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**Article**

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# 1 The measurement of public goods: lessons from 10 years of Atkinson in the United Kingdom

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**Abstract**: When considering issues of measuring welfare beyond gross domestic product (GDP), a key ongoing, but unfinished, agenda concerns how to measure the outputs of goods and services which are 'free at the point of delivery'. Public services such as schools and health services are major examples of this kind. Over a decade ago, Sir Tony Atkinson provided a principled framework for this end. Consistent with the basic principles of national accounting, he advocated an approach by which this output should be measured as the value added by the services concerned, where this equates to the incremental contribution to (monetised consumer utility from) outcomes resulting from the delivered outputs. This value, in turn, equated to the improvement in outcomes directly attributable to the activities of the public services concerned. Implementing this approach, as Atkinson recognised, is by no means straightforward, but the United Kingdom experience shows that considerable improvements can be made. Working with experts and practitioners, quantity and quality measures can be identified and used to give a good approximation of the value added by key public services, and thus their contribution to GDP. New data and intelligent use of existing data means this can be done at low cost and in a way which maximises stakeholder understanding and acceptance.

But national statistical institutes are also now grappling with a second task; measuring changes in welfare or well-being more generally, regardless of how they are generated. Health outcomes — for example, life expectancy or healthy life expectancy — are influenced by a variety of factors besides publicly-funded health services: diet, smoking prevalence and other lifestyle choices are obvious determinants. So, the central tasks under this agenda become firstly the identification of appropriate measures of outcome changes, secondly determining how much value our societies place on those changes, and thirdly to understand the relationship between the impact of the public service and other factors on the headline outcome measures.

**JEL codes**: C46, C82, E01, H4, H5, I1, I21, I38, K42, 047

**Keywords**: national accounts, GDP, public sector, services, economic well-being, quality adjustment, productivity

([1]) Office for National Statistics, United Kingdom. The views expressed within are the personal views of the authors and do not represent, or claim to represent, the views of the Office for National Statistics.

# 1. Introduction

Current debates about measuring the impact of the digital economy, (specifically free digital goods which deliver welfare gains to consumers), even if their exact treatment in the national accounts is under debate, need to be seen in the context of a larger group of transactions which are also free, or nearly free, to consumers; these are mainly public services. In the United Kingdom, around 20 % of gross domestic product (GDP) is accounted for by the output of public services. Other G7 countries exhibit similar magnitudes ranging from 19 % to 24 %, with the one exception being the United States at around 14 %. Measurement of these free goods is a common issue affecting almost all countries.

The United Kingdom has had an interest in this question since 2003 when the then National Statistician, Len Cook, asked Sir Tony Atkinson to conduct an independent review of the measurement of government output in the national accounts, with a final report produced in 2005. The resultant publication was a seminal text which informed the development of the System of National Accounts 2008 (2008 SNA) in how to conceptualise and then empirically measure the outputs of public services contained in GDP. The United Kingdom, alongside several other countries, pressed ahead with implementing these methods. This work managed to address the largest parts of the public services, but gaps remained.

The Bean Review (2016) commended the Office for National Statistics (ONS) for this work but identified that renewed efforts were needed to update the methods being applied where quality adjustments were in place and to create new adjustments where these were not.

This paper makes four contributions to this debate. First, it draws attention to the importance of these issues both in terms of economic activity and more widely to consumer welfare: whilst the impact of changes in digital technology over the last 20-30 years are important, considering the life-saving and life-enhancing improvements in medical care over the same period gives important context. Secondly, to re-iterate a commonly missed Atkinson recommendation: the fast pace of change in public service ([2]) delivery and usage means that methodologies need to be kept under regular monitoring and updated as required. Thirdly, the paper draws out key lessons the United Kingdom has learnt over this period which the authors hope might contribute to the process of mutual learning. Finally, it highlights how a better understanding of the public sector's contribution can only enhance efforts to measure economic welfare.

The paper is structured as follows:

- a brief account of the historical context of measuring public services in the United Kingdom, in the wake of the 1993 SNA, and the problems that were encountered that led to the Atkinson Review;
- an account of the Atkinson Review and its implementation in the United Kingdom;
- a discussion of the current methods used to calculate quality adjustments in the United Kingdom;
- a summary of the most significant issues identified in the United Kingdom in measuring public service outputs and outcomes, and how these have been addressed over the last decade;
- a discussion of the challenges in capturing welfare gains related to public services alongside other non-GDP welfare gains in any new metric; and,
- conclusions.

([2]) This paper focuses on 'public service' rather than the 'public sector' simply because mainly public services are now delivered via both the public and private sectors in many countries.

# 2. Measuring public service output and productivity: the historical context

The treatment and measurement of public service output and, by extension, public service productivity, has long been known to raise tricky but important issues. Quite clearly, their measurement is not straightforward. Most transactions included within GDP are measured at their market or exchange value. But most outputs provided by the public sector — health services or public provision of education, for example — are non-market services. So, while such services clearly have value, there is no observable price to guide the valuation. The value, therefore, must be imputed and this may not be simple to do ([3]).

The founding fathers of national accounting wrestled with how public service outputs should be treated in the accounts and indeed some, like Kuznets, proposed excluding them entirely. Hicks changed his mind at least twice on this question. In the event, the consensus was to adopt a convention — the so-called 'output equals inputs' convention — whereby these non-market outputs were deemed equal in value to the inputs used to produce them. The implication of 'outputs equals inputs' is that public service productivity is always constant, with its growth rate, by definition, zero.

Leaving aside the measurement complexities, there are important reasons for taking public service output and productivity seriously. One is the sheer scale of the transactions involved. In the United Kingdom, for example, non-market public service output accounts for around a fifth of GDP ([4]); the sector is over twice the size of manufacturing. So, omitting these public services from the national accounts would be to ignore a major part of the value which the economy generates. Similarly, to do so would be to overlook a material contribution to the overall productivity of the economy. Nor does such productivity performance simply mirror that of the rest of the economy. In recent years public service productivity in the United Kingdom has been rising while the productivity performance of the rest of the economy has been stagnant.

A second reason why public service productivity is important relates to fiscal policy. Finance ministries are continuously in the horns of a dilemma, though one whose acuteness varies over time. On the one hand, the political pressure for improved public services is strong. Citizens as users have rising expectations of what they receive from health services, from publicly provided education, by way of social care and so on — no less than they have rising expectations for economic performance overall. Where many public services are key to tackling inequality and improving life chances, as these issues are important in public debate and amenable to improved public services, understanding the output of the public sector helps users understand governments' steps to tackle inequality. But citizens as taxpayers are also reluctant to pay the rising taxes that might finance the improving public services. The only way to square this circle is to improve the efficiency and effectiveness of how taxpayers' funds are used, so that through increased productivity, more output is produced by the same amount of taxpayers' money.

([3]) This does not imply that where prices exist measurement is self-evidently simple. Capturing quality change and ensuring price deflators accurately compare like-for-like products are still substantial challenges even when prices exist. Whilst in this paper the authors predominantly reflect on the instance where prices cannot be observed, many of the issues described are still of relevance to countries where these services are delivered via the market.

([4]) This can vary marginally by year selected.

Accordingly, monitoring public service productivity is of policy importance over and above the sector's (sizeable) contribution to productivity performance overall.

Third, the performance and efficiency of public services conditions the productivity of the rest of the economy. A well performing legal system, for example, is vital for underpinning a well-functioning commercial sector. An efficient and well-performing health service is a major contributor to a healthy and productive workforce, while the outputs of publicly provided education make a direct contribution to the nation's human capital. Arguably, the same outputs also feed into social capital and thus again underpin a well-performing economy overall.

Given the importance of these issues for economic commentary and policymaking, the balance of opinion in the national accounting community increasingly moved towards thinking that the 'outputs equals inputs' convention was untenable. There was no reason to suppose that it gave an accurate view of how the outputs and productivity of this growing sector were behaving within the overall economy. Since, by definition, it implied necessarily unchanging productivity within the sector, it could give no useful information regarding the other two issues: how well public services were making use of taxpayers' funds or how productively public services condition the performance of the rest of the economy. These drawbacks from 'outputs equal inputs' were substantial.

Accordingly, the System of National Accounts 1993 (1993 SNA) recommended that, in future, countries should move away from the previous convention and instead adopt methodologies which measured the output of public services directly, using observable information relating to these services. This would mean of course that there was no reason why the estimated outputs from such methodologies would equate to the observed inputs. Consequently, it would also be possible to estimate how productivity in these various sectors was changing over time.

The ONS was one of the early movers, together with a handful of other national statistical institutes (NSIs), in taking forward this new agenda. By the late 1990s, measured by value, some two thirds of public service outputs were measured directly. The remaining third continued to be measured by 'outputs equals inputs'; the so-called collective services, particularly the defence sector, were the main part of this residuum ([5]). However, not long after the new methodologies were put in place, the estimated productivity series began to demonstrate paradoxical behaviour. Having been rising at fairly steady rates up to 1997, the estimated productivity of the directly measured sectors fell by over 20 % in the four or five years after 1997. It was hard to understand why the estimates were showing such declines. Nor was there any corroborating evidence to suggest that such declines had occurred. Accordingly, users' confidence in the validity of the estimates became increasingly strained. Since the output-driven estimates also now fed into the United Kingdom's overall national accounts, confidence in those, too, was also in question.

In these circumstances, at the end of 2003, the then United Kingdom National Statistician, Len Cook, asked Sir Tony Atkinson to conduct an independent review of methodologies to measure public service output and productivity. His terms of reference also included looking at the way the ONS had approached the new SNA agenda and its implementation of direct measurement methodologies. The Atkinson Review lasted for just over a year and Sir Tony published a report in January 2005 setting out his conclusions.

([5]) This does rule out that the same cash amount of public expenditure can result in higher outputs. If public authorities can buy the relevant inputs more cheaply, then the same amount of cash will buy a higher volume of inputs and thus under the 'output equals inputs' convention be deemed to generate higher output. But this is an effect from more efficient procurement and should be distinguished from the productivity channel.

## The Atkinson Review and its legacy

The Atkinson Review was a milestone in this agenda. The report clarified many issues and through its recommendations proposed a model for measuring public service outputs including a research and implementation programme in the main public service areas. Len Cook accepted Atkinson's conclusions, subject to underlining that their full implementation would take time and be conditioned by availability of resources ([6]).

Fundamentally, Atkinson agreed wholeheartedly that the SNA had been right to counsel direct measurement of non-market public services. The drawbacks of the traditional 'outputs equal inputs' convention were too great to be acceptable, for the reasons set out earlier in this paper. By the same token, the ONS had been right to take up this agenda. The issues observed in the United Kingdom data were real ones but were rooted in how the agenda had been implemented, as discussed further below, not because the overall agenda was problematic.

Atkinson's report saw the problem as being the ONS's failure to base its methodologies and estimates on a clear set of explicit principles. Not unnaturally, when faced with a difficult task, in many cases ONS statisticians had sometimes used stop-gap methodologies and/or readily available indicators or other data sources, in the hope that this would be better than nothing, but these did not necessarily relate directly to what was needed to measure public service outputs. Experience showed these hopes were not always realised: it can be argued, in some cases, that the procedures had led to estimates which were worse than not having anything.

The complete set of Atkinson's principles is shown in Annex A. One superficial reaction to them is that many look like common sense. Who would not be able to agree to them? On the other hand, their usefulness and power comes from employing them as a yardstick against which to compare the actual procedures which were in place. They quickly highlighted areas where the ONS's existing procedures did not measure up. This gave a clear indication of where remedial action was required as well as helping guide the nature of the remedial action and revised procedures.

One particularly important principle related to what should, in theory, be included in a country's national accounts and therefore what the methodologies should be striving to capture. Atkinson contended that the key consideration in national accounts was value; thus, GDP could be considered as the cumulative value added from the economy, going through the various stages of production. It was therefore essential to avoid measuring public service output solely by what were essentially activities — say, the number of medical procedures performed or the number of pupils taught, particularly where such measures may incentivise perverse outcomes; such as fire-protection services being measured using the number of fires they put out, where increasing fire protection activity would lead to a reduction in output, rather than a growth.

([6]) The Atkinson approach, measuring the incremental contribution to consumer utility as the measurement principle, is not the only approach which could be taken. The main alternative, a measurement target that adopts a producer perspective is described in, for instance, Diewert (2017) and Schreyer (2012).

The problem he saw was that such activities may or may not have value. His private sector analogy was the production of broken bricks. A factory which produced only broken bricks would find its output next to negligible since the broken bricks would have little or no value, as opposed to well-produced whole bricks which, of course, would have value. In the public services, the equivalent issue was to establish whether the hospital procedures carried out or the number of pupils taught were adding value or otherwise; what was the quality of the 'bricks' they represented.

A key principle was therefore that the estimates of public service output should be quality adjusted, to reflect the incremental contribution to (monetised consumer utility from) outcomes resulting from the delivered outputs. At a common-sense level, the value of a health care intervention clearly depends upon its quality. The procedure is of value only to the extent that it leads to a health outcome superior to a counterfactual where the procedure had not been carried out. This leads inevitably to the question as to how outcomes should relate to the estimates. Traditionally, national accountants had been reluctant to consider outcomes as relevant and with some good reason. In most countries, life expectancies and healthy life expectancies have risen significantly over time. While improving health services have played a part in this, the broad evidence is that this has been a minority contributor with factors such as improving diets, falling levels of smoking and healthier environments being much more important. It would therefore be quite wrong to ascribe the whole value of the improved health outcomes to the output of healthcare sectors. On the other hand, to the extent that an improved health outcome can be directly attributed to the activities of healthcare systems, then that should be taken into account in the estimated output.

The Atkinson Report was widely debated in the years following its publication. Its approach was largely accepted and helped shape the revised System of National Accounts 2008 (2008 SNA). The principle of allowing for quality adjustments in estimates of output was accepted and emphasised, as part of a wider trend of economists becoming increasingly comfortable in addressing social welfare function issues. The European System of Accounts (ESA) which generally follows the SNA, as its guiding principles, surprisingly, and somewhat regrettably, took a flatly opposite view and banned quality adjustments within its 2010 iteration, focusing on, for example the quantity output method for individual non-market services such as education and health ([7]).

This illustrates how contentious this topic remains. The decision was purportedly in the interests of international comparability but the authors would argue there seems to have been some muddled thinking at work. Imposing arbitrary comparability in methods does not necessarily serve the interests of comparability of the realities. With quality adjustments not allowed, those countries where public services have improved in quality are estimated with outputs below the reality and conversely for those where quality improvement has been relatively low. This can only prejudice rather than help international comparability. Eurostat has been organising work to review this issue so, hopefully, this is on the way to being resolved.

([7]) ESA 2010 (§10.29-10.30).

Since the Atkinson Review, the United Kingdom has delivered public service output and productivity estimates, with varying degrees of success, differing both between and within service areas as shown in Figure 1. The approaches are categorised broadly into three types.

**'Output equals inputs'** — accounting for around 38 % of public service output in 2016, this approach assumes that the volume of output is equivalent to the volume of inputs used to create them. Typically capturing what are referred to as 'collective services' (such as defence), this convention is used when the output of a service area is conceptually difficult to define and/or measure. As a result, productivity is assumed to remain constant and growth will always be zero. This is the least satisfactory method.

**Quantity output** — representing 12 % of public service output in 2016, this approach, in line with that recommended in ESA 2010, uses long-standing indicators of activities known as cost-weighted activity indices (CWAI). Here an index is constructed as the weighted sum of change in the level of different activities from one year to the next. As most public services do not have a market price to use as a weight, given they are not sold on a market, the costs of producing a unit of activity (unit cost) are used as a proxy. Although this cost weighting occurs, the use of measured outputs is believed to be an improvement on the previous input-based methodology and is used as a measure of output in United Kingdom estimates of total public service output. More detail about this approach, and the steps involved, can be found in Annex B.

It is, however, recognised as the second-best approach. While some elements of quality change can be captured (for example, through the differentiation of activities), a CWAI will fail to capture all quality improvements. An example of this would be the gradual introduction of a new healthcare procedure which yields better outcomes at lower cost. If activity growth is connected between old and new procedures, the CWAI approach would result in the weight of this activity in the index gradually falling over time. If the old and new procedure are recorded separately in the index, the CWAI approach would even lead to a fall in output.

**Quality adjusted output** — the third category then accounts for the remaining 50 % of public service output in 2016. This approach takes the CWAI as a starting point and builds on this by adjusting the quantity output to take account of changes in quality, in line with the recommendations of the Atkinson Review, reflecting improvements in outcomes that can be attributed directly to public service activity ([8]).

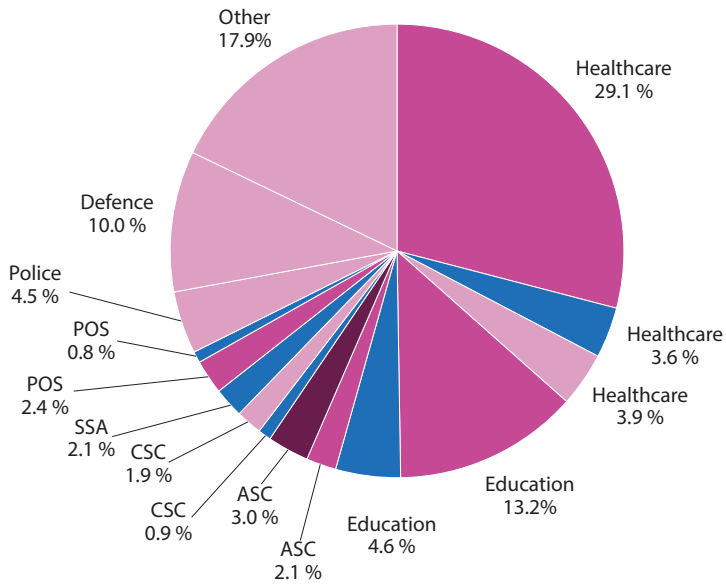
Within the market sector, higher-quality variants of outputs can be picked out. As higher-quality outputs sell for more than lower-quality outputs, the change in quality is accounted for by the price differential. This is, of course, much harder (but no less important) to do for public services because service users do not pay directly for services, and thus there is no user-driven differential to use. Where they can be identified quality metrics are, therefore, used to augment volume data, based on how far outcomes can be attributed to public services, to give a well-based measure of the public service output concerned.

([8]) In relation to adult social care we have quality adjusted output, where output is calculated on an inputs = outputs basis. We have included this in 'quality adjusted output' for the sums in the text.

It is important to note that such quality adjustments are explicitly excluded from the measurement of output in the national accounts central framework by ESA 2010, and are not part of the output series used in other ONS measures of productivity.

More details about the general methodology can be found in Annex C, while more specific details are provided later in Part 3 of this paper.

**Figure 1: Output-type share by service area, United Kingdom, 2016**




Note: shares may not sum to 100 % due to rounding. POS (public order and safety) includes courts and probation services, the prison service and fire-protection services. Other government services includes services such as economic affairs, recreation and housing. ASC refers to adult social care. CSC refers to children's social care. SSA refers to the social security administration.

*Source:* Office for National Statistics — Public service productivity: total, United Kingdom, 2016 (ONS (2019b))

Atkinson made a further important recommendation to 'triangulate' estimates with corroborating evidence when assessing public service output. Such evidence might be subjective or objective. The sharp downturn in the ONS' estimates of public service output that had led to the Atkinson Review being set-up turned out to be largely illusory and due to problems with data sources and methodologies. A subjective source of evidence that might have shown up the problems earlier would have been talking to practitioners and expert commentators. When, during the Review, they were asked what might have caused the sharp downturn in productivity, their invariable response was that they were not aware there had been such a downturn.

Such evidence would not have been conclusive but would, at least, have rung alarm bells. Such subjective evidence can, moreover, be supplemented by objective evidence. In the hospital sector, one of the key factors affecting efficiency is the average length of stay. With relatively fixed hospital capacity in the short-term, a shorter length of stay allows more patients to be treated. So, if there had been a sharp downturn in health sector productivity, it would have been reasonable to expect the average length of stay to have increased. But, in fact, it had not behaved out of the ordinary: again, not conclusive but another possible alarm bell to give reason to question the estimates.

A third precept from the Atkinson Review stemmed from the nature of what it saw to be the task. Assessing changes in the quality of various public services, or for that matter collecting and assessing triangulation evidence, may well not be within most NSI's core competences.

Fortunately, such issues are the core business of other communities. Assessing, for example, the quality of teaching and the contribution that schools make is what many education experts spend much of their time doing. Similarly, such issues in the healthcare sector are a central preoccupation of public health experts, epidemiologists, health economists and so on. Practitioners, by definition, are a complementary source of expertise. So, too, are government departments and other public authorities, who will have much greater expertise and experience of the services in their fields than an NSI could ever hope to muster. Atkinson therefore recommended that the ONS (and other NSIs) should form networks with such experts to allow them to tap into the expertise that would be needed to compile authoritative estimates of output in public services.

One important purpose that such networks could serve would be to feed into periodic reviews of the ways that public services are delivered and whether intervening changes mean that the original data sources and methodologies for compiling output and productivity estimates remain valid or whether changes are necessary. Models for delivering public services change no less quickly than the business models underpinning private sector activity. So, without such periodic reviews, there would be the possibility of maintaining methodologies that no longer corresponded to the real world. Of course, in principle, detecting such changes should be an ongoing concern. But, periodic reviews should serve as a safety net to ensure that relevant changes are picked up.

The Atkinson Report set out a principled approach which it recommended as a general model for measuring public service output and productivity. It also had chapters with suggested agendas for applying the approach in four key areas:

- healthcare services;
- public sector education services;
- public order and safety (specifically the criminal justice system);
- services relating to adult social care.

It recognised that completion of the work programme to fulfil these agendas would take several years. The rest of this paper discusses the United Kingdom's experience in taking this work forward and some of the principal lessons learned. Then, in light of this work, it considers both the welfare implications of public services but also how we treat those welfare gains which are not attributable to changes in public service provision.

# 3. Current methods of calculating Atkinson quality adjustments

We begin by briefly explaining the methods used to derive the four quality adjustments currently in use in the United Kingdom. It is important at this point to note that these all apply to services which are received by an individual (one person receives an operation, one individual receives any particular qualification, and so on), as opposed to collective services, such as defence. Collective goods, which are non-excludable by nature, present a further set of challenges in terms of measurement over and above those described below, which focus on the individual.

## Healthcare

In the United Kingdom, health care is primarily a public service under the Atkinson Review definitions. Nearly 80 % of the United Kingdom's health care expenditure is publicly-funded with much of this public expenditure funding free-at-the-point-of-use care through the National Health Service (NHS) ([9]).

The task of valuing the output and measuring the productivity of a free-at-the-point-of-use service, without insurers or other intermediaries negotiating prices from care providers, therefore faces the same challenges Atkinson sought to address across other public services.

But mitigating the considerable challenge of measuring the productivity of a service for which a price does not exist, the NHS provides the advantage of a wealth of data, collected on a uniform basis from all NHS providers.

### MEASURING HEALTH CARE OUTPUT

As with other public service sectors, quantity output is measured through a cost-weighted activity index (CWAI) ([10]). The data for this comes from detailed published management information. NHS provider organisations responsible for hospital, community and mental health care report detailed data on activity and unit costs as part of the process of setting reimbursement rates for the thousands of different activity types carried out across these sectors, as well as for use as a management information resource. For this purpose, activity and expenditure are analysed by healthcare resource group (HRG) and by care setting. The HRG system provides a more detailed and precise treatment-classification system as an alternative to the internationally-used diagnosis-related group (DRG) system, with over 25 000 individual activity types in the most recent years.

([9]) The NHS provides healthcare in Great Britain. In Northern Ireland, the Health and Social Care Service provides similar free-at-the-point-of-use care. For brevity, 'NHS' is used to describe all public health care services in the United Kingdom.

([10]) Produced by chain-linked Laspeyres indices. Estimates of quality adjusted output are produced in a similar manner as explained in Annex B.

For other elements of publicly-funded health care outside of NHS hospital, community and mental health care provision and drug prescriptions, data are scarcer. Data availability is particularly problematic for general practice, where output is currently measured using modelled estimates based on historical and demographic data, and for the rapidly growing component of NHS-funded services that are outsourced to independent sector providers.

NHS hospital, community, ambulance and mental health provision accounts for 64 % of total spending according to the most recent data, with a further 10 % from prescription drugs. Other family health services, of which general practice is the largest component, along with the more easily measurable dental and ophthalmological services, account for 15 % and services purchased from non-NHS providers a further 11 %.

The United Kingdom's public service health care output therefore combines a large element of some of the most precise output measures available for United Kingdom public services, with estimations needed for some of the other elements of the service. But as with other service sectors, the limits of cost-weighted activity in determining the value of public services provided still hold across all service elements. Hence a quality adjustment is required.

## MEASURING HEALTH CARE PERFORMANCE AND OUTCOMES

The comparative wealth of data available for health care extends to data on the quality of services. Here, a large variety of measures are available — NHS performance statistics provide monthly measures of performance against targets for a range of activities, while outcomes data from life expectancy to cancer survival rates provide indicators of the ultimate goals of the health service.

However, this trove of data does not automatically translate into the quality adjustments envisaged by Atkinson for output and productivity.

Consider the use of NHS performance indicators as quality adjustments and, as an example, accident and emergency (A&E) department waiting times, which are one of the NHS's highest-profile headline performance measures.

We can track the percentage of A&E patients who are seen within the NHS's national four-hour waiting time target. But it is not clear how a change in a quality adjustment incorporating the proportion of patients seen in four hours should affect the value of A&E output. Should we give equivalence to the volume and quality measure such that a 1 % increase in activity and a 1 % decrease in patients seen within the time target are roughly the same as a stable value of output?

This would imply that the value of providing A&E services to patients after the four-hour target is near-zero. However, given that patients counted in the activity data after a wait of four hours have endured the loss of their valuable time in surroundings not of their choice to receive care, it appears clear, even to a logic-seeking economist, that the value patients place on receiving emergency medicine services is greater than zero. So, such a simple solution would clearly be inadequate.

And the problems of how to apply such a performance measure to output do not stop with only the question of how such expenditure is scaled. Such a performance indicator only reflects one aspect of quality and research shows a tendency of providers to modify their behaviour to meet the minimum requirements, but not necessarily the spirit, of performance targets (Kings Fund (2017)). For instance, the four-hour waiting time target may encourage A&E departments to prioritise seeing patients who are approaching the four-hour mark, but improvements in performance against the four-hour target may not reflect shorter waiting times for patients in other parts of the waiting times distribution.

Therefore, robust quality adjustments cannot simply be drawn from the NHS performance targets. Instead, they should inform the effect of health provision on the outcomes they are trying to achieve.

One alternative measure from the health economics literature provides a conceptual framework which fits the criteria for quality adjustment far more closely, the quality-adjusted life year (QALY). The QALY is a tool for evaluating health care interventions that was first developed in the 1960s and 1970s and is now used globally (Mackillop and Sheard (2018)). The QALY is particularly prominent in the evaluation of health care in the United Kingdom, where the National Institute of Clinical Excellence (NICE) uses it to make recommendations on what treatments should be funded on the NHS.

While there is no single definition of a QALY, NICE uses the definition that a QALY is *a measure of the state of health of a person or group in which the benefits, in terms of length of life, are adjusted to reflect the quality of life.*

The QALY thus has two elements, a health-related quality of life element and a temporal element; and can therefore combine the effect of improvements in health-related quality of life and increases in the length of life resulting from treatment.

Health-related quality of life is measured on a scale between zero and one, with zero being a state equivalent to death and one representing perfect health. For the evaluation of health care, the gain in health-related quality of life from an intervention is then measured across time to produce a measure of QALY gain, such that a gain of one QALY represents one additional year of life in perfect health following the intervention.

However, while the QALY serves to provide much of the theoretical grounding for a quality adjustment, the quality adjustment used by the ONS cannot simply consist of a change in measured QALY both for the practical reasons that no systematic regular data collection on patients' health-related quality of life before and after treatment exists, nor are consistent data available on the increase in patients' life expectancy resulting from treatment, but also for the conceptual reason that changes in health states are not just caused by health provision, but also by an array of other factors.

## QUALITY ADJUSTING HEALTH CARE OUTPUT

Unlike other adjustments where the ONS and the relevant government department generally undertook the relevant work, given the challenges of constructing a quality adjustment to meet the principles from the Atkinson Review, the current health care quality adjustment was designed through a rigorous process, which set out the measurement framework, involving an expert group of health economists ([11]).

The construction of the measure incorporated a range of relevant factors, while taking care to minimise combining metrics which would overlap and thus record the same quality drivers multiple times. For instance, the elective inpatient care adjustment combines health gain, survival, waiting times and patient satisfaction, thereby covering the main aspects of care quality. The quality adjustment used by the ONS for healthcare output continues to be based on this research.

The measure produced can be divided into three components:

- hospital procedures adjustment;
- primary care outcomes adjustment;
- patient experience adjustment.

While we will discuss each of these in turn, of the three, the hospital procedures adjustment is by a large margin the most significant in terms of its effect on the measure, while also being by far the most complex. The hospital procedures adjustment continues to be produced by the Centre for Health Economics at the University of York and is used both to quality adjust healthcare output in the ONS measure and for a separate productivity analysis carried out by the Centre for Health Economics (see Dawson et al. (2005)).

### *Hospital procedures adjustment*

The quality adjustment utilises the hospital episode statistics (HES) dataset, whilst incorporating other data from various sources. The HES dataset is a highly detailed administrative dataset recording details of all patients receiving hospital treatment from the NHS in England. Observations in HES are coded to appropriate activity types using the aforementioned HRG system which is used to produce cost-weighted output.

The team did not try to value welfare gains on a QALY basis, although the concept of QALY is central to the hospital procedures quality adjustment, for the following reasons:

- There is no certain value to one QALY — NICE does not specify a single value, though their treatment recommendations imply a value for one QALY of GBP 20 000-30 000. However, other bodies use different approaches to value health, with the Department for Transport using a single figure per life lost to evaluate road safety interventions (Glover and Henderson, 2010).

([11]) Funded by the United Kingdom's Department of Health, the project team consisted of several economists from the Centre for Health Economics at the University of York and the National Institute of Economic and Social Research (NIESR), along with the input of other involved bodies, including the Department of Health and ONS.

- The value of a QALY should vary over time with average incomes and the marginal utility of income, but an increase in incomes should not be attributed to a quality adjustment for the NHS. However, holding the value of a QALY constant could result in the quality adjustment effect declining over time as cost inflation affects the ratio between quality and quantity value.
- Other factors beyond pure QALY gains may be important for the quality adjustment, such as patient experience.
- As discussed in Part 4, below, QALY gains could be influenced by other factors outside of the influence of the NHS, such as the output of other services, environmental factors or changes in patients' behaviour.

The hospital procedures adjustment which was instead developed can itself be broken down into three sub-components:

- estimate of health gain;
- short-term survival;
- waiting times.

The health gain estimate is an attempt to derive a proxy for the gain in health-related quality of life on an equivalent zero-to-one scale as is used in the calculations for QALYs. While, as previously mentioned, there is no systematic collection of health-related quality of life for all patients across the NHS, patient reported outcome measures (PROMs) are collected from patients across two high-volume treatment groups — hip replacements and knee replacements, and until 2017, were also collected for groin hernia and varicose veins procedures. The PROMs give measures for health-related quality of life gains before and after treatment using the EQ-5D scale, a widely used assessment framework — which uses patient responses to questions on ability to pursue usual activities, anxiety/depression, pain, mobility and ability to self-care — to produce a health-related quality of life score on a scale of zero to one.

However, these PROMS measures cover a tiny fraction of the total number of patients receiving hospital treatment on the NHS. The health-related quality of life gain for the majority of patients therefore needs to be estimated. The Centre for Health Economics produced a single 'rough estimate' ([12]) for all remaining elective treatments (procedures scheduled in advance) and a single 'rough estimate' for all non-elective treatments (urgent, unscheduled procedures). These estimates assume a greater health gain for non-elective procedures as patients generally arrive in a worse health state than elective patients, and so experience a greater health gain ([13]).

The gain in health-related quality of life is spread across remaining life expectancy as derived from the ONS data on life expectancy by age, although due to a lack of data, no adjustment is made to counter the effect that treatment may extend life expectancy or that patients may have a lower life expectancy than the general population due to their pre-existing health issues. Gains in health-related quality of life across the future are discounted using the social time preference rate.

([12]) The Centre for Health Economics' assessment, not that of the authors.
([13]) Some further adjustments to these rates are applied to procedures with high mortality rates to avoid the quality adjustment giving a negative valuation to these procedures, but for brevity we will not explore the details of these further adjustments here.

Post-operative short-term survival rates are then incorporated in this measure to reflect health-related quality of life falling to zero for patients who do not survive the procedure or die before being discharged.

A waiting times factor then incorporates the forgone potential health gain for treatment being delayed, with waiting times at the 80th percentile taken to reflect the importance of uncertainty and the risk of long waiting times to patient well-being.

### *Application of the hospital procedures adjustment*

The overall adjustment for hospital procedures is then calculated from the change in the health-related quality of life element (health gain/survival rate factor) multiplied by the change in the temporal element (life expectancy/waiting time factor). This adjustment is calculated individually for each HRG and then applied to the output data which is also calculated at the HRG level, meaning the quality adjustment is not simply applied as an aggregate of all procedures carried out, but incorporates the same cost-weighting as non-quality adjusted output.

However, the complexity of the calculation means that the drivers of this quality adjustment can be difficult to discern and the direction of effect not always immediately intuitive. Table 1 explains the effect of these changes.

**Table 1: Effect of changes in components of hospital procedures quality adjustment on output**

| An increase in … | Effect on quality adjusted output | Mechanism of effect |
|---|---|---|
| Health-related quality of life (HRQoL) gains reported in patient reported outcome measures | Increases | Changes HRQoL gain |
| Proportion of treatments that are elective ([1]) | Decreases | Changes HRQoL gain |
| Post-operative survival rates | Increases | Changes HRQoL gain |
| Average age of patients being treated *(life expectancy at birth unchanged)* | Decreases | Changes length of period over which the gain is experienced |
| Life expectancy at birth *(age at treatment unchanged)* | Increases | Changes length of period over which the gain is experienced |
| Waiting times (80th percentile) | Decreases | Changes length of period over which the gain is experienced |

([1]) The Centre for Health Economics assigns a greater health gain factor to non-elective treatments than elective treatments (see paragraph on pp. 13).

***Primary care output adjustment***

While the hospital procedures adjustment provides a quality adjustment for a large proportion of spending, the NHS also comprises many other smaller services. As previously mentioned, the relative paucity of detailed output data for other NHS services also applies to quality data.

For general practice, the largest component of primary care, a quality adjustment has been built using a selection of appropriate outcomes data from the quality and outcomes framework (QOF), an incentive scheme for general practitioners (GPs). These measures relate to the extent to which patients' health risk factors fall above or below risk thresholds, thus incentivising GPs to monitor, medicate and promote behaviours for healthy outcomes; for example, the proportion of patients with coronary heart disease who have blood pressure and cholesterol readings above a threshold. The quality adjustment is scaled down to reflect the fact that only a small proportion of the population has the relevant risk factors.

The GP outcomes adjustment is a demonstration of the fact that the collection of quality and outcomes data can vary as policy changes. Data from the QOF improved rapidly after their introduction as an incentive scheme in the early 2000s, but the scale of improvements decreased in subsequent years as GPs moved closer to the maximum achievable scores. As the QOF system has matured and the gains in outcomes have become more marginal, the number of measures collected has fallen, further reducing the proportion of GP activity that the quality adjustment covers.

***Patient experience adjustment***

The patient experience adjustment covers a range of NHS services and was included to account for the issue that the other aspects of the quality adjustment do not incorporate non-clinical aspects of care quality which may also be valued by patients, such as being well-informed and involved in decision-making, having good relationships with staff and having a comfortable environment.

The patient experience adjustment is calculated using data from the overall patient experience scores, which are based on national surveys covering in-patients, out-patients, emergency care, community mental health services and primary care, although the patient survey for primary care has been discontinued since the quality adjustment was designed.

Generally, the patient experience scores demonstrate only minor variations over time, and as with the GP outcomes adjustment, result in a relatively minor effect on the overall quality adjustment.

## Education

Education services comprise eight publicly-funded sectors ranging from pre-school to higher education training of teachers ([14]) and is captured using data on student numbers for the respective sectors. Unsurprisingly then, the two largest sectors are primary schools and secondary schools (including academies) both in terms of spend and active student numbers. Like other individual services, the output of education services is measured directly, reflecting changes in the aggregated activities delivered. However, looking deeper into this, the demography of the United Kingdom will mean that using pupil numbers alone gives only a very low or constant growth in education output over time, implying the volume of output of the public education system may not have significantly improved during this period.

This obviously abstracts away from quality factors such as the quality of teaching pupils receive; the depth to which a syllabus is taught; the individual attention afforded to them by teachers; and the skill sets developed. Therefore, if these changes in quality are accounted for, it would be expected that the volume of education service output would change, even if demographic factors hold student numbers constant. Therefore, following Atkinson (2005), additional steps were incorporated to explicitly account for changes in the quality of provision in estimates of education output.

In general, the output of education sectors is quality adjusted in two stages. Firstly, student numbers are adjusted by attendance rates. In line with specific recommendations outlined by Atkinson, rather than using pure registered pupil numbers, adjusting by absence aims to provide a more accurate measure of the amount of teaching activity received by pupils, so absence (both authorised and unauthorised) are captured.

Secondly, metrics of 'high-level' attainment, using information about examination results, measure changes in the overall quality of services provided.

In Foxton (2018a), output associated with both primary and secondary schools is adjusted using the average point score (APS) per student at the General Certificate of Secondary Education (GCSE) level or equivalent examinations, which are normally taken during the student's 11th year of schooling. It is the best current measure for the annual change in the quality of output. It rests on the assumptions that the change in the APS can be used to approximate quality, and:

- should be applied to all pupils in primary and secondary schools ([15]) (from reception class to the end of the sixth form) in the United Kingdom;
- is an adequate approximation for all educational outcomes, for example attainment after the age of 16 and development of wider outcomes such as citizenship.

([14]) Initial teacher training (ITT).
([15]) Including Academies and City Technology Colleges (CTCs) in England.

As these examinations vary across geographical areas, the APS quality adjustment is applied to primary and secondary school output in each country separately. The APS at GCSE level for England and Wales are provided by the Department for Education and the Welsh Government respectively, while the APS associated with Standard exams in Scotland are provided by the Scottish Government. For reasons of data comparability and availability, the level of education quantity in primary and secondary schools in Northern Ireland is quality adjusted using the APS of English schools. Initial teacher training (ITT) quantity in each country of the United Kingdom is adjusted using the QTS award rate for England, which is also provided by the Department for Education. Here the implicit assumption is made that changes in quality in ITT in Wales, Scotland and Northern Ireland follow the trend in England ([16]). This and a number of other factors in relation to the measurement of education continue to undergo revision in the United Kingdom.

## The criminal justice system

Introduced as part of Foxton (2018b), when measuring the output and productivity of public order and safety (POS), explicit adjustments are made to the measure of output from the criminal justice system (CJS) to take account of changes in quality and improvements in associated outcomes. The basic activity measures, common to both public service productivity estimates and national accounts, consist of cost-weighted aggregates of services provided (such as prison bed-days or cases processed per court) which are paid for by the United Kingdom government. This is covered in greater detail both in Part 2 of this paper and Annex B. The quality adjustments applied then consider some of the aspects of quality not already captured by the simple activity measure of output for POS.

Within the POS service area there are four main components: fire-protection services, courts (which itself has five further sub-components), probation services and prisons. The quality adjustments are applied to a subset of these components, as shown in Table 2, which are identified as forming part of the CJS, alongside an indication of the weightings used. A quality adjustment is not applied to fire-protection services or County Courts, which deal with civil cases ([17]).

The criminal justice quality adjustment has four components:

- recidivism (re-offending) adjustment;
- prison safety adjustment;
- custody escapes adjustment;
- courts' timeliness adjustment.

([16]) This is a key issue in relation to geographical comparability — is it better to quality adjust all geographies, even when no quality adjustment data are available in that area, or is it better to present unadjusted data in these areas, even if this introduces a variation of its own.

([17]) United Kingdom court cases are divided into 'civil' and 'criminal'. Civil cases covering areas of family and contract law do not address 'criminal offences' and are therefore out of scope of a quality adjustment designed around addressing criminal behaviour. Similarly, fire-protection services are exempted from the described quality adjustment.

The first relates to achieving an overall outcome — reducing re-offending — for the whole CJS and therefore treats the CJS as one interlinking system that allocates and provides appropriate disposals ([18]) and rehabilitation services. It can, however, be argued that the associated sub-components may have specific target outcomes, in addition to reducing recidivism. Therefore, the remaining three adjustments relate to specific target outcomes for sub-components of the CJS.

**Table 2: Quality adjustment weights by output component**
(%)

| Component | Quality adjusted | Recidivism | Prison safety | Custody escapes | Courts' timeliness |
|---|---|---|---|---|---|
| Fire-protection services | No | | | | |
| Magistrates Courts ([1]) | Yes | 50.0 | | | 50.0 |
| County Courts ([1]) | No | | | | |
| Crown Courts ([1]) | Yes | 50.0 | | | 50.0 |
| Crown Prosecution Service ([1]) | Yes | 100.0 | | | |
| Legal Aid ([1]) | Yes | 100.0 | | | |
| Probation services | Yes | 100.0 | | | |
| Prisons ([2]) | Yes | 29.2 | 37.5 | 33.3 | |

([1]) Subcomponent of United Kingdom courts and related activities.
([2]) Weights for prisons quality adjustments are taken from prison and probation performance statistics 2014-2015. Further details on sources and methods used can be found in Foxton (2018b).

*Source:* Foxton (2018b)

### *Recidivism adjustment*

The recidivism adjustment is applied across all output associated with the CJS. It approximates the effect the CJS has on reducing the volume and severity of further crimes being committed by those who have gone through it — this being an important social outcome for the system. The ONS measure works by adjusting the cost-weighted activity indices of the service areas identified in Table 2 by a severity-adjusted rate of recidivism.

This adjustment itself is composed of three parts, the first being the change in the number of proven re-offences committed by adult and juvenile offenders categorised between crime types. These include such categories as violence against the person, robbery and fraud. Secondly, an adjustment is made to offenders, to account for differences between cohort characteristics and their likelihood to re-offend. The final adjustment made provides a weighting by which to aggregate together all re-offences. This weighting is based upon the relative severity of the re-offence and is derived from ONS (2016). More information on this source, as well as others used, can be found in Foxton (2018b).

([18]) A disposal can be thought of as an appropriate sentence for the crime and mitigating factors, such as repetition, aggravation, or factors which make the case more severe (for instance, assault with a weapon, as opposed to assault without a weapon).

### *Prisons safety adjustment*

The prisons safety adjustment relates to the number of incidents of assaults, self-harm and deaths that occur in prison custody. The purpose of this being to reflect that safety of prisons is an important component of the quality in the activity and services provided, as set out in the Prison Safety and Reform White Paper (Ministry of Justice (2016)).

We measure the number of incidents per 1 000 prisoners, which are grouped into 'severe', 'less severe' and 'those resulting in a death'. These groups are subsequently weighted and aggregated together based on their relative cost. This is achieved by using the total cost to society of workplace injuries as a proxy, taken from the Health and Safety Executive ([19]).

### *Custody escapes adjustment*

The escape adjustment relates to ensuring prisons fulfil the role of public protection and is applied to activities used to measure the output of the prison service.

The measure is based on changes in the difference between the number of escapes and a baseline of 0.05 % of the England and Wales prison population — a historic target used by the Ministry of Justice. The purpose of this being that as the absolute number of escapes approaches zero, the relative change year-on-year would have a disproportionate effect on a non-baselined quality adjustment index.

### *Courts' timeliness adjustment*

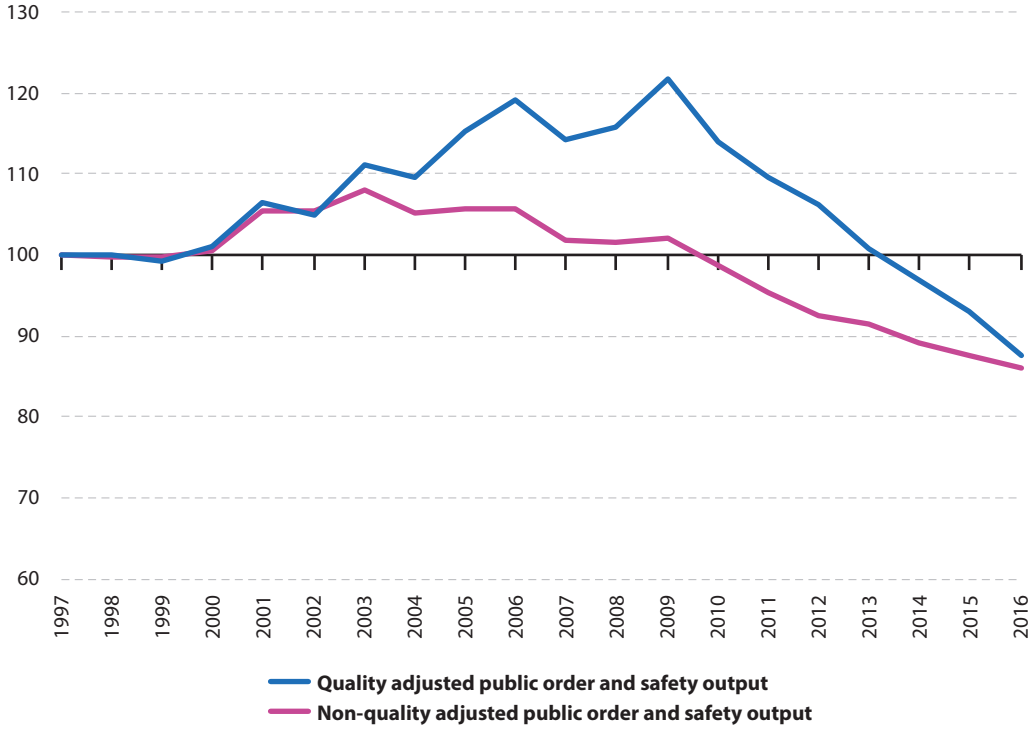
The courts' timeliness adjustment relates to the average time taken for criminal cases to be taken to completion, on the basis that the delivery of a sentence in a timely manner is favourable. However, there is currently no adjustment made to reflect whether there has been fair treatment of the suspect or victims or to allow the appropriate time for preparations of criminal cases with differing levels of severity or complexity.

For Magistrate Courts, the measure is based on the mean average time of charge and laying of information to completion. For Crown Courts, the measure captures the average waiting times experienced by all defendants and the mean time from main hearing to completion. As implemented, the measure accounts for changes in the average time taken to completion by criminal courts because increases in volume may reflect a worsening.

The net effect of this measure can be seen in Figure 2 which demonstrates the impact of quality adjustment on the output of the public order and safety sector in recent years.

([19]) This method is currently under review: the weight applied to a lost life compared with other injuries mean these data fundamentally drive this component. We are exploring with experts whether greater weight should be applied to other injuries which form the bulk of instances.

**Figure 2: Non-quality adjusted output and quality adjusted output for public order and safety, United Kingdom, 1997-2016**




*Source:* Office for National Statistics — Public service productivity: total, United Kingdom, 2016 (ONS (2019b))

## Adult social care

Adult social care (ASC) services comprise care and support provided to older people, adults with learning or physical disabilities, adults with mental health problems, drug and alcohol misusers, and carers. By spending, the largest two client groups are older adults and adults with learning disabilities. The services covered by ASC include placements in residential and nursing care homes, home visits by carers, day care services and supported living arrangements in accommodation adapted to users' needs.

Unlike the NHS, which has provided free-at-the-point-of-use health care to patients since it was formed 70 years ago, ASC services have not undergone the same funding and policy unification. While the NHS is a single public body in each of England, Scotland and Wales, responsibility for the provision of ASC services remains with local authorities ([20]). The funding of ASC comprises a number of streams, with the main sources being:

- Local authorities' own funds.
- Fees charged to clients, which for many services is subject to means testing based on clients' wealth and income.
- Payments from the NHS. There are a number of schemes under which NHS bodies transfer funds to ASC services. The funding transferred through these schemes has grown in recent years at the behest of government policy. The transfers are intended to financially support local authorities to relieve pressures on the NHS by reducing unnecessary hospital attendances by care clients (so-called 'bed-blocking') and promote co-operation between NHS and ASC service providers.

The provision arrangements are further complicated by most ASC services being contracted out by local authorities to the independent sector (typically private firms and charities), while a minority of services continue to be provided directly by local authorities.

There is also a substantial private sector, where clients purchase ASC services directly from private providers without necessarily involving local authorities.

As explained above, following the Atkinson Review guidelines, the remit of public service output and productivity is delineated by public spending as opposed to public provision. Therefore, the proportion of ASC services funded by local authorities and payments from the NHS is within public service output and productivity, whether provided by local authority or independent sector providers; while client-funded activity is excluded.

***Measuring the output of ASC services***

Activity and expenditure for ASC services are measured using data collected by the NHS from local authorities, enabling the construction of a cost-weighted activity index. When the Atkinson Review was published, activity data were available for residential care, nursing care, home care, day care, the provision of equipment and home adaptations, meal deliveries and referrals and care assessments undertaken. Residential, nursing and day care were further split by client group to reflect differences in the costs of providing care to different client groups.

However, this data collection was ended in 2013/14 and the collection that replaced it in 2014/15 covered a reduced set of activities, causing the proportion of ASC expenditure covered by the cost-weighted activity index to fall from 76 % to just 36 %. As a result, a new methodology has been developed (see Lewis (2018b)) which uses activity data, where available, to generate a cost-weighted activity index, and where it is not, calculates volume output using the 'outputs equals inputs' convention.

([20]) Local government in England is divided between 152 'top-tier' local authorities, with fewer in the smaller nations of Scotland and Wales. The Health and Social Care Service in Northern Ireland is a public body with responsibility for both health care and adult social care, although funding arrangements are similar to the rest of the United Kingdom, with health care being available free-at-the-point-of-use, but certain ASC services are means-tested and can charge clients directly.

While this is the best measure available for output, the loss of such a large proportion of activity data limits our ability to measure productivity across the whole ASC service sector, although separate productivity measures covering the service elements for which activity data remain (residential and nursing care) are produced to analyse these services specifically.

***Developing quality indicators for ASC services***

While activity data matching the requirements of the Atkinson Review were readily available in the 2000s, suitable quality measures were not.

The absence of available quality measures for ASC was not only a problem for the implementation of the Atkinson Review guidelines but also a problem for policy analysts trying to understand the performance of the ASC sector, whose main data source was the inspection reports of care homes carried out by the Care Quality Commission.

As a result, the ONS organised a cross-body programme, Measuring Outcomes for Public Service Users (MOPSU) to develop a toolkit for measuring ASC outcomes, along with other strands on building quality measures for early years education and measuring the third sector (see ONS (2010)). The MOPSU project on ASC outcomes was led by the Personal Social Services Research Unit (PSSRU) at the University of Kent providing sector-specific research and economic expertise.

At first glance, health care and adult social care may appear to be similar services, with both involving the care of individuals with health problems. However, while the main element of the health care quality adjustment measures the gain in health resulting from a hospital procedure performed at a point in time, the primary benefit from social care is an improvement in quality of life over the period social care is being received.

The project considered several approaches to measuring the outcomes of social care (see ONS (2007)), including:

- the extra-welfarist approach, where the desired outcome is pre-determined by the researcher and achievement against this outcome measured on a scale;
- the hedonic psychology approach, which involves studying clients' spontaneous approach/avoid, continue/desist and good/bad reactions at various moments in time as they use services;
- the capabilities and functioning approach, first developed by Sen (1985), which measures clients' opportunities or potential to obtain desirable 'functionings' such as being fed or having meaningful social relationships.

The approach taken followed the capabilities and functioning approach, and applied it to form a measure on a QALY-style zero to one scale, known as social care-related quality of life (SCRQoL). This is used as a quality adjustment on ASC output.

As described in the section on health care, there are several alternative questionnaire forms for measuring the quality of life element of QALYs, with the EQ-5D used in the NHS patient-reported outcome measures. The MOPSU project therefore needed to design a questionnaire for eliciting SCRQoL, based loosely on the capabilities described by Sen as essential elements of well-being.

An analysis of existing literature revealed eight broad domains which, with minimal overlap, appear to determine quality of life:

- personal cleanliness and comfort;
- accommodation cleanliness and comfort;
- safety;
- food and nutrition;
- control over daily life;
- occupation;
- social participation and involvement;
- dignity.

However, simply surveying care clients to rate their satisfaction on each of the eight domains against four possible responses for each creates two problems. Firstly, there is no reason to assume that each of the domains is of equal value to care clients — some may be more important to overall well-being than others. Secondly, it is not certain that the levels of responses that clients give against their experience (such as needs fully met, mainly met, partly met or not met) should be allocated a set of equally-spaced utility values, such as 1, 0.67, 0.33 and 0.

To deal with these issues, the Personal Social Services Research Unit (PSSRU) worked with RAND Europe on a study to determine the relative importance of each of the domains, and various 'levels' of experience within the domains, by asking care clients to rank the best and worst outcomes of a range of possible 'levels' of the above categories.

This study ([21]) enabled the construction of 'weights' for the preferences such that each 'level' of experience for each domain is attributed a utility value. Table 3 shows an example with two of the domains. The weights demonstrate that a difference in utility value between the top and bottom level responses for the control over daily life domain (the client having as much control over their daily life as they want and the client having no control over their daily life) is greater than the difference in utility value between the top and bottom responses for the social participation domain (the client having as much social contact as they want with people they like and the client having little social contact with people and feeling socially isolated). Of the eight domains, control over daily life had the greatest range in utility between the highest and lowest response, and this was bounded between zero and one. However, the utility weighting study also revealed that the difference between the first and second level response of each domain was lower for the control domain than for the social participation domain.

([21]) While the MOPSU project established the principles of weighting different domains of quality of life, the actual weights used in the quality adjustment are derived from a later study based on a number of specific surveys (see Netten et al. (2012)).

**Table 3:** Utility weights for two example domains

| Domain level | Utility weight |
|---|---|
| Control over daily life | |
| 1. I have as much control over my daily life as I want | 1.000 |
| 2. I have adequate control over my daily life | 0.919 |
| 3. I have some control over my daily life, but not enough | 0.541 |
| 4. I have no control over my daily life | 0.000 |
| Social participation and involvement | |
| 1. I have as much social contact as I want with people I like | 0.873 |
| 2. I have adequate social contact with people | 0.748 |
| 3. I have some social contact with people, but not enough | 0.497 |
| 4. I have little social contact with people and feel socially isolated | 0.241 |

*Source:* Netten et al. (2012)

## IMPLEMENTATION OF THE ADULT SOCIAL CARE QUALITY ADJUSTMENT

To collect the social care-related quality of life (SCRQoL) data needed to measure the performance of local authority social care services, the Adult Social Care Survey was introduced in April 2010 and now interviews over 10 % of adult social care clients in England annually. The measure of SCRQoL, along with other outcome measures from the Adult Social Care Survey, form the Adult Social Care Outcomes Framework, a set of indicators used to evaluate the performance of local authority ASC services across England.

While a change in the measure of SCRQoL gives a good indication of changes in the well-being of the care population, the measure does not give a definitive answer on whether a change in SCRQoL can be attributed to social care services or results from changes in the underlying care population or their wider environment. For instance, an improvement in the average response to the control over daily life question in Table 3 could result from improvements to the quality of care which result in clients being more involved in decisions about their care, but could also result from a change to the care population to include more lower-need clients whose health status may afford them more independence than other clients.

To produce an attributable quality adjustment, it is therefore necessary to develop a measure which isolates the effect of service quality on outcomes from the other factors which may also influence these outcomes. Adjusted social care-related quality of life (adjusted SCRQoL) was developed by the Quality and Outcomes of Person-Centred Care Research Unit (QORU) from the earlier work on SCRQoL to provide such a measure for the Adult Social Care Outcomes Framework (ASCOF) and was introduced into the 2016/17 indicator set.

The adjusted SCRQoL measure controls for a range of factors outside the control of social care providers which may affect SCRQoL including age, health status, the suitability of the clients' home for meeting their needs and the clients' ease of travelling around outside in their local environment through using regression analysis to derive an estimate for the expected effect of these factors on SCRQoL (Forder et al. (2016)).

While the adjusted SCRQOL measure has only been published in 2016/17 and for community care clients, the ASC output quality adjustment used by the ONS for community care is produced using the same parameters from data provided by the Adult Social Care Survey for the period 2010/11-2016/17.

For residential and nursing care, the quality adjustment is derived from a similar regression analysis informed by Yang, Forder and Nizalova (2017) and controls for:

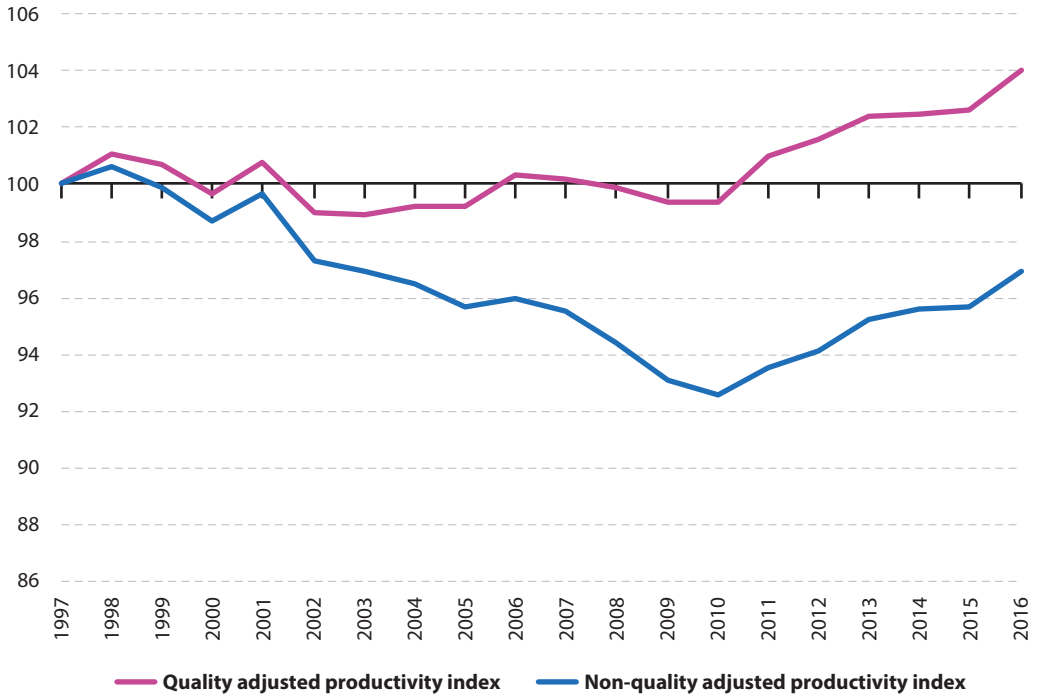
- gender;
- ethnicity;
- age;
- self-reported health status, level of pain and level of anxiety;
- the number of basic activities of daily living (ADLs) the client needs support with;
- whether the client can deal with their finances and paperwork.

The ASC quality adjustment therefore provides an estimate of the change in the key ASC outcome attributable to social care services.

## Aggregate impact

The aggregate impact of these quality adjustments on total public service productivity estimates are notable. In ONS (2019b) it was shown that non-quality adjusted public service productivity fell by 3.1 % between 1997 and 2016, while quality adjusted productivity rose by 4.0 %.

**Figure 3: Total public service productivity index, quality adjusted and non-quality adjusted, United Kingdom, 1997-2016**
(1997=100)



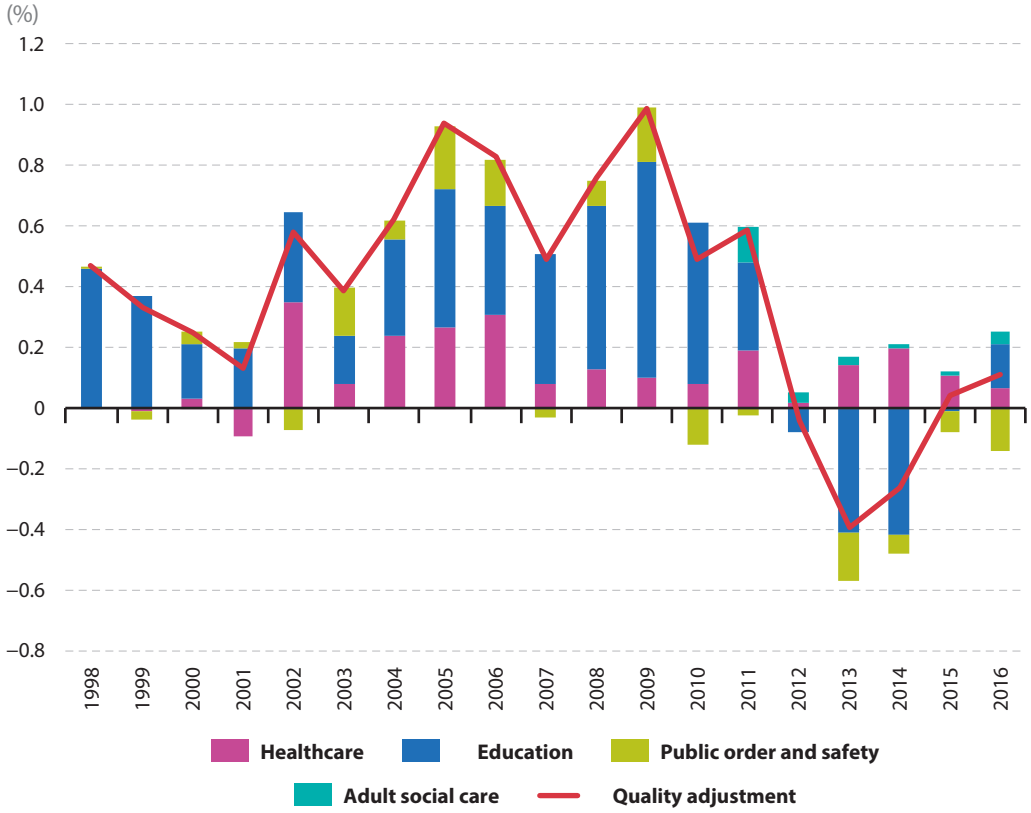

*Source:* Office for National Statistics — Public service productivity: total, United Kingdom, 2016 (ONS (2019b))

We can also break down this aggregate quality adjustment factor into contributions from the four components, as shown in Figure 4 where the education quality adjustment can be seen to be the largest contributor to overall public service quality, and thus that volatility in this series can induce substantial movements on the aggregate.

On average, the education quality adjustment has added 0.2 percentage points per year to growth in total quality adjusted output between 1998 and 2016. However, it acted as the main driver for the decline of overall quality between 2012 and 2015, averaging a negative contribution of 0.2 percentage points in this period, although we continue to explore method improvements here. In 2016, it returned to having a positive contribution of 0.1 percentage points.

For healthcare, the impact of its quality adjustment has been positive, with some variation in the size of its effect, contributing upwards in every year except 2001. The public order and safety quality adjustment, on the other hand, generally made upward contributions to the total rate up until 2010, but has since made consecutive downward contributions. This was due largely to the negative impact of the prison safety adjustment, reflecting increases in the number of self-harm and assault incidents reported in prisons. Finally, applied from 2011 onwards adult social care quality contributed positively.

**Figure 4: Contribution to total quality adjustment growth by service area, United Kingdom, 1998-2016**




Note: sum of components may not equal the total due to rounding. Healthcare quality adjustment applied from 2001 onwards. Adult social care quality adjustment applied from 2011 onwards.

*Source:* Office for National Statistics — Public service productivity: total, United Kingdom, 2016 (ONS (2019b))

# 4. The big issues in measuring public service outcomes

As outlined above, generating quality adjustments for a variety of public services is both feasible and capable of significantly improving the quality of the statistics being produced. In addition, where methodologies have been developed the authors believe there is a strong potential for other countries to use these as a substantive foundation upon which to build methodologies tailored to their countries service design.

However, in line with Atkinson's recommendations we do not believe it is feasible in the United Kingdom, or any country to stand still. Continuous improvement and development of these methods is required, and to make the most of this opportunity it is sensible to consider the key lessons which the current practices provide, particularly if other countries wish to learn from these examples.

Similarly, before discussing the welfare implications of outcomes which the public services contribute towards, this section addresses the key issues and 'lessons learnt' from a decade of attempting to apply the Atkinson principles in the United Kingdom context. These are:

- how should various aspects of quality change be valued and weighted?
- how should different quality adjusted services be weighted together?
- how do we keep pace with the rate of technological change?
- should we be following individuals or use aggregate data?
- what do we do when a change in policy affects our measure?
- where do we source objective weights?
- how do we trade-off consistency of estimates with different needs for data in relation to devolved matters?

## How should various aspects of quality change be valued and weighted?

There are two symmetric problems in relation to the valuation and weighting of quality change:

- what to do when a public service delivers multiple outcomes, which could all contribute towards the quality adjustment we calculate for that service; and
- what to do when a single outcome is impacted by multiple public services?

Clearly for the first of these, when a common metric exists which can be applied to multiple outcomes, such as quality-adjusted life years (QALYs) in health, this appears a trivial question: once the value of a single QALY is established healthcare interventions can be theoretically evaluated by comparing their cost to the value of the number of QALYs they deliver per course of treatment.

Complexities can, however, still emerge. As explained above, the QALY measure has two elements, a health-related quality of life element and a temporal element; and can therefore

combine the effect of improvements in health-related quality of life and increases in the length of life resulting from treatment. Data is required for both dimensions across the whole population to derive a quality adjustment, which is a non-trivial investment. Equally, while the increase in QALYs following an intervention would be far closer to a measure of the quality of health service provision than NHS performance indicators or broader outcome measures such as life expectancy, which would require attribution factors to be generated, the use of a quality adjustment solely based on QALYs would still face the problems described in Part 3.

So, given that in the United Kingdom we do not use QALYs, the health quality adjustment is applied to output as a simple scalar variable, such that a 1 % increase in the quality adjustment results in a 1 % increase in quality adjusted output.

But changes in quality may reflect changes in the value of the service that are less or greater than this simple scalar imposes. Deriving accurate valuations to either weight contributions to the quality adjustment, or to weight the quality adjustment vis-à-vis the outputs remains a formidable challenge, as illustrated by research by Ryan et al. (2014) on the case of valuing patient satisfaction. Whilst a range of methods are available, eliciting firm reliable values is at present almost impossible, and relies on an ability to calculate objective weights. This can make it difficult to diagnose the exact causes of quality change over time, a non-trivial complaint in a measure regularly used to inform public policy analysis.

The second scenario is perhaps most easily explained in relation to the way health and social care interact to support improved health outcomes, or the interactions between the various agencies within the criminal justice system (CJS). The CJS is a collection of agencies working in partnership towards a common goal. The effective functioning of the CJS requires the processing of offenders from arrest to prosecution, to the delivery of justice — whether punishment or acquittal. An accurate measure of the increment to collective welfare from the CJS should reflect this. This implies that one cannot treat the police, the courts, and the prisons as entirely individual, stand-alone entities: the effectiveness of each agent within the CJS depends, to varying degrees, on the effectiveness of the others. For example, the quality of prosecutions undertaken by the Crown Prosecution Service will depend on the quality of the investigative work undertaken by the police. In describing the CJS we have sometimes used the analogy of a car engine. Subsequently, the question becomes one of attributing a system-level outcome (reducing re-offending) across the various component parts of the CJS, when some of these, particularly prisons, have their specific quality measures (for example, safety and decency). This can lead to some parts of the system having a lower weight for reducing re-offending when they may be assumed to have a higher weight than others.

However, we continue to need to weight the activities which count towards output, and in doing so we need to weight their output by the quality measures, returning us to the first bullet point above. This brings together the different outcome measures when different parts of the overall system have different outcomes relating to them. In principle, it is most desirable to weight together different quality metrics or indicators based on the value placed by individuals and society on services and their various attributes. Such an approach was taken with the adult social care quality adjustment, using data from separate studies specifically commissioned to understand how social care clients valued different aspects of well-being. The stated preference approaches provided differential weights for different aspects of well-being and enabled different levels of responses to be assigned relative values.

Extending such an approach across all service sectors requires the conducting of a range of studies to identify such preferences. In each case, three key questions would need to be answered before extending this approach: whose preferences are used, how to reflect changes in preferences over time, and how to derive an 'average' valuation?

Another possibility may be to weight domains of quality according to the relative costs associated with them. This assumes that the revealed preference of service managers on what they consider important reflect social preferences. However, costs do not necessarily correlate with quality — this is where the Atkinson Review came into the story.

In the absence of adequate data then a default solution may be to tend towards equal weights. However, this method is clearly sub-optimal: the long-term robustness of equal weighting, lacking in empirical support, could undermine the validity of the associated measure produced. In relation to prisons, where re-offending, prison safety and preventing escapes come together as three clear outcomes we need to recognise, we used the approach of taking a weighted average of prison performance measures, as used by Her Majesty's Inspectorate of Prisons, on the basis that these were set by Ministers in Parliament, and as such could be argued to represent social preferences. This relies on assumptions of government efficacy in delivering this role but appeared justifiable over any other arbitrary set of weights. Such 'social preferences', however, cannot be observed in all areas of public services, although the experiment of using such performance structures may be replicable in other 'inspected services'.

## How should different quality adjusted services be weighted together?

The challenge described above in relation to a single service, become an even more complex matter when one begins to combine services together. The classic method used under Atkinson is to do this using cost weights. These are objective, and if one believes the marginal pound is efficiently allocated by government then should be reflecting equal value. However, if one considers the question: would a 10 % reduction in the quality of GBP 1 000 of spending on health be worth more or less than a 10 % reduction in the quality of GBP 1 000 of spending on forestry, one can immediately see that, by dint of the sheer differential in the volume of funding devoted to these two services, this would likely deliver very different marginal impacts and public reactions. Therefore, are cost weights appropriate if we cannot break down changes in costs between changes in the prices of output and changes in the quality of the outcomes delivered by these outputs? Diewert and Fox (2017) present arguments for alternative weighting approaches based upon the relative value to users, which the authors consider intuitively strong and worthy of significant further consideration.

## Keeping pace with new technology, systems and data

An additional recommendation raised by Atkinson was the need to maintain and continue to develop quality adjustments through time. Quality measures which were identified initially, particularly in periods of rapid technological change, may no longer be fit for purpose and

may, with the passing of time, fail to continue to measure the key underlying principle you are trying to measure. Principled measures are key, but must reflect change.

For example, the health quality adjustment itself remains largely unchanged since its introduction in 2005, but the range of metrics health policy analysts study has not. In 2010, a new set of indicators for measuring health care performance, the NHS Outcomes Framework (NHSOF), was introduced and has become the central source for analysts measuring health care outcomes. Having been produced prior to the NHSOF, the results of the current health care quality adjustment do not always triangulate with the story that health care policy analysts derive from the NHSOF. In 2016, the Centre for Health Economics at the University of York convened a workshop to bring together policy analysts and health economists to consider the criteria that should be used for selecting NHSOF indicators, and this was followed up with a paper, Bojke et al. (2018), applying the criteria to these indicators. The challenges of adopting NHSOF indicators within a quality adjustment exercise are considerable, as they are not drawn from a single data source, and so are published at different times and often variable frequencies. However, such a review demonstrates the need to regularly review quality measures to ensure their continued relevance as policies and data sources change and may lead to a quality adjustment with relevance to users.

The *quid pro quo* here is the allocation of development time by NSIs. In the authors' experience the trade-off between investing in updating existing quality adjustments versus the creation of new measures covering new service areas has regularly required consideration. In recent years, new service areas have been prioritised where developments in reporting and data sources have opened the door to creating a new adjustment at relatively low costs. The continued pace of change in health and education, the United Kingdom's two largest public services, however probably make the need to revert to revising their measures inevitable in the coming years.

In relation to new data, where it is difficult to forge a link through to an individual's experience, which is the approach followed in health and adult social care, we have found that the most practicable application is through the use of published data sources, which are generally aggregated at the population level to track the movement in group or average performance. Criminal justice is a prime example of this. Efforts to focus on individual offenders, or the 'offender journey' resulted in a failure to deliver a quality adjustment in this space until 2017, when the ONS changed tack to focus on aggregate performance data. The key to unlocking this was the delivery by the ONS of an experimental dataset on the relative severity of crime (capable of answering questions like 'how many burglaries equal a murder?'), which provided a set of objective weights to adjust raw re-offending data and provide a consistent measure of whether outcomes were improving or weakening through time.

This approach brought the additional benefit of allowing service providers to better engage with the productivity statistics, as they were grounded in concepts and measures they were currently working with and understood. Providing objective insights where these had been missing previously appears to the author's to be a positive direction of travel, particularly when this work could be delivered at little additional cost.

## What do we do when a change in policy affects our measure?

There are instances where the measure itself is subject to policy decisions, and is directly affected by policy change, not just in terms of the level, but also in terms of the definition of the measure itself. This is, broadly, always the case, but in some areas it is more pertinent than others. It is particularly the case when there are fears of 'gaming', that is where the definition of the measurement itself leads to undesired outcomes. Education is a prime example of where government policy has been shaped by the need to address a set of interlocking concerns.

Whilst the ONS has historically used the GCSE APS attainment as a quality metric, the actual application has changed noticeably over time, in response to three key issues, where there was a perceived threat that the measure had been corrupted ([22]). Firstly, there is the question of whether attainment through time has been consistently measured or suffered from 'grade inflation' ([23]), secondly have schools made greater use of 'easier' or more vocational courses to artificially inflate APS scores, and thirdly have schools improved marks by teaching to the test rather than giving a rounded education.

In light of this, the Department for Education established a review which found evidence of improvement in pupil's attainment in England over the period. However, when similar analysis was carried out on other measures and systems of pupil attainment used in the United Kingdom and within the OECD, they found, in contrast to the APS, little overall improvement in the level of pupil attainment. It is, however, worth noting that these findings were based on less timely data with much smaller sample sizes than national performance data, but they called into question the validity of GCSE APS data as a proxy either of educational attainment at that age, or as a proxy for the whole system, as the current quality adjustment implies.

To address these worries, reforms to GCSE grades were introduced by the Department for Education in 2014, following the Wolf Report (2011). This changed the qualifications eligible to count towards APS, particularly in relation to vocational qualifications on school performance measures in England ([24]). To reflect this an alternative approach to quality adjusting United Kingdom public service education output was proposed (ONS (2015a)) and adopted (ONS (2015b)).

The method replaced the use of APS data for England with Level 2 (or L2) attainment at age 16 for the years 2008 to 2013. Level 2 attainment equated to five or more GCSEs at grades A*-C or an equivalent (and eligible) Level 2 vocational qualification. This is a threshold measure of the percentage of students achieving a particular level of attainment, compared with the APS which takes into account the full distribution of attainment data, making Level 2 attainment less susceptible to changes in the education system and pupil behaviour. This is the current method used for quality adjustment in England. However, alongside these changes, in 2017 a further revision to GCSE grading was introduced which presented a more fundamental

([22]) Notwithstanding the fact that our experience of using a single measure (age 16 GCSE test results) as a proxy for performance across the age spectrum is that this model makes it difficult to reflect differential performance in one part of the education system (for example, primary or early years) against another (for example, secondary), when the quality measure simply does not capture more than one of these.

([23]) The converse argument is that, in the face of increasing tuition fees, and low wage growth in low skilled jobs, students have responded to market forces by investing more heavily in their own development whilst education is free, resulting in improving performance.

([24]) The significant increase in APS between 2008/2009 and 2011/2012 could partly be attributed to increases in the number of non-GCSE examinations taken because of changes in the type of examinations, which counted towards performance.

challenge. In a further effort to address perceptions of grade inflation, a new grading structure was introduced. This deliberately did not enable a one-to-one matching with the old banding structure, introducing computational challenges in preventing a discontinuity in the series.

**Table 4:** Old and new GCSE band equivalences

| Old structure | New structure |
|---|---|
| A* | 9 |
| A | 8 |
| | 7 |
| B | 6 |
| C | 5 |
| | 4 |
| D | 3 |
| E | 2 |
| F | 1 |
| G | |
| U | U |

Clearly, a measure which is the subject of frequent change is not a stable base upon which to build a long-term quality adjustment.

## How do we trade off consistency of estimates with different needs for data in relation to devolved matters?

As mentioned above in relation to the education quality adjustment, for reasons of data comparability and availability, the level of education quantity in primary and secondary schools in Northern Ireland is quality adjusted in line with that applied to English schools.

Similarly, while current measures and methodologies to reflect quality change in the CJS are applied to the output of the United Kingdom as a whole, the associated metrics reflect but a subset — covering England and Wales. Here the implicit assumption is made that changes in quality of the CJS in Scotland and Northern Ireland follow the trend observed in England and Wales.

Whilst only United Kingdom level estimates are produced we can, to some degree duck these issues, but in light of a growing need to provide statistics for devolved administrations and lower-level geographies it is clearly problematic to either attempt to compare an area whose quantity of output is quality adjusted with one which is not, or to quality adjust two areas by an adjustment factor derived in only one of them. In a world where decision-making powers in relation to these services have been devolved to administrations in each of the component countries of the United Kingdom it is clearly problematic for decision makers in Northern Ireland or Scotland to have to view the productivity of services they have responsibility for through a lens which can be argued to be distorting their view of their system relative to the other nations of the United Kingdom. This issue was explicitly recognised in Atkinson's Principle E.

This is exacerbated where different administrations or legal systems have resulted in long-standing differences between the model of services provided by the constituent countries, their methods of delivery and the machinery of government. These differences are set to become potentially more important because of devolution. Likewise, by applying common factors, we may well fail to reflect variations in priorities/desired outcomes, particularly as quality metrics and their associated weightings become more granular.

Given that many public services in the current model are not quality adjusted and at the aggregate level we are therefore regularly comparing quality adjusted and non-quality adjusted sectors, the ONS is exploring removing non-native quality adjustments ([25]) where these are currently applied.

# 5. The treatment of non-attributable outcomes as welfare gains

Atkinson and Parts 2-4 of this paper focus on the outcomes which are directly attributable to the activities and outputs of public services, however there is merit in stepping back to consider some fundamental questions about the exact scope under consideration and the implications of that scope on the object of interest: welfare gains.

There is a well-known difference between the evolution of outcomes which people value and the effect of public services in generating those outcomes, (see, for example, Stiglitz et al. (2009) or, Bean (2016)).

At its simplest, the Atkinson framework conceives that the volume of activity is not adequately measured by the outputs of that sector if insufficient attention is paid to quality change. For products in the market-sector this is captured through adjustments made to the deflator to decompose price changes into those caused by changes in the general price level and those caused by changes in the quality of the product. The relative price of a product should increase as its quality increases. This is obviously a more complex exercise when prices cannot be observed and public services, where such prices do not exist, exemplify this. The Atkinson Review therefore argued for the application of quality adjustments derived from directly observable data.

Are then these quality adjustments equivalent to the changes in consumers' welfare? The answer here from Atkinson is unequivocally 'no'. Increasing life expectancy, for example, is clearly of value but only a part of that can be attributed to improved health services. The majority of the rise is likely to belong to dietary and other lifestyle changes. So, there is an additional question as to how these wider effects can be measured. The Atkinson quality adjustments only capture that aspect of the welfare gain which is directly attributable to the public service.

([25]) In other words, applying English quality adjustments to Scottish or Northern Irish services.

However, in terms of the debates (summarised in Heys, Martin and Mkandawire (2019)) about measuring the modern economy and the need to understand why citizens increasingly view GDP as a poor proxy for welfare measures, this is a key point for two reasons:

- Whilst Stiglitz et al. (2009) encourage the focus to no longer be on improving GDP as a welfare measure, recent studies (Brynjolfsson et el. (2019), Hulten and Nakamura (2018)) show there remains an appetite for this approach because of the dominance of GDP within political debate. If public services are a significant fraction of GDP, and quality adjustments have a noticeable impact on volume growth in relation to these services, and this is not being taken into account, as it generally isn't, then this may introduce a wedge between GDP and welfare growth even if the concept of GDP, including public service quality adjustments, should share a common growth rate with welfare. This does not negate the thrust of arguments which suggest we should go 'beyond GDP' to measure welfare, but it remains valid to attempt to measure GDP growth as accurately as possible.
- Welfare gains from outcomes which relate to, but are not attributable to public services, may be a significant driver of any perceived difference in the behaviour of GDP and welfare, so if one wanted to identify a way to measure welfare, one would need to find a way to capture this element outside of GDP to contribute to a welfare measure.

This opens intriguing options:

- we know or can calculate the increased number of QALYs that a society is enjoying compared with some base year;
- we can also, using the methodologies set out and discussed earlier, place a value on each QALY reflecting the benefit society is estimated to receive from it;
- the simple product of the two gives an estimate of the increased welfare that society enjoys as a result of longer life expectancy or improved quality of life.

It should be emphasised that this is not a measure of public service output or would or should be used as a component of GDP. On the other hand, this measure of a key dimension of welfare is of importance and relevance in its own right. Further, a number of the data sources that would be needed are readily available — many of them, for example, are collected as part of the datasets being assembled for the sustainable development goals (SDGs). In turn, this should enhance the international comparability of such measures.

This suggests there are three topics of interest for future research:

- how to measure the welfare gains from increased life expectancy (for example Crafts (2002));
- how to measure the contribution to these welfare gains from public services, to improve public service output and productivity measurement; and,
- what is the relationship between the two?

To expand on the illustration described above, for example, the public service health quality adjustment is not denominated in pounds, but is a quantity uplift factor. Research is required to identify a method for getting both the wider welfare gain and the public service quality adjustment into the same base for valuation to allow comparison and evaluation.

# 6. Conclusions

This paper discusses possible ways forward in two related but different areas. It draws upon the United Kingdom's experience for this purpose.

One relates to the ongoing but unfinished agenda as to how to measure the outputs of goods and services which are 'free at the point of delivery', for the purposes of national accounts. Public services such as schools and health services are major examples of this kind. Over a decade ago, Sir Tony Atkinson provided a principled framework for this end. Consistent with the basic principles of national accounting, he advocated an approach by which this output should be measured as the value added by the services concerned. This value, in turn, equated to the improvement in outcomes directly attributable to the activities of the public services concerned.

Implementing this approach, as he recognised, is by no means straightforward, but the United Kingdom experience recounted above shows that strong progress can be made. Working with experts and practitioners, quantity and quality measures can be identified and used to give a good approximation of the value added by key public services, and thus their contribution to GDP. New data and intelligent use of existing data mean this can be done at low cost and in a way which maximises stakeholder understanding and acceptance.

But NSIs are also now grappling with a second task; measuring changes in welfare or more generally well-being, regardless of how they are generated. Health outcomes — for example, life expectancy or healthy life expectancy — are influenced by a variety of factors besides publicly-funded health services: diet, smoking prevalence and other lifestyle choices are obvious determinants. So, the central tasks under this agenda become first the identification of appropriate measures of outcome changes and then to determine how much value our societies place on those changes.

Adopting approaches based on clear principles, as Atkinson advocated, appears to be important for both agendas. For one thing, the outcomes used for the purposes of measuring the output of public services should be consistent with those used for measuring welfare more widely. Secondly, a principled approach helps to ensure intellectual rigour. Thirdly, international comparability is important. The specific circumstances and institutions of particular countries will vary and methodologies need to take this into account. Nevertheless, provided methodologies are all based on the same underlying principles, comparability can be safeguarded, particularly if they make use of commonly accepted and produced high level outcome measures.

Using widely recognised measures of well-being, such as life expectancy, enables us to create estimates of wider welfare measures to sit alongside GDP under the SNA. To answer our second question on the development of welfare measures, research is needed to understand the share of such gains attributable to public services.

For example, for education, the high-level outcome could be incremental additions to the stock of human capital (such as proposed by Jorgenson and Fraumeni (1992)). Improved human capital might be expected to lead not just to higher wages and salaries now but over a period of time, and hence consideration must be given to how the value of future expected wage returns should be discounted. To assess the value of public sector output in its contribution to human capital growth, and by extension, the productivity of publicly-funded education services, we would need to estimate the proportion of human capital growth attributable to publicly-funded education services. The additional growth in human capital beyond that created by education services would form a residual attributable to non-educational drivers of human capital in a welfare estimate or welfare account.

The challenges presented by these twin agendas are ones we believe the statistical community needs to take up. We are convinced that whilst implementation raises non-trivial issues, these are not insurmountable. If we chose not to do so, we would have little to say about the value of critical components of economic welfare, or the performance of a fifth or so of our respective economies. We would also miss a vital contributor to measuring the changing well-being of our societies. The cost of such a decision to our reputation would be profound. In a world where digital innovation is offering a stream of new free goods and services which undoubtedly add to welfare, missing flows of value such as those described above would cast any measure of welfare into doubt as incomplete and potentially misleading. The need to tackle these issues is both important and pressing. Failing to push on from the start that Atkinson established in this area would be a huge opportunity missed.

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# Annex A: The Atkinson Principles

As drawn from pp. 55-56 of Atkinson (2005).

**Principle A**: the measurement of government non-market output should, as far as possible, follow a procedure parallel to that adopted in national accounts for market output.

**Principle B**: the output of the government sector should in principle be measured in a way that is adjusted for quality, taking account of the attributable incremental contribution of the service to the outcome.

**Principle C**: account should be taken of the complementarity between public and private output, allowing for the increased real value of public services in an economy with rising real GDP.

**Principle D**: formal criteria should be set in place for the extension of direct output measurement to new functions of government. Specifically, the conditions for introducing a new directly measured output indicator should be that (i) it covers adequately the full range of services for that functional area, (ii) it makes appropriate allowance for quality change, (iii) the effects of its introduction have been tested service by service, (iv) the context in which it will be published has been fully assessed, in particular the implied productivity estimate, and (v) there should be provision for regular statistical review.

**Principle E**: measures should cover the whole of the United Kingdom; where systems for public service delivery and/or data collection differ across the different countries of the United Kingdom, it is necessary to reflect this variation in the choice of indicators.

**Principle F**: the measurement of inputs should be as comprehensive as possible and in particular should include capital services; labour inputs should be compiled using both direct and indirect methods, compared and reconciled.

**Principle G**: criteria should be established for the quality of pay and price deflators to be applied to the input spending series; they should be sufficiently disaggregated to take account of changes in the mix of inputs and should reflect full and actual costs.

**Principle H**: independent corroborative evidence should be sought on government productivity, as part of a process of 'triangulation', recognising the limitations in reducing productivity to a single number.

**Principle I**: explicit reference should be made to the margins of error surrounding national accounts estimates.

# Annex B: Estimating public service quantity output

The process is carried out in several steps:

1. Time series data are compiled examining (a) the number of differentiated activities and (b) the level of expenditure in each individual sector, at the available geographic granularity.
2. A chain-linked Laspeyres volume index of output is produced for each educational sector such that:

$$\psi_t = \psi_{t-1}\left(\sum_i\left(\frac{\left(\left(a_{i.j,k,t}\right)-\left(a_{i.j,k,t-1}\right)\right)}{a_{i.j,k,t-1}} * \frac{x_{i,j,k,t-1}}{\sum_j x_{i,j,k,t-1}}\right)+1\right)$$

Where:
*i, j, k* and *t* index individual sectors, differentiated activities, geographical area and time respectively
$\psi_t$ is a chain-linked Laspeyres index of quantity output
$a_t$ is the number of activities
$x_t$ is the level of expenditure in current price terms

Output in the initial period (*t*=0) is set equal to 100.

3. A United Kingdom-level, chain-linked Laspeyres volume index of output is calculated using the individual sector indices and the relative cost weights, such that:

$$\Psi_t = \Psi_{t-1}\left(\sum_i\left(\frac{\psi_{i,t}-\psi_{i,t-1}}{\psi_{i,t-1}} * \frac{x_{i,t-1}}{\sum_i x_{i,t-1}}\right)+1\right)$$

Where:
*i* and *t* index individual sectors and time respectively
$\Psi_t$ is a chain-linked, aggregate United Kingdom, Laspeyres index of quantity output
$\psi_t$ is a chain-linked Laspeyres index of individual sector quantity output
$x_t$ is the level of expenditure in current price terms.

Output in the initial period (*t*=0) is set equal to 100.

The result of this process is a chain-linked, United Kingdom-level, Laspeyres index of quantity output for the respective service area. There are several equivalent methods of generating this result. In particular, this approach is equivalent to first calculating the indices for geographical areas and then aggregating over educational sectors.

# Annex C: Estimating public service quality adjusted output

The process is carried out in several steps:

1. The quality adjustment measures are converted into indices such that:

$$q_{i,j,k,z,t} = q_{i,t-1}\left(\frac{\beta_{i,j,k,z,t} - \beta_{i,j,k,z,t-1}}{\beta_{i,j,k,z,t-1}}\right)$$

   Where:
   *i*, *j*, *k*, *z* and *t* index individual sectors, differentiated activities, geographical area, quality measures and time respectively
   $\beta_t$ is respective quality metric
   $q_t$ is the level of quality achieved in delivery
   $q_{i,t=0}$ equals 1.

2. A chain-linked Laspeyres volume index of quality adjusted output is produced for each individual sector such that:

$$I_t^Q = I_{t-1}^Q\left(\sum_i\left(\frac{\left(\left(a_{i.j,t}q_{i,t}\right)-\left(a_{i.j,t-1}q_{i,t-1}\right)\right)}{a_{i.j,t-1}q_{i,t-1}} * \frac{x_{i,j,t-1}}{\sum_j x_{i,j,t-1}}\right)+1\right)$$

   Where:
   *i*, *j* and *t* index educational sectors, geographical area and time respectively
   $I_t^Q$ is a chain-linked Laspeyres index of quality adjusted output
   $a_t$ is the number of activities
   $q_t$ is the level of quality achieved in delivery
   *xt* is the level of expenditure in current price terms

   Output in the initial period (*t*=0) is set equal to 100.

   For sectors which are not explicitly quality adjusted, $q_{i,t} = q_{i,t-1} = q_{i,t=0} = 1$.

3. As before, a United Kingdom-level, chain-linked Laspeyres volume index of quality adjusted output is calculated using the individual sector indices and the relative cost weights, such that:

$$L_t^Q = L_{t-1}^Q\left(\sum_i\left(\frac{I_{i,t}^Q - I_{i,t-1}^Q}{I_{i,t-1}^Q} * \frac{x_{i,t-1}}{\sum_i x_{i,t-1}}\right)+1\right)$$

   Where:
   *i* and *t* index educational sectors and time respectively
   $L_t^Q$ is a chain-linked, aggregate United Kingdom, Laspeyres index of quality adjusted output
   $I_t^Q$ is a chain-linked Laspeyres index of quality adjusted output for each individual sector.