to bear some resemblance to the national accounts series missing before 1997. This being so, the first test provides a useful way of ascertaining whether the PIM and VICS data can be entertained as reliable candidates: major departures from the Frascati series could be indicative of material inconsistency with the national accounts, perhaps as a result of data drop-outs or other ONS processing errors in the PIM and VICS datasets. The second test is the closeness of an indicator in the 1997 to 2013 period with the 2014 Blue Book revisions to investment arising from the capitalisation of non-central government R&D.

Chart A4: Different vintages of R&D investment data since the 2014 Blue Book



Sources: 2 October 2019; 21 October 2020; 31 October 2023 <https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/annualgrossfixedcapitalformationbyindustryandasset> [accessed 16 May 2024]; Duff (30 September 2015); also where relevant see sources used for Chart A1. **Notes:** Total R& D investment data consistent with the 2014 Blue Book were derived using 2015 Blue Book data corrected for (minor) 2015 Blue Book revisions detailed in Duff (30 September 2015). The 9 September 2016 release was consistent with the 2015 Blue Book; the remaining releases relate to the Blue Books as follows: 2 October 2019 (2018 Blue Book); 21 October 2020 (2019 Blue Book); 31 October 2023 (2023 Blue Book, which superseded the 2021 Blue Book consistent version).

Chart A5: R&D survey-based expenditure estimates at the time of the 2014 Blue Book



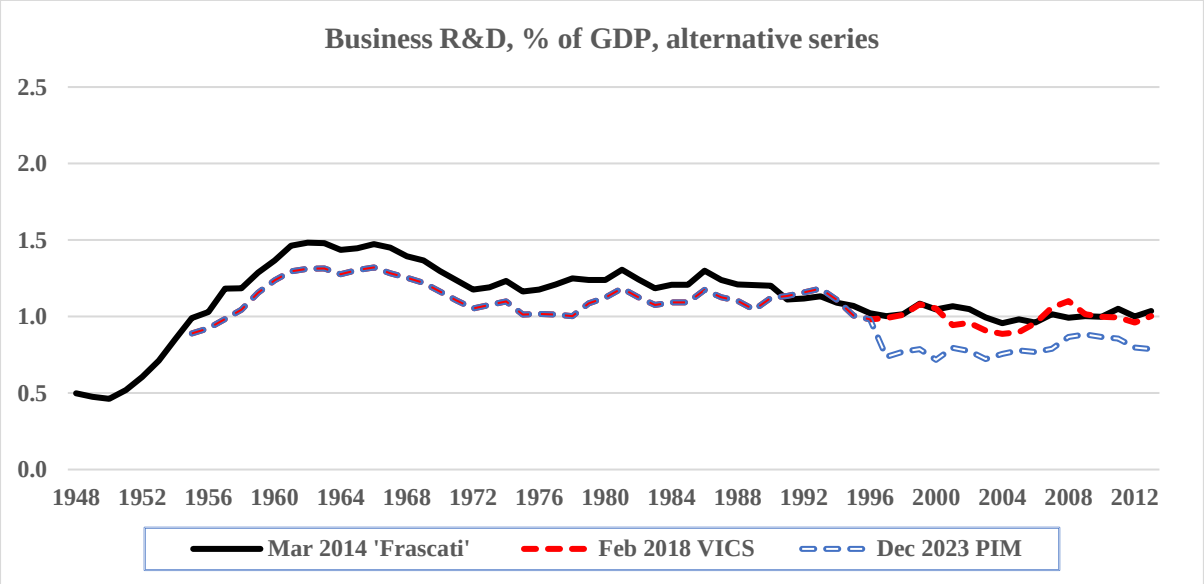
Sources: (i) ONS (12 March 2014) 'UK Gross Domestic Expenditure on Research and Development, 2012', accompanying database: <[ARCHIVED CONTENT] UK Gross Domestic Expenditure on Research and Development - Time Series Data, 2012 - ONS (nationalarchives.gov.uk)> [accessed 6 May 2024]; (ii) OECD, Research and Development Statistics, 'Gross domestic expenditure on R&D by sector of performance and type of expenditure', <Research and Development Statistics (RDS) - OECD> [accessed 7 May 2024]; (iii) CSO (1965 and 1968) Annual Abstract of Statistics, available from ESCoE <Headline Macro Data - ESCoE : ESCoE >; (iv) Edgerton (1993, Table. 4.1); (v) Edgerton and Horrocks (1994, Table 2); (vi) ONS (2 April 2024) 'UK Economic Accounts: October to December 2023'. **Notes**: (a) R&D data are expressed as a per cent of the latest (at time of calculation) estimates of nominal GDP; (b) R&D data of 2014 Blue Book vintage are derived by combining the different datasets over the following intervals: (i) ONS - 1981 to 2013; (ii) OECD - 1964 to 1981; (iii) CSO -1955 to 1964 (the separate series for private industry and public corporations are combined); (iv) Edgerton (1993) - 1950 to 1955 (business only); (v) Edgerton and Horrocks (1994) - 1945 to 1950 (business only); the ONS and OECD data match at the interval boundary of 1981 and are not further adjusted; the components of the remaining datasets are spliced at the overlapping interval dates; (c) linear proportionate interpolation is used to estimate data for years affected by missing observations; dates on which there is at least one series missing an observation are: 1946-1949, 1951-1954, 1956-1957, 1959-1960, 1962-1963, 1965, 1970-1971, 1973-1974, 1976-1977, 1979-1980, 1982, 1984; (the government R&D series has relative few missing observations after 1963: 1965, 1982, 1984): (d) the R&D data are subject to changing sampling error,

methodological changes and series breaks; the business R&D data before 1955 are derived from surveys undertaken by the Federation of British Industries Industrial Research Committee and the Department of Scientific and Industrial Research; the 1965 Annual Abstract data are based on surveys carried out on behalf of the Advisory Council on Scientific Policy; the OECD and ONS datasets conform to the evolving 'Frascati Manual' which has set international standards since 1963; the OECD dataset denotes breaks affecting at least one of the R&D series for the years 1978, 1981, 1983, 1985, 1986, 1991, 1992, 1993, 2001, 2010, 2011 and a change in methodology affecting the higher education R&D data in the 1964-1979 interval; the ONS R&D data release (i) notes that the redesign of the survey after 2010 affected the 'comparability of data over time … it is not possible to measure this impact' (ONS (12 March 2014), p. 18).

Chart A5 presents a version of the Frascati data of a vintage comparable to the 2014 Blue Book. The data are pieced together from an ONS 'Gross Expenditure on R&D (GERD)' release of March 2014, an historic OECD database, no longer updated, and a back series of earlier surveys published by the Central Statistical Office (CSO), the predecessor of the ONS. The 'Business sector' refers to data that in 2014 came under the heading of 'Business Enterprise', but in the earlier surveys were divided into separate categories for 'private industry' and public corporations. [145] The chart adds these categories together. Observations for years when surveys were not undertaken have to be interpolated. When overlapping periods present themselves, it is possible to correct (rescale) back series by splicing older data onto newer data. However, as the ONS warns, the data are unlikely to be comparable over time. There have been multiple changes of methodology, series breaks and revisions.[146] The official survey data begin in 1955, as Ker noted.[147] Before 1955, the chart draws on academic work that extracted R&D survey data from the archives of the Federation of British Industries Industrial Research Committee. The academics, Edgerton and Horrocks, were those cited by Ker in his reference to data that existed 'as far back as 1930'.[148] The academics' data have been spliced to the 1955 value to extend the business sector R&D series back to 1948. All the survey data are expressed as a share of nominal GDP of the latest vintage available at the time of calculation.

Two features of Chart A5 warrant a mention. First, the R&D 'Frascati' series follow fairly smooth trends, with an absence of the volatility seen in other types of capital investment. Business R&D as a share of GDP rises from around ½ per cent in 1948 to 1½ per cent in 1960. The share declines slowly thereafter, falling to 1 per cent of GDP by the early-1990s and then staying put. The R&D undertaken by universities and charities ('Higher education and non-profit sector') rises from a trivial share of GDP in 1955 to a still modest ½ per cent share by the late-2000s. The second feature of Chart A5 is the sharp difference between the 'Frascati' estimates of the level of government R&D and the revisions that may be plausibly estimated to have taken place in the 2014 Blue Book. The revisions, based on 'OSCAR' data and inferred in Chart A3, start from zero before 1963 and rise gradually to about ¼ per cent of GDP by the late-1990s. By contrast, the Frascati series falls from a peak share of about ¾ per cent of GDP, reached in the late-1950s, to an insignificant amount by the 2010s. As previously concluded, the Frascati series cannot plausibly be used as an indicator by which to gauge the 2014 Blue Book revisions to central government R&D before 1997.

Chart A6: Business R&D, % of GDP, alternative measures



Sources: For 'Mar 2024 'Frascati'', see Chart A5, 'Feb 2018 VICS': 'Volume index of UK capital services (experimental): estimates to Quarter 2 (Apr to Jun) 2017', 7 February 2018, <UK productivity: analytical release, February 2018 - Office for National Statistics (ons.gov.uk)>, accompanying dataset, < Capital services estimates - Office for National Statistics (ons.gov.uk)> [accessed 26 May 2024]; 'Dec 2023 PIM': 'Capital stocks and fixed capital consumption, UK: 2023', 8 December 2023, <Capital stocks and fixed capital consumption, UK - Office for National Statistics>, accompanying dataset, <Perpetual inventory method (PIM) inputs - Office for National Statistics (ons.gov.uk)>, [accessed 16 May 2024]. **Notes**: The PIM and VICS 'business sector' comprise public and private sector corporations in the national accounts 'market sector'. The PIM market sector data were extracted using the PIM database asset classification and sectorisation codes.

To examine the congruence of the business data, Chart A6 traces the constructed 'Frascati' series for business R&D spending with comparable series in the PIM and VICS databases. The vertical scale is the same as that in Chart A5. The PIM and VICS sources differ only with regard to vintage. The PIM data are those released in December 2023; the VICS data are those released in February 2018. The VICS market sector data for R&D released in November 2023 (not shown) are identical to the PIM series released in December 2023. Unlike the PIM data, the earlier-vintage VICS data are not affected by the revisions to the R&D statistics introduced after the 2018 Blue Book, as recorded in Chart A4. Compared with the early-2018 vintage series, the average downward revision to the business R&D data from 1997 is equivalent to 0.2 per cent of GDP. The ONS took these revisions back to, but not before, 1997, with the result that the

December 2023 PIM and the February 2018 VICS R&D data are identical over the historic period.

