

GDP and Welfare: A spectrum of opportunity

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This paper is interested in two aspects in the debate: i) different users require different measures to address different policy problems and ii) changes in technology, data techniques and new sources of data mean the economic measurement community, and specifically National Statistics Institutes, are on the cusp of being able to affordably move from just measuring what the economy can produce to potentially measuring variables of wider interest, particularly economic welfare.

As such, this paper attempts to map and prioritise the options available on a practical spectrum, which can be broadly broken into four segments; variants consistent with the current international guidance on national accounting (Current GDP), variants which could be seen as being in scope of potential future iterations of this guidance (Future GDP), variants which move beyond the likely future scope of national accounting, and which therefore stray into being welfare measures (Welfare), and finally the range of frameworks which capture multi-dimensional measures of wider human well-being beyond the economic (Well-Being).

Keywords: welfare, official statistics, economic measurement, modern economy, capital, time use

JEL classification: I31, E01, E21, E22

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GDP and Welfare: A spectrum of opportunity

1. GDP as an indicator of welfare

Gross Domestic Product (GDP) is a common statistic which many people claim to understand, but most, including some economists do not fully grasp. At its simplest, GDP is an indicator of production and can be measured three ways: as the sum of value added by industries to purchases of materials and supplies to produce their output; as the value of output sold to households, government, business and exports; or finally as the sum of income generated through production which is distributed as compensation of employees for the household, operating surplus for the business sector and taxes for the government.

GDP and the accompanying National Accounts only came into being around eighty years ago, in the particular circumstances of the Second World War and subsequent post-war period. In a world where material consumption was the most significant driver of human well-being (also referred to throughout as living standards, utility, or welfare), GDP rapidly fell into being used as a short-hand for these terms. This success at colonising alien territory has both made GDP the dominant measure of our age (Coyle 2017), and a target for every voice which argues that *'we live in a society in which a priesthood of technically trained economists, wielding impenetrable mathematical formulas, set the framework for public debate'* (Pilling 2018).

And it is indeed alien territory. Economists generally define welfare (or well-being) as a measure of the utility or satisfaction the society derives from the consumption of goods and services. These goods and services are both economic and non-economic. The economic goods relate to material living standards and hence those covered by GDP. Non-economic goods and services however can play an extremely important role in the quality of life of society. In this sense, welfare is multidimensional encompassing material living standards such as income, consumption and wealth and the non-economic aspects of people's lives (what they do and what they can do, how they feel, the natural environment in which they live, etc).

There have been multiple instances where the international community of statistics has identified that alternative measures are required². Nevertheless, through its success at becoming the accepted measure of something it is not a measure of (i.e. welfare), GDP has become caught in a debate described by one eminent economist as *'akin to a religious war'*. The debate can be boiled down to 'if GDP is the accepted measure of welfare, should it be re-defined to become a good measure of welfare'? Whether it is Brynjolfsson et al (2019) or Hulten and Nakamura (2018), new variants of GDP are regularly proposed to 'square the circle'. Given GDP is simply a measure economists use, once its definition is called into question, the debate rapidly moves to whether it continues to adequately reflect the modern world, particularly in the UK where the scale of the 'productivity puzzle' has caused measurement to be questioned, with the spectre of 'mismeasurement' emerging (see Bean 2016).

² For example, In November 2007, the European Commission, European Parliament, Club of Rome, the OECD and the World Wide Fund For Nature hosted the high-level conference 'Beyond GDP', with the objectives of clarifying which indices are most appropriate to measure progress and how these can best be integrated into the decision-making process and taken up by public debate. In August 2009, the European Commission released its Communication *GDP and Beyond: Measuring progress in a changing world*. The Communication outlined an EU road map with key actions to improve indicators of progress in ways that meet citizens' concerns and make the most of new technical and political developments. The starting point in the work of all these initiatives was the view that gross domestic product alone was no longer the best way to measure a country's progress and needed to be complemented by environmental and social indicators. In particular, statisticians have been repeatedly called upon to find ways of measuring the 'quality of life' of a nation alongside its raw economic growth.

What is ‘mismeasurement’? In short, it can *either* be measuring the right concept incorrectly, or measuring the wrong concept. The debate in the UK, whilst containing elements of the first³, has increasingly focussed on the second of these, particularly in relation to what concepts should be within the ‘production boundary’ – the definition of which activity falls within National Accounts and hence GDP.

We can produce simple pen-pictures of the two sides of this debate, which set aside the alternative measures debate, and, whilst stylised and disguising a range of positions within each group, provide a summary of the issues:

- **The Orthodox view:** GDP is a measure of the productive economy, which provides clear insights to economic policy-makers in relation to fiscal and monetary policy; the setting of taxes, spending plans and interest rates, to name just the most immediate. Tailored to meet this requirement the National Accounts have ‘*a place for everything and for everything a place*’, having complete coverage of the concepts it is designed to cover. As such it is a ‘perfect measure’ and does not need substantive revision.
- **The Moderniser view:** What society needs is a measure of welfare which reflects modern life, particularly as the consumption of material goods is becoming ever less important as a measure of living standards. Equally a headline measure which was created in a world of apparently infinite raw materials is increasingly problematic as these become scarcer. Because GDP is the dominant measure used to set policy, GDP and the National Accounts should be transformed to capture these components: if GDP is going to masquerade as a measure of living standards, should it not be reformed so it can serve this function properly?

This paper tries to sidestep this debate by approaching the issues from the practical viewpoint of how National Statistical Institutes (NSIs) can try and meet a variety of user needs simultaneously, reflecting on the key challenges facing us, which we address in turn below:

Different users need different measures because they are trying to solve different policy problems.

This simple truism reflects the diversity of user needs. As with many other services, one-size-fits-all is not a viable model for 21st century economic statistics. Therefore, users need a range of metrics to suit different purposes, but clearly there is something about the alternatives which have already been made available which are not meeting need. It therefore seems clear that this is the time to explore the potential to create new measures. The question is what should any new measure(s) look like, conceptually and practically. Annex A sets out some key criteria which need to be considered, as the current debate shows, statistics are competitive, and GDP is a winner: GDP is undoubtedly the most successful of the economic statistics in terms of dominating the debate and public discourse, and as such sets the benchmark which any new metrics will need to attain if they are to be successful in this competition. This paper, however, will move directly on to considering two questions, which any efforts to meet user needs must answer:

- Are there changes which would allow a revised GDP measure, under a future iteration of the SNA, to meet orthodox needs whilst also getting closer to the ambitions of the Modernisers?
- Are there changes which would fall outside the scope of a future revised GDP which more fully meet Modernisers’ objectives, under the banner of a new complementary measure of economic welfare, to meet the clear demand for a different measure from orthodox GDP?

2. Why is GDP not a good measure of economic welfare?

³ See ONS (2018a).

To begin, National Accountants routinely make clear GDP is not a measure of welfare⁴. This is, however, an over-simplification. *All* economic variables of price and volume are measures of welfare to some degree: GDP *is* a measure of welfare, but it is also importantly true that it is *not a very accurate one*⁵. Understanding this is key:

- There is a powerful argument that any single number measure is going to be a poorly performing measure of welfare because all single number estimates fail to address the matter of equity and the distribution of outcomes experienced by different citizens, as well as the multi-dimensional nature of economic activity, encompassing as a minimum the concepts of income, consumption and wealth. Any single number estimate has to reflect on whether it can address this.
- Welfare is fundamentally driven by consumption, but not necessarily just of goods and services produced in the productive sector. Economic theory argues that welfare is generally increasing in consumption across all goods and services. As Stiglitz, Sen and Fitoussi (2009) note GDP mainly measures market production and consumption of those goods and services provided by the market, and therefore excludes goods and services produced in the household sector. This is mainly therefore an issue of coverage: GDP is, more accurately, an incomplete measure of welfare, to which it is not necessarily consistently correlated.⁶

It is important to be clear on this fundamental failing of GDP as a measure of welfare. If one thinks about the use of time, one can see that citizens can use their time in one of three ways:

$$\begin{aligned} & \textit{time spent in producing goods and services in the productive economy} + \\ & \quad \textit{time spent in producing goods and services in the household sector} + \\ & \quad \quad \textit{leisure time (including sleep)} \\ & \quad \quad \quad \equiv 24 \textit{ hours} \end{aligned}$$

If one considers statistics on labour markets over the last 14 years, we can see that the average number of hours in paid employment (i.e. time spent in producing goods and services in the productive economy – or time spent producing the output observed in GDP) has fallen steadily. Comparing Jan-Mar 2019 to Jan-Mar 1995 we see the average hours worked in the UK to have fallen 3.4% (Figure One). Compared to older data (see for example the Bank of England historical series⁷) where in the early 1800s average hours worked were closer to 70 hours per week than 30 hours, we can see this is the tip of the iceberg.

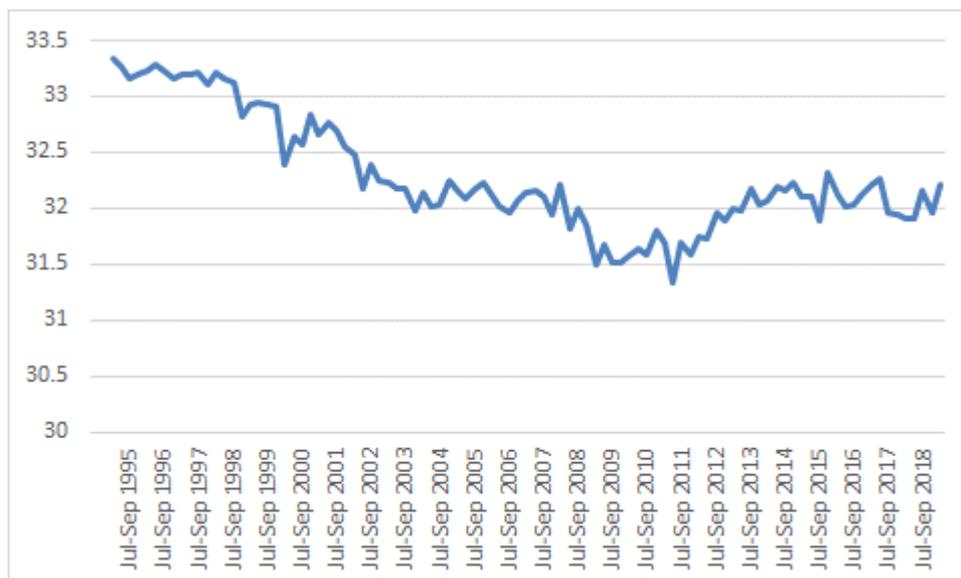
⁴ This paper also draws a distinction between what refers to as ‘economic welfare’, and ‘well-being’. Economic welfare in this paper refers to the classical concepts welfare as described above whilst economic well-being captures a wider set of factors impacting on quality of life and is often displayed as a dashboard or an index compiled with subjective weights.

⁵ Indeed, it is not even the most accurate of the major measures of the economy. Net National Income would provide an unambiguously superior measure of welfare, for example, as would real household disposable income (RHDI).

⁶ Jones and Klenow (2016) in their study observe that GDP per person is an informative indicator of welfare across a broad range of countries and find that this metric has a correlation of 0.98 with their welfare measure. This is particularly true in a period when people’s consumption of paid-for material goods and services are the predominant drivers of living standards. Nevertheless, they state, there are economically important differences between GDP per person and welfare. Across 13 countries studied the median deviation was around 35 percent.

⁷ Available at <https://www.bankofengland.co.uk/statistics/research-datasets>

Figure One: Average Hours Worked per Worker (Seasonally Adjusted, 1995-2019)



Source:

<https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/datasets/averagehoursworkedbyindustryhour03>

In thinking about the welfare implications of this observation we can observe that clearly the relative value *in welfare terms* to the average citizen of either leisure time or producing goods or services in the household has increased relative to the value of the goods and services which can be purchased by incomes earned in paid activity.

Assuming the marginal value of an hour of leisure must be falling as more hours become available in the average day of the average citizen, we must look to goods and services produced in the household. But what are these?

In essence it is anything produced by the household for its own consumption. So, if I drive my children to an activity, this is a transport service produced by the household, as opposed to a transport service produced by the taxi sector. A home-cooked meal is the equivalent of a purchased restaurant meal. Helping one's children with their homework is the equivalent of purchased education services from a tutor. If I now have more time available to produce more or better household goods and services, which would be measured by a country's 'Household Accounts' in parallel to the National Accounts, then one would assume I would gain more welfare from these, if we assume welfare is driven by the consumption of all goods and services.

This is not a new argument. Kutznets' original conception of GDP as a measure included the household sector, see Coyle (2014). Adding together the flow of goods and services from what we will refer to as the 'two core accounts' – National and Household – would provide a clearly improved welfare measure⁸, although one should note that the continued exclusion of the welfare effects of

⁸ If the satellite household account could be produced on the required frequency, this would bring into scope all the free goods and services which have not already been captured (childcare, household transport services, household catering and cleaning services, etc). This area is vital: GDP is still, despite recent changes in the labour force, a 'male concept'. Even though female participation in the labour market has increased throughout the twentieth century, economic growth has been partly driven by the market (GDP) now delivering activities home-makers (who at least in the Twentieth century were predominantly female), would once have delivered in an unpaid household capacity (laundry services, restaurants, pre-prepared food and 'ready meals', formal childcare, etc). Whilst it is argued that technology has enabled the movement of activity out of GDP into the household sector, this probably continues to be dominated in volume terms by the flows

leisure time, which would need the creation of a Leisure Account, means it would continue to be an incomplete, albeit less incomplete measure of welfare than GDP.

Therefore, if we wish to produce a better measure of welfare than GDP, incorporating consumption of goods and services produced in the household, we need to ensure it captures all forms of consumption, whilst taking account of the impact of saving and delayed consumption. In short, whilst ‘income’ has been generally seen by the literature as a proxy for consumption, if one wishes to consider consumption of goods and services from outside the productive sector one must invest intellectual effort in mapping the equivalent ‘incomes’ which accord to these additional items to ensure they are captured in any new measure. So, the key question becomes how to define and measure the full range of ‘incomes’ which one would wish to use to provide an all-encompassing view of welfare.

Again, we do not start from a blank slate here, so it is worth considering why previous attempts at addressing this problem have not passed muster. The National Accounts, for example, include a number of aggregates of income (e.g. Household Disposal Income, Gross National Income, or Adjusted Household Disposal Income, Net National Disposal Income, to name just a few). Whilst household disposal income may initially appear to be a metric which accords to what we are trying to observe, it of course only captures the incomes from the productive sector, excluding incomes from the production of household goods and services,⁹ including services derived from capital owned or accessed by the household, leaving us with key gaps to fill.

This paper looks to this challenge and explores the degree to which reforms need to be applied within the conceptual scope of the production boundary, and to what degree we need to build a new welfare index which is the aggregate of the productive flows from the Household and National Accounts.

To do this, we start from the core proposition that given the reason identified above, that GDP is not a good accurate measure of welfare because it is incomplete, the route forward is best addressed by identifying and quantifying incomes and proxies for income which are currently not included in GDP, which one could count towards an all-inclusive welfare metric.

In short, is it possible to leave GDP as orthodox users currently require it, and create an alternative measure of welfare for modernisers through making pragmatic additions of incomes which are currently not in the scope of GDP, and how might one implement them?

3. Creating a spectrum of potential outcomes

This question can be broken down into two parts: 1) what additions would we make, and 2) where would they fall within a landscape of three broad scenarios:

- Changes to the measurement of incomes¹⁰ which the UK could apply to its national accounts now, consistent with ESA10,
- Changes to the measurement of incomes which the UK could envisage as being applied in any future iteration of the SNA, and which could be expected to contribute to a ‘*Future GDP*’ or ‘*future national accounts*’, which would move us towards a measure of welfare, or,

described above in the opposite direction, and whilst one may doubt the merits of the infamous Newcastle Brexit heckler that ‘*it’s your bloody GDP, not ours,*’ in terms of gender there is more than a grain of truth in this complaint.

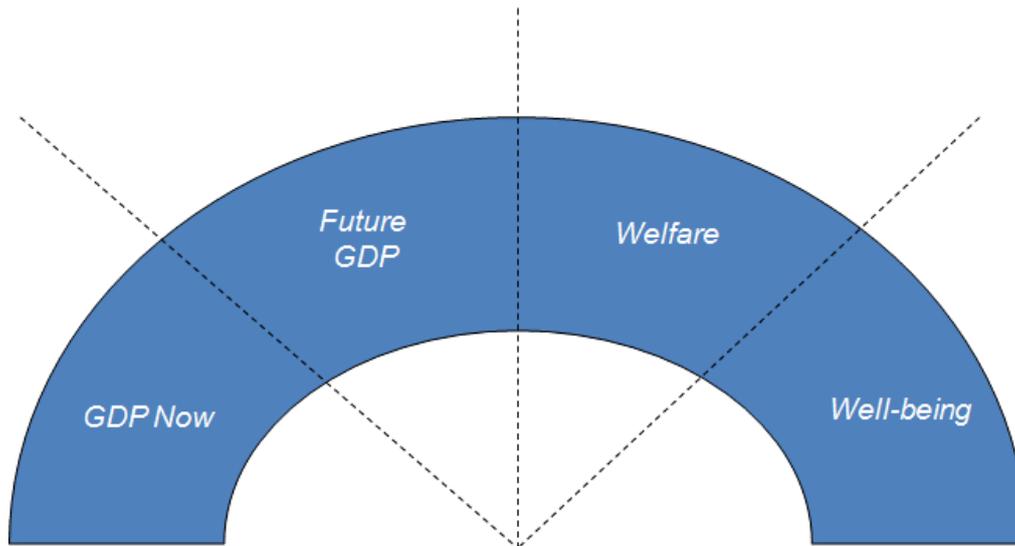
⁹ The household consumes the services of the house as part of household consumption. This must be paid for by imputing an equivalent flow reflecting income to expand the budget set so that the household can afford all it consumes.

¹⁰ Recognising these will come with production and expenditure equivalents.

- Changes to the measurement of incomes which would always lie outside conceivable GDP frameworks, and therefore would only find a home in some form of welfare index?

Let us imagine a spectrum (Figure Two): starting at GDP, consistent with ESA10, at one end ('*GDP Now*'), through a version of GDP which takes account of potential changes which the next SNA may implement ('*Future GDP*'), on to an economic welfare index ('*Welfare*'), until we reach the fully inclusive wellbeing dashboards and frameworks ('*Well-being*') at the other. From a practical perspective, the question is essentially: where on this spectrum would various ideas be implementable, and therefore what any new measures could look like?

Figure Two: A simple spectrum from market activity measurement to welfare



Thinking about moving around such a spectrum, it is worth reflecting on the drivers which could be addressed in such a transition. The three major aspects which this paper discusses do not just target improving the measure of *average* welfare. In this model we also target improving measures of inequality or the distribution of welfare, but also the sustainability of welfare. The authors consider it is only by capturing all of these aspects that any new proposition is likely to gain traction vis-à-vis GDP.

4. Future GDP

Gross Domestic Product (GDP) is one of the fundamental defining measures of the modern world, covering the level and growth of market production. It is comparable across both time and geography to allow policy-makers to evaluate the impact of their decisions, including in relation to productivity. It is a clear, logical and objective measure, delivered against internationally agreed standards.

However, these standards change. The System of National Accounts (SNA), based off an initial report published in 1947 have been revised in 1953, 1960, 1964, 1968, 1993 and 2008. These revisions have updated and amended key concepts and the recommended methods used to measure them. Both the European System of Accounts (ESA) and SNA are subject to routine updates and revisions, so concepts can and do change through time. Changes are based on negotiation and the latest research. Therefore, GDP is not static, but can change through time.

Equally, not every country fully takes on all changes simultaneously, and not all subsidiary guidance, such as ESA, is always fully consistent with the SNA. Considering these from a UK perspective:

- Whilst all European countries aim to fully comply with ESA10, Eurostat’s audits regularly identify areas where action is required to improve consistency within Europe. Therefore, there can be marginal variation within Europe, within a rolling regime of alignment activity.
- ESA10 is not fully compatible with SNA08. Whilst the vast majority of SNA08 was transcribed in the European rules, there are areas where different conceptual approaches have been taken. Therefore, the UK is not necessarily fully consistent with countries compliant with SNA08, or their own local interpretation of the SNA.
- Not every country outside the European Statistical System currently complies with all aspects of SNA08, so the UK is not necessarily fully consistent with these countries.

Indeed, if one were to look at the current work programme at the ONS¹¹, there are areas of improvement being implemented which will change the current estimates, including: improving deflators, particularly in relation to capturing quality change; double deflation; introducing new surveys of the services sector; and improving measures of trade. These are important, but this paper puts them to one side because they cause no changes to the conceptual boundary of GDP.

Public service quality adjustment

To start, we need to reflect on the fact that GDP is not actually one of the extreme options. GDP is often labelled as the ‘productive sector’ or our ‘measure of the market economy’. However, this is not strictly accurate. Whilst much of this paper will focus on the treatment of free good and services, this is a problem which is neither exclusively modern or only pertains to digital issues. There are a wide range of services which are ‘free at the point of delivery’, and currently equate to around a third of UK GDP, of which the most significant are the public services (for ease here, including charitable activity), and imputed rentals from domestic housing assets.¹²

None of these have a market price: we generally use the cost of the inputs, or direct volume metrics, to measure the value of the outputs from the government sector, and we derive the value of housing services through calculating the rental equivalence – what it would cost a household to access the same housing services in the rental market. In particular, in relation to the public services, the difference between the volume of the outputs being produced and the value of the outcomes these deliver is a well-known issue (Stiglitz et al., 2009; Bean, 2016; Atkinson, 2005). If we wish to accurately capture the value of the incomes and income equivalents received by households, capturing the difference between these is a vital step.

It is vital to consider these areas of the accounts when contemplating the question of what is the true total income of the UK, or UK households? Clearly one could argue that people pay tax and receive services in return, but is it always true that the value that consumers receive is equivalent to the tax they have paid? Surely the public services can create additional value added? The key question is how to estimate this value added, as this additional value delivered to households by the public services can be considered as effectively equivalent to an income by those using the services.

The UK is a world-leader in this quality adjustment of public services. The Atkinson Review (2005) sets a definitive framework for understanding how improvements in *outcomes* for citizens allow us to capture the welfare effects of these services, measuring them as more than just the sum of their inputs.¹³ This argument was accepted and included in SNA08, but not in ESA10, in part because there

¹¹ See ONS (2018a)

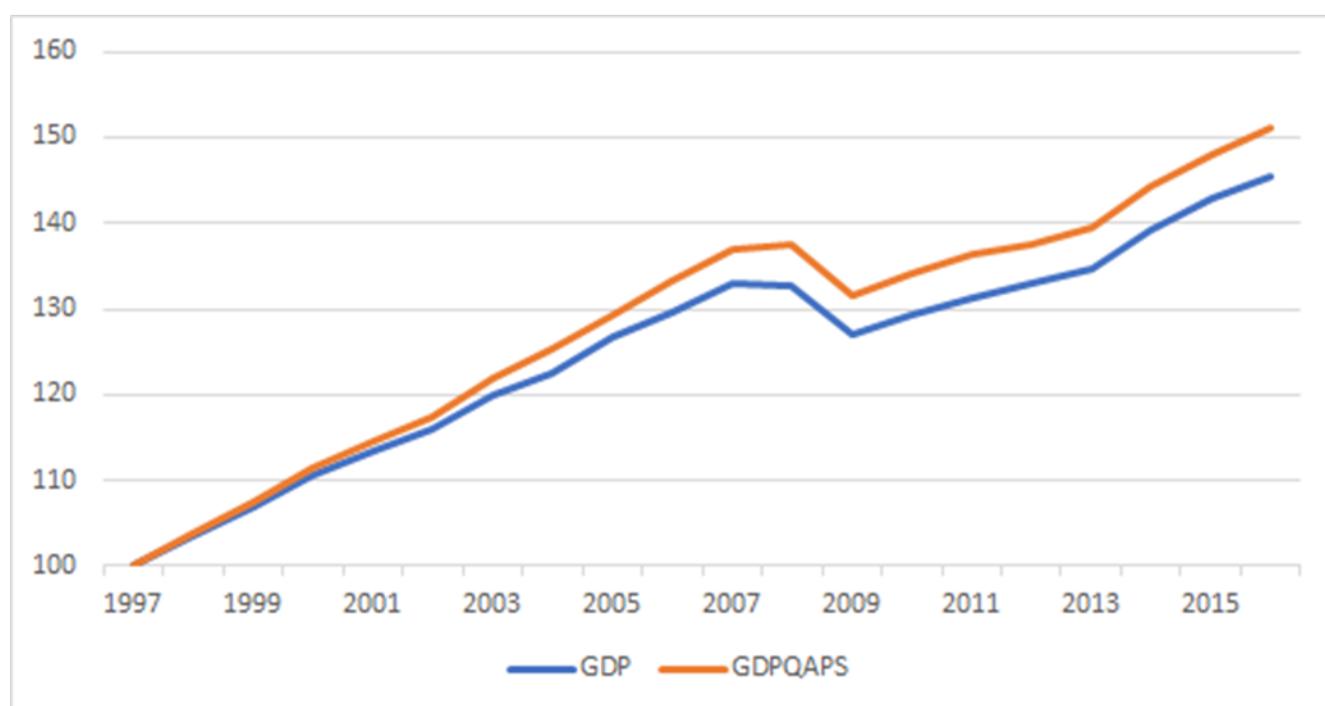
¹² Households who own their property receive a flow of benefits called ‘housing services’. The value of this can be imputed from equivalent rentals. This is included in the National Accounts to facilitate comparison between countries, particularly where they have different rates of owner-occupancy and renting.

¹³ That is, rather than counting the number of operations and the cost of these, we also take into account the welfare improvements received by users through improved mortality rates, shorter length of stay in hospital and lower re-admittance rates. It is, however, the case that the Atkinson Review may need reviewing in terms of the last decade’s attempts to apply it to currently available data sources.

was insufficient time or data available to define consistent methods for application across all EU countries. Therefore, if one were to argue that ‘*GDP Now*’ could be viewed as consistent with ESA10, with ‘*Future GDP*’ on an SNA08 basis, on-boarding this aspect of the ONS’s work into the national accounts and thus GDP would be a starting place¹⁴.

Would this be a substantive change? In the UK we can investigate this through the quality adjustments applied to derive Public Service Productivity (PSP) National Statistics, which are reviewed in Foxton, Grice, Heys and Lewis (2019). To support these estimates, which are not consistent with the National Accounts, quality adjustments are applied to the output of public services to produce Atkinson-consistent productivity estimates. Whilst other differences exist between the PSP and National Accounts systems, if one conducts a simple thought experiment (Figure Three)¹⁵ of applying these quality adjustments to the government services industries in GDP (sections O, P, and Q in the UK Standard Industrial Classification (SIC) 2007), one can observe the impact on GDP growth rates.

Figure Three: A simple estimate of an ‘Atkinson-consistent’ GDP including Quality Adjusted Public Services (GDPQAPS) compared to GDP (Blue Book 2018 vintage) (1997-2017)



Notes:

1. Growth rates of GDP and industry output taken from GDP(O) low-level aggregates.
2. Output growth not exactly comparable between GDP source data and public service productivity non-quality adjusted output measures, due in part to alignment of service area breakdowns (based on Classification of the Function of Government) and industrial classifications.
3. Public service productivity measures are not a direct match with the activities of government, including some third sector activity.

¹⁴ One could argue that ‘*GDP Now*’ could align with compliance with SNA08, and that this implementation could be undertaken therefore within ‘*GDP Now*’. This paper does not support this proposition. The losses in terms of comparability with our closest neighbours would outweigh the benefits which would arise from including these adjustments; the public services equate to around 20% of GDP, so this is better considered as a component of ‘*Future GDP*’,

¹⁵ This is a simple application of this method, and fails to take account of second-order effects which would result within a fully balanced national accounts framework, and therefore should be considered as only an indicative series.

4. Calculations do not consider second-round effects on GDP weights.

Whilst this would give us a different view of the recent past, it does not fundamentally alter the economic ‘story’. However, partly this is due to scope. The Atkinson Framework adjusts public service outputs to take account of the improvements in outcomes which are attributable to public service provision (e.g. health improvements through better treatment), as opposed to the full value of improvements in such outcomes, which may be determined by other factors, such as health improvements through lifestyle change such as stopping smoking.

Obviously, we require a consistent method for thinking about how to calculate the increase in value / equivalent income from both the public services (within the national accounts) and from other sources (potentially outside the national accounts). One approach to thinking about how to incorporate these adjustments is through a capitals perspective. Assuming these services are delivering investment into a capital asset, from which households receive a flow of benefits (or, in the jargon, capital services), the question is whether we can think of this flow of capital services as a form of income for households. This is actually relatively easy: services received for free which they would need to otherwise pay for are delivering an equivalent welfare gain at any fixed level of income. As such, we can conceptualise these gains as an addition flow of income which we should add to our measure.

An example could be that improved health leads (from the health and social care industry, SIC07 section Q) to increased life expectancy, which alongside investment in education (from the education industry, SIC07 section P) leads to growing human capital. Therefore, public service output in sections P and Q can be viewed as investment in these capitals within the national accounts landscape, but where would we put the contribution from other aspects? Again, there is an existing answer to this question within the SNA framework. These elements can be conceptualised as own-account investment in these capitals in the Household Account.

“Missing Capitals”

This way of thinking requires us to look to another proposed reform we could expect to see playing into future negotiations around a future SNA. Based on changes since 1968, the inclusion of an enhanced picture of capital assets, depreciation and other modes of depletion, and the resultant flows of services which are used in productive activity, is clearly an aspect of ‘*Future GDP*’.

There are key “missing” or excluded capitals from the National Accounts. The SNA makes a distinction between economic assets and non-economic assets. All economic assets and the income derived from them are within the asset boundary of the SNA as long as ownership rights can be established. All other assets are treated as non-economic assets and are dealt with outside the National Accounts.¹⁶ Therefore, when thinking about measuring welfare they do not generate income to be included in the measurement of material well-being but are included in assessments of well-being through the non-economic aspects of welfare such as quality of life or environmental sustainability.

There is a fundamental problem with this though: if these assets do contribute to the production function (and also need to be captured as outputs where this is not currently the case), and are not currently integrated into the National Accounts *and the Household Account* (as production can occur in either), then incomes which are derived from these are omitted and our welfare measure would inherently suffer. A simple example is the air-cleansing properties of trees: if trees absorb carbon and deliver a value we can estimate in terms of addressing climate change, then a programme which plants trees delivers an extra income to citizens over one which does not, but is otherwise exactly equivalent.

¹⁶ The SNA has several satellite accounts which deal with specific issues in detail and consistent with the principles of the SNA. The System of Environmental and Economic Accounts (SEEA), for example, takes up this challenge and includes both economic and environmental assets.

Our view of “missing capitals” includes natural or environmental capital, human capital, and some intangible productive assets¹⁷. Capturing these would provide a more rounded assessment of the inputs in use in our economy and the degree to which our society is sustainable¹⁸, as well as more accurately portraying the incomes accruing to citizens and how these are changing over time. Where these are vital to the creation of goods and services, including free digital goods, to not include these in the National Accounts leaves us with an incomplete view of the economy.

As we import more capitals into the National Accounts, as described under *Future GDP*, it is clear these will assist us in gaining a better understanding of the long-term impacts on welfare through the creation or depreciation of capital assets in their assorted forms. Consider life expectancy: currently an economic activity could increase GDP as measured today, with a cost of shortening life expectancy. GDP would view this positively, whereas this could be viewed as potentially detrimental to welfare through falling human capital, depending on how we discount benefits in future periods. Conversely, a policy which massively increased an uncapitalised intangible asset or natural capital might deliver substantive positive future returns and similarly could improve welfare, but this would not be captured in the current GDP measure.¹⁹

We have considered the components most likely to fit into a future measure of GDP, and how to capture them in a measure which would meet the general requirements of orthodox users whilst also addressing some of the core concerns amongst modernisers. This would address challenges in measuring the free goods already in GDP and produce a set of National Accounts which better facilitate growth accounting. In theory, these should be improvements in the eyes of both orthodox users and modernisers; however, we recognise the practical challenges to orthodox users, if only because of the scale of human capital stocks and flows.²⁰ Research by Corrado, O’Mahony & Samek (forthcoming) provides a methodology for attempting this.

However, as mentioned above, capitalisation of missing capitals into the National Accounts would not be sufficient. To capture the household own-account investment we need to move our horizon beyond the production boundary.

5. Welfare Minus

We phrase this section as ‘Welfare Minus’ because, we set aside distributional issues at this stage to focus on identifying the aggregate level of Welfare by capturing as full a range of incomes and

¹⁷ Included within this set of missing capitals are some intangible assets: SNA08 incorporated the majority of the Hulten, Corrado and Sichel (2005) categories of intangibles into the National Accounts, but not all of them. The strengthening of the inclusion of databases and other intangibles would provide clear mechanisms to improve the measurement of the economy and productivity, particularly when consumers barter their data for free content. Where these play a key role in our understanding of the production of digital goods, the omission of these may introduce a bias in our estimation of productivity in the economy. We can then look to the best way to use this expanded framework to cover the capital assets which deliver free digital goods and services

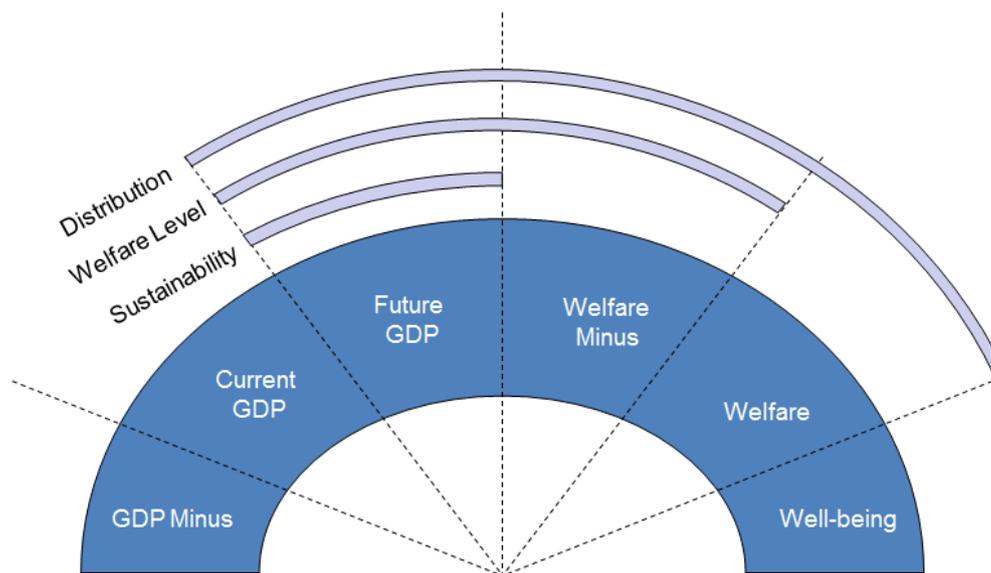
¹⁸ The completion of the capitals, and a full understanding of depreciation would render net measures (net domestic product and net national income) more pertinent than GDP and GNI, their gross equivalents. As we broaden out the definition of capital, the importance of the net/gross distinction rises, both in the aggregate, but also in terms of distributional effects. As intangible capital depreciates rapidly, from the perspective of welfare, this makes the upward revisions to GDP which result as more and more intangible capital is pressed into service misleading.

¹⁹ Indeed, if one considers agriculture, which has invested heavily in improving ecosystems and other environmental outcomes in recent years, alongside food production, if this investment in natural capital was also included in the National Accounts, the output of this sector would be expected to jump. Whilst this should be captured in the Natural Capital Account this paper assumes it is easier to simply add together two accounts, the National Accounts and the Household Accounts, rather than a composite of multiple satellite accounts, particularly when the capitals in these satellites are influential within the two ‘core accounts’ as defined here.

²⁰ In 2017, the UK’s real full human capital stock was £20.4 trillion, equivalent to just over 10 times the size of UK gross domestic product (GDP). Incorporation of this asset would significantly transform the capital stock in the National Accounts. See Vassilev (2018). Returning to the practical, this does not mean that one might not continue to publish a traditional GDP and augment it with a parallel ‘enhanced GDP’ publication, nor that future SNA revisions may not lead to this being used in the future, but the costs of this would obviously need to be taken into account.

income equivalents received by UK citizens. This is illustrated in Figure Four. *Welfare Minus*, therefore, is where we begin to combine components across the production boundary which would be applied into a welfare measure.

Figure Four: The key challenges behind each step in the spectrum



The ONS’s current well-being publication (for example Giles and Vassilev (2018)) contains a dashboard of ten metrics: real GDP per capita, net national disposable income per head, real household disposable income per head, median equivalised disposable income, real household expenditure per head, whole economy new wealth per head, household new wealth per head, perception of financial situation, unemployment rate and inflation rate (CPIH). Setting aside those which relate to unemployment, inflation or wealth, this leaves us five helpful measures which already exist: real GDP per capita, net national disposable income per head, real household disposable income per head, median equivalised disposable income, and real household expenditure per head. Clearly these indicate the prevalence of income metrics.

This is an area where there is an active academic literature, which this paper complements. Whilst this paper begins with GDP, and seeks to, from a pragmatic viewpoint, add omitted income and income-equivalents to better identify total value received by consumers/citizens, in doing so, we quickly move towards the metrics already proposed in the literature.²¹

If one looks to include an estimation of the full value consumers receive which relate to goods and services (including capital services) they receive for free, one could consider net household disposal income. This paper does not, because it is important to take a view across the whole economy, including those incomes which do not flow to households directly, but which they accrue either through the public sector or as shareholders when one considers income to businesses. Once one recognises the necessity of this one ends up remarkably close to net national disposable income, which is defined by Eurostat as ‘*derived from national income by adding all current transfers in cash receivable by resident institutional units from non-resident units and subtracting all current transfers*

²¹ For example, if in *Future GDP* one includes a wide variety of capitals, which depreciate at noticeably different rates, we would fail to fully tackle the capital question unless we address depreciation, building on the methods contained in the SNA and SEEA. As such the spectrum implicitly assumes that progress would take us towards a net, rather than gross, measure.

*in cash payable by resident institutional units to non-resident units*²², and which is often referred to in the literature as a feasible option. At the moment this is derived using estimates of social transfers and benefits in kind, but would exclude the outcomes related to increases in capital services from public services produced by adding quality adjustment into the National Accounts, or household own-account investment into the same outcomes used to generate quality adjustments for the public sector, or free digital goods. Adding these (as conceptualised in *Future GDP* and *Welfare Minus*, and laid out in Figure Four) would permit a more ‘welfare-inclusive’ estimate of Net National Disposable Income (NNDI_w). Controlling for population change through this experimental NNDI_w per capita measure would take us effectively to something synonymous to the welfare concept of interest²³, capturing the full set of goods and services (including capital services). This new aggregate based off the National Account and the Household Account would work as an effective proxy for welfare, akin to Jones and Klenow.²⁴ However, little of this is conceptually new, even if computationally or methodologically challenging. The key question of importance is to what degree the modern economy may require us to reconsider the range of incomes we need to consider, in particular if the modern economy causes real incomes and measures of output to behave in markedly different ways.

6. Why might the modern economy behave differently?

The modern economy has distinctive attributes which may affect a concept of welfare. The modern economy, for example, is increasingly digital, but the digital economy is a fluid concept. At its widest (see for example Reinsdorf, Quiros et al 2017), it is proposed that it covers all goods and services, transmitted, produced or intermediated via digital means. This definition is appealing because it reflects all the key impacts of the digital revolution. However, this paper fears it has a weakness: in presenting a maximalist view of what is ‘digital’, it ultimately does this by drawing everything which has a digital component in its supply chain into scope.²⁵

In due course, this paper fears a wide definition of the ‘digital economy’ will become as redundant as the ‘electric economy’ would have done if economic statisticians had been considering such a term in the early 20th century, simply because its scope becomes so all-inclusive it may ultimately capture all elements of production and consumption in the economy. This paper, therefore, focuses on a narrower definition, which in measurement terms can be made meaningful, although it recognises the wider work to explore how to capture wider conceptualisations of the digital economy. Our definition is:

Any good or service produced in a digital form, and consumed as either a final or intermediate product by any sector of the economy.

This scope is still wide, but is designed to capture, say, logistics software development, but exclude the traditional components of the logistics industry. It therefore deliberately excludes those goods and services *facilitated* by digital intermediation. In relation to digital goods and services sold by players in the productive sector, this paper identifies two key areas of output in the National Accounts:

²² http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:National_disposable_income

²³ Although Jorgenson & Schreyer (2018) suggest using the household as the unit of measurement, following appropriate equivalisation.

²⁴ This piece-meal aggregation of key components of welfare is not the same as structuring a measure around a social welfare function which reflects any diminishing marginal utility of resources. Jorgenson & Slesnik (1984, 2014) proposes using a logarithmic transformation of expenditure to represent consumption. This has various attractions, particularly when considering free digital goods: do twice as many cat videos watched via a free video-sharing platform (e.g. YouTube) deliver double the welfare gain? However, the treatment of public goods in this instance is problematic – does spending on defence and other collective services have similar diminishing returns characteristics, and how does one attribute these services to different parts of the population?

²⁵ Wherever the line is drawn in relation to digital (e.g. e-books) and non-digital production (a physical book purchase on-line) and the degree to which these are both part of the digital economy, there is an interesting question about services which only exist in that particular form because it has been facilitated by the emergence of the digital platform (e.g. Airbnb, Uber). Is Uber just a taxi company with a sophisticated digital input (the Uber platform), or an inherent part of the digital economy?

- Data (the vehicle for digital goods and services) is delivered to consumers via telecommunications services.²⁶
- Digital content transmitted to a consumer and paid for at the point of delivery (e.g. e-books or digitally transmitted paid-for music files).

However, the real issue from an accounting perspective is neither of these, but rather when digital services are delivered for ‘free’. Free goods are not, of course, new: free to air commercial television has been around for decades, so it is worth exploring what is different with the current generation of free goods. Currently, if firms make free goods or services, the National Accounts already captures the costs of this activity, as all spending by firms is included²⁷.

Strictly, in the National Accounts, the classic way these should be captured (although we will turn to the flaws in this shortly) is as follows: firms engage in fixed capital formation, such as through producing own-account software assets, which is used to provide (free) capital services to users, which can be characterised as a transfer in the form of an ‘income in kind’ to consumers. An equivalent amount would be recorded as household final consumption expenditure (or intermediate consumption for firms).²⁸ But for this activity to be profitable there must be some resultant income, as all firms must cover their costs to continue into the medium term. So, what is happening?

The answer to this lies in discerning whether the good is really ‘free’ or just ‘free at the point of delivery and/or consumption.’ ‘Free goods/services’ could actually be being paid for in at least one of four ways:

- **Advertising** – if the digital manufacturer creates an app and sells advertising space before giving the app away to consumers for free, the ‘free app’ will just be treated as a marketing expense in the National Accounts. Free television has traditionally been paid for via this means. This can either be direct (the free good is the advert), or indirect (the free good is paid for via advertising fees, normally in return for advertising space on the digital ‘page’). Such payments are already included within the National Accounts.
- **Payment in kind (barter payments)** – sometimes consumers do not pay in cash, but instead through a different means of exchange. In many cases, this is through a barter process whereby the consumer pays for the free good through granting access to their personal data. For example, users of online maps pay in kind to use the service with their personal data²⁹, which the provider then either sells on, or sells access to, or sells services from. This data has a market value, either again for advertising or product innovation purposes.
- **Patient investors** – This model argues that a patient investor will fund a ‘loss-leader’ product on the basis of an expected return in the future. This model might best be explained through services like Spotify, where a basic version of the product is given away free, but the

²⁶ The measurement issues in relation to this sector are considered in Awano and Heys (2016) and Abdirahman et al (2017).

²⁷ Free digital content has an upfront production cost, its replication and dissemination are effectively free, but has the capability to create future revenue streams (particularly in the cases where the driver for producing the good is personal advertising or revenue generation). As such free digital content could be considered as intangible capital investment equivalent to ‘own account software’. The creation of these products should therefore add to the capital stock of the producer, and be treated in the equivalent way to other capital investments in the National Accounts. The SNA takes the position that the value of an asset at any point in time is equal to the discounted flow of income it generates over its productive life time. It is this line of thought that determines the valuation of assets when estimating capital stock based on international guidance in the Measuring Capital OECD Manual.

²⁸ The key challenge then becomes how to value the flow of capital services, whose market price is zero, to eventually cover the cost of the initial fixed capital formation.

²⁹ Data on the following questions, among many others: Where do I go, what roads do I drive on, what speed do I travel at, what shops do I frequent, how long do I stay at these shops?

premium version is dependent on subscription purchases, creating a flow of revenue to cover the cost of the fixed capital investment and deliver a rate of return. The key question in this area is how the capital asset which creates the market (the free version), which allows future revenue streams (from the premium version) is valued. In this case the ‘free good’ is simply a ‘loss-leader’. They may also be accruing payments in kind (e.g. personal data) they can later sell-on.

- **State intervention** – we should not forget that the majority of free goods in the economy are provided free at the point of use by the state, paid for via taxes.

However, these approaches all are not without difficulty in implementation:

- As advertising is treated as an intermediate consumption good, in effect the treatment of these goods (even if it is consistent with established National Accounts principles) appears odd, with the costs of producing and disseminating the free good become an aspect of the delivery of an entirely different good or service (e.g. online maps being treated as intermediate consumption in the production of washing powder).
- The patient investor model requires us to split returns between the free and the premium version, in effect identifying the value of the option inherent within the free version, of purchasing the premium version.
- The barter model is clearly reliant on the capitalisation of data. Following international guidance, databases are treated as a fixed asset in the National Accounts, but this excludes the value of the data itself. In the UK, the current measure of investment in the ‘software and databases’ asset is based on survey data for the purchased component, and modelled primarily using labour-force data for the own-account component. These measures are, in practice, imperfect, and omit a key component contributing to the value of the databases – the data themselves. The result is that there is currently an un-capitalised intangible asset (data) outside the SNA08 framework, which means that revenues derived in some way (as previously discussed) from the database will be largely treated as income from other activities. It is likely therefore that both intermediate consumption and turnover from these ‘free goods’ are captured in the Accounts, but without the full inclusion of database intangible assets it is hard to assess the degree to which there are appropriately attributed.³⁰

³⁰ The definition of a ‘database’ in ESA 2010 (authors highlights) is: “***Files of data organised to permit resource-effective access and use of the data. For databases created exclusively for own use the valuation is estimated by costs, which should exclude those for the database management system [which is software] and the acquisition of the data.***”

SNA 2008 says similarly: “***Databases consist of files of data organized in such a way as to permit resource-effective access and use of the data. Databases may be developed exclusively for own use or for sale as an entity or for sale by means of a licence to access the information contained. The standard conditions apply for when an own-use database, a purchased database or the licence to access a database constitutes an asset.***”

Thus, the value of a database is the ‘value added’ by structuring the data, not the value of the data itself. If you use ‘personal data’ as payment for a digital service, then international guidance says *do not* capitalise the value of your data. It would instead say capitalise any work that the company receiving your personal data does to amalgamate and structure your data with other data (e.g. through linking, matching, sorting), such that they can make resource-effective use of it – e.g. to sell tailored advertising space at a premium. As such, the ONS currently only captures purchases of (in practice, more likely licences to use) databases or externally developed bespoke databases. In-house (own-account) development of databases are not captured in the same way as software, although ONS plans improvement in Blue Book 2019, which will address the capitalisation of the time of ‘data scientists’ or ‘data architects’ (see Martin, 2019).

The value of these revenue streams *should* be in the National Accounts, accepting that, as with many components of the Accounts they can sometimes be challenging to measure.

So, whilst the productive sector *should* be fully capturing the value firms receive from free goods and services made by firms, there is one production activity where there may remain gaps, which relate to what can be described as ‘pure home production’. This is where a household (the archetypal ‘*geek coding in their bedroom*’) produces a new product outside the market sector. This initial invention stage may be missed by GDP (i.e. the initial creation of Facebook), but once such individuals or groups of individuals incorporate they should be captured, including the value of the intellectual property they have created³¹. This may be with a delay, but this is a time-limited problem – suggesting the lost decade of productivity growth cannot be explained through this route³².

Whilst we can therefore theoretically understand the impact of free digital goods and services *within* GDP, the question is how to conceptualise the impact of these goods on welfare. Alternatives are expanded upon in Annex B, but we wish to move directly to what we consider the correct conceptual framework for thinking about this issue.

7. The impact of free goods on welfare

As argued above, conceptually, when one considers the impact of free digital goods and services within the productive sector, the current treatment, if correctly applied should capture this appropriately. However, it will not capture any welfare effect on consumers outside the production boundary. This paper proposes analysing modern free services such as search engines (Google), social media (Facebook), public databases (e.g. Wikipedia), and other publicly available apps (Google Maps etc) as per the approach below:

- i. The new ‘free goods’ are not ‘free’ but are paid for via a barter transaction.

In relation to the first point, whilst there is no monetary payment, this paper is going to assume in the absence of any other clear rationale for a firm to give a free service to the consumer that said consumers are paying for these goods and service with their personal data.³³ As Tett (2018) and others have argued, what we see in the digital market is the re-emergence in developed nations of a significant volume of ‘barter’ transactions, where consumers pay the service provider (e.g. Facebook corporation) through allowing them access to their personal data. This transaction is undertaken by consumers in the light of the fundamental value they receive from the digital services they can access. The assumption of this being the process in place allows us to make two decisive steps forward. Firstly, because barter is recognised in ESA10 we can capture these transactions in the National Accounts, but secondly it provides us a line of sight of how to value these transactions, as shown in Figure Five.

In this Figure, the left-hand side represents the productive economy and the right-hand side households. Starting from the top left, firms create capital assets and provide the capital services to households without cash payment. In return households release access to their personal data. Firms use this data to create databases. These can be used to target advertising or other services to other firms to invest into their production process.³⁴

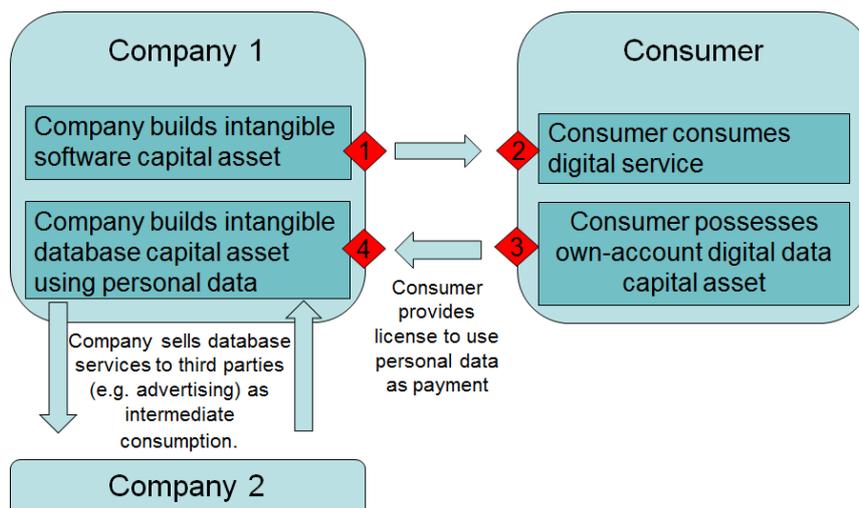
³¹ For example, through K.1 (economic appearance) in the ‘other changes in volume account.

³² Pure home production could also be a type of investment by the household. For example, coding an app, or writing an exciting economic statistics blog, could be seen as a personal investment in improving one’s reputation and CV, for the eventual reward of higher wages. This can deliver welfare to others, for example anonymous Wikipedia edits.

³³ This is an assumption or theory which can be challenged. But for the moment it is the basis we are working to.

³⁴ In this simplified case we observe the addition of the free good has added to aggregate welfare, however, there is a question whether the free good has thus ‘crowded out’ some market activity. For example, now on-line maps and sat navs are available, how many cars still have a road atlas in the glove compartment? This is a fundamental insight around

Figure Five: Understanding Data Barter Transactions



So, what is the value of ‘raw data’? Using the Atkinson framework as a starting point it is clear we should focus on ‘value’. After all, this is the driving force in this market: companies give away their product to millions of consumers for no money, simply because they place a value on the data they acquire.

This basic mapping allows us to identify four ways of estimating the value of the barter transaction, as numbered in the red diamonds in Figure Five:

Value 1: The cost of production of the capital services.

Value 2: The value the consumers / households place on receiving the capital services

Value 3: The ‘willingness to accept’ price that consumers place on their personal data being available to others, or put another way the value they place in their own data, a license to which they have bartered in payment.

Value 4: The value Company 1 places on the data as an intermediate consumption input into their production of the database described in the Figure.

Viewed from this perspective, two equalities become clear when considering the firm and consumers:

- The firm’s equality: **Value 1 ≤ Value 4**: that is, firms will invest in building their capital asset, up to the point where the cost of producing the capital service given away in exchange for personal data is less than or equal the value to the firm of the personal data.
- The consumer’s marginal equality: **Value 2 ≥ Value 3**: that is, firms will accept free services up to the point where the marginal value of these free services falls to equal their willingness to accept price for their personal data.

These two equalities have the resulting implications:

- The rational firm gives away capital services to the value of the data received. There is therefore no value added from the household sector. Whilst the firm is using a new

considering free goods. It is possible for benefits to accrue not through traditional GDP, but instead through directly driving positive growth in economic welfare from consumer surplus, even whilst GDP is falling. Finally, the aggregate price level in this example has fallen, reflecting the downwards pressure on prices from free competitors. This is before any requirement to adjust prices to take account of quality change in purchased goods from new free digital intermediate consumption. Note this is distinct from adjusting prices to ‘take account’ of free goods: in this set-up, free goods do not play into the estimate of price deflators for the market volume.

intermediate input (data) this is equal to the value of the capital service created within the firm and already in the National Accounts. In effect, the National Accounts give the correct value of the firm, but for completeness two new flows (digital services out of the productive sector and personal data into the productive sector) need to be created (as per the OECD's Digital Supply-Use Tables), but these are always of equal and opposite value. As such, whilst the wiring needs to be re-worked the value of GDP in the National Accounts will not change.

- Consumers will take on free services until the cost, in terms of access to data, is too great. As such the willingness to accept price is the floor price for free services.
- Consumers may value the free services higher than the willingness to accept price. There is therefore a secondary question on how to treat this extra value.

This third bullet is of absolute importance. Brynjolfsson et al (2019) argue that the excess of value over price as a classic consumer surplus. They then proceed to calculate how to estimate consumer surplus over the basket of goods to add this aggregate value to GDP to produce a new measure (GDP-B). Whilst instinctively and mathematically powerful, we put forward an alternative proposition:

- ii. The new services are not consumption services.

The major difference between free to air commercial television and the new free digital services is that, setting aside the ubiquitous 'cat video' and other media content, the new free digital services are not final consumption goods, but intermediate consumption goods.

As discussed above, the household is not just a consumer, it is also a producer of 'own-account' goods and services. The new digital products are in the main intermediate consumption goods in the production these own-account services. For example, one of the authors spends a seemingly large proportion of his time delivering free taxi services for his teenage and younger daughters. Google Maps, as an example, allows the same outputs to be produced with lower labour inputs (he spends less time driving as he avoid traffic jams). Other examples relating to own-account communication services can be quickly identified (e.g. Whatsapp is a free and immediate alternative to writing and posting a traditional letter).

This is an essential distinction because whilst consumption goods can generate consumer surplus, intermediate consumption goods can only make production more effective and therefore increase 'own-account' value-added in the household account. Rather than viewing the values provided in experiments by Brynjolfsson et al (2019) from consumers as estimates of consumer surplus, the alternative is to view these as consumer's estimate of the increase in value added in the Household Account from the own-account goods and services produced, which are affected by the arrival of these free intermediate consumption inputs.

This is a key insight because instead of valuing consumer surplus in the National Accounts context, these data could be used to estimate the increase in value-added in the Household Account. The excess of **Value 2** over **Value 3** is therefore an increase in value-added in the Household Account. This insight massively simplifies our welfare problem as suitably adjusted, the sum of the Household Account and the National Accounts can therefore continue to be viewed as a consistent measure of welfare, allowing us to continue to set aside issues of consumer surplus as GDP has traditionally done.

Two further interesting thoughts emerge from this framework:

- Did individual data always have these value characteristics, or has the emergence of the new digital companies created a market for this asset which has driven up its value? In short, has the creation of the digital economy 'endowed' each individual with a one-off revalorisation of their personal data, which they have been able to use in this barter market as a new unearned

income endowment? We would need to capture this in the ‘other changes in price and volumes’ accounts in the Household account.

- The marginal value of one person’s personal data (or more correctly ‘observation’) to a company is inherently zero, but it holds a shadow value which can be released via being developed into data and a database asset when combined with the observations gained from a large number of other individuals. This value-added is created in the productive sector by producing a marketable product, either through licensing others to use the data, or through producing a data driven service (e.g. credit scores/pricing advice/demand forecasts/targeted ads, etc)³⁵, but the shadow value is the driver of the expenditure which delivers us the firm’s value of this data. Nevertheless, as the value of the database is generated in the productive sector, it continues to be an intangible asset in the National Accounts.

To tackle this, we would need a willingness-to-pay type methodology proposed by Haskel, Corrado, Fox, et al (2017), building on the research by Brynjolfsson et al (2018), and Diewert & Fox (2017). This would deliver an estimation of the value consumers feel they receive, as it is doubtful whether the man in the street would distinguish between a consumer surplus or a change in household value added. Such a willingness to pay experiment could be combined with a time-use survey to place a value on the time using free digital content, and to ask the public the value they put on their personal data.

The difference between these two is obviously the net change in income for the household from the barter transaction, which can be seen as an increase in value added within production within the Household sector. This could be added to Atkinson style welfare estimates for public service outcomes not attributable to public services to deliver the estimate of additional incomes from the Household Account to go into a measure of welfare. This, therefore is the method recommended by this paper.

8. Welfare

If we define net national disposable income (adjusted for welfare) ($NNDI_w$), as the summation of GDP enhanced with quality adjustment for free public services, taking account of “missing capitals”, and the value of goods and service produced within the household and measured by the Household Account,³⁶ it therefore seems clear that $NNDI_w$ would deliver us Welfare Minus as per Figure Six. Being a single number estimate, it would not, of course capture any change in the distribution of resources, although this is a standing issue in relation to GDP and the national accounts.

Moving to ‘Welfare’, one of the issues of $NNDI_w$ is that it remains, despite being fundamentally more inclusive, what Weale and Aitkin (2017) would describe as a ‘*plutocratic*’ measure. That is a measure which reflects the average household, not the average of all households.³⁷ This approach steers us towards an approach which takes distribution into account directly, particularly if we capture the growth rates of different percentiles of the economy.

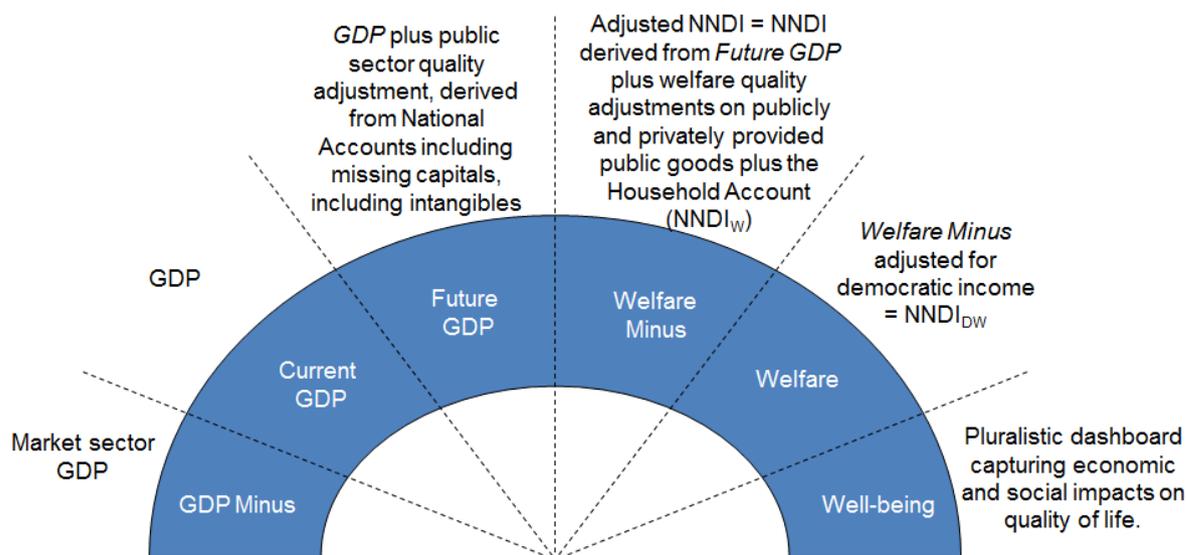
³⁵ See Li (2018) for an excellent mapping of such mechanisms.

³⁶ Under SNA08 all digital content produced by households for the consumption of those *outside* the household sector would be within the SNA production boundary and therefore in the National Accounts. What is outside the National Accounts is the household production of services for its own use with two exceptions i.e. *owner occupied dwelling services* and *domestic services only*. These are what the SNA2008 describes as *unpaid household activities* that lead to the production of *unpaid household services*. For a discussion of these see SNA2008 paragraphs 29.143 – 29.161 and for the rationale for excluding them from the boundary of the SNA see SNA2008 paragraphs 1.41 – 1.42.

³⁷ Consider a billionaire purchasing a £60m yacht. In this instance, in an economy of 60 million people, the average basket of goods across all consumption would contain £1 of luxury yacht per consumer, which clearly would not reflect the experiences of the average consumer.

This paper advocates that such an approach is the natural complement to capturing more components into our measure of welfare, as clearly at least some of these have clear distributive effects. Life expectancy, schooling and access to digital technology all clearly correlate with the income distribution, and therefore one can assume that welfare adjusted measures of income will behave similarly. There is, however, merit in considering a phased approach, akin to that described in Figure Six.

Figure Six: A simple spectrum from market activity measurement to welfare



Finally, we have to consider the appropriate deflator if we are to use a welfare measure derived from the income conceptualisation of the National Accounts. Should we deflate $NNDI_w$ with the consumption deflator rather than a variant of the GDP deflator if it is to serve as an indicator of welfare accruing? Jorgenson and Schreyer (2018) review different methods and conclude that ‘applying the deflator for private consumption expenditure from the national accounts constitutes a reasonable method to derive measures of real consumption.’ Aitken & Weale (2018) propose a ‘democratic’ CPI which is a theoretically appropriate deflator for deflating the mean of log consumption, as its growth rate is an average of each family’s growth rate of real income. This delivers a measure which can be easily explained as the average rate of growth of each family’s real consumption - and thus a measure which treats all households equally. This paper advocates using this approach.

9. Well-being

This paper has deliberately drawn a distinction between economic welfare and well-being. There are many factors which improve life beyond the economic. It is theoretically possible to attribute a value to all of these and include them into a single economic welfare measure, objectively weighted according to value. However, the practicalities of doing this, for example for the hundreds of indicators contained within the UN’s Sustainable Development Goals, make this presently beyond the scope of NSIs without very significant further investment. Given the amount of work necessary as described in this paper to create a ‘basic’ measure of economic welfare, this paper essentially treats these ‘well-being’ aspects as out of scope, but from a practical base, not an ideological one.

10. What has already been achieved?

A key viewpoint for understanding the implications of these proposals is to consider the degree to which these data already exist in the UK context. Taking each of the key areas in turn, this section summarises the estimates currently available.

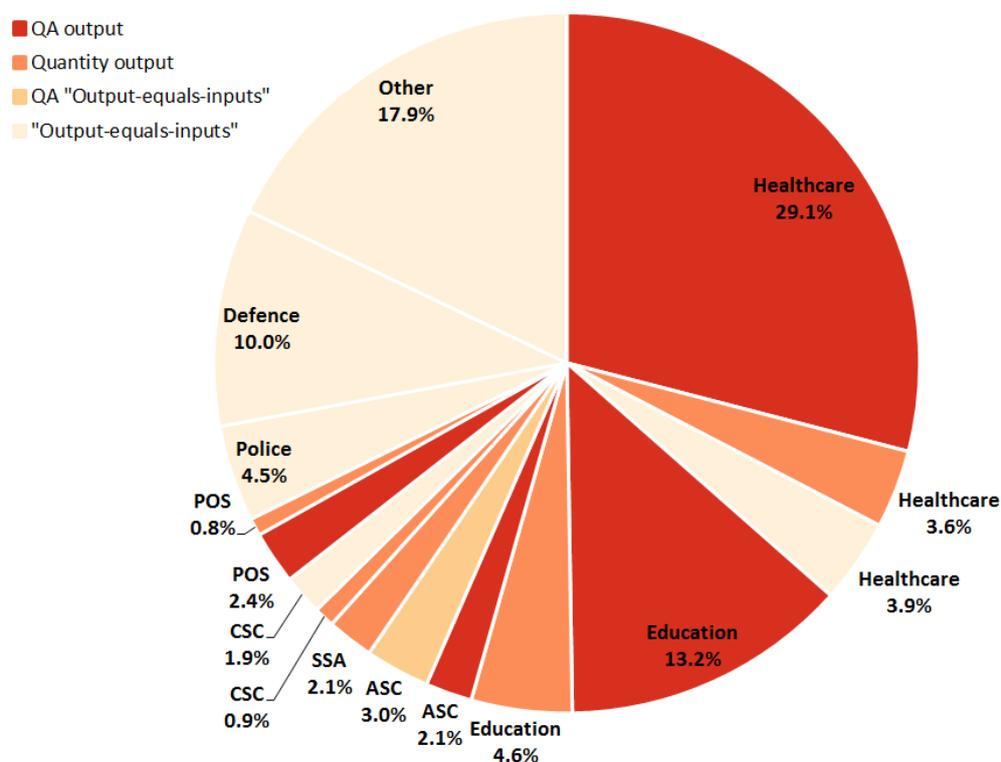
Public Service Outcomes

Since the Atkinson Review the UK has delivered public service productivity estimates which take account of inputs, outputs and outcomes where available. These estimates build up in terms of complexity on a scale dependent on data availability:

- Where it is not conceptually possible to identify an output on a service delivery approach, (i.e. the defence sector, where the ‘output’ is ‘the ability to defend the country’), output is taken to be equivalent to inputs.
- Where outputs can be identified, but outcomes may be problematic to relate to these outputs, we measure outputs and inputs separately to deduce productivity growth. One such area would be tax administration, where we can observe the number of tax incidences handled per staff member, but this would not capture any quality aspect of taxes missed or incorrectly collected.
- Where outcomes can be identified, this data is used to augment output data to capture the full effects of government spending. At present, healthcare, education, criminal justice and adult social care have outcomes-based quality adjustments.

Figure Seven describes the current picture and demonstrates that whilst around half of the public services are quality adjusted in the 2019 publication, this still leaves around half of all public services to be similarly adjusted. Clearly, whilst the methodologically simpler areas have been addressed first, continued investment to keep these up to date are required.

Figure Seven: Output-type share by service area, 2016, UK



1. Output in some service areas (for example, healthcare) comprise a mix of the different output measures.
2. Sum of components may not equal 100 due to rounding.
3. Other refers to other government services which include services such as economic affairs, recreation and housing.

4. Public order and safety includes courts and probation services, the prison service and the fire service.
5. QA refers to quality adjusted.

However, as Foxton, Grice, Heys and Lewis (2019) point out, the application of the Atkinson approach has focussed on identifying metrics which closely align to the public services' contribution towards relevant outcomes, rather than valuing those outcomes per se. The clearest example of this is in relation to health where average life expectancy is *not used* as the outcome measure because multiple authors have identified that only a fraction of changes in life expectancy are caused by changes in healthcare provision. Therefore, the ONS currently applies a detailed methodology capturing multiple aspects of the impact of various healthcare outputs to identify the contribution of healthcare services exclusive of other influences on health outcomes. Under the approach described in this paper, however, Foxton et al. (2019) propose moving to modelling outcomes (such as changes in life expectancy) in their totality, dividing this into the fraction attributable to the public sector to go into the National Accounts and the residual to go into an estimate of household own account investment into these human and social capital assets.

It appears possible to quickly develop alternative outcome-based models on this basis to cover at least the services for which quality adjustments already exist (healthcare, adult social care, education and criminal justice), and possibly others – for example, children's social care could be modelled using an amalgam of human capital from the education quality adjustment and re-offending from the criminal justice model, to capture the different impacts of a service which aims to both prevent negative life choices and support positive ones.

Missing Capitals

The ONS produces a wide variety of estimates of capital, either from within the National Accounts (Groves 2018), through the surrounding satellite accounts (Connors & Thomas (2018), Vassilev (2018)), but also in relation to the missing intangibles (Martin (2019)). Whilst Annex A provides a universal snapshot of capital in the UK, there are four issues across this set which we would need to consider:

- Completeness – whilst many of the current measures capture stock, inflow, depreciation and other outflows, this is not a universal picture. Equally some areas, such as social capital (Morrison (2017)) currently only provide qualitative data without quantified outputs, and some other areas only have partial quantitative estimates (Connors & Thomas (2018)).
- Appropriate deflators to derive volume measures – the data in Annex C is presented in nominal terms as many of the estimates cannot currently be derived in volume terms, as identifying deflators to convert these into volume terms on a consistent basis contains some key challenges.
- Double-counting – the different measures of capital are produced for different purposes. For clarity, Annex D contains a short summary of where the same information feeds into different measures, which would need to be stripped out if these are being added together, which the generation of Annex C revealed.³⁸
- The appropriate flow of services around the economy – increasing the scope of capitals under consideration raises serious questions about who 'benefits' from these capitals. The simplest example of this is that human capital is owned by the household sector, but the services from human capital are consumed in the productive sector. The authors plan to explore this issue in greater depth in a future paper, and how a wider set of capitals would require us to re-conceptualise the allocation of capital services to the 'consumers' of these services, rather than the 'owners' of these capitals. This structure may also address issues relating to cloud computing and other 'capital services' which are currently 'consumed' in-year as a non-

³⁸ With particular thanks to Emily Connors who created the content for Annex D.

capital cost by those companies who use these services, including infrastructure. This is a complex field and worthy of deeper consideration.

Digital Measurement and Distributions

The ONS has commissioned a UK ‘willingness to pay survey’ via the Economic Statistics Centre of Excellence (ESCoE) and a parallel ‘time use survey’ is being launched to test the feasibility of gathering suitable data from citizens which could populate this section of a *Welfare Minus* measure. Similarly, the ESCoE is developing the required methods to deliver democratic price indices to serve as deflators, drawing on previous ONS work.

11. Conclusions

Fundamentally, a measure like GDP will continue to be of value in informing government’s fiscal and monetary strategies. However, it is struggling as a measure of change at the innovative frontier, and so it is logical to look at how a complementary measure could be used. Whilst Stiglitz et al (2009) encourage the focus to no longer be on improving GDP as a welfare measure, recent studies (Brynjolfsson et al (2019), Hulten and Nakamura (2018)) show there remains an appetite for this approach because of the dominance of GDP over political debate. National Accounts frameworks which try to produce alternatives which simply re-hash existing data have clearly failed to capture the policy-makers imagination so whilst GDP is theoretically a (weak and incomplete) measure of welfare, it is clear we need to consider how we can build on it to deliver a viable alternative which could have traction in the debate.

This paper attempts to do this through applying basic tenets of National Accounting – focusing on value added, the correct identification of goods and services into final and intermediate consumption, focussing on the totality of income and the growing importance of the appropriate and accurate treatment of capitals – to produce an alternative measure which addresses fundamental issues since the inception of the framework of National Accounts to deliver something consistent but more complete than GDP to act as a measure of welfare.

This paper argues that to deliver meaningful changes in economic statistics one needs to be aware of the constraints (driven by user needs as much as international frameworks) as well as the opportunities, but also the ‘layered’ nature of potential reforms. This ‘layering’ is driven by practical considerations around prioritising those areas already within the production boundary, particularly ‘free at the point of delivery’ services which are not yet quality adjusted, and the completion of the capitalisation revolution which has been under debate in SNA revisions since 1968.

This is not to argue that the welfare impacts of new digital ‘free at the point of delivery’ services is in some way less important. This paper absolutely argues that understanding these is vital to inform users, but places them second in its prioritisation simply because there is no value to be gained in building a new statistic on foundations of sand, particularly when we can fix those foundations as described under *Future GDP*. This would deliver significant gains in and of itself, not least in improving our understanding of the drivers of productivity growth in the economy.

When reviewing this spectrum, one final cross-check can be carried out to review whether all the significant areas of suggested reforms from modernisers have been captured, or whether this model fails to capture some key component which would benefit from inclusion.

Putting aside those explicitly addressed, this paper sees two further topics:

- Finance and FISIM – Mazzucato (2018) argues that the current position of finance within the production boundary, compounded by the use of the FISIM (Financial Intermediation Services, Indirectly Measured) method to measure it distorts our perceptions of the economic health of modern, developed economies. Her fundamental question is whether we should

view finance as creating value or merely as an intermediate input into production. This paper has considered adding elements to GDP, not taking them away, as the current SNA/ESA is the implicit base for the spectrum described above. Nevertheless, it is important to note this is an area of debate. The Bean Review (2016) also investigated FISIM, and the degree to which, as a minimum, it needs to be risk-adjusted as a methods improvement.

- Imputed rentals – as Coyle (2017a) notes, currently imputed rentals from household capital goods can be found either in the National Accounts (owner-occupier housing), or in the Household Account (other household capital items, household digital goods which behave like a capital³⁹). Whilst there are good reasons for doing this to allow for international comparisons of GDP, if we were to produce a welfare index, which could include the Household Account, the question of whether imputed rentals from owner-occupied housing should be located in GDP would need to be addressed. This imputed rental already complicates productivity calculations by providing a significant distortion⁴⁰ and as such is frequently excluded. Therefore, whilst having imputed rentals in GDP helps to improve international GDP comparisons, they equally weaken international productivity comparisons, meaning this debate is not cut and dried. Imputed rentals from owner-occupied housing may be better homed in the Household Account. However, if a *Welfare* measure was created, this would merely result in a re-positioning of this component from the GDP part of the equation to the Household Account part. One could take this as either being a supporting argument for moving this element, or as making this move moot.

In reviewing these, the spectrum as proposed is a solid start in moving forward, and even if these issues were to crystallise as priorities they could be addressed with the proposed suite as refinements without needing to radically reshape the work necessary to create the new components. In short, they would be complements not substitutes.

Therefore, how to move forward? This paper sees a number of key steps, which could, in combination, deliver a viable route to the routine production of a welfare measure with a clear relationship to other economic statistics:

- Estimates of quality adjustments for the full range of public services need to be created, before they can be applied to GDP in line with the Atkinson methodology. These adjustments need to be applied to all three measures, as extra output, extra imputed income and extra imputed expenditure.⁴¹
- Estimates of uncapitalised intangible assets and other missing capitals, including time series into the recent past need to be created and applied to the National Accounts. Annex C outlines the starting point for this.
- To facilitate these additions, a headline, simplified, version of GDP may be required, stripping back much of the granular detail in the first instance to allow these transformations to be applied. As these data would not be consistent with SNA08 or ESA10, these would need to be seen as an experimental series – GDP(X) – even if future iterations of these frameworks may ultimately catch up with this presentation of economic statistics.
- Improving the frequency of the Household Account from annual to quarterly to allow timely routine production of a welfare measure.
- To estimate the welfare implications of new digital ‘free at the point of delivery’ goods, research to understand UK consumer’s willingness to pay, alongside time-use work to

³⁹ Purchased once and used in perpetuity at marginal cost of zero.

⁴⁰ Imputed rentals from previous investments deliver output with no commensurate inputs in the current period. As such productivity in the light of imputed rents of £x can be infinite ($x/0 = \infty$).

⁴¹ Work by Soloveichik (2018) on the changing value of retail services delivered alongside retail items could also be used to generate a quality adjustment for retail, taking account of the integrated nature of the bundle of goods and services inherent in any retail experience.

understand the volume of use and home production seem currently the strongest methodologies available to capture these components. Importantly the willingness to pay element may need to consider whether it could capture historic changes in these valuations. It is a key concern that many of the key changes have occurred in the past, and that understanding welfare from this point on may fundamentally miss the key events causing the perception that welfare and GDP have different growth paths.

These steps would enable the delivery of a *Welfare Minus* series, but all require significant investment. The necessity of increasing the frequency of production of the household account to move to a *Welfare* measure which captures distributional aspects would require further research and moving through to routine delivery of democratic income based on NNDI_w.

Is this an impossible shopping list? What scale of investment would be required to develop these measures and take them into routine production? The authors consider that additional investment would be required, but is more likely to be millions rather than tens of millions of pounds per annum. The question therefore becomes: would the benefits of having these additional data outweigh these costs?

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Annex A: The Characteristics of GDP which any new statistics must be able to overcome

What is it about GDP and how it is produced which makes it more useful to policy-makers than alternatives? From a practical perspective, it is vital to understand its key characteristics, the factors which have allowed it to claim this status, if we are to prevent the creation of ‘white elephants’: statistics which fail to win sufficient favour amongst sufficient users to make a difference.

All statistics live and die by their perceived ‘quality’, but what makes up this attribute and how should it be evaluated? This paper argues ‘quality’ is a composite of a number of different characteristics, and it is easy to see that GDP has relative strengths against many of the most important of these:

- **Frequency** – the data must be published with regular enough frequency to be able to be used to monitor the performance of policy to inform routine decision-making (e.g. setting of interest rates by the Monetary Policy Committee), key fiscal events (OBR forecasts, budgets, spring statements) and ad-hoc policy decisions. GDP, which is currently published quarterly and monthly in the UK, is able to routinely inform the political economy debate. This is not currently the case for the Household and Environmental Accounts, for example.
- **Accuracy** – the data must be accurate, which in relation to a composite metric such as GDP, drawn from many sources, requires complete conceptual coverage of the relevant components and a full set of data being available to fully populate the output.
- **Timeliness** – the data must be produced quickly enough to inform the current debate. GDP, which is published with a lag of three months provides sufficient insight to still be relevant to the debate as it is published.
- **Comparability** – the data must be able to facilitate comparisons which can inform the policy debate in the light of previous similar events. In the case of GDP this comparison can occur going back into the past to compare with previous performance in the UK economy, or internationally to observe how other economies are addressing similar challenges. A reliable and comparable back-history of internationally comparable data is a key strength that GDP possesses.
- **Granularity** – the data must be able to be disaggregated to allow comparisons of different parts of the whole – whether it be by industry, region, or the characteristics of the economic actors. GDP possesses sufficient data density to permit this type of granular analysis to be implemented.
- **Accessibility** – the data must be accessible to all users. GDP, which we all have seen on the news since childhood, could be said to suffer from being too accessible. As a single point estimate it is easy to communicate, understand and contextualise against other countries or time periods, which a dashboard of indicators cannot do as easily.

In aggregate, these factors set a high bar, but in reality the bar for a new statistic is often even higher, due to two further facets of economic statistics:

Statistics are hard to stop.

Statistics can gain a capacity to live on beyond their natural usefulness or lifespan. Once users have acquired the habit of using a specific measure it can be difficult to get them to move on to use something else.

Whether this is due to model inertia⁴², the fear of losing the accrued knowledge derived from closely monitoring a particular series for an extended period of time, or simply because users honestly believe it to be a good quality metric of the specific concept they are attempting to grapple with, sometimes NSIs can face challenges in making such changes. Of course, this situation is worse for advocates of change when there is a strong lobby arguing, with justification, that the statistics under discussion

⁴² The fear that replacing one data feed with another may erode the forecasting accuracy of a previously successful model.

continue to be needed on their current basis into the future. This can be observed for GDP, where orthodox users of GDP require an orthodox measure, because of the role it plays in setting fiscal and monetary policy.

Statistics are not free to produce, and delivering headline statistics can crowd out alternatives.

It is also unfortunately true that collecting and publishing statistics can be a costly business, requiring specialised staff with professional skills, which are often in scarce supply.

It is these propositions which have brought us to where we are today: NSIs are obliged to produce certain statistics, such as GDP and GNI, either by law, international requirements, or because orthodox users require them. Due to funding, data and staff capability constraints, they have not routinely produced alternatives which can compete with GDP, despite there being a clear demand from users.

However, just as the modern economy is changing, the conditions for creating economic statistics are changing at the fastest pace in their history. New technology, new methods, new data sources and new data collection techniques mean that we stand at the cusp of being able to create affordable measures of concepts which were previously beyond our grasp. Therefore, the fiscal barriers to creating ambitious new metrics are crumbling and the impossible is coming within reach. This allows us to aspire to use the right measure for the right concept, potentially weakening erroneous relationships, such as GDP being perceived as a measure of living standards.

Annex B: Alternative methods of valuing free digital services

This paper recognises valuing free digital services is a live area of debate, and that there are multiple models for considering how to value these. Using the Atkinson principles to guide us may provide a means of estimating the relevant quality adjustments for those products which share characteristics with publicly delivered public goods and services. Specifically, that is those which, following the purchase of the required hardware and any commensurate software licenses, are non-rivalrous and non-excludable; that is consumption by any one consumer does not impair the ability of another consumer to also consume the good, and no member of society can be excluded from consuming the good. Methods which could be used include:

- Nakamura and Soloveichik (2017) propose assuming that consumer's time can be valued as an input into the production process for advertising, in terms of them delivering a service to advertisers – in essence hours on free apps are hours 'spent' (in the economic sense) observing advertising. Consumers and businesses receive content in exchange for exposure to advertising or marketing. Whilst different from the model proposed above, this approach treats the provision of the 'free' digital content as payment in kind for viewership services produced by households and businesses, rather than user's data. This approach does not provide a willingness to pay or welfare valuation of the 'free' content. But this approach does provide an estimate of the value of the content that is consistent with national accounting estimates of production. It does however open a wider debate about how far consumption should be viewed as an input into production. For this reason, this paper sets aside this approach.
- Awano and Heys (2016) point out that some free digital content has market equivalents, where we could source shadow prices from those observed in the market, which we can use to generate 'imputed prices'. The example provided was free statistical software, such as R. Close substitutes, such as SAS and STATA, are commercially available and market prices for these can be used to generate imputed prices. Equivalently the price of Microsoft Office could be used for free Google equivalents, or the price of commercially available computer games could be used as an imputed/shadow price for many games-type apps. Newspaper and blog/comment websites, where these are not behind a paywall, could use an imputed price based on those paywall charges. The issues with this model relate to the costs of achieving universal coverage of shadow prices.

Annex C: Capital in the UK – a universal snapshot of available estimates

Table A: Investment flow data at ONS

Asset hierarchy	Investment flows			Notes	
	2014	2015	2016	All data in current prices, £ million	
0 Assets within National Accounts boundary	319,741	327,542	341,212		
1 Produced non-financial assets	319,741	327,542	341,212		
2 Fixed assets	307,228	320,660	332,807	Investment in all assets included with estimates of Gross Fixed Capital Formation. All assets except Dwellings (and Transfer Costs, not separately identified here) included in Business investment. ONS does not include any items within the asset category Other intellectual property products.	
3 Dwellings	63,643	67,945	74,573		
3 Other buildings and structures	102,630	107,618	108,718		
3 Transport equipment	16,448	22,383	25,854		
3 ICT, other machinery, equipment and weapons systems	62,461	62,291	61,629		
3 Cultivated biological resources	1,482	1,226	1,363		
3 Research and development	29,276	30,998	32,367		
3 Computer software and databases	24,724	21,656	22,149		
3 Entertainment, literary and artistic originals	5,744	5,765	5,790		
3 Mineral exploration and evaluation	820	778	364		
3 Other intellectual property products					
2 Inventories	12,565	7,046	8,556		Negative net investment inflows are a result of more inventories being drawn from stocks than being added in the period. Sub-categories not currently separately identified in published ONS data.
3 Materials and supplies					
3 Finished goods					
3 Work-in-progress					
3 Military inventories					
3 Goods for resale					
2 Valuables	- 52	- 164	- 151	Negative net investment inflows are as result of sales to the rest of the world exceeding purchases from the rest of the world in the period. Sub-categories not currently separately identified in published ONS data.	
3 Precious metals and stones					
3 Works of art					
3 Other valuables					
1 Non-produced non-financial assets					
2 Natural resources	NA	NA	NA	Conceptually transactions can be recorded between units in different industries or sectors, but new natural resources cannot be created. Potential for overlap with natural capital.	
3 Land	NA	NA	NA		
3 Mineral and energy reserves	NA	NA	NA		
3 Non-cultivated biological resources	NA	NA	NA		
3 Water resources	NA	NA	NA		
3 Other natural resources	NA	NA	NA		
2 Contracts, leases and licences				Not currently measured at ONS. Cherished number plates included in stocks, but not flows.	
3 Marketable operating leases					
3 Permits to use natural resources					
3 Permits to undertake specific activities					
3 Entitlement to future goods and services on an exclusive basis					
2 Goodwill and marketing assets				Not currently measured at ONS. Potential for overlap with some uncapitalised intangible assets, especially branding.	
3 Goodwill					
3 Trademarks, franchises, mastheads etc					

Asset hierarchy	Investment inflows			Notes	
	2014	2015	2016		
	All data in current prices, £ million				
0	Assets outside National Accounts boundary	187,186	195,959	213,215	
1	Natural capital	NA	NA	NA	
2	Provisioning services	NA	NA	NA	Conceptually transactions can be recorded between units in different industries or sectors, but new natural capital cannot be created. Potential for overlap with natural resources.
3	Agricultural biomass	NA	NA	NA	
3	Fish caught	NA	NA	NA	
3	Timber	NA	NA	NA	
3	Water abstraction	NA	NA	NA	
3	Minerals	NA	NA	NA	
3	Oil and Gas	NA	NA	NA	
3	Renewable energy	NA	NA	NA	
2	Regulating services	NA	NA	NA	See above.
3	Carbon sequestration	NA	NA	NA	
3	Air pollutants removed by vegetation	NA	NA	NA	
2	Cultural services	NA	NA	NA	See above.
3	Recreation	NA	NA	NA	
1	Human capital				
2	Employed				Stocks of human capital are measured in monetary terms by ONS as the total potential future earnings of the working age population. Investment flows could conceptually be recorded, but by the nature of the measurement approach are not currently calculated. Future work will consider a full stock-flow model.
3	Degree or Equivalent				
3	Higher Education				
3	GCE A-Levels or equivalent				
3	GCSE grade A* to C or equivalent				
3	Other Qualifications				
3	No Qualifications				
2	Unemployed				See above.
1	Uncapitalised intangible assets	81,991	83,885	88,303	
2	Innovative property	16,205	16,510	17,288	Investment flows include purchased and own-account investments, following the Corrado, Hulten and Sichel (2005) framework. Could be considered for inclusion in Other intellectual property products, in ESA10-consistent measures of GFCF.
3	Design	14,300	14,785	15,089	
3	Financial product innovation	1,905	1,725	2,199	
2	Economic competencies	65,786	67,375	71,015	Potential for overlap between branding and organisational capital, and Goodwill and marketing assets. Training could be seen to be part of the investment flows in human capital.
3	Branding	15,145	15,034	15,200	
3	Organisational capital	23,785	25,007	26,333	
3	Training	26,856	27,334	29,482	
1	Consumer durables	105,195	112,074	124,912	
2	Household goods	23,697	25,591	30,374	Estimates of investment taken from the Consumer Trends publication. Currently treated as current expenditure, but this paper considers that this could be reclassified as capital expenditure. Likely that not all expenditure is on long-lived assets.
3	Furniture and furnishings	14,440	15,485	16,198	
3	Carpets and other floor coverings	3,755	4,504	7,196	
3	Major appliances	5,239	5,208	6,414	
3	Major tools and equipment	263	394	566	
2	Personal transport equipment	45,040	47,739	51,140	See above. Some of these assets are likely used in the sharing economy; some investment in these assets should therefore be captured in ESA10-consistent measures of GFCF, but may not be due to data limitations.
3	Motor cars	42,797	45,390	48,360	
3	Motor cycles	641	734	914	
3	Bicycles	1,602	1,615	1,866	
2	Recreational and entertainment goods	24,543	26,330	30,395	See above.
3	Telephone and telefax equipment	773	873	1,401	
3	Audio-visual and recording equipment	4,228	4,441	5,310	
3	Photographic etc. equipment	2,078	2,257	2,406	
3	Information processing equipment	7,328	6,573	8,024	
3	Major durables for outdoor recreation	9,832	11,895	13,014	
3	Musical instruments and major durables for indoor recreation	304	291	240	
2	Other durable goods	11,915	12,414	13,003	See above.
3	Jewellery, clocks and watches	8,280	8,845	9,361	
3	Therapeutic medical appliances and equipment	3,635	3,569	3,642	

Table B: Capital stocks data at ONS

<i>Asset hierarchy</i>	<i>Capital stocks</i>			<i>Notes</i>	
	2014	2015	2016	All data in current prices, £ million	
0 Assets within National Accounts boundary	8,747,947	9,314,171	9,798,123		
1 Produced non-financial assets	4,502,388	4,629,827	4,822,242		
2 Fixed assets	4,215,300	4,337,100	4,517,000	Value of stocks taken from ONS Capital Stocks publication. ONS does not include any items within the asset category Other intellectual property products.	
3 Dwellings	1,688,100	1,719,600	1,779,900		
3 Other buildings and structures	1,614,900	1,671,500	1,730,100		
3 Transport equipment	102,600	113,700	124,400		
3 ICT, other machinery, equipment and weapons systems	623,000	646,300	698,700		
3 Cultivated biological resources	7,400	7,500	8,000		
3 Research and development	68,800	69,400	67,900		
3 Computer software and databases	62,900	61,700	60,700		
3 Entertainment, literary and artistic originals	42,100	42,200	42,600		
3 Mineral exploration and evaluation	5,500	5,200	4,700		
3 Other intellectual property products					
2 Inventories	287,088	292,727	305,242		Goods for resale not currently measured at ONS.
3 Materials and supplies					
3 Finished goods					
3 Work-in-progress					
3 Military inventories					
3 Goods for resale					
2 Valuables				Stocks not currently measured at ONS.	
3 Precious metals and stones					
3 Works of art					
3 Other valuables					
1 Non-produced non-financial assets	4,296,235	4,740,626	5,021,053		
2 Natural resources	4,293,728	4,737,961	5,018,197	Value of stock of land calculated by residual. Changes in the volume of stock should be recorded in the Other changes in volume account. Potential for overlap with natural capital.	
3 Land	4,293,728	4,737,961	5,018,197		
3 Mineral and energy reserves					
3 Non-cultivated biological resources					
3 Water resources					
3 Other natural resources					
2 Contracts, leases and licences	2,507	2,665	2,856	Not fully measured at ONS currently. Cherished number plates included in stocks, but not flows.	
3 Marketable operating leases					
3 Permits to use natural resources					
3 Permits to undertake specific activities	2,507	2,665	2,856		
3 Entitlement to future goods and services on an exclusive basis					
2 Goodwill and marketing assets				Not currently measured at ONS. Potential for overlap with some uncapitalised intangible assets, especially branding.	
3 Goodwill					
3 Trademarks, franchises, mastheads etc					

Asset hierarchy	Capital stocks			Notes	
	2014	2015	2016		
				All data in current prices, £ million	
0	Assets outside National Accounts boundary	19,966,332	20,929,996		
1	Natural capital	721,153	760,510		
2	Provisioning services	300,081	322,060	Stocks of Natural Capital are valued by net present value (NPV), as recommended by the System of Environmental-Economic Accounts (SEEA) and it is applied for all ecosystem services. The NPV approach estimates the stream of services that are expected to be generated over the life of the asset. These values are discounted back to the present accounting period. In future, these stocks will be disaggregated by region and habitat. Potential for overlap with natural resources.	
3	Agricultural biomass	85,314	86,010		
3	Fish caught	10,720	10,660		
3	Timber	5,730	6,260		
3	Water abstraction	33,995	34,590		
3	Minerals	9,297	10,420		
3	Oil and Gas	134,653	138,270		
3	Renewable energy	20,372	35,850		
2	Regulating services	130,596	137,690	See above.	
3	Carbon sequestration	99,178	104,850		
3	Air pollutants removed by vegetation	31,418	32,840		
2	Cultural services	290,476	300,760	See above.	
3	Recreation	290,476	300,760		
1	Human capital	19,245,179	20,169,486	20,779,351	
2	Employed	18,501,133	19,497,453	20,164,046	Stocks of human capital are measured in monetary terms as the total potential future earnings of the working age population.
3	Degree or Equivalent	6,686,577	7,203,979	7,678,056	
3	Higher Education	1,403,023	1,463,185	1,461,888	
3	GCE A-Levels or equivalent	4,425,884	4,590,499	4,679,560	
3	GCSE grade A* to C or equivalent	3,612,099	3,636,330	3,632,624	
3	Other Qualifications	1,434,962	1,583,079	1,689,946	
3	No Qualifications	938,587	1,020,381	1,021,972	
2	Unemployed	744,046	672,033	615,305	See above.
1	Uncapitalised intangible assets				
2	Innovative property				Stock values not measured yet at ONS. Follows the Corrado, Hulten and Sichel (2005) framework. Could be considered for inclusion in Other intellectual property products.
3	Design				
3	Financial product innovation				
2	Economic competencies				Potential for overlap between branding and organisational capital, and Goodwill and marketing assets. Stock of Training could be seen to be part of human capital.
3	Branding				
3	Organisational capital				
3	Training				
1	Consumer durables				
2	Household goods				Stock values not measured at ONS.
3	Furniture and furnishings				
3	Carpets and other floor coverings				
3	Major appliances				
3	Major tools and equipment				
2	Personal transport equipment				See above. Some of these assets are likely used in the sharing economy.
3	Motor cars				
3	Motor cycles				
3	Bicycles				
2	Recreational and entertainment goods				See above.
3	Telephone and telefax equipment				
3	Audio-visual and recording equipment				
3	Photographic etc. equipment				
3	Information processing equipment				
3	Major durables for outdoor recreation				
3	Musical instruments and major durables for indoor recreation				
2	Other durable goods				See above.
3	Jewellery, clocks and watches				
3	Therapeutic medical appliances and equipment				

Table C: Capital consumption data at ONS

Asset hierarchy	Capital consumption			Notes		
	2014	2015	2016			
0	Assets within National Accounts boundary	210,137	215,732	222,361	All data in current prices, £ million	
1	Produced non-financial assets	210,137	215,732	222,361		
2	Fixed assets	210,137	215,732	222,361	Consumption of fixed capital is not recorded on animals (cultivated biological resources) in line with ESA10. ONS does not include any items within the asset category Other intellectual property products.	
3	Dwellings	51,771	52,698	54,191		
3	Other buildings and structures	44,152	45,818	46,943		
3	Transport equipment	12,097	13,003	14,021		
3	ICT, other machinery, equipment and weapons systems	50,343	52,101	54,598		
3	Cultivated biological resources	NA	NA	NA		
3	Research and development	23,483	23,681	23,768		
3	Computer software and databases	21,372	21,541	21,992		
3	Entertainment, literary and artistic originals	5,844	5,831	5,878		
3	Mineral exploration and evaluation	1,075	1,059	970		
3	Other intellectual property products					
2	Inventories	NA	NA	NA		Consumption of fixed capital cannot be recorded on inventories; changes in value should be recorded in the revaluation account.
3	Materials and supplies	NA	NA	NA		
3	Finished goods	NA	NA	NA		
3	Work-in-progress	NA	NA	NA		
3	Military inventories	NA	NA	NA		
3	Goods for resale	NA	NA	NA		
2	Valuables	NA	NA	NA	Consumption of fixed capital cannot be recorded on valuables; changes in value should be recorded in the revaluation account.	
3	Precious metals and stones	NA	NA	NA		
3	Works of art	NA	NA	NA		
3	Other valuables	NA	NA	NA		
1	Non-produced non-financial assets	NA	NA	NA		
2	Natural resources	NA	NA	NA	Conceptually transactions can be recorded between units in different industries or sectors, but new natural resources cannot be created. Potential for overlap with natural capital.	
3	Land	NA	NA	NA		
3	Mineral and energy reserves	NA	NA	NA		
3	Non-cultivated biological resources	NA	NA	NA		
3	Water resources	NA	NA	NA		
3	Other natural resources	NA	NA	NA		
2	Contracts, leases and licences	NA	NA	NA	Consumption of fixed capital cannot be recorded on non-produced assets; changes in value should be recorded in the revaluation account.	
3	Marketable operating leases	NA	NA	NA		
3	Permits to use natural resources	NA	NA	NA		
3	Permits to undertake specific activities	NA	NA	NA		
3	Entitlement to future goods and services on an exclusive basis	NA	NA	NA		
2	Goodwill and marketing assets	NA	NA	NA	Not currently measured at ONS. Potential for overlap with some uncapitalised intangible assets, especially branding.	
3	Goodwill	NA	NA	NA		
3	Trademarks, franchises, mastheads etc	NA	NA	NA		

Asset hierarchy	Capital consumption			Notes	
	2014	2015	2016		
				All data in current prices, £ million	
0	Assets outside National Accounts boundary	NA	NA	NA	
1	Natural capital	NA	NA	NA	
2	Provisioning services	NA	NA	NA	Conceptually transactions can be recorded between units in different industries or sectors, but new natural capital cannot be created, nor suffer deterioration. Potential for overlap with natural resources.
3	Agricultural biomass	NA	NA	NA	
3	Fish caught	NA	NA	NA	
3	Timber	NA	NA	NA	
3	Water abstraction	NA	NA	NA	
3	Minerals	NA	NA	NA	
3	Oil and Gas	NA	NA	NA	
3	Renewable energy	NA	NA	NA	
2	Regulating services	NA	NA	NA	See above.
3	Carbon sequestration	NA	NA	NA	
3	Air pollutants removed by vegetation	NA	NA	NA	
2	Cultural services	NA	NA	NA	See above.
3	Recreation	NA	NA	NA	
1	Human capital				
2	Employed				Consumption of fixed capital could conceptually be recorded, but by the nature of the measurement approach is not currently calculated. Future work will consider a full stock-flow model.
3	Degree or Equivalent				
3	Higher Education				
3	GCE A-Levels or equivalent				
3	GCSE grade A* to C or equivalent				
3	Other Qualifications				
3	No Qualifications				
2	Unemployed				See above.
1	Uncapitalised intangible assets				
2	Innovative property				Stock values not measured yet at ONS. Follows the Corrado, Hulten and Sichel (2005) framework. Could be considered for inclusion in Other intellectual property products.
3	Design				
3	Financial product innovation				
2	Economic competencies				Potential for overlap between branding and organisational capital, and Goodwill and marketing assets. Stock of Training could be seen to be part of human capital.
3	Branding				
3	Organisational capital				
3	Training				
1	Consumer durables				
2	Household goods				Consumption of fixed capital could conceptually be recorded, but consumer durables not currently treated as assets, and therefore deterioration of consumer durables not currently measured at ONS.
3	Furniture and furnishings				
3	Carpets and other floor coverings				
3	Major appliances				
3	Major tools and equipment				
2	Personal transport equipment				See above.
3	Motor cars				
3	Motor cycles				
3	Bicycles				
2	Recreational and entertainment goods				See above.
3	Telephone and telefax equipment				
3	Audio-visual and recording equipment				
3	Photographic etc. equipment				
3	Information processing equipment				
3	Major durables for outdoor recreation				
3	Musical instruments and major durables for indoor recreation				
2	Other durable goods				See above.
3	Jewellery, clocks and watches				
3	Therapeutic medical appliances and equipment				

Table D: Productive services data at ONS

Asset hierarchy	Productive services			Notes	
	2014	2015	2016		
0	Assets within National Accounts boundary	547,321	546,853	567,692	All data in current prices, £ million
1	Produced non-financial assets	547,321	546,853	567,692	
2	Fixed assets	547,321	546,853	567,692	
3	Dwellings				
3	Other buildings and structures	271,009	289,953	318,880	
3	Transport equipment	34,387	34,411	38,834	
3	ICT, other machinery, equipment and weapons systems	157,561	140,981	128,589	
3	Cultivated biological resources	2,925	2,439	2,547	
3	Research and development	28,230	28,387	29,207	
3	Computer software and databases	35,053	34,368	33,981	
3	Entertainment, literary and artistic originals	16,117	14,306	13,852	
3	Mineral exploration and evaluation	2,038	2,008	1,802	
3	Other intellectual property products				
2	Inventories				Productive services of inventories may be encompassed in estimates of productive services for fixed assets, as these are assumed to exhaust GOS.
3	Materials and supplies				
3	Finished goods				
3	Work-in-progress				
3	Military inventories				
3	Goods for resale				
2	Valuables	NA	NA	NA	Productive services do not exist for valuables, as they do not contribute to production. They could be seen to deliver welfare benefits to owners.
3	Precious metals and stones	NA	NA	NA	
3	Works of art	NA	NA	NA	
3	Other valuables	NA	NA	NA	
1	Non-produced non-financial assets				
2	Natural resources				Productive services of natural resources may be encompassed in estimates of productive services for fixed assets, as these are assumed to exhaust GOS. Potential for overlap with natural capital.
3	Land				
3	Mineral and energy reserves				
3	Non-cultivated biological resources				
3	Water resources				
3	Other natural resources				
2	Contracts, leases and licences				Productive services of Contracts, leases and licences may be encompassed in estimates of productive services for fixed assets, as these are assumed to exhaust GOS.
3	Marketable operating leases				
3	Permits to use natural resources				
3	Permits to undertake specific activities				
3	Entitlement to future goods and services on an exclusive basis				
2	Goodwill and marketing assets				Not currently measured at ONS. Potential for overlap with some uncapitalised intangible assets, especially branding.
3	Goodwill				
3	Trademarks, franchises, mastheads etc				

Asset hierarchy	Productive services			Notes
	2014	2015	2016	
				All data in current prices, £ million
0	Assets outside National Accounts boundary	23,540	16,275	
1	Natural capital	23,540	16,275	
2	Provisioning services	14,322	7,799	Productive services of natural capital are shown as the value of the service flow from each type of service. Productive services of provisioning services may be encompassed in estimates of productive services for fixed assets, as these are assumed to exhaust GOS.
3	Agricultural biomass	3,408	2,399	
3	Fish caught	296	292	
3	Timber	269	227	
3	Water abstraction	1,202	588	
3	Minerals	617	354	
3	Oil and Gas	7,245	1,157	
3	Renewable energy	1,286	2,782	
2	Regulating services	2,698	2,600	See above. Productive services of regulating services contribute to welfare rather than economic production under current ESA10 guidance.
3	Carbon sequestration	1,559	1,553	
3	Air pollutants removed by vegetation	1,139	1,047	
2	Cultural services	6,520	5,876	See above. Productive services of cultural services may contribute to economic production in recreation industries, and to welfare.
3	Recreation	6,520	5,876	
1	Human capital			
2	Employed			Productive services could be estimated as equal to some fraction of total labour compensation (compensation of employees, plus the labour share of mixed income) by each group of workers. Remaining labour compensation would be the return on unskilled labour. Productive services may also contribute to household production.
3	Degree or Equivalent			
3	Higher Education			
3	GCE A-Levels or equivalent			
3	GCSE grade A* to C or equivalent			
3	Other Qualifications			
3	No Qualifications			
2	Unemployed			See above.
1	Uncapitalised intangible assets			
2	Innovative property			Productive services of uncapitalised intangible assets may be encompassed in ESA10-consistent estimates of productive services for fixed assets, as these are assumed to exhaust GOS. Future work will estimate these explicitly.
3	Design			
3	Financial product innovation			
2	Economic competencies			See above.
3	Branding			
3	Organisational capital			
3	Training			
1	Consumer durables			
2	Household goods			Productive services of some items may contribute to ESA10-consistent economic production as part of 'the sharing economy', but may not currently be captured due to data limitations. Productive services of all items may contribute to household production.
3	Furniture and furnishings			
3	Carpets and other floor coverings			
3	Major appliances			
3	Major tools and equipment			
2	Personal transport equipment			See above.
3	Motor cars			
3	Motor cycles			
3	Bicycles			
2	Recreational and entertainment goods			See above.
3	Telephone and telefax equipment			
3	Audio-visual and recording equipment			
3	Photographic etc. equipment			
3	Information processing equipment			
3	Major durables for outdoor recreation			
3	Musical instruments and major durables for indoor recreation			
2	Other durable goods			See above.
3	Jewellery, clocks and watches			
3	Therapeutic medical appliances and equipment			

Source: Office for National Statistics

General notes to Tables:

1. All figures correct as of February 2019.
2. Figures may not match published sources due to rounding and differences in breakdowns.
3. This paper does not assume to have all the answers to the conceptual challenges presented here, and these Tables and explanatory notes should not be taken to be exhaustive or final. Heys et al. (forthcoming) will explore these ideas in more detail. Future work by ONS and the Economic Statistics Centre of Excellence (ESCoE) will develop this further.

Conceptual notes to Tables:

1. Reconciliation of the opening and closing balance sheet are given by the equation:

$$\begin{aligned} \text{Net Stock}_t = & \text{Net Stock}_{t-1} + \text{Net Investment}_t + \text{Consumption of Fixed Capital}_t \\ & + \text{Other changes in volume}_t + \text{Other changes in price}_t \end{aligned}$$

Capital services in period t are delivered by the net stock in period t . Tables are included for stocks, investment flows, deterioration of the stock (consumption of fixed capital when considering fixed assets), and productive services (capital services). Tables for ‘Other changes in volume’ and ‘Other changes in price’ are not included, as these movements are not currently separately identified in ONS estimates, so the Tables would contain no data. Conceptually, however, the treatment of any of these items as capital assets could conform to this structure.

2. All items included in the ‘Assets outside National Accounts boundary’ Tables are to some extent included within the national accounts, but labelled as such here as they are not treated fully or consistently as capital. In particular, output of some ‘uncapitalised intangibles’ is recorded as market output by the producer, and is thus included in GDP. Expenditure on these assets is treated as intermediate consumption, and so nets out of the output measure of GDP, but is captured as a transaction. Similarly, expenditure on ‘consumer durables’ by households is included as Final Consumption Expenditure in GDP, but is not treated as capital investment.
3. Changes to the treatment of some expenditure in the ‘Assets outside National Accounts boundary’ tables could be capitalised in the ‘Future GDP’ measure within an ESA 2010 consistent set of national accounts. In particular, estimates of investment in the uncapitalised intangible asset ‘design’ could be considered for inclusion in Gross Fixed Capital Formation in the ‘Other intellectual property products’ asset. Similarly, assets bought by the household sector and used for economic production within the ESA 2010 production boundary (such as cars used as taxis in the ‘sharing economy’ by unincorporated households) should be treated as Gross Fixed Capital Formation (GFCF) in the national accounts, but may not currently be treated as such due to limitations in data collection.
4. Changes to the treatment of some expenditure in the ‘Assets outside National Accounts boundary’ tables would fall within the ‘Welfare minus’ measure. In particular, some consumer durables (such as kitchen appliances) likely contribute to household production, as measured in the household satellite account by ONS. The ‘Welfare minus’ measure would incorporate the household account, and the assets used for this production.
5. Changes to the treatment of some expenditure in the ‘Assets outside National Accounts boundary’ tables would fall within the ‘Well-being’ measure. In particular, expenditure on some consumer durables by households (such as jewellery), and the stock of natural capital,

may contribute to individual well-being and leisure, as well as, or rather than, economic production.

6. Most fixed assets (such as machinery) deteriorate through use; the value of this deterioration is recorded as consumption of fixed capital (CFC), and other things equal, the net stock in the next period will be lower in value than the net stock in the previous period. Human capital may have particular characteristics that make accounting for these changes difficult, or controversial. 'Use' of human capital through work (practice) may lead that capital to increase in value, rather than deteriorate. This change in volume could be recorded through 'other changes in volume'. CFC could be recorded for deteriorations in human capital caused by loss of knowledge, due to aging or anticipated obsolescence in outdated ideas; neither of these factors may be directly related to use. Disappearances of the stock due to death and migration could be recorded as 'other changes in volume', while increases in the value of the stock due to a general increase in wages could be recorded as 'other changes in price'. Investments could be recorded as the spending on formal education or training as well as directed informal learning and training that could lead to an increase in the stock of human capital.

Annex D: Area of double-counting between different capital estimates produced by ONS – for use in conjunction with Annex A.

This section is authored to Emily Connors.

Grass and Feed: National accounts ‘cultivated biological resources’ are likely to include some duplication with ‘agricultural biomass (crops)’ as included in the Natural Capital accounts. Farmed animals are not included as they are a produced asset rather than natural. The grass and feed the animals consume is included.

Timber and Minerals: Timber and minerals may be contained in ‘materials and supplies’ within National Accounts ‘inventories’. These are likely to also be found in ‘timbers’ and ‘minerals’ in the Natural Capital Accounts.

Precious metals and stones: Contained within ‘valuables’ in the National Accounts, these are possibly also included within ‘minerals’ in the Natural Capital Accounts.