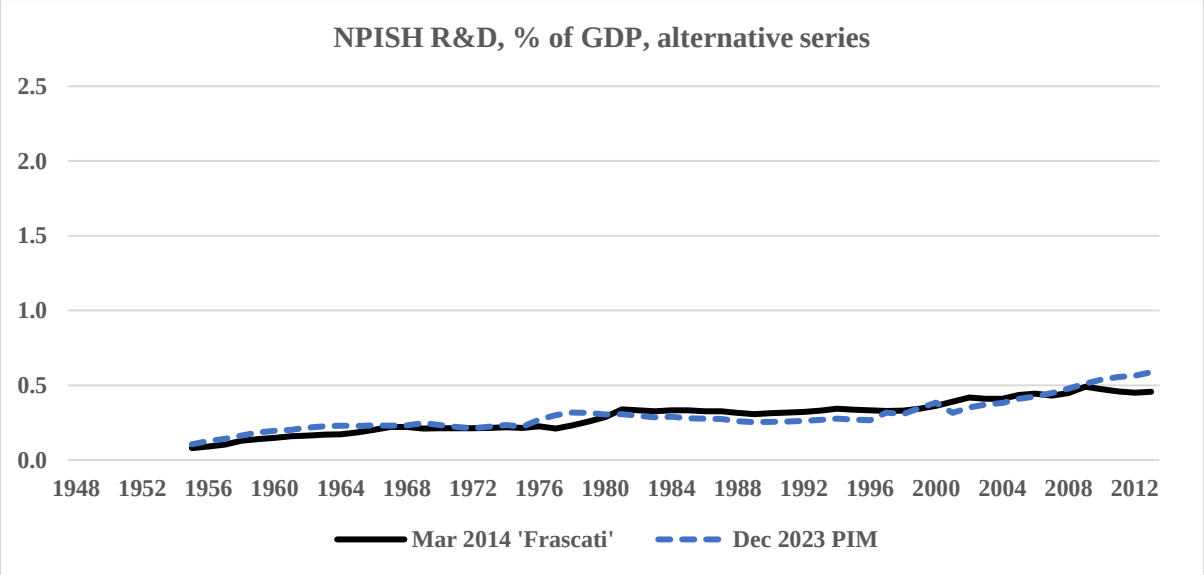
The most striking feature of Chart A6 is that the Frascati and PIM/VICS series move closely together before 1997, and, save for the revisions that affect the later-vintage PIM series, continue closely to align from 1997. This congruence provides some reassurance that the historic PIM/VICS R&D data are, in fact, consistent with the national accounts, despite the blanket ONS qualification of possible inconsistency that accompanies the PIM and 'experimental' VICS releases. The average excess of the Frascati data over the PIM/VICS data in the historic period before 1997 amounts to 0.1 per cent of GDP, an average around which there is little variation. After 1990, the excess of the Frascati data over the VICS series diminishes, and, in 1993 and 2008, briefly reverses, although the negative difference is no more than the equivalent of 0.1 per cent of GDP. Many reasons, such as changing survey methodology or an increase in unintended double-counting of software expenditure, might explain the slight change in the relationship after 1990.[149] The change is insufficient to undermine the conclusion that the PIM/VICS data are a close fit to the Frascati survey data on which the 2014 Blue Book R&D estimates were based.

This conclusion applies to the historic period back to 1955, the start date of both the official survey data and the PIM/VICS series. Before 1955, the comparison cannot be made, and the survey data sources differ. The 'Frascati' business series in Charts A5 and A6 before 1955 draw on data reported by the academic historians Edgerton and Horrocks, cited by Ker, and taken, as previously noted, from surveys conducted by the Federation of British Industries (a precursor of today's Confederation of British Industry). Edgerton's estimate for 1955 refers to 'industrially funded' R&D, which will be less than the R&D undertaken by companies which received other sources of finance. According to Horrocks, 'considerable government funds, mainly for defence projects, were spent on research carried out by private industry, especially during the 1950s'.[150] The important distinction between R&D performed and R&D self-financed probably explains why Edgerton's figure for business R&D in 1955 is just forty per cent of the CSO survey figure, itself based on data published by the Advisory Council on Scientific Policy, a government body.

The conclusion drawn is that Ker's reference to data 'as far as 1930' is unlikely to be indicative of the length of the historic national accounts series for R&D constructed for the 2014 Blue Book. The data before 1955 are neither sufficiently consistent with later survey data nor possessed of the degree of detail that the ONS required to convert survey data into national accounts data. It is more probable that the unpublished 2014 Blue Book series begin either in 1955, the start date of the PIM and VICS data, or in 1981, the year from which information

was available in 2014 enabling the ONS better to align the Frascati series with national accounts concepts. There are clues that point in favour of both dates. A VICS dataset published in January 2015, and so just after the 2014 Blue Book, contains figures for R&D capital services in real terms that begin in 1955. The capital services estimates would have required, as one of the raw materials for the calculation, data on R&D investment in current prices, although these were not published in the January 2015 version of the VICS database. In favour of 1981 as the start date is an academic paper, discussed in draft form in August 2014, written by two experts, then at the Bank of England. One of the co-authors also co-authored the February 2007 ONS article exploring the impact of R&D capitalisation on productivity.[151] In the academic paper, R&D investment data begin in 1981. This partial evidence does not permit elimination of either 1955 or 1981 as the possible start date for the business R&D data introduced into to 2014 Blue Book. No other year is in contention, however.

Chart A7: NPISH R&D, % of GDP, alternative measures



Sources: Where relevant, see Chart A6. **Notes:** The NPISH 'Frascati' data comprise the survey data for the 'Higher Education' sector and the 'Private non-profit' sector.

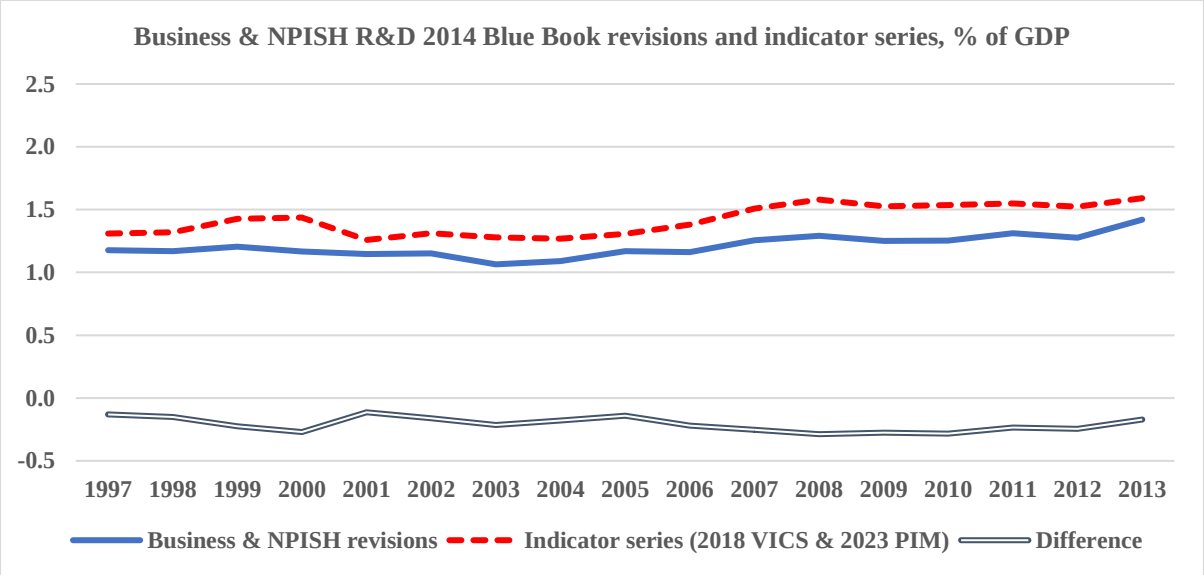
Chart A7 repeats the exercise for the NPISH sector, comprising higher education institutes, including universities, charities and trusts. NPISH data are not to be found in the VICS database, which is confined to the business ('market') sector. The comparison is therefore between the 2014 vintage 'Frascati' data and the 2023 PIM data. The vertical scale in Chart A7 is the same as that used in Charts A5 and A6. The general conclusion is that the two NPISH series move closely together. There are minor departures in some years, but never more than plus or

minus 0.1 per cent of GDP. The average difference between the two series, both in the historical period and since 1997, is zero.

From this examination of the alternative sources, it is judged reasonable to entertain an indicator series that combines the February 2018 VICS data for the business sector and the December 2023 PIM data for the NPISH sector. A comparison with the 2014 Blue Book revisions is presented in Chart A8. Its vertical scale is the same as that used in Charts A5 to A7, save that it descends below zero to capture the difference between the two series expressed as a per cent of GDP. The difference is calculated by deducting the indicator series from the 2014 Blue Book revisions, after allowing for the likely revisions in the 2014 Blue Book to central government R&D spending. The difference is always negative in the 1997 to 2013 interval, but small, running between minus 0.1 per cent and 0.3 per cent of GDP. These minor differences arise, first, because the ONS revisions to R&D are somewhat less than the actual level of R&D investment in the 2014 Blue Book and, second, because the actual level is exceeded by the level of the indicator series, with this excess rising after 1998. The excess of the indicator series over the actual level of investment in the 2014 Blue Book may be explained by the later vintage of the indicator and by the impact on it of revisions that occurred after 2014. In 1997 and 1998, the indicator level is very close to the actual level of R&D investment recorded in the 2014 Blue Book, so that the slight excess of the indicator over the revisions to R&D in 1997 and 1998 is entirely in keeping with the relationship between the apparent level of, and revision to, R&D investment in the 2014 Blue Book.[152]

On this basis, and because of the earlier reassuring comparisons with the ‘Frascati’ data over the historic period, it is concluded the constructed indicator may be used with a reasonable degree of confidence to backcast the unpublished 2014 Blue Book revisions to R&D spending by the business and NPISH sectors. The method adopted is a simple one of splicing the value of the indicator series in 1997 to the 2014 Blue Book revision to R&D investment in 1997, with due allowance for the estimated revision to central government R&D spending in 1997.

Chart A8: Business & NPISH 2014 Blue Book R&D revisions and indicator



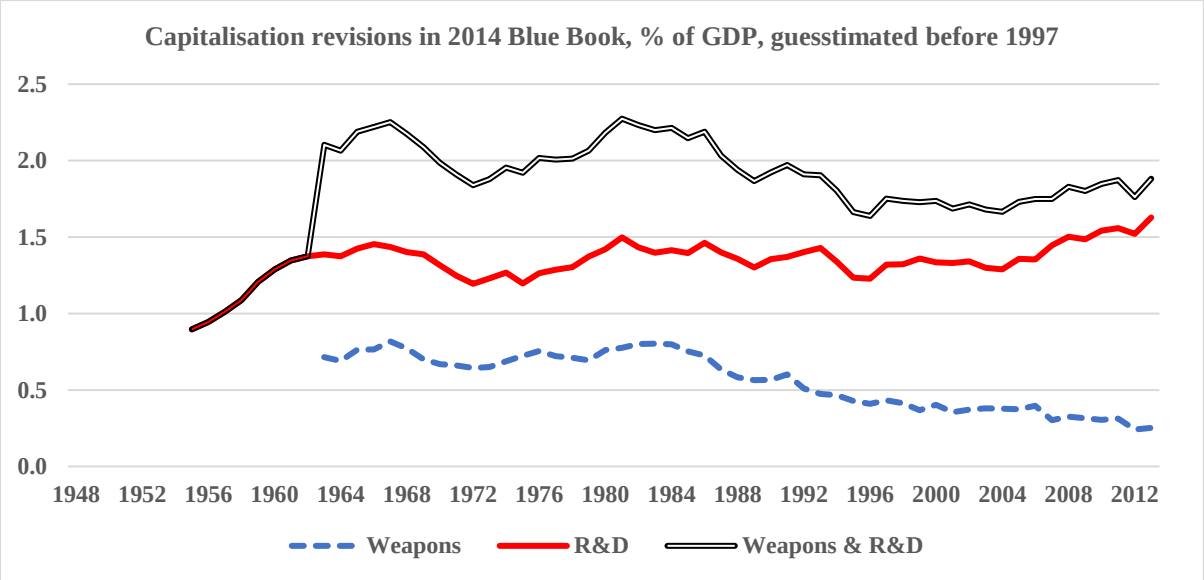
Sources: Where relevant, see Charts A3, A6 and A7; Table A1 **Notes:** The 2014 Blue Book revisions to R&D spending by the business and NPISH sectors are calculated by deducting the estimated central government R&D revisions (Chart A3) from the R&D data revisions published by the ONS and shown in Table A1 expressed as a share of GDP. The indicator series combines the February 2018 VICS data for the business ('market') sector and the December 2023 PIM data for the NPISH sector. The difference is calculated by deducting the indicator series from the 2014 Blue Book revisions.

Chart A9 traces the resulting best guess estimates of the historic revisions, before 1997, that were incorporated, but not published, in the 2014 Blue Book, as a result of the capitalisation of military weapons systems and R&D spending, together with the ONS published revisions, as recorded in Table 1. The vertical scale of the chart is the same as that used in Charts A5 to A7 and, as before, the revisions are expressed as shares of GDP of the most recent vintage at the time of calculation. The chart incorporates certain assumptions about the start dates of the business and NPISH sector R&D revisions in the 2014 Blue Book. It has been argued that these revisions are unlikely to go back any earlier than 1955; it is possible that they may have started much later in 1981. For illustration, the chart traces the effect of these revisions from 1955. The data in the Public Sector Analytical Tables show that no revision to central government investment occurred before 1963, a finding which squares with Gittins' advisory on the capitalisation of weapons systems. Since they were derived from the same internal government database ('OSCAR'), it can be assumed that the revisions to central government R&D data began no earlier than 1963, but very probably ran alongside the revisions to the weapons systems data. Confidence in this

conclusion is increased by the absence before 1987 of any data for central government R&D in the PIM dataset.

The result of these varying starting dates is that there are likely to be discontinuities in the historic revisions incorporated in the 2014 Blue Book, with level jumps in 1963 (central government investment) and in 1955 or 1981 (business and NPISH R&D). On the assumption that the business and NPISH R&D revisions begin in 1955, Chart 9 shows the revisions due to capitalisation rising from 1 per cent of GDP in 1955 to 2 per cent in 1963. The revisions then vary between just below and just above 2 per cent until the early-1990s. In the remaining period, including the 'contemporary' period from 1997, the overall revision stays below 2 per cent of GDP, with a rising revision due to the capitalisation of R&D offsetting a declining revision due to the capitalisation of weapons spending.

Chart A9: Capitalisation revisions in the 2014 Blue Book, guesstimated before 1997

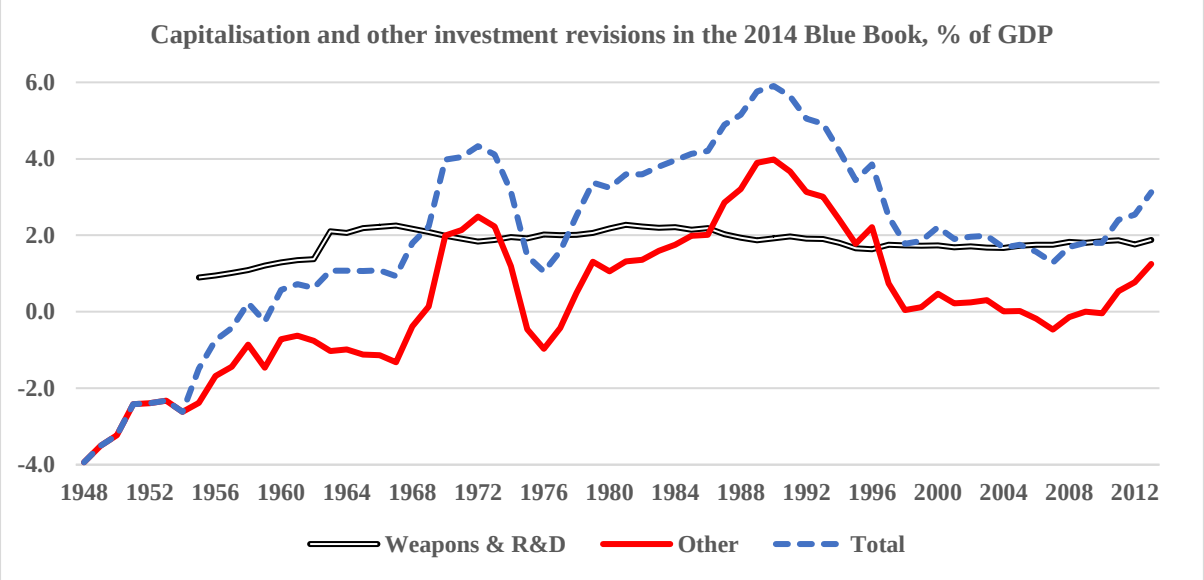


Sources: Where relevant, see Charts A3 and A8 **Notes:** The start date of the 2014 Blue Book historic revisions to business and NPISH R&D investments may be 1955, as shown in the chart, or 1981.

Chart A10, using a much wider vertical scale than in the preceding charts, traces out the implications for the investment revisions in the 2014 Blue Book that are *not* due to capitalisation.[153] As in Chart A9, it is assumed that the revisions to business and NPISH R&D begin in 1955. The striking feature of Chart A10 is the absence of volatility of the estimated capitalisation revisions compared with the revisions to total investment. The result is that the other revisions, not attributable

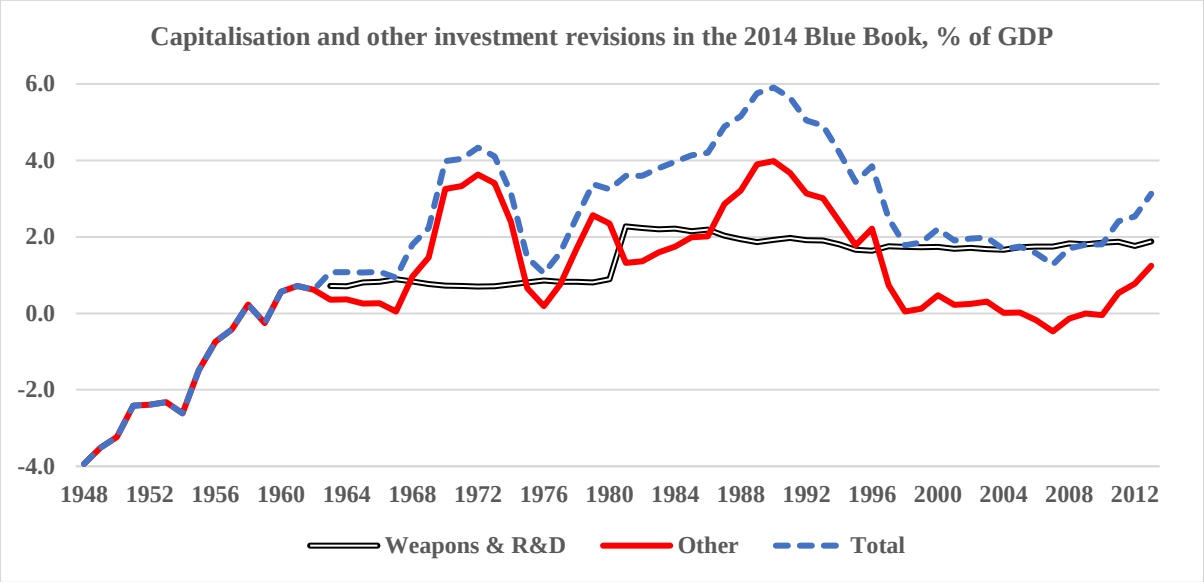
to capitalisation, move sympathetically with the total revisions. Before 1955, the capitalisation revisions are zero, and the 'other' and total revisions are the same. Chart A11 explores the alternative assumption, selecting 1981 as the start date of the business and NPISH R&D revisions. The capitalisation revisions are now smaller as a result of the near zero revisions attributed to R&D capitalisation up to and including 1980. The capitalisation revisions before 1981 are confined to those arising from the capitalisation of weapons and central government R&D spending beginning in 1963. Compared with Chart A10, the 'other' revisions to investment in Chart A11 during the 1955 to 1980 interval are raised by the absence of any material revisions attributed to the capitalisation of R&D.

Chart A10: Capitalisation and other investment revisions in the 2014 Blue Book (1)



Sources: Where relevant, see Charts 3, A3, A8, A9. **Notes:** The start date of the 2014 Blue Book historic revisions to business and NPISH R&D investment is assumed to be 1955. Newly capitalised small tool investment has not been deducted from the 'other' revisions beginning in 1997. The amounts involved are trivial (0.04 per cent of GDP).

Chart A11: Capitalisation and other investment revisions in the 2014 Blue Book (2)



Sources: Where relevant, see Charts 3, A3, A8, A9. **Notes:** The start date of the 2014 Blue Book historic revisions to business and NPISH R&D investment is assumed to be 1981. See also Chart A10.

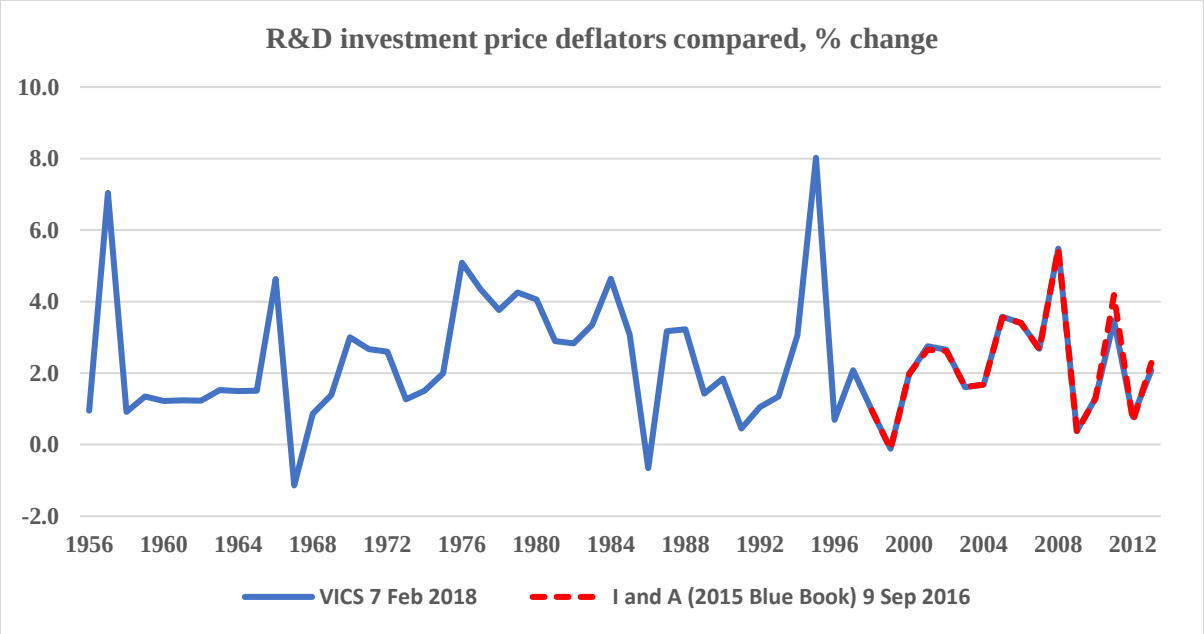
Appendix B: Backcasting investment price deflators and company sector profit revisions

1) Price deflators

In order to calculate the impact of the 2014 Blue Book capitalisations on the volume of investment and activity, it is necessary to adjust the current price estimates derived in Appendix A for changes in prices. Ker (10 June 2014) describes the method used to estimate an R&D price deflator for the 2014 Blue Book but does not provide the data. The deflator is described as a weighted average of economy-wide materials and services prices and of R&D labour costs with no adjustment for changes in labour productivity.[154] Nolan (30 September 2014) charts from 1997 the index level of the R&D price deflator ('Figure 3.5'), while the ONS, 'Annual gross fixed capital formation by industry and asset', dataset published 9 September 2016, and consistent with the 2015 Blue Book, provides a more accessible reading of the data, albeit of a later vintage. Nolan (30 September 2015) reports a revision of the price deflator for computer software in the 2015 Blue Book, but does not record any revision to the deflator for R&D investment. For the period since 1997 when the two series overlap, the rate of inflation implied by the 2015 Blue Book R&D price deflator accords well with that seen in the February 2018 VICS dataset for market sector R&D (Chart B1). This VICS dataset is the one used to backcast the business sector component of the current price revisions to R&D.

An historic R&D price deflator was formed by splicing the February 2018 VICS deflator to the 1997 value of the 2015 Blue Book series. No account has been taken of revisions to the historic series for R&D prices in later VICS datasets, a decision consistent with the absence since 2014 of material revisions to the national accounts total investment price deflator. For military weapons systems, the price deflator is taken from the same December 2023 PIM dataset that provided the current price series used to backcast the revisions to central government investment in weapons. Price indices were rescaled for convenience to match the reference years used in the 2014 and 2023 Blue Books, 2011 and 2019 respectively. Volume measures combining and excluding the two capitalisations were calculated using the chained-linking method.

Chart B1: Comparison of R&D investment price deflators, % change



Sources: 'Volume index of UK capital services (experimental): estimates to Quarter 2 (Apr to Jun) 2017', 7 February 2018, <UK productivity: analytical release, February 2018 - Office for National Statistics (ons.gov.uk)>, accompanying dataset; ONS, 'Annual gross fixed capital formation by industry and asset', ('I and A') datasets published 9 September 2016.

2) Company profits

To estimate the impact of the capitalisation of R&D investment on company profits, it is necessary to apportion the estimated 2014 Blue Book revision by sector. The revisions to central government R&D are not relevant. The remaining R&D revisions affect public corporations, and, within the 'private sector', private non-financial corporations (PNFC), financial corporations (which for purposes here include some public sector financial corporations) and NPISH. The December 2023 PIM dataset can be used to estimate the shares of R&D investment in each of these sectors. These shares have been used to apportion the 2014 Blue Book R&D revision to the otherwise unknown revision to the R&D undertaken by PNFC and by the private sector. The revision to PNFC R&D investment is assumed to equal the associated revision that the ONS applied in the 2014 Blue Book to PNFC profits (gross operating surplus).

PNFC profits data before 1987 were not published at the time of the 2014 Blue Book. The 6 October 2014 UK Economics Accounts dataset provided data back to 1997, which were later supplemented with data back to 1987 in the 30 June

2015 UK Economic Accounts. The latter were consistent with the 2014 Blue Book. It was not until the 2015 Blue Book and the UK Economic Accounts dataset published on 23 December 2015 that a full historic series was made available back to 1948. The 2014 Blue Book historic data for PNFC profits that were not published in the 2014 Blue Book or in the related UK Economic Accounts releases were backfilled using the December 2015 UK Economic Accounts release consistent with the 2015 Blue Book but adjusted for the small revisions in 1985 and 1986 noted in Banks, McCrae and Hughes (30 September 2015).

Notes

1 Dr Harrison is the editor of the 2008 edition of the international System of National Accounts. She discovered the suspect data when reconstructing an earlier vintage of Britain's national accounts now available in the Historical Data, National Accounts section of the data repository curated at the Economic Statistics Centre of Excellence (ESCoE): <National Accounts - ESCoE : ESCoE> [accessed 5 June 2024].

2 Martin (June 2019), pp. 9-10. See, also, Martin (June 2020), pp. 20-25, 61-62, Annex D; also e-mail correspondence with the ONS.

3 E-mail correspondence, 3 March 2020.

4 E-mail correspondence, 30 October 2020.

5 Verbal comment, ONS workshop, 22 July 2021.

6 ONS content, described here as 'advisory' and now typically found on the ONS website, can range from the anonymous one-page note to the multi-authored blockbuster.

7 The qualification reads: '[…] the historic GFCF [gross fixed capital formation] estimates are inherently uncertain compared with the 1997-onwards estimates', (Mosquera and others (2 July 2014), p. 7; also, Davies and others (23 February 2015), p. 5). Note that the qualification is relative: the reliability of one period's data is being compared with the reliability of another period's data. The qualification does not tell the user how unreliable the 'historic' data actually are. These and other old ONS advisories (in the before-2016 sense) are now to be found (with limited search capability) on the National Archives <[ARCHIVED CONTENT] Office for National Statistics (ONS) - ONS (nationalarchives.gov.uk)> [accessed 31 May 2024].

8 In chronological order, these papers are: Wilkes (2022), Alayande and Coyle (2023), Weston (8 December 2023; 13 February 2024; 4 April 2024).

9 The Office for Statistics Regulation (OSR) – the regulatory arm of the UK Statistics Authority - prefers the term 'Accredited Official Statistics': <Accredited official statistics – Office for Statistics Regulation (statisticsauthority.gov.uk)>. The OSR's January 2024 'quality focused assessment' did not identify the suspected historic problems with the ONS company profits data. The OSR announced its intention to review ONS business investment statistics on 19 January 2024.

10 The rationale was that ‘the concept of fixed capital formation is designed to measure changes in the physical capacity for production in the United Kingdom’ (Maurice (1968), p. 361). The emphasis on the ‘physical’ became problematic once the accounts recognised investment in non-physical, intangible assets such as computer software and original works of art. The term ‘domestic’ was dropped from the terminology in 1998.

11 Reproduction of ONS information is licensed under the ‘Open Government Licence v.3.0’.

12 For the latest national accounts revision policy, see < National Accounts Revisions Policy: updated May 2024 - Office for National Statistics> [accessed 8 June 2024].

13 The 2022 Blue Book investment revisions before 1997 are confined to the investment series for financial corporations. The revisions amount to 0.1 per cent of GDP in the 1970 to 1996 interval, and 0.0 per cent (to one decimal place) prior to 1970. Improvements to insurance and pension industry data detailed by Birt (20 June 2022) may be responsible, although this ONS advisory makes no mention of an impact on investment data. Balfe and Evans (13 January 2022) note the larger-than-normal number of intended benchmark changes in the 2022 Blue Book, some of which would affect investment, although the period affected by these benchmark revisions is not stated. The 2023 Blue Book revisions to total investment before 1997 were inconsequential (0.0 per cent of GDP). Reclassification of investment data raised central government investment and reduced private non-financial company investment by the equivalent of 0.1 per cent of GDP in 1987, the earliest date for which this comparison can be made.

14 There is a case for expressing the investment data as a share of GDP data of equivalent vintage: 2013 Blue Book data for both the investment and GDP figures, for example. Use of the latest vintage GDP data for each comparison simplifies the exposition by confining the revisions to the numerator of the share expression. Recent revisions to the GDP figures since the completion of the calculations do not affect the conclusions of this paper.

15 This equivalence follows from the identity that the change in GDP share is equal to the 30 per cent downward revision relative to the original investment level multiplied by the original investment share in GDP: the product of 30 and 0.13 is about 4.

16 The revision relative to the 2013 Blue Book level of investment reaches its peak one year later; the different timing is explained by the large proportionate fall in the original investment share between 1990 and 1991.

17 More formally, the making and distribution of profit are not ‘a central aim’ of a non-profit making institution <https://www.ons.gov.uk/methodology/classificationsandstandards/economicstatisticsclassifications/ukeconomicstatisticssectorandtransactionclassificationsthec lassificationprocess> [accessed 29 June 2024].

18 See, for example, ‘Public sector classification guide and forward work plan’, 31 May 2024, ONS <Public sector classification guide and forward work plan - Office for National Statistics (ons.gov.uk)> [accessed 16 June 2024]. Although NPISH refers to ‘institutions’, in the plural, not to an ‘institution’, official documentation insists on adding an extra ‘s’ – ‘NPISHs’ – making for a full English of sneezes.

19 Exceptionally, the national accounts did distinguish between the final consumption expenditure of households and NPISH. The 2017 Blue Book provided the first set of accounts fully to distinguish between the two sectors.

20 For example, the investments by banks nationalised after the 2007-2008 banking crisis do not affect the data before 1997, and average 0.1 per cent of GDP in the 2009 to 2013 interval.

21 Although some earlier data were provided at the time for private, non-financial companies, the investment data for these sectors were effectively lost following the conversion of the previous far more comprehensive national accounts to a (then) new European accounting standard, ESA95, in 1998.

22 For an attempt to resurrect such data, and an account of the difficulties, see Martin (June 2019; June 2020).

23 The monthly release is also known as ‘Public sector finances borrowing by sub-sector’. The differences between the public sector finances data and the national accounts data arise because of different revision cycles, the national accounts being slower to include new information and classification changes, or to correct mistakes. Prior to July 2004, the published datasets were aligned (Davies, 30 September 2019, p. 3).

24 See Martin (June 2019) and Martin (June 2020) for a detailed explanation.

25 Unlike the PSAT tables of corresponding vintage, the 2013 Blue Book was notable for incorrectly attributing significant amounts of public corporations investment to local government in the 1974 to 1991 interval. When 'Arms Length Management Organisations' took over the running of some local government housing, the related investment expenditure should have been reclassified to the public corporations sector. The 2006 Blue Book took the required adjustment back to 1992, but not before. The error was discovered in 2008 (see, Martin, 2009, p. 744). The misclassification has no impact on the public sector figures as a whole (the errors cancel out), but makes unusable the historic data provided in the 2013 Blue Book for general government investment. The 2014 Blue Book data are consistent with the PSAT data from 1997, as they should be, but small discrepancies exist in the 1987 to 1996 interval; in 1987, the discrepancy at the public sector level (due to discrepancies in the local government and public corporations accounts) is equivalent to 0.2 per cent of GDP.

26 The absence of revisions before 1963 is consistent with statements in an ONS advisory regarding the 2014 Blue Book revisions to central government investment data: Gittins (10 June 2014), p. 7.

27 This estimate of any error may itself be an understatement. It is possible that the true but unobserved figure for the level of investment in 1948 that would be consistent with national accounting principles in the 2014 Blue Book is higher than the figure in the 2013 Blue Book. If so, the downward revision of investment observed by comparing the 2014 with the 2013 Blue Book figures would be less than the true, but unobserved, downward revision from the true level of investment in 1948. A reconstruction described later (Chart 12) of what the 2014 Blue Book revision to historic investment could have been puts the shortfall measured against this tentative depiction of the 'true' level of investment in 1948 at 4½ per cent of GDP.

28 In exceptional cases, the impact of a revision on the three measures will be known from first principles.

29 The 1992 Blue Book was the first to include the effects of detailed supply and demand ('use') balancing that eliminated the published gap between the income and expenditure measures of GDP (the 'residual error') in those years for which the necessary detailed information was available back to 1985. In the 2013 and 2014 Blue Books, as in today's national accounts, the first zero residual error occurs in 1986.

30 To incorporate historic revisions for earlier years in a balanced way, the ONS adds the required changes 'in a layered manner […] on top of previous estimates of GDP' (Kent-Smith (2002), p. 4), each change being 'introduced individually' (Gittins (8 June 2023), p. 12.). The precise way in which the layered balancing of the historic accounts was undertaken in 2014 (or in most other years) is not documented in ONS advisories.

31 Minor items include the depreciation of capital owned by the institutions that comprise the NPISH sector. The household sector's gross operating surplus mainly comprises an estimate of the value of housing services that owner-occupiers derive from their homes. These values are not observed and have to be invented ('imputed') by national accounts statisticians. Also included in household gross operating surplus is households' rental income from buildings. Rental income received by landlords on private dwellings, on the other hand, is classified as 'mixed income', alongside sole-traders' self-employment income.

32 The ONS prefers to refer to 'data' as a plural <What are data? - Office for National Statistics (ons.gov.uk)> [accessed 21 July 2024]. This paper tries to oblige.

33 Ramsden (2015), p. 5. See, also, Bean (2016), Box 2.A, p. 28.

34 'The European System of National and Regional Accounts, 2010'. ESA10 (or 'ESA 2010') is the European equivalent of the worldwide standard, the System of National Accounts, 2008.

35 Chadha and others (April 2019), p. 10 note that the 'switch to ESA95 […] occurred in two stages in BB1998 and BB2001 [1998 Blue Book and 2001 Blue Book]'.

36 Bean (2016) para. 4.87, p. 147, concludes that this loss of expertise had a 'significant – though not necessarily permanent - detrimental effect'.

37 One of the reasons was the absence of a coherent set of sector accounts before 1987. For a brief history and its impact see Martin (March 2007; December 2007; 2009).

38 Everett (5 October 2011), p. 3.

39 Barker and Ridgeway (8 July 2014), para. 5.5, p. 71.

40 Penneck (2009) details the ONS programme of statistical modernisation that began 10 years earlier in 2001.

41 Denley (23 May 2016) p. 2.

42 Deneen (23 February 2012).

43 Ibid. The quarterly capital expenditure survey collected data on the basis of the previous industrial classification (SIC 2003) until the first quarter of 2011; and thereafter on a SIC 2007 basis (Nolan and Jones (29 May 2014), p. 3).

44 As late as mid-August 2011, the ONS advised that it would be publishing comprehensively revised investment data in the 2011 Blue Book, scheduled for publication on 5 October, and capital stocks and capital consumption data on 2 November 2011 (McLaren, 19 August 2011). Other notifications of the suspension of the investment and capital stocks data came in early 2012: Deneen (23 February 2012) and the ONS statement: '2011 Capital Stocks and Capital Consumption Publication' (1 March 2012). The latter contained no substantive detail.

45 Denley (23 May 2016), p. 3. Denley also describes the data reinstated by the time of the 2015 Blue Book.

46 In 2021, the ONS published what it refers to as 'headline data pre-1997' for 'business investment'. These data begin in 1965, but are very crudely constructed. The construction involves splicing data from the 2007 Blue Book and 2010 Blue Book – that is data before the ESA10 changes and other revisions - onto the latest series. Investment data distinguished by sector and by broad asset category are currently available from 1987.

47 Denley (23 May 2016), p. 4.

48 Carney (26 November 2013) 'Oral evidence: Bank of England November 2013 Inflation Report'.

49 Davies and others (23 February 2015); the 2014 Blook Book was published on 31 October 2014.

50 Ibid. p. 2.

51 There are many references to sense checking in his review, for example: 'A paucity of economic expertise, together with cumbersome systems, have meant inadequate sense checking takes place before data are released.' Bean (2016), para. 5.38, p. 201.

52 Davies and others (23 February 2015), p. 6.

53 This conclusion might not have been shaken had the reader absorbed an earlier statement in the advisory: '[m]uch of the change to the pre-1997 estimates of GFCF arises from modelling the changes in the aggregate series, through the linking factor.' The 'linking factor' is a reference to the way the ONS spliced old data onto new. Examining the advisory's 'Figure 5', the reader might suspect that the higher level of the 2014 Blue Book series throughout nearly all its historic range compared with the 2013 Blue Book series was the result of linking an old series, in which R&D did not feature, with a new higher series, in which R&D did feature.

54 The use of the term 'red herring' is mine, not Jump's.

55 Jump (23 July 2024), p. 18.

56 Ker (10 June 2014).

57 The calculations for central government R&D are vulnerable in principle to any inconsistency between the purportedly national accounts consistent Public Sector Finances Analytical Tables and the national accounts. Reassurance that these calculations are not so affected is provided by the absence in the 2023 vintage capital stocks database of any central government R&D data before 1987, when the data mysteriously 'drop out'.

58 Nolan (30 September 2014) p. 5 gives the details.

59 Harris (17 January 2013) provided a short update on progress by the ONS to re-instate the data.

60 The five authors were Jonathan Franco Mosquera, Andrew Banks, Louisa Nolan, Wesley Harris and Oliver Carpenter: Mosquera and others (2 July 2014). Four additional contributors were cited. The advisory was written under the purview of the ONS '[g]ross capital formation branch', and runs to 36 pages.

61 I am grateful to the senior ONS statistician who first drew my attention to the key mid-2014 advisory (e-mail correspondence, 3 March 2020).

62 The use of the PIM method in a UK context dates back to Redfern (1955) and Dean and Irwin (1964). Griffin (1975; 1976) and West and Clifton-Fearnside (1999) describe earlier incarnations of the PIM model used to derive estimates of capital consumption required for the UK national accounts. Dunn and Johannson (2022) describe the latest version of the PIM method and database, which had been published in full for the first time.

63 The ONS had additionally to resurrect the 2010 capital stocks database using price deflators to inflate the 2010 vintage volume data (the absence of the current price investment data is not explained), and to devise new price deflators with which to construct the constant price (not CVM) investment figures used in the PIM capital stock model.

64 Mosquera and others (2 July 2014), p. 6.

65 Ibid., p. 7.

66 The descriptive statements about linking factors, multiplication and adding up are inferred from the somewhat opaque text in the advisory, notably its description of the two options that the capital stocks team considered for the linking factors: 'linking the lower level (asset by industry) time series, to preserve the asset by industry growth rates, or linking the aggregate level time series, to preserve the aggregate growth rates […]' (ibid.). Figures 6 through 8 in the advisory record linking factors that are calculated in the manner described here.

67 In fact, there were still some discrepancies; see the ONS release: 'Capital stocks and fixed capital consumption UK: 2013 (2 July 2014), p. 7.

68 Davies and others (23 February 2015), p. 5. Note that the reference to the data being 'consistent' does not necessarily mean that the historic total investment data in the national accounts were the same as those in the reclassified, rescaled 2010 PIM database. There is a distinction between a state of consistency and one of equality. The national accounts investment data by both asset and industry are not published for periods before 1997.

69 Bean (2016), p. 28, Box 2.A.

70 Mosquera and others (2 July 2014), p. 6.

71 Ibid., p. 7.

72 Harris (25 June 2014), p. 10 notes: 'The more detailed the estimate breakdowns, the higher the uncertainty, as a proportion of the series.' Harris' observation squares with the tendency of the statistics agency's former reliability ratings to rise with the scale of the investment attributed to each industry (see: CSO (1985), p. 198).

73 Jones and others (14 March 2014), p. 7. See, also, Nolan and Jones (29 May 2014), pp. 3-5. Examples of advisories that extolled the advantages of the 2013 Blue Book changes include Nolan (27 March 2013 and 25 June 2013) and Jones (31 July 2013). The latter (unpaginated) advisory notes, 'For Blue Book 2013, the method [of compiling the quarterly data] was consistent with previously used methods but it was carried out at a lower level of aggregation. It is this step in the new method that has introduced some volatility into the quarterly current price series […]'. In their quality review, Barker and Ridgeway (8 July 2014, p. 74) note how the Jones (31 July 2013) advisory 'defended the volatility in the data', the very feature that was later regarded as undesirable. Other causes of the 2013 Blue Book revisions to the national accounts volume series beginning in 1997 included the introduction of revised deflators for computer software and for dwellings.

74 By contrast, the 1997 'linking factor' used in this paper to backcast the 2014 Blue Book revisions to non-government investment in R&D was 1.1. The corresponding figure for the much smaller revisions to military weapons systems was 1.2. The backcasts of both series were additionally tested against other criteria: R&D survey data and the revisions to central government investment recorded in the Public Sector Analytical Tables.

75 Mosquera and others (2 July 2014, p. 11) state that as a result of splicing the 'change in artistic originals in GFCF [gross fixed capital formation] is shown to be around £15bn in 1997'. The difference of £15bn is much greater than the revision to artistic originals due to splicing shown in the advisory's 'Figure 2' (of the order to £3½bn in 1997). Nor does the £15bn figure square with the size of ONS revisions to these data and the resulting national accounts estimates. Nolan (21 June 2013) reports that the improved methods of estimation added about £2bn to the national accounts figure for artistic originals in 2012. She does not provide data for the national accounts revisions in other years. It can be inferred from Martin (no relation, 7 February 2018) that the ONS figure for artistic originals investment in 1997 was around £4½bn. The figure of £15bn given in Mosquera (2 July 2014) might make more sense if the author(s) was(were) referring to the cumulative impact over a period of years of the splicing methodology on the estimates for artistic originals: "by" (rather than 'in') 1997.

76 Mosquera and others (2 July 2014), p. 11.

77 The methods were developed by academics and national accounts agencies to derive balanced estimates of GDP from disparate sources of current and constant price data that had to satisfy certain accounting constraints; examples of the literature include Sefton and Weale (1995) and Dagum and Cholette (2006). Martin (June 2019) provides a brief summary and an application of one simple form of the balancing methodology.

78 Mosquera and others (2 July 2014), p. 7. Also note that the capital stocks team derived price deflators, required to turn the current price figures into constant price figures, that were differentiated solely by the type of capital asset involved: 'the new methodology for GFCF [gross fixed capital formation] makes no adjustment by industry to the asset-level deflators' (Mosquera and others (2 July 2014), p. 8).

79 In their 2014 quality review, Barker and Ridgeway draw attention to the separated function of the 'central GDP balancing team' which was blindsided (not the authors' expression) in 2013 by the last-minute delivery of new data from 'the GFCF [gross fixed capital formation] compilers'. The detailed national accounts balancing was performed 'outside the main computing system, using Excel to facilitate a largely manual process' (Barker and Ridgeway (8 July 2014), p. 73 and p. 46). The authors do not describe the manner in which the historic revisions were balanced.

80 Martin (June 2020), Annex A describes other examples of major changes to the historic sector accounts that were not documented by the ONS.

81 The 1997 revision, including one of £¾bn arising for another reason, is of the order of £6½bn. It exceeds by 2½bn the revision to the level of total investment in 1997 that occurred between the 2010 and 2013 Blue Books.

82 The ONS detailed capital stocks user guide states: 'Differences [with the published national accounts data] include the sectoral breakdown of private sector estimates, general government estimates and *estimates prior to 1997*.' [emphasis added]. <GitHub - ONSdigital/Capstocks: R scripts and readme for producing capital stocks estimates> [accessed 7 August 2024]. See also the discussion of military weapons systems data in Appendix A.

83 Investment data in current prices published in the 2010 capital stocks release matched those in the 2010 Blue Book but typically the data began in 1996: the full history of the investment series was not published.

84 E-mail correspondence, 6 March 2020, Harrison to ONS and others. The technical issue arose from the absence of separate series for the asset classes ‘new buildings and works’ and ‘costs of ownership transfers’.

85 Harris (25 June 2014), pp. 13-14.

86 Mosquera and others (2 July 2014), p. 7.

87 For an account of the deficiencies of the historic national sector accounts that emerged after the transition to ESA95 in 1998, see Martin (March 2007; December 2007; 2009). Analysing revisions to imputed rentals of owner-occupied dwellings, Sefton and Weale (October (2022), p. 4, ft. nt. 7) note, ‘For many years the Office for National Statistics did not regard the maintenance of historic data as being of great importance […]’.

88 Commentary and Harold Macmillan’s speech quote from Hennessy (2006), p. 533.

89 Thorpe (2011), Chapter 16, pp. 273-287; also, Dow (1964) p. 71.

90 Hennessy (2006), p. 192. According to an ONS dataset, the quinquennial average number of dwellings completed a year after 1951 remained close to or above 300,000 into the 1970s (‘House building, UK: permanent dwellings started and completed by country, 24 April 2024).

91 See Crafts (2007) and many of his other books and papers.

92 See: entry ‘stop-go’, Oxford English Dictionary, n.d. www.oed.com> [accessed 21 August 2024].

93 The 1959 ‘Radcliffe’ Report on monetary policy argued that the ‘light engineering industries have been frustrated in their planning, and the public corporations have had almost equally disheartening experience’ (paragraph 472). Scott and Walker (2017) concisely summarise the debate with multiple references and conclude that the policies involved in stop-go had ‘devasting impacts on Britain’s consumer durables industries’.

94 Matthews (1968), p. 561. Stafford (1970) offers a critique of Matthews’ data choices and interpretation. Matthews showed that investment as a share of GDP was much higher after 1945 than before. This finding survives the downward 1950s data revisions investigated here because the pre-war share was so much lower.

95 The 1952 recession followed a balance of payments crisis in the previous year, affecting overseas sterling countries as much as the UK. The Bank of England's bank interest rate was raised and import controls applied. The 1958 recession was similarly preceded by a sterling crisis, although one sparked, it is argued, purely by a loss of confidence. The Chancellor and his team resigned, bank rate rose, an American recession deepened, and UK export volumes fell. More details can be found in Dow (1964).

96 As the weights vary, the same rate of volume growth of any expenditure component can have a different impact in one year compared with another, or in a comparison of different vintages of the Blue Books.

97 The figures are subject to rounding error. To two decimal points, the revision to GDP volume growth in 1958 is 0.66 percentage points (1.35 per cent minus 0.69 per cent). The contributions of the volume of investment growth in total and excluding capitalised R&D are calculated to be 0.86 and 0.74 percentage points respectively.

98 The quotient of dividing the 1960 level by the 1948 level is now 3.32 after adjusting for the assumed impact of R&D capitalisation; in the 2013 Blue Book the quotient was 1.93.

99 Recent ONS modelling resulted in 'a lowering in the CPI [consumer price index] 12-month inflation rate of 0.2 percentage points on average' over the 1950 to 1988 interval (Payne, 18 May 2022). The comparison is with the modelled historic inflation series published by the ONS in 2014. The 2022 advisory does not say whether the downward revision to modelled price inflation will lead to an upward revision in the ONS data for the volume growth of consumer spending in the post-war period.

100 Drawing on external analyses, the Office for Budget Responsibility (OBR) concluded that UK potential productivity would be reduced by 4 per cent in the long run (OBR, March 2020), Box 2.1, pp. 26-28.

101 Denison (1968), p. 235, Table 6.3, row 13. Denison's estimate for the average rate of growth of 'output per unit of input' over the 1950 to 1955 interval is 1.27 per cent. The revision since the 2013 Blue Book to the volume of GDP growth over the same interval is 0.65 percentage points a year.

102 Haskel, J. (8 July 2024), p. 13.

103 According to the *OED*, the earliest known use of the noun ‘output gap’ was in 1954, but usage of the term did not begin to rise significantly until the 1970s. See: entry ‘output gap’, Oxford English Dictionary, n.d. www.oed.com> [accessed 22 August 2024].

104 For an account of the problems of estimation and of the consequences for monetary policy, see, for example, Orphanides and van Norden (2002) for the USA and Nelson and Nikolov (2003) for the UK.

105 A comprehensive account of the period to 1974, and of the government’s fiscal and exchange rate policies, can be found in Blackaby (1978).

106 The calculation of the investment revision contribution abstracts from the effect of the 2014 Blue Book capitalisation of R&D and military weapons systems.

107 A revised statistical adjustment to the expenditure measure of GDP accounts for a ½ percentage point decrement to the GDP growth revision in 1972.

108 Nelson and Nikolov (2003), Table 4, p. 362. They note (p. 360), ‘The errors in the gap appear one-sided in each of the samples considered, with the initial estimates consistently suggesting more spare capacity than the final estimates.’ Self-evidently, given the date of their paper, the authors’ calculations are not affected by the 2014 Blue Book revisions.

109 To capture the 1970s inflation process, it is assumed that the inflation rate responds one-for-one to the previous year inflation rate and output gap, with no interest rate policy response. This ‘specification’ fits with the depiction of 1970s inflation as a so-called unit root process with a response to the output gap broadly in keeping with the coefficient estimate, using final estimates of the output gap, given in Nelson and Nikolov (2003), p. 363.

110 Kennedy (1978), p. 58.

111 The Merrett and Sykes article appeared on 30 September 1974 in the *Financial Times*.

112 Jump (2024) emphasises how data revisions undermine the Glyn and Sutcliffe view of the timing of the profits squeeze, which they had located in the 1964 to 1969 interval.

113 Shaikh (1978), p. 246.

114 Glyn and Sutcliffe (1970; 1972); Bacon and Eltis (1978). The first edition of the Bacon and Eltis book was published in 1976 following their 1975 articles in the *Sunday Times*.

115 Martin (1981).

116 This statement follows from the identity for the net rate of return on capital: gross profit minus depreciation expressed as a proportion of GDP divided by the net capital stock, also expressed as a proportion of GDP.

117 There are also qualifications that arise as a result of the different sources of data, as discussed in connection with Charts 4 and 5, and the approximate apportionment of the R&D revision to different sectors, as discussed in Appendix B. For many years, the national accounts have not provided investment data for private non-financial companies before 1987.

118 The unresolved conundrum is how a balancing process would have led to the large downward revision of private company profits before 1960 *if* a large proportion of the 2014 Blue Book revision to total investment came from a downward revision to investment in new dwellings. According to the 1961 Blue Book, only 16 per cent of the investment in new dwellings in 1948 was undertaken by the private sector, and none of that by 'companies'; new dwelling investment was primarily undertaken by 'local authorities'. The 2010 Blue Book records a similar split between private and public sector investment in new dwellings in 1948.

119 Thomas and Dimsdale (2017).

120 The heading in the spreadsheet is 'Composite value measure spliced using within chain shares to ensure additivity'.

121 *Financial Times* (13 October 2023).

122 The dataset accompanying Walker (10 June 2014) shows that COINS was the source of the data used in the derivation of the £4,894mn extra investment in 2009 attributed to the capitalisation of military weapons systems.

123 The advisory contains several statements to this effect; for example: 'it was necessary to calculate data back to 1963 (the start point of the existing government data) […]; 'Adding historic Gross Fixed Capital Formation (P.51g) data back to 1963 […]; Gittins (10 June 2014), p. 7 and p. 10 respectively.

124 For PIM inputs dataset versions issued since January 2023, see <Perpetual inventory method (PIM) inputs - Office for National Statistics (ons.gov.uk)> [accessed 27 June 2024]. Earlier versions of the dataset can be found via <GitHub - ONSdigital/Capstocks: R scripts and readme for producing capital stocks estimates> [accessed 14 May 2024]. The earliest version retrieved at the time of writing is dated 1 December 2020. The level of detail for current price investment data varies between dataset versions: for example, the 1 December 2020 version has 1,780 spreadsheet rows of information; the 8 December 2023 version has 1,836 rows; the 13 June 2024 version has 1,819 rows. The 8 December 2023 version was the latest available at the time of calculation. The ONS capital stocks user guide states with reference to the PIM asset data: 'AN.114 - weapons systems (although these assets are calculated separately, they are only published at the combined asset level with machinery and equipment' (Dunn and Johannsson (15 July 2022), p. 6). The PIM dataset weapons series are designated 'OTH.MACH.WEAP', under government function labels 'GF0201' and 'GF0203' assigned to SIC industry 84 (public administration and defence). According to the European classification of the functions of government (COFOG), 'Military Defence' comes under COFOG '02.10' and 'Foreign Military Aid' comes under COFOG '02.30' ('Manual on sources and methods for the compilation of COFOG statistics — Classification of the Functions of Government (COFOG) — 2019 edition', p. 202) <ed64a194-81db-112b-074b-b7a9eb946c32 (europa.eu)> [accessed 14 May 2024].

125 The 'ONSdigital/capstocks' webpage notes 'Differences include the sectoral breakdown of private sector estimates, general government estimates and estimates prior to 1997', <GitHub - ONSdigital/Capstocks: R scripts and readme for producing capital stocks estimates>, [accessed 14 May 2024]; the ONS capital stocks user guide on the other hand claims that '[t]he asset breakdown of general government GFCF estimates used in the PIM generally align with the national accounts series', although this statement accompanies a chart confined to years since 1997 (Dunn and Johannsson (15 July 2022), p. 9).

126 An ONS 'Capstocks' representative helpfully confirmed that the PIM investment data, and specifically those for weapons systems and R&D, may differ from the national accounts data before 1997 (private correspondence 21 May 2024 to 24 June 2024).

127 The 2014 Blue Book UK Economic Accounts data for the 1987 to 1996 interval used in Chart A2 were backfilled using the 30 June 2015 release. These earlier data were not provided in the UK Economic Accounts of 6 October 2014 that (after correction) coincided with the publication of the 2014 Blue Book. The UK Economic Accounts data are internally consistent in the sense that the summation of the individual sector data (private and public sectors) equals national total investment from 1987. The 2014 Blue Book PSAT date source in Charts A2 and A3 is the 29 September 2014 release. The conclusions drawn from Chart A3 are not affected by the differences in the vintages of the UK Economic Accounts (June 2015) and PSAT (September 2014) data sources for the 1987 to 1996 interval: over this interval, or in any year up to 2012, the investment data recorded in the June 2015 PSAT release were the same as those recorded in the September 2014 PSAT release.

128 Ker (10 June 2014), p. 5. The Eurostat 'Manual on measuring Research and Development in ESA 2010' is available from <Manual on measuring Research and Development in ESA 2010 - Products Manuals and Guidelines - Eurostat (europa.eu)> [accessed 1 July 2024].

129 Kerr (10 June 2014) p. 3.

130 Hill (6 July 1997), cited by Ker, notes the inconsistency of nevertheless including the royalty payments to holders of patents, thereby treating the patents as if they were fixed produced assets.

131 The first draft of the manual, then called the 'Proposed Standard Practice for Surveys of Research and Development', was revised and accepted by experts at an OECD conference held in Frascati, Italy in June 1963.

132 Ker (10 June 2014) p. 9.

133 Ibid., p. 10.

134 Ibid., pp. 9-10.

135 Edworthy and Wallis (February 2007), p. 21 report that their national account consistent estimates for business R&D exceeded those found in the UK survey 'Research and Development in UK Businesses (MA14)'.

136 Ibid., p. 13.

137 In 2014, the ONS surveys were collated in the 'Gross Expenditure on R&D' (GERD) release, comprising 'Business Expenditure on R&D' (BERD); 'Government expenditure on R&D (GovERD), which included research councils; and the R&D spending of Higher Education Funding Councils (HERD) and Private Non-Profit Organisations (PNP). Apart from the rebranding of the data for non-profit organisations as 'PNPRD', the same nomenclature is used today: <Gross domestic expenditure on research and development, UK - Office for National Statistics (ons.gov.uk)> [accessed 1 July 2024].

138 The 'other' component is equated with the discrepancies between the UK Economic Accounts and national accounts consistent PSAT data in the 1987 to 1997 interval (that is, these discrepancies are not scored to the inferred R&D revision).

139 The acronym was coined by Oulton and Srinivasan (2003).

140 The focus on the market sector and the provision of current price investment data are features of vintages of the VICS dataset from February 2018. Before then, vintages of the dataset covered all sectors relevant to national productivity analysis but provided no current price investment data.

141 This finding for the December 2023 PIM dataset may be compared with this statement in the ONS capital stocks user guide: 'The sectoral GFCF [gross fixed capital formation] estimates for the financial corporations sector, and for the dwellings and research and development assets are consistent in national accounts and the PIM inputs.' The user guide's reassurance for R&D investment should be taken to apply only from 1997.

142 This equality between the PIM and VICS was verified for the late-2023 versions of the datasets.

143 It is possible that earlier vintages are publicly available but have so far eluded an extensive search.

144 See: McCrae and Roberts (20 August 2019), pp. 8-9; Howley (2 February 2020), p. 4.

145 The same terminology is used today.

146 The latest 'transformation' of the R&D data is described here: <Update on transformation of research and development statistics - Office for National Statistics (ons.gov.uk)> [accessed 20 May 2024].

147 Ker (10 June 2014), p. 10.

148 Ibid., p. 9.

149 Holding the ratio of the PIM/VICS market sector data to the business Frascati data at its 1990 value (93 per cent) reduces the R&D revision estimate by the equivalent of 0.1 per cent of GDP in the 1991 to 1994 interval.

150 Horrocks (1999) p. 6.

151 At the time of the February 2007 article, Mr Wallis was employed by HM Treasury. He was at the Bank of England when he co-authored the academic paper later published as Oulton and Wallis (2016). At the time of the research for the academic paper, Mr Oulton was a consultant to the Bank of England.

152 The calculations underlying these statements were performed for total R&D investment derived in the case of the indicator series by adding the December 2023 PIM central government and NPISH R&D data to the February 2018 VICS R&D market sector data. For the derivation of the 2014 Blue Book data, see Chart A4. The reason for the apparent excess of the level of R&D investment over the official revisions to R&D investment in the 2014 Blue Book is not documented. The 1997 level of R&D expenditure reported in the ONS ‘Annual gross fixed capital formation by industry and asset’, dataset published 9 September 2016 for the 2015 Blue Book (but with no record of revisions since the 2014 Blue Book affecting the 1997 observation (Birt, Whiting and Wild (30 October 2015); Duff (30 September 2015)) is £13,517mn. The official revision to R&D expenditure in the 2014 Blue Book is £12,578 (Wild and Whiting, 31 October 2014, p. 22). The difference is equivalent to 0.1 per cent of GDP. Differences of similar size as a share of GDP are recorded each year in the 1997 to 2013 interval.

153 The vertical scale in Chart A10 is the same as that used in Chart 6.

154 Ker (10 June 2014), pp. 19-20.

References

Abramsky, J. (10 June 2014) ‘Changes to National Accounts: Framework for Research and Development in the United Kingdon National Accounts, ONS.

Alayande, A. and Coyle, Diane (2023) ‘Investment in the UK: Longer term trends, Working Paper, Bennett Institute for Public Policy, University of Cambridge, UK.

Bacon, R., and Eltis, W. (1978) *Britain’s Economic Problem: Too Few Producers*, second edn, Macmillan.

Balfe, A. and Evans, C. (13 January 2022) ‘Proposed changes to be implemented in Blue Book and Pink Book 2022’, ONS.

Banks, A., McCrae A., and Hughes, M. (30 September 2015) ‘Impact of methods changes to the National Accounts and Sector & Financial Accounts, Q1 1997 to Q2 2015’, ONS.

Barker, K. and Ridgeway, A. (8 July 2014) ‘National Statistics Quality Review: National Accounts and Balance of Payments’, NSQR Series: 2, Report 2, ONS.

Bean, C. (2016) ‘Independent Review of UK Economic Statistics’, Independent review of UK economic statistics: final report - GOV.UK (www.gov.uk)

Birt, L. (20 June 2022) ‘Insurance and pension methods changes: 1997 to 2020, ONS.

—— Whiting, G. and Wild, R. (30 October 2015) ‘Commentary on Supply and Use balanced estimates of annual GDP, 1997-2013’, ONS.

Blackaby, F. (ed.) (1978) *British Economic Policy 1960-74*, Cambridge University Press.

Borgo, M., Goodridge, P., Haskel, J., and Pesole, A. (2013) ‘Productivity and Growth in UK Industries: An Intangible Investment Approach’, *Oxford Bulletin of Economics and Statistics,* 75.6, pp. 806–834.

Carney, M. (26 November 2013), Oral evidence: Bank of England November 2013 Inflation Report, HC 825, https://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/treasury-committee/bank-of-england-inflation-report-hearings/oral/3912.html

Chadha, J., Rincon-Aznar, A., Srinivasan, S., and Thomas, R. (April 2019), 'A Century of High Frequency UK Macroeconomic Statistics: A Data Inventory', ESCoE Technical Report 03, ESCoE.

Corrado, C., Hulten, C., and Sichel, D. (2005) ‘Measuring capital and technology: an expanded framework’, in Corrado C. A., Haltiwanger J. C. and Sichel D. E. (eds.) *Measuring Capital in the New Economy*, Vol. 65, The University of Chicago Press, pp. 11–46.

Crafts, N. (November 2017) ‘The Postwar British Productivity Failure’, University of Warwick, Working Paper Series, No. 350.

CSO (1985) *United Kingdom National Accounts: Sources and Methods*, third edn, HMSO.

Dagum, E. and Cholette, P. (2006) *Benchmarking, Temporal Distribution, and Reconciliation Methods for Time Series*, Springer Science+Business Media.

Davies, T., Denley, H., Field, S., and Nolan, L. (23 February 2015) ‘Methodological improvements and ESA 2010 changes to historic GDP datasets for Blue Book 2014’, ONS.

Davies, W. (30 September 2019) ‘Alignment between public sector finances and national accounts: September 2019', ONS.

Dean, G., and Irwin, J. (1964) ‘The Stock of Fixed Capital in the United Kingdom in 1961’, *Journal of the Royal Statistical Society,* Series A (General), 127.3, pp. 327-358.

Deneen, S. (23 February 2012) ‘Gross capital formation estimates – availability of data from the GCF systems’, ONS.

Denison, E. (1968) ‘Economic Growth’, in *Britain’s Economic Prospects,* by Caves. R. and Associates (1968), Chapter 6, pp. 231-278.

Denley, H. (23 May 2016) ‘National Accounts historic dataset developments since Blue Book 2011, ONS.

Dow, J. C. R. (1964) *The Management of the British Economy 1945-60*, Cambridge University Press.

Duff, S. (30 September 2015) ‘Changes to National Accounts: GFCF and Business Investment - impact of incorporating Blue Book 2015 changes’, ONS.

Dunn, M., and Johannsson, K. (15 July 2022) ‘Capital stocks user guide’, ONS.

Edgerton, D. E. H. (1993) ‘Research, Development and Competitiveness’, in K. Hughes (ed.), *The Future of UK Competitiveness and the Role of Industrial Policy*, Policy Studies Institute.

Edgerton, D. E. H. and S. M. Horrocks (1994) ‘British Industrial Research and Development Before 1945’, *Economic History Review*, ns. 47.2, pp. 213-238.

Edworthy, E., and Wallis, G. (February 2007) ‘Treating research and development as a capital asset’, *Economic and Labour Market Review,* 1.2, pp. 16-24.

Evans, P., Hatcher, M., and Whittard, D. (September 2008) ‘The preliminary R&D satellite account for the UK: a sensitivity analysis’, *Economic and Labour Market Review*, 2.9, pp. 37-43.

Everett, G. (5 October 2011) ‘Historic National Accounts’, ONS.

Galindo-Rueda, F. (December 2007) ‘Developing an R&D satellite account for the UK: a preliminary analysis, *Economic and Labour Market Review*, 1.12, pp. 18-29.

Gittins, P. (10 June 2014) ‘Transition to ESA2010: Capitalising Government Spending on Military Weapons, ONS.

—— Gittins, P. (8 June 2023) 'Developments and Challenges in Production of Supply and Use Tables in the United Kingdom', Paper for 29th International Input-Output Association Conference, <4796_IOconference_UKSUTscompilationpaper_final.pdf (iioa.org)> [accessed 18 June 2024].

Glyn, A. and Sutcliffe, R (‘B’) (March/April, 1971) ‘The Critical Condition of British Capital’, *New Left Review*, 66.1, pp. 1-31.

—— (1972) *British Capitalism, Workers and the Profits Squeeze*, Penguin.

Griffin, T. (October 1975) ‘Revised estimates of the consumption and stock of fixed capital’, *Economic Trends*, no. 264, pp 1-4, CSO.

—— (October 1976) ‘The stock of fixed assets in the United Kingdom: how to make best use of the statistics’, *Economic Trends*, no. 276, pp 5-18, CSO.

Harris, W., (17 January 2013) ‘Capital Stock, Capital Consumption – Update on progress to reinstate estimates’, ONS.

—— (25 June 2014) ‘Methodological changes to the estimation of capital stocks and consumption of fixed capital, ONS.

Harrison, A. ‘Official historical national accounts data – the pre-ESA95 national accounts 1948-1997, <National Accounts - ESCoE : ESCoE> [accessed 1 June 2024].

Haskel, J. (8 July 2024) ‘UK inflation: What's done and what's to come – speech by Jonathan Haskel’, given at King’s College London with the Economic Statistics Centre of Excellence (ESCoE), Bank of England.

Hennessy, P. (2006) *Having it so good: Britain in the Fifties*, Allen Lane.

Hill, P. (6 July 1997), ‘Intangible assets, patents and copyrights in the 1993 SNA, <intAssets.pdf (un.org)> [accessed 14 May 2024].

Horrocks, S. (1999) ‘The Nature and Extent of British Industrial Research and Development, 1945-1970’, *Refresh*, 29, <Horrocks29b.pdf (ehs.org.uk)> [accessed 12 May 2024].

Howley, E. (2 February 2020) ‘Latest developments and changes to be implemented in Blue Book and Pink Book 2020), ONS.

Jones, J. (31 July 2013) ‘Explaining the impact of the Blue Book 2013 changes to gross fixed capital formation and business investment, ONS.

—— Nolan L., Banks, A., Wales, P., and Morgan D. (14 March 2014) ‘Explaining United Kingdom investment estimates: past, present and future’ ONS.

Jump, R. (23 July 2024) ‘Revisiting the Role of Profits in the Collapse of Britain’s Post-War Consensus’, University of Greenwich, Business School, available from <Revisiting the role of profits in the collapse of Britain's post-war consensus by Robert Calvert Jump :: SSRN> [accessed 2 August 2024].

Kennedy, C. (March 1978) ‘Inflation accounting: retrospect and prospect’, *Economic Policy Review*, Vol. 4, pp. 58-64. <Front Matter and Table of Contents · CPES Online Archive> [accessed 22 August 2024].

Kent-Smith, R. (3 February 2020) ‘A new framework for UK GDP: progress, challenges and the future’, ONS.

Ker, D. (10 June 2014) ‘Changes to National Accounts: Measuring and Capitalising Research and Development’, ONS.

Marrano, M., Haskel, J. and Wallis, G. (2009). ‘What happened to the knowledge economy? ICT, intangible investment and Britain’s productivity record revisited?’, *Review of Income and Wealth*, Vol. 55, pp. 686–716.

Martin, B. (‘W. E.’) (ed.) (1981) *The Economics of the Profits Crisis*, HMSO.

—— (March 2007) ‘UK historic sector national accounts’, Memorandum to The Statistics Commission, <Bill Martin - Cambridge Judge Business School> [accessed 12 June 2024]’

—— (December 2007), 'Resurrecting the UK historic sector national accounts', Working Paper 356, Centre for Business Research, University of Cambridge.

—— (2009) ‘Resurrecting the U.K. historic sector national accounts’, *Review of Income and Wealth*, 55(3), pp. 737-751.

—— (June 2019) ‘Resurrecting the UK Sector National Accounts after 1945’, Working Paper 514, Centre for Business Research, University of Cambridge.

—— (June 2020) ‘Resurrecting the UK Corporate Sector Accounts’, Working Paper 519, Centre for Business Research, University of Cambridge.

Martin, J. (7 February 2018) ‘Experimental estimates of investment in intangible assets in the UK: 2015’, ONS.

Matthews, R. C. O. (1968) ‘Why has Britain had Full Employment since the War?’, *The Economic Journal*, vol. 78, Sep., pp. 555-569.

Maurice, R. (ed.) (1968) *National Accounts Statistics: Sources and Methods*, CSO, HMSO.

McCrae, A. and Roberts, D. (20 August 2019) 'National Accounts articles: Impact of Blue Book 2019 changes on gross fixed capital formation and business investment', ONS.

McLaren, C. H. (19 August 2011) 'Blue Book 2011, Improvements to gross capital formation estimates', ONS.

Mosquera, J. F., Banks A., Nolan, L., Harris, W., and Carpenter, O. (2 July 2014) 'Impact of methodological changes to the estimation of capital stocks and consumption of fixed capital', ONS.

Nelson, E. and Nikolov, K. (2003) 'UK inflation in the 1970s and 1980s: the role of output gap mismeasurement', *Journal of Economics and Business*, 55, pp. 353-370.

Nolan, L. (27 March 2013) 'GDP continuous improvement: summary of improvements to the estimation of gross fixed capital formation in the UK National Accounts, ONS.

—— (21 June 2013) 'The measurement of artistic originals in the UK', ONS.

—— (25 June 2013) 'GDP continuous improvement: improvements to the estimation of gross fixed capital formation in the UK National Accounts', ONS.

—— and Jones, J. (29 May 2014) 'Changes to National Accounts: gross fixed capital formation (investment) – changes for Blue Book 2014 (excluding ESA10)', ONS.

—— (30 September 2014) 'Investment – impact analysis of changes to the estimation of gross fixed capital formation and business investment for Blue Book 2014', ONS.

OBR (March 2020) ‘Economic and fiscal outlook’, CP 230, Office for Budget Responsibility.

Orphanides, A. and van Norden, S. ‘The unreliability of the output gap estimates in real time’, *Review of Economics and Statistics*, 84.4, pp. 569-583.

OSR (18 January 2024) ‘Statistics on Profitability of UK Companies and Gross Operating Surplus of non-financial corporations produced by the Office for National Statistics’, Assessment Report 383.

Oulton, N., and Srinivasan, S. (2003) ‘Capital stocks, capital services, and depreciation: an integrated framework’, Working Paper no. 192, Bank of England.

Oulton, N., and Wallis, G. (2016) 'Capital stocks and capital services: integrated and consistent estimates for the United Kingdom, 1950–2013', *Economic Modelling*, 54, pp. 117-125.

Payne, C. (18 May 2022) ‘Consumer price inflation, historical estimates, UK, 1950 to 1988 – methodology’, ONS.

Penneck, S. (2009) ‘The Office for National Statistics (ONS) Statistical Modernisation Programme: What went right? What went wrong?’, ONS.

Ramsden, D. (2015) ‘HMT Response to call for evidence: Review of Economic Statistics’, <Review of economic statistics: call for evidence - GOV.UK (www.gov.uk)> [accessed 18 July 2024].

Redfern, P. (1955) ‘Net investment in Fixed Assets in the United Kingdom, 1938-1953’, *Journal of the Royal Statistical Society,* Series A (General), 118.2, pp. 141-192.

Scott, P. and Walker, J. (2017) ‘The impact of ‘stop-go’ demand management policy on Britain’s consumer durables industries, 1952-65’, *The Economic History Review*, 70, pp. 1321-1345.

Sefton, J. and Weale, M. (1995) *Reconciliation of National Income and Expenditure*, Cambridge University Press.

—— (October 2022) 'Historical Estimates of Imputed Rental for Owner-Occupied Dwellings for the United Kingdon', ESCoE Discussion Paper No. 2022-22, ESCoE.

Shaikh, A. (1978) 'Political economy and capitalism: notes on Dobb's theory of crisis, *Cambridge Journal of Economics*, 2, pp. 233-251.

Stafford, G. B. (1970) 'Full employment since the war – comment', *The Economic Journal*, vol. 80, Mar., pp. 165-172.

Thomas, R and Dimsdale, N (2017) 'A Millennium of UK Data', Bank of England OBRA dataset, http://www.bankofengland.co.uk/research/Pages/onebank/threecenturies.aspx [accessed 18 August 2024].

Thorpe, D. R. (2011) *Supermac: The Life of Harold Macmillan*, Pimlico.

Vaze, P. (November 2003) 'Estimates of the volume of capital services', *Economic Trends*, 600, pp. 58-66.

Walker, G. (29 May 2014) 'National accounts articles: Impact of ESA95 changes on current price GDP estimates', ONS.

—— (10 June 2014) 'National accounts articles: Impact of ESA10 changes on current price GDP estimates', ONS.

Wallis, G. (November 2005) 'Estimates of the volume of capital services', *Economic Trends*, 624, pp. 42-50.

—— and Dey-Chowdhury, S. (December 2007) 'Volume of capital services: estimates for 1950 to 2006', *Economic and Labour Market Review*, 1.12, pp. 37-47.

Walton, A. (30 September 2013) ‘National accounts and related outputs workplan 2013/14 – 2017/18’, ONS.

Wenzel, L., Khan, M. K. N., and Evans, P. (September 2009) ‘Capitalising research and development: towards the new System of National Accounts’, *Economic and Labour Market Review*, 3.9, pp. 16-23.

West, P., and Clifton-Fearnside, A. (March 1999) ‘The Capital Stock of the United Kingdom – some new developments in coverage and methodology’, *Economic Trends*, no. 544, pp 39-48, ONS.

Weston, T. (8 December 2023) ‘The UK economy in the 1950s’, House of Lords Library, <The UK economy in the 1950s - House of Lords Library (parliament.uk)>, [accessed 5 June 2024].

—— (13 February 2024) ‘The UK economy in the 1960s’, House of Lords Library, <The UK economy in the 1960s - House of Lords Library (parliament.uk)>, [accessed 5 June 2024].

—— (4 April 2024) ‘The UK economy in the 1970s’, House of Lords Library, <The UK economy in the 1970s - House of Lords Library (parliament.uk)>, [accessed 5 June 20204].

Wild, R., and Whiting, G. (31 October 2014) ‘Commentary on Supply and Use balanced estimates of annual GDP, 1997-2012’, ONS.

Wilkes, G. (2022) ‘Business Investment: Not Just One Big Problem’, Institute for Government.

Abbreviations and acronyms

CSO: Central Statistical Office

ESA10: European system of national and regional accounts, 2010

ESA95: European system of national and regional accounts, 1995

ESCoE: Economic Statistics Centre of Excellence

HMSO: Her Majesty's Stationery Office

NPISH: Non-profit institutions serving households

OBR: Office for Budget Responsibility

OECD: Organisation for Economic Co-operation and Development

ONS: Office for National Statistics

OSR: Office for Statistics Regulation

PIM: Perpetual Inventory Method

R&D: Research and Development

UK: United Kingdom

USA: United States of America

VICS: Volume index of capital